CHEMISTRY

WORKSHEET-1

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-1

(C. Organic Chemistry)

Fundamental Principles

USE THIS SPACE FOR SCRATCH WORK

Q.1 Which of the following is not an aromatic compound?

A) Phenol C) Benzaldehyde

B) Vinyl alcohol D) Nitrobenzene

Q.2 Identify the incorrect statement about properties of organic compounds:

A) They have low melting points

B) Their solutions are non-conductor

C) They show isomerism

D) They are non-flammable

Q.3 Which of the following is not a polar molecules?

A) $CHCl_3$ C) CCl_4

B) CH_3COCH_3 D) CH_3OH

Q.4 Which one of the following statements is not correctly matched?

Options	Class of organic compound	Example
A)	Straight chain compound	1-Butene
B)	Alicyclic compound	Cyclohexene
C)	Aromatic compound	Toluene
D)	Heterocyclic compound	Aniline

Q.5 Which of the following is not example of heterocyclic compound?

A) Pyrrole C) Furan

B) Catechol D) Thiophene

Q.6 Which of the following is not nucleophiles?

A) R_3C^+ C) CN^-

B) $R - CH_2^-$ D) NH_3

Q.7 Which of the following is electrophile?

A) Cl^- C) H_2O

B) BF_3 D) NH_2^-

Q.8 Which of the following hydrocarbons is the most reactive?

A) Alkane C) Alkene

B) Alkyne D) Benzene

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Q.9 In geometric isomerism, the cis-isomers have all of the following properties EXCEPT:

A) They are polar molecules

B) They have high boiling points

C) They are symmetrical molecules

D) They have low melting points

Q.10 Which of the following organic compounds does not show geometric isomerism?

A) 2-Butene C) 2-Pentene

B) 3-Hexene D) 1-Butene

Q.11 Which of the following is/are basic conditions for geometric isomerism?

A) Having Carbon Carbon double bond (C = C)

B) Different groups are attached with carbon containing double bond

C) Double bond involves free rotation

D) Both A and B

Q.12 Which of the following is the most stable free radical?

A) 

C) 

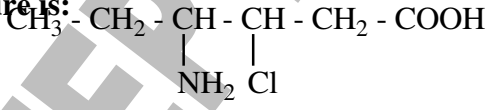
B) $R-C^{\bullet}H_2$ D) $C^{\bullet}H_3$

Q.13 Which of the following is the least stable carbocation?

A) Me_3C^+ C) Me_2CH^+

B) CH^+_3 D) $MeCH_2^+$

Q.14 The correct name according to IUPAC of the given structure is:



A) 4-Amino-3-chlorohexanoic acid

B) 3-Amino-4-chlorohexanoic acid

C) 4-Amino-5-chlorohexanoic acid

D) 2-Amino-3-chlorohexanoic acid

Q.15 Which of the following type of cracking (pyrolysis) is used

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to increase production of petrol?

A) Thermal cracking C) Electrolytic cracking

B) Catalytic cracking D) Steam cracking

Q.16 Consider the following condensed formula of alkane:

$$(CH_3)_2CH(CH_2)\text{-}C(CH_3)_3$$

Correct name of above formula according to IUPAC is:

A) 2,3,4-Trimethylpentane C) 2,4,4-Trimethylpentane

B) 2,6,6-Trimethylpentane D) 2,2,4-Trimethylpentane

Q.17 The structural formula of the following given compound 4-Ethyl-3,4-dimethylheptane is:

A) $H_3C - CH_2 - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle C_2H_5}{\overset{|}{\underset{|}{C}}}} - CH - CH_2 - CH_3$

B) $H_3C - CH_2 - CH_2 - \underset{\displaystyle C_2H_5}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - CH - CH_2 - CH_3$

C) $H_3C - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{CH}}}} - \underset{\displaystyle C_2H_5}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{CH}}}} - CH - CH_2 - CH_3$

D) $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{CH}}}} - \underset{\displaystyle C_2H_5}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{CH}}}} - CH - CH_2 - CH_2 - CH_3$

Q.18 Consider the following structural formula of alcohol:

$$H_3C - \underset{\displaystyle OH}{\overset{|}{CH}} - \underset{\displaystyle OH}{\overset{|}{CH}} - \underset{\displaystyle OH}{\overset{|}{CH}} - CH_3$$

The correct name of above formula according to IUPAC is:

A) 1,2,3-Pentanetriol C) Pentane-2,3,4-triol

B) 1,2,3-Propanetriol D) Propylene-1,2,3-triol

SCRATCH WORK

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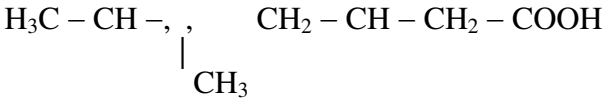
Q.19 Consider the following structural formula of a carboxylic acid:



The correct name according to IUPAC is:

A) 5-Methylhexanoic acid C) 2-Methyl-5-hexanoic acid

B) 2-Methylhexanoic acid D) 5-Methylvaleric acid

Q.20 The correct name according to IUPAC of the following alkene is:

$H_3C - CH = CH - CH_2 = CH_2$

A) 1,3-Pentadiene C) 2,3-Pentadiene

B) 2,4-Pentadiene D) 1,4-Pentadiene

Q.21 An atom or a group of atoms or a double bond or triple bond whose presence imparts specific properties to organic compounds is called a functional group, because they are the chemically functional parts of molecules. Which of the following is functional group of carboxylic acid?

A) -COOH C) $-CONH_2$

B) -OH D) -CHO

Q.22 Which of the following is functional group of thioalcohol?

A) Cyano group C) Mercapto group

B) Formyl group D) Amino group

Q.23 The type of isomerism which arises due to shifting of proton from one atom to other in the same molecule is called:

A) Tautomerism C) Geometric isomerism

B) Metamerism D) Chain isomerism

Q.24 Which of the following class of organic compounds contains ring which has more than one kind of atoms?

A) Aromatic C) Non-benzenoid

B) Heterocyclic D) Aliphatic

Q.25 The type of structural isomerism which arises due to the unequal distribution of carbon atoms on either side of the functional group is called:

A) Chain isomerism C) Tautomerism

B) Metamerism D) Position isomerism

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Q.26 Which of the following pair of organic compounds shows position isomerism?

A) CH_3-CH_2-CHO and CH_3-CO-CH_3

B) CH_3-CH_2-CH_2-OH and CH_3-CH(OH)CH_3

C) C_2H_5-O-C_2H_5 and CH_3-O-C_3H_7

D) CH_3-COOH and $HCOOCH_3$

Q.27 There are two types of isomerism i.e. structural isomerism and stereoisomerism. The two main types of stereoisomerism are: Diastereomerism (including 'cis-trans isomerism' and Optical Isomerism). Each non-superimposable mirror image structure is called a/an:

A) Metamer C) Enantiomer

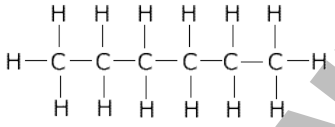
B) Elastomer D) Tautomer

Q.28 Which of the following is skeletal formula of hexane?

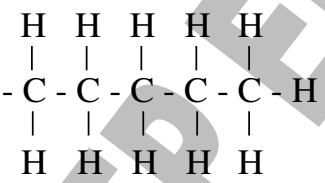
A) C_6H_{14}

B) $H_3C – CH_2 – CH_2 – CH_2 – CH_2 – CH_3$

C) 

D) 

Q.29 Which of the following is structural formula of pentane?

A) 

B) $H_3C – CH_2 – CH_2 – CH_2 – CH_3$

C) $H_3C(CH_2)_3CH_3$

D) 

Q.30 A reaction which results in the removal of a small molecule from a large one is called?

A) Addition reaction C) Substitution reaction

B) Elimination reaction D) Oxidation reaction

Q.31 Which of the following terms is not used for organic compound?

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A) Molecular formula C) Skeletal formula
B) Structural formula D) Ionic formula

Q.32 Mark the incorrect statement about petrol (gasoline):

A) Greater is octane number better is the quality of petrol
B) Quality of petrol is increased by reforming
C) Production of petrol is increased by cracking
D) If octane number of petrol is 60 it is considered good quality of petrol

Q.33 Which of the following is/are types of organic reactions mechanisms?

A) Polar or ionic mechanism only
B) Free radical mechanism only
C) Both A and B
D) Neither A nor B

ANSWER KEY (Worksheet-1)							
1	B	11	D	21	A	31	D
2	D	12	A	22	C	32	D
3	C	13	B	23	A	33	C
4	D	14	A	24	B		
5	B	15	B	25	B		
6	A	16	D	26	B		
7	B	17	A	27	C		
8	C	18	C	28	C		
9	C	19	A	29	B		
10	D	20	A	30	B		

ANSWERS EXPLAINED

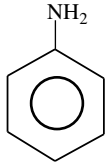
Q.1 (B) **Vinyl alcohol (CH_2=CH-OH)** is **not** an **aromatic compounds** while others **A, C and D** are **aromatic compounds.**

- **The term aromatic was derived from Greek word "aroma" meaning fragrant and was used in organic chemistry for a special class of compounds.**
- **These compounds have a low hydrogen to carbon ratio in their molecular formula and have a characteristics odour.**
- **However, it was soon realized that many aromatic compounds are odourless where as many others are fragrant though they are not aromatic.**
- **Further, when aromatic compounds of higher molecular mass were subjected to various methods of degradation, they often produced benzene or derivatives of benzene.**
- **It was observed that almost all the aromatic compounds have a six carbon unit in their molecules like benzene.**
- **Hence, benzene was recognized as the simplest and the parent member of this class of compounds.**
- **Aromatic compounds, also known as arenes or aromatics, are chemical compounds that contain conjugated planar ring systems with delocalized pi electron clouds instead of discrete alternating single and double bonds. Typical aromatic compounds are benzene and toluene. They should satisfy Hückel's rule (4n + 2).**

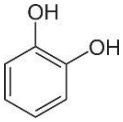
Q.2 (D) Organic compounds are in the form of gases, liquids and solids. They are **volatile** and **highly inflammable**

Q.3 (C) **Carbon tetrachloride (CCl_4)** has polar carbon-chlorine bonds but the molecule is non-polar because their bond moments **cancel** the **effect** of each other. That is why **its μ=0** and molecule is **non-polar**. But others **A, B and D are polar molecules.**

Q.4 (D) **Aniline is not heterocyclic compound. It is aromatic compound and its structural formula is:**



Q.5 (B) **Catechol**



also known as **pyrocatechol** or **1,2-dihydroxybenzene,** is an organic

compound with the molecular formula **$C_6H_4(OH)_2$.**

Q.6 (A) **Tertiary carbocation (R_3C^+)** bears **positive charge** and it acts as **electrophile** while all others **B, C and D are nucleophiles.**

Q.7 (B) **BF_3** is a **electrophile** because central atom boron is deficient **one electron pair** while all others **A, C and D are nucleophiles.**

Q.8 (C) In alkene there is Carbon Carbon double bond (C = C).

- A pi-bond is weak bond as compared to a sigma-bond.
- During a reaction pi-bond breaks comparatively easily rendering alkenes as reactive group of compounds.
- Moreover, the loosely held pi electrons are more exposed to attack by the electrophilic reagents. Alkenes act as a nucleophilic reagent and they give electrophilic addition reactions. Both the above mentioned facts make the alkenes a very reactive class of compounds. The general order of reactivity is shown below:

Alkenes > Alkynes > Benzene > Alkanes

Q.9 (C) Since **cis-form** of **geometric isomerism** is **unsymmetrical** molecule so it has certain dipole moment value. It has **high** boiling point and **low** melting point.

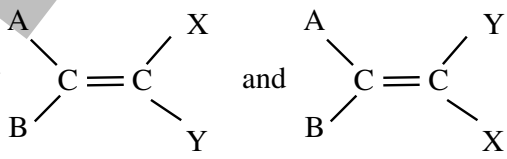
Q.10 (D) **1-Butene does not** fulfill the conditions of **geometric isomerism.** Though it has carbon carbon double bond (C = C) but different groups are **not** attached with carbon containing double bond, as shown in the structure $CH_2 = CH - CH_2 - CH_3$.

Q.11 (D) **Basic conditions for geometric isomerism are such as:**

- **Having Carbon Carbon double bond**
- **Different groups are attached with carbon containing double bond**

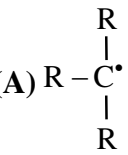
Memorize: The **presence of a double bond** is **not** the only condition for geometrical isomerism. Each double bonded carbon atom must have two **different groups** attached to it.

e.g.



are geometrical isomers only if $A \neq B$ and $X \neq Y$. A can be the same as X and Y, and B can be the same as X or Y.

Q.12 (A)

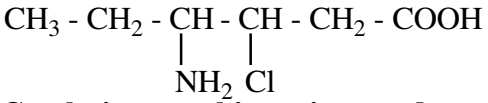


is the most stable free radical while others B, C, and D are not.

Q.13 (B) **CH_3^+ (methyl carbocation)** is **the least stable** because of **less number** of alkyl groups (i.e. electron donating) are attached with it. **Order** of **stability** of carbocations is

$Me_3C^+ > Me_2CH^+ > MeCH_2^+ > CH_3^+$.

Q.14 (A) **The correct name according to IUPAC of the given compound is 4-Amino-3-chlorohexanoic acid.**

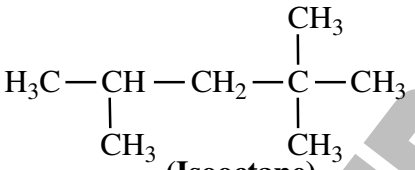


Q.15 (B) **Catalytic cracking is used to increase production of gasoline of higher octane number and, therefore, this method is used for better quality of gasoline. Whereas thermal cracking and steam cracking are used to produce lower unsaturated hydrocarbons (e.g. ethene and propene).**

Q.16 (D) **2,2,4-Trimethylpentane** is the **correct name** according to **IUPAC** of given **condensed formula**

$(CH_3)_2CH(CH_2)$-$C(CH_3)_3$

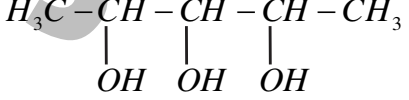
- **Its structural formula is:**



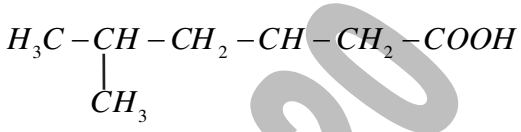
(Isooctane)

Q.17 (A) $H_3C - CH_2 - CH_2 -$  is the structural formula of 4-Ethyl-3,4-dimethylheptane.

Q.18 (C) **Pentane-2,3,4-triol** is the **correct name** according to **IUPAC** of given **structural formula**



Q.19 (A) **5-Methylhexanoic acid** is the **correct name** according to **IUPAC** of given **structural formula**



Q.20 (A) **1,3-Pentadiene** is the **correct name** according to **IUPAC** of given **structural formula**

Q.21 (A) **–COOH is a functional group of carboxylic acid.**

Q.22 (C) **Mercapto (SH –) is a functional group of thioalcohol.**

Q.23 (A) The type of isomerism which arises due to shifting of proton from one atom to other in the same molecule is called **tautomerism.**

Q.24 (B) **The compounds in which the ring consists of atoms of more than one kind are called heterocyclic compound or heterocycles. In heterocyclic compounds generally one or more atoms of elements such as N, O or S which are known as hetero atoms. e.g. Pyridine, Furan, Pyrrole and Thiophene are heterocyclic compounds.**

Q.25 (B) **The type of structural isomerism which arises due to the unequal distribution of carbon atoms on either side of the functional group is called metamerism.**

Q.26 (B) **CH_3-CH_2-CH_2-OH (1-propanol) and CH_3-CH(OH)CH_3(2-propanol) show position isomerism.**

Q.27 (C) **Optical isomers are two compounds which contain the same number and kinds of atoms, and bonds (i.e., the connectivity between atoms is the same), and different spatial arrangements of the atoms, but which have non-superimposable mirror images. Each non-superimposable mirror image structure is called an enantiomer. All α-amino acids show optical isomerism except glycine.**

Q.28 (C) 

is the **skeletal formula** of **hexane.**

Q.29 (B) **$H_3C - CH_2 - CH_2 - CH_2 - CH_3$** is the **structural formula** of **pentane.**

Q.30 (B) **Those reactions which involve the removal of atoms or groups of atoms from adjacent carbon atoms to form a multiple bond are called elimination reaction.**

Q.31 (D) **Ionic formula does not represent organic molecule.**

Q.32 (D) The concept of octane number was introduced by Edgar.

- According to him n-heptane is the worst fuel and its octane number is zero and Isooctane is the best fuel its octane number is 100.
- The octane number of any fuel is the percentage by volume of isooctane in a mixture of isooctane and n-heptane.
- e.g. a petrol that burns like 90 : 10 mixture of isooctane and n-heptane is said to have an octane number of 90.
- Memorise: Good petrols have high octane number.
- The octane number of a petrol can be improved:

i. By increasing the proportion of branched chain and cyclic alkanes

ii. By addition of aromatic hydrocarbons such as benzene

iii. By addition of methanol or ethanol

iv. By addition of tetraethyllead $(C_2H_5)_4Pb$

- **Most modern cars run on petrol with an octane number of 95 – 99**
- **The petrol obtained from the gasoline fraction has an octane number of only about 55 – 60.**
- **It needs considerable modification blending before it can be used as a motor fuel.**

Q.33 (C) **1) <u>Polar or ionic mechanism:</u>**

(i) The mechanism of reactions involving the attack of electrophilic or nucleophile reagents on the polar substrate molecule is referred to as polar or ionic mechanism.

e.g.

$$\mathbf{R^{+\delta} - X^{-\delta} + OH^- \longrightarrow R\text{-}OH + X^-}$$

Polar substrate nucleophile

(ii) This type of mechanism is applicable to organic reactions in which heterolytic bonds fission takes place.

(iii) In this case the substrate molecule develops polarity (positive or negative centers).

2) <u>Free radical mechanism:</u>

(i) The mechanism of reactions involving the attack of free radicals on the substrate molecule is referred to as a free radical mechanism.

e.g. $CH_4 + Cl^{\bullet} \rightarrow CH_3^{\bullet} + HCl$

Substrate **Free radical**

(ii) This type of mechanism applies to organic reactions in which homolytic bond fission takes place.

(iii) The first step is the formation of free radical ($R^{\bullet}$) from a reagent by a homolytic fission. These free radicals can then attack the substrate to give the product.

$$R^{\bullet} + A - B \rightarrow B^{\bullet} + R - A$$

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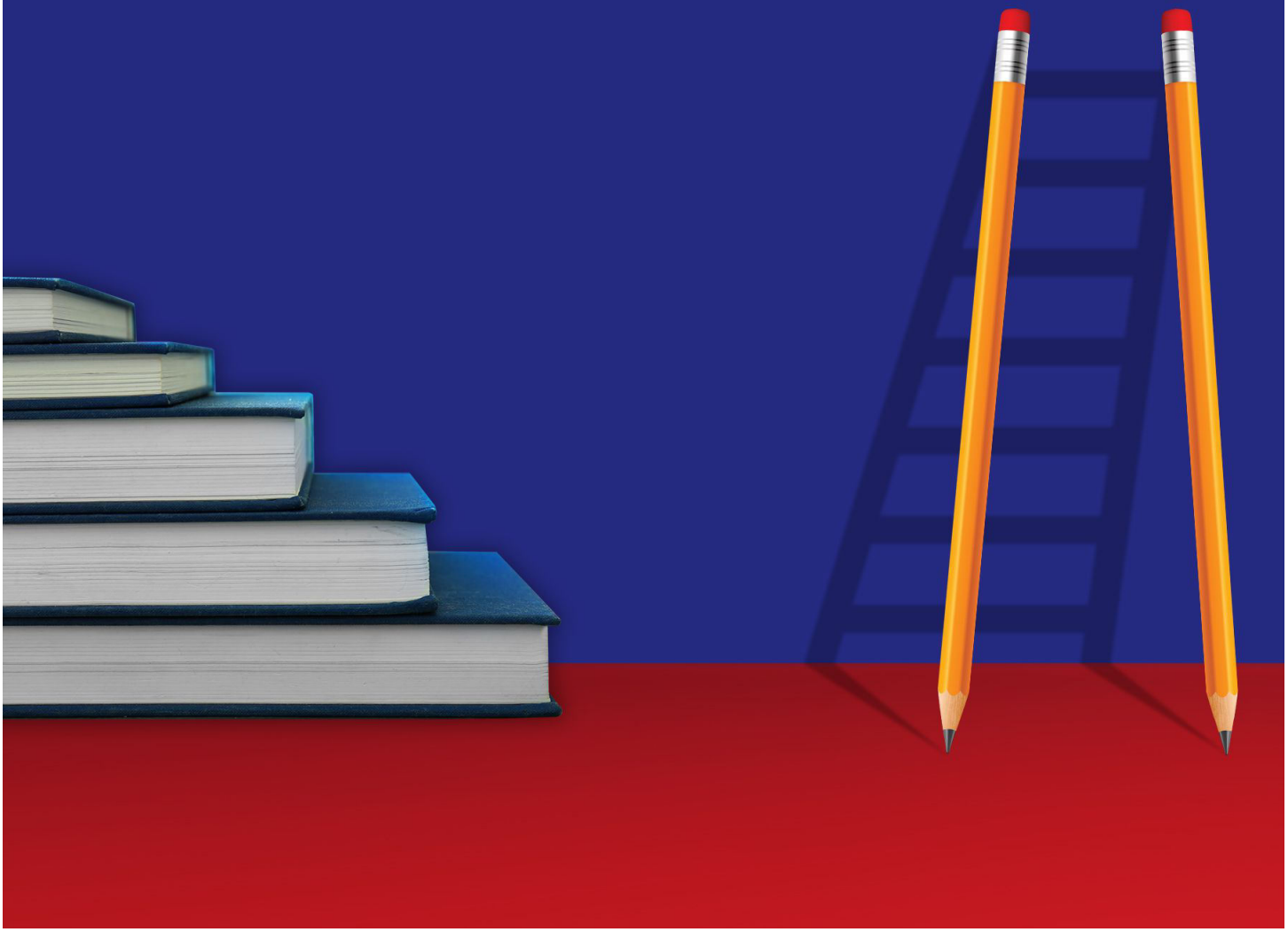

CHEMISTRY

WORKSHEET-2

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Worksheet-2

(C. Organic Chemistry)

Hydrocarbons

Q.1 The reaction of chlorine with methane is carried out in the presence of diffused sunlight. What is function of the light?

A) To break up the C - H bonds in methane

B) To break up the chlorine molecules into free radicals

C) To heat up the mixture

D) To break up the chlorine molecules into ions

Q.2 Methane when burnt in the presence of metallic catalyst (Cu), at high temperature (400^{o}C) and pressure (200atm), which of the following is the ultimate product?

A) Methanol C) Methanal

B) Ethanal D) Methanoic acid

Q.3 Chlorination of methane is believed to proceed through free radical mechanism. Which of the following is propagation step?

A) $Cl\text{-}Cl \xrightarrow{h\upsilon} 2Cl^{\bullet}$

B) $CH_3^{\bullet} + Cl_2 \longrightarrow Cl^{\bullet} + CH_3\text{-}Cl$

C) $CH_3 + HCl \longrightarrow H^{\bullet} + H_3C\text{-}Cl$

D) $H_3C^{\bullet} + C^{\bullet}H_3 \longrightarrow H_3C\text{-}CH_3$

Q.4 Nitrobenzene maybe prepared by reacting benzene with a mixture of conc. H_2SO_4 and conc. HNO_3 at 55^{o}C. Which of the following best explains the role of conc. H_2SO_4?

A) It removes water

B) It forms an unstable complex with benzene

C) It is protonating nitric acid

D) It acts as a solvent

Q.5 Benzene reacts with acetyl chloride in the presence of catalyst $AlCl_3$ to give:

A) Aldehyde C) Benzyl Chloride

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B) Acetophenone D) Benzophenone

Q.6 β-elimination is competitive to nucleophilic substitution reaction. It has all of the following conditions for reaction as compared to nucleophilic substitution reaction EXCEPT:

A) It takes place in the presence of less polar solvent (like alcohol)

B) It takes place at high temperature

C) It requires strong nucleophile (base)

D) It takes place at low temperature

Q.7 All of the following are dehydrating agents EXCEPTS:

A) SiO_2 C) Al_2O_3

B) Conc. H_2SO_4 D) H_3PO_4

Q.8 Which of the following is correct order of ease of dehydration of alcohols?

A) 1 ° alcohol > 2 ° alcohol > 3 ° alcohol

B) 3 ° alcohol > 2 ° alcohol > 1 ° alcohol

C) 2 ° alcohol > 1 ° alcohol > 3 ° alcohol

D) 3 ° alcohol > 1 ° alcohol > 2 ° alcohol

Q.9 Which of the following tests is not used to distinguish between alkanes and alkenes?

A) Baeyar's test C) $Cl_2(CCl_4)$

B) $Br_2(CCl_4)$ D) Tollen's test

Q.10 A hydrocarbon, which is a liquid at room temperature, decolourizes aqueous bromine. Which could be the molecular formula of the compound?

A) C_2H_2 C) C_7H_{16}

B) C_2H_4 D) $C_{10}H_{20}$

Q.11 Which of the following alkenes does not follow Markownikov's rule?

A) 1-Pentene C) 1-Hexene

B) 1-Butene D) 2-Butene

Q.12 Aromatic compounds burn with sooty flame because:

A) They have high percentage of hydrogen

B) They have a ring structure

C) They have high percentage of carbon

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D) They resist in reaction with air

Q.13 Alkanes are used as fuels. We burn them for many reasons. Which of the following is not its use?

A) They are used to generate electricity in power stations

B) They are used to heat our homes and cook our food

C) They are used to provide electricity for electrolytic cell

D) They are used to provide electricity for galvanic cell

Q.14 Consider the following reaction:

$$H_2C = CH_2 + HBr \rightarrow H_3C - CH_2Br$$

The mechanism of reaction is:

A) Nucleophilic addition reactions

B) Electrophilic addition reaction

C) Free radical substitution

D) Nucleophilic substitution reaction

Q.15 Which property of benzene may be directly attributed to the stability associated with its delocalized pi-electrons?

A) It has a low boiling point

B) Its enthalpy change formation (ΔH_f) is positive

C) It is susceptible to attack by nucleophilic reagent

D) It tends to undergo electrophilic substitution rather addition reaction

Q.16 Among the followings the compound that can be most readily nitrated is:

A) Benzoic acid C) Phenol

B) Benzene D) Chlorobenzene

Q.17 When toluene is treated with chlorine in the presence of sunlight, which of the following is ultimate product?

A) Benzyl chloride C) Benzoyl chloride

B) Benzotrichloride D) Benzal dichloride

Q.18 The most important addition reaction of alkenes forms the basis of the plastic industry. Addition polymerization is such process in which smaller molecules (monomers) repeatedly combine to form large molecular having greater molar mass (polymer) as shown:

$$H_2C = CH_2 \xrightarrow[100\ atm.]{400^\circ C} (-H_2C - CH_2-)_n$$

Traces of O_2 (0.1%) n = 1000

A good quality polythene is obtained when ethene is polymerized in the presence of:

A) Aluminium triethyl $(C_2H_5)_3$ only

SCRATCH WORK

USE THIS SPACE FOR

B) Titatinum tetrachloride ($TiCl_4$) only

C) $TiCl_4 + AlCl_3$

D) $TiCl_4 + Al(C_2H_5)_3$

Q.19 Benzene cannot undergo:

A) Substitution reaction C) Addition reaction

B) Elimination reaction D) Oxidation reaction

Q.20 All of the following statements are correct EXCEPT:

A) Introduction of R-group in the benzene ring in the presence of $AlCl_3$ is called alkylation

B) Introduction of acyl group in the benzene ring in the presence of $AlCl_3$ is called acylation

C) Benzene cannot undergo polymerization

D) Ozonolysis of benzene results in the formation of $(COOH)_2$

Q.21 o- and p- directing groups have all of the following properties EXPECT:

A) They are electron-donating groups

B) They increase reactivity of mono- substituted benzene ring

C) They have all lone pair at the central atom of molecules expect alkyl group

D) Halogeno-substituted benzene is more reactive than benzene

Q.22 All of the following methods explain stability of benzene EXPECT:

A) Resonance energy

B) Resonance method

C) Crystal field theory

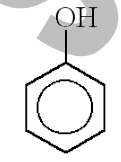
D) Atomic orbital treatment

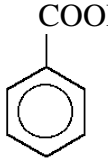
Q.23 When different alkenes are treated with hot concentrated $KMnO_4$ solution, different products are obtained. Which of the following alkenes produces two moles of ketone?

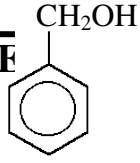
A) $H_2C = CH_2$ C) $R^1R^2C = CR^3R^4$

B) $R - CH = CH - R$ D) $R^1R^2C = CH^3R^4$

Q.24 On the oxidation of toluene by acidified $KMnO_4$, which of the following products is obtained?

A) 

C) 



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SCRATCH WORK

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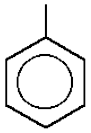
B) D) 

Q.25 Which of the following methods is used to prepare ethyne on the industrial scale by?

A) Dehydrohalogenation of vic-dihalides

B) Dehalogenation of tetrahalides

C) Electrolysis of aqueous solution of potassium salt of unsaturated dicarboxylic acids

D) Reaction of calcium carbide with water

Q.26 Kolbe's electrolytic method is used to prepare ethyne. Which of the following salts of carboxylic acid is used for this purpose?

A) Sodium acetate C) Sodium oxalate

B) Sodium succinate D) Potassium maleate

Q.27 On oxidation of ethyne with strong alkaline $KMnO_4$ solution, the final product formed is:

A) Glyoxal C) Acetic acid

B) Glycol D) Oxalic acid

Q.28 Acetaldehyde is prepared by the reaction of ethyne with water in the presence of $HgSO_4$/ H_2SO_4 at 75^oC. Number of steps involved in this reaction is:

A) 1 C) 2

B) 4 D) 3

Q.29 When ethyne is treated with ammonical Cu_2Cl_2 solution, then ppt of dicopper acetylide are formed. The colour of ppt is?

A) White C) Yellow

B) Reddish brown D) Violet

Q.30 When acetylene is passed under pressure over an organo-nickel catalyst at 70^oC _____ is formed?

A) Vinyl acetylene C) Neoprene

B) Di-vinyl acetylene D) Benzene

USE THIS SPACE FOR SCRATCH WORK

Q.31 Consider the following reaction

$$HC \equiv CH + H_2O \xrightarrow[HgSO_4]{\text{dil. } H_2SO_4} CH_2 = CH - OH \rightleftharpoons B \xrightarrow[[O]]{V_2O_5} C$$

Which of the following is correct sequence for the product shown as B, C?

A) CH_3CHO, CH_3COOH

B) CH_3COCH_3, CH_3COOH

C) CH_3CH_2OH, CH_3CHO

D) CH_3CHO, CH_3CH_2OH

Q.32 According to atomic orbital treatment of benzene, all of the following statements are correct about benzene EXCEPT:

A) In it each carbon atom has sp^2-orbital hybridization

B) It is cyclic hexagonal planar structure

C) It has diffused or decolonized electron cloud

D) It has 10 sigma bonds and 6 pi electrons

Q.33 Cyclohexane is an example of:

A) Alicyclic hydrocarbons

B) Aromatic hydrocarbon

C) Aliphatic saturated hydrocarbon

D) Aliphatic unsaturated hydrocarbon

ANSWER KEY (Worksheet-02)							
1	B	11	D	21	D	31	A
2	D	12	C	22	C	32	D
3	B	13	D	23	C	33	A
4	C	14	B	24	C		
5	B	15	D	25	D		
6	D	16	C	26	D		
7	A	17	B	27	D		
8	B	18	D	28	C		
9	D	19	B	29	B		
10	D	20	D	30	D		

ANSWERS EXPLAINED

Q.1 (B) The function of the light is to **break up** the chlorine molecules **into free radicals** such as

$Cl–Cl \xrightarrow{h\mu}, \longrightarrow {}^{\bullet}, Cl + {}^{\bullet}, Cl$ (initiation).

Halogenation is believed to proceed through **free radical substitution mechanism.** It involves the three steps such as **initiation, propagation and termination.**

Q.2 (D) Ultimate product of catalytic oxidation of methane is **methanoic acid.**

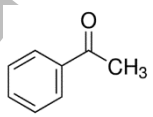
Q.3 (B) **Propagation step** is such as

$CH^{\bullet,3} + Cl_2 \longrightarrow CH_3 - Cl + Cl^{\bullet}$

Q.4 (C) The role of **conc. H_2SO_4** is **protonating nitric acid** such as

$$HONO_2 + H_2SO_4 \overset{50–55°C}{\rightleftharpoons} NO^{+,2} + HSO^{-,4} + H_2O$$

Q.5 (B) **Acetophenone**



Acetophenone is the organic compound with the formula **$C_6H_5COCH_3$** (also represented by the letters **PhAc** or **BzMe).** It is the simplest aromatic ketone. This colourless, viscous liquid is a precursor to useful resins and fragrances.

(IUPAC 1-Phenylethan-1-one)
Other names:

- **Methyl phenyl ketone**
- **Phenylethanone**

Q.6 (D) **β-Elimination does not** take place at **low temperature**, however it takes place at **high temperature,** in the presence of less polar solvent and in the presence of strong nucleophile.

Q.7 (A) **SiO_2** is **not dehydrating** agent while others **B, C and D** are used as **dehydrating agent.**

Q.8 (B) Order of reactivity of alcohols for dehydration is such as **3° alcohol > 2° alcohol > 1° alcohol.** Because the order of stability of their carbocations is as **3° carbocation > 2° carbocation > 1° carbocation.**

Q.9 (D) **Tollen's test is not** used to distinguish between **alkanes and alkenes. Tollen's test** is used to distinguish between **alkenes and alkynes** while **alkynes** having acidic **hydrogen terminal alkynes** give this test. By passing acetylene in the **ammonical silver nitrate** white **ppt. of disilver acetylide** are obtained as shown in the reaction.

$$HC \equiv CH + 2AgNO_3 + 2NH_4OH \longrightarrow$$
$$AgC \equiv CAg + 2NH_4NO_3 + 2H_2O$$
white ppt

Q.10 (D) **Decene ($C_{10}H_{20}$)** is an **alkene** with the formula **$C_{10}H_{20}$**. It is in the liquid state. It decolourizes reddish brown aqueous bromine solution because of the presence of double bond **(unsaturation). Decene** contains a chain of ten carbon atoms with one double bond. There are many

isomers of decene depending on the position and geometry of the double bond.

Q.11 (D) **2-Butene** is a symmetrical molecule and does not follow **Markownikov's rule.** Its structure is shown as follow **CH_3-CH=CH-CH_3 (symmetrical molecule).**

Q.12 (C) They have **high percentage** of carbon.

Q.13 (D) It is **not** used to provide electricity for **galvanic cell** because **galvanic cell** is itself the source of electricity.

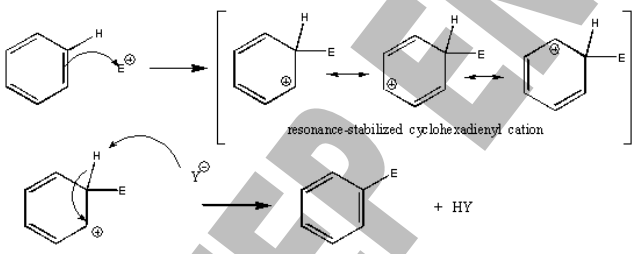
Q.14 (B) **Electrophilic addition reaction is shown as**

$$H_2C = CH_2 + {}^{\delta+}H\text{-}Br^{\delta-} \rightarrow H_3C\text{-}CH_2Br$$

Nucleophile Electrophile

Q.15 (D) Due to the **extra resonance stability** of the benzene ring, it **does not** undergo addition reaction in which the benzene ring resonance would be destroyed. Benzene ring by undergoing preferably electrophilic substitution retains the aromatic system. Other **A, B, and C options do not fulfill the condition.**

$$\mathbf{E - Y \longrightarrow E^+ + Y^-}$$



Q.16 (C) **Phenol** is the more reactive because **OH-** group is activating group, order of **reactivity is as follow:**

Phenol > Benzene > Chrlorobenzene > Benzoic acid. Thus phenol can be the most readily nitrated.

Q.17 (B) As a result of **chlorination** of **benzene** in the presence of **sunlight** **mixture** of products are obtained such as **benzyl chloride, benzal dichloride and benzotrichloride. Benzotrichloride** is the ultimate product.

Q.18 (D) For the better quality of polyethylene, mixture of **$TiCl_4$ + $Al(C_2H_5)_3$** are used as a catalyst. It is known as **Ziegler-Natta catalysts.**

Q.19 (B) Benzene **does not give** elimination and **polymerization reaction.**

Q.20 (D) **Benzene** reacts with **ozone** and gives **glyoxal** through benzene **triozonide** but **not oxalic acid.**

Q.21 (D) Halogeno-substituted benzene is less reactive than benzene because its inductive effect and resonance effect are in opposite direction. Its resonance effect is slightly greater than inductive effect, because of this reason halogen group is ortho-para-directing group but with more deactivation of benzene ring .

Q.22 (C) Crystal field theory doesn't explain stability of benzene. It explain color formation by the complexes of transition metal ions .It involves d-d transition.

Q.23 (C) When $R^1R^2C = CR^3R^4$ is treated with concentrated with $KMnO_4$ solution two moles of ketones are obtained.

- **$R^1R^2C = CR^3R^4 + [O] \rightarrow R^1R^2C = O + R^3R^4C = O$**
- **Oxidation under harsh conditions using a hot, concentrated solution of $KMnO_4$. Three reactions take place and different products are obtained.**
- **If a carbon atom is bonded to two hydrogen atoms we get oxidation to a CO_2 molecule**

$$H_2C = CH_2 + 6[O] \longrightarrow CO_2 + CO_2 + 2H_2O$$

- **If a carbon atom is bonded to one hydrogen atom and one alkyl group we get oxidation to a –COOH (carboxylic acid) group**

$RCH = CHR + 2[O] \longrightarrow RCHO + RCHO \xrightarrow{2[O]} RCOOH + RCOOH$

Q.24 (C) Alkyl benzenes are readily oxidized by acidified $KMnO_4$ or $K_2Cr_2O_7$. In these reactions, the alkyl groups are oxidized keeping the benzene ring intact.

- **Whatever the length of an alkyl group may be, it gives only one carboxyl group. Moreover, the colour of $KMnO_4$ is discharged. Therefore this reactions is used as a test for alkylbenzenes.**

Q.25 (D) In the reaction between calcium carbide and water, acetylene gas is produced on the industrial scale:

$$CaC_{2(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(s)} + C_2H_{2(g)}$$

Q.26 (D) On the electrolysis of aqueous solution of potassium maleate results in the preparation of ethyne as shown in the reaction.

$$HC - COOK, \|, HC - COOK + 2H_2O \xrightarrow{\text{electrolysis}} ,H - C \equiv C - H + 2CO_2$$

$$+$$

$$,2KOH + H_2$$

Q.27 (D) Ethyne on oxidation by strong alkaline $KMnO_4$ gives glyoxal followed by its further oxidation results in the formation of oxalic acid as shown in the reaction.

$$HC \equiv CH, + 4[O], \xrightarrow[\text{dil. alk. } KMnO_4]{}$$

Ethyne, (Acetylene) — Oxidising, agent

Fehler!

Q.28 (C) When acetylene is treated with water in the presence of $HgSO_4/H_2SO_4$ at 75^oC, No of steps involved in this reaction is 2 as shown in the reactions:

i. $$HC \equiv CH + H^{\delta+} - OH^{\delta-} \xrightarrow[H_2SO_4]{HgSO_4},$$

$$H_2C = CH - O - H$$

ii. $$H_2C = CH - O - H \rightleftharpoons CH_3 - \overset{O}{\overset{\|}{C}} - H$$

Q.29 (B) When ethyne is treated with ammonical Cu_2Cl_2 solution, then ppt of dicopper acetylide are formed. The colour of ppt is reddish brown as shown in the reaction.

$$CH \equiv CH + Cu_2Cl_2 + 2NH_4OH \rightarrow CuC \equiv CCu + 2NH_4Cl + 2H_2O$$

Dicopperacetylide (Reddish brown ppt)

Q.30 (D) When acetylene is passed under pressure over an organo-nickel catalyst at 70^oC benzene is formed as a result of addition polymerization.

$$3HC \equiv CH \xrightarrow[70^oC]{\text{Organo-Nickel catalyst}}$$

Acetylene — Benzene

Q.31 (A) The correct sequence for the product is as B (CH_3CHO), C (CH_3COOH) first of all product B (ethanal) is formed which on

further oxidation gives ethanoic acid as shown in the reaction

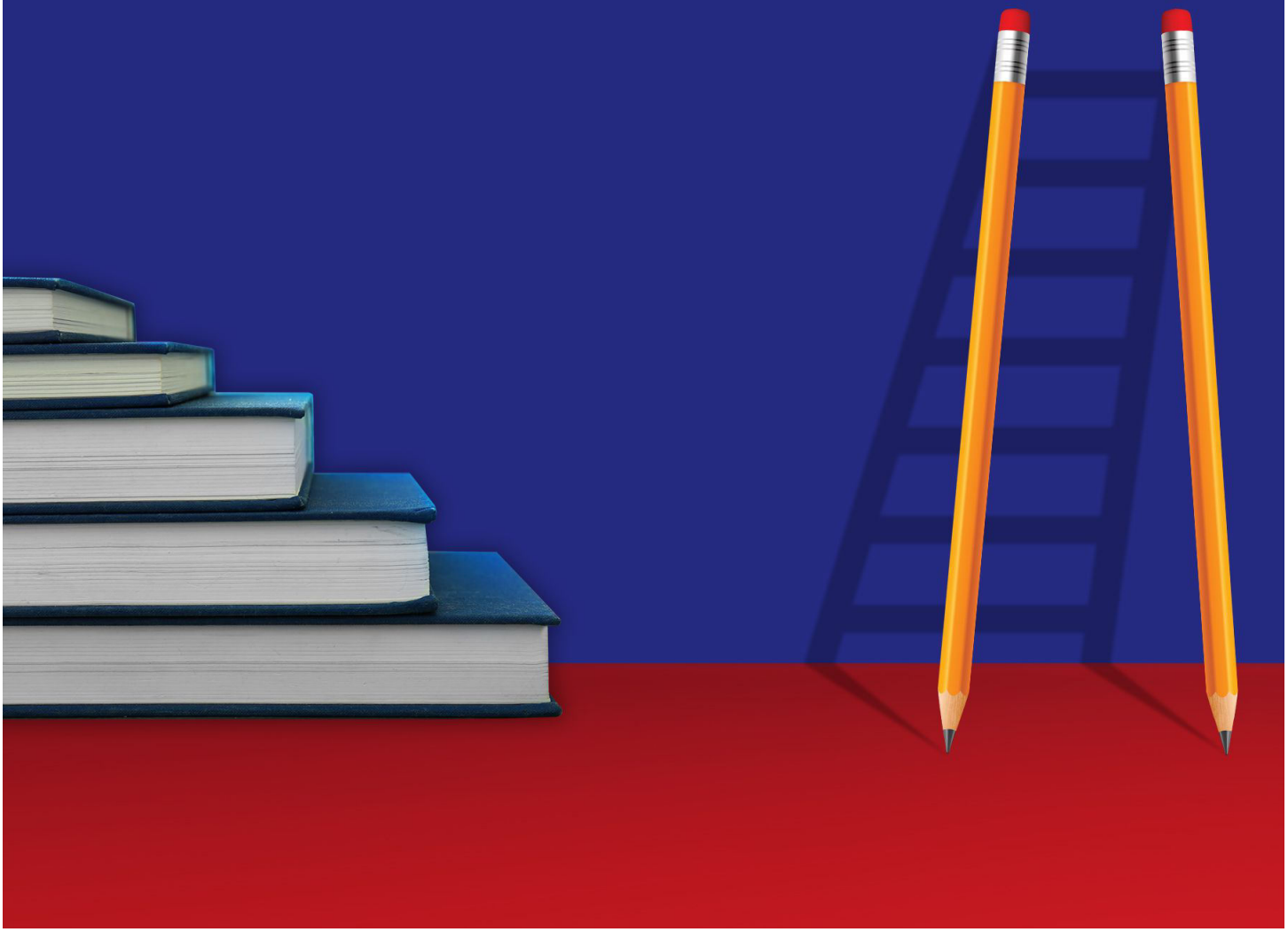
$$HC \equiv CH + H_2O \xrightarrow[HgSO_4]{\text{dil. } H_2SO_4} CH_2 = CH - OH \longrightarrow \underset{(B)}{CH_3CHO} \xrightarrow[[O]]{V_2O_5} \underset{(C)}{CH_3COOH}$$

Q.32 (D) In fact, benzene has 12 sigma bonds and 6 pi electrons.

Q.33 (A) Cyclohexane is an example of **alicyclic hydrocarbon**.

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-3

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-3

(C. Organic Chemistry)

Alkyl Halides, Alcohols and Phenols

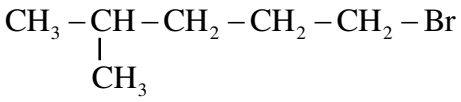
USE THIS SPACE FOR SCRATCH WORK

Q.1 The type of alkyl halides in which halogen is attached with such C-atom which is further attached with two C-atoms are called?

A) 1^o alkyl halides C) 3^o alkyl halides

B) 2^o alkyl halides D) 4^o alkyl halides

Q.2 Consider the following structure formula of alkyl halide:



The correct name according to IUPAC is:

A) 1-Bromo-4-methylpentane

B) 2-Methyl-5-bromopentane

C) 2-Methyl-1-bromopentane

D) 2-Methyl-2-bromopentane

Q.3 Which of the following is the best method to prepare alkyl halides?

A) Reaction of alcohol with HCl in the presence of catalyst $ZnCl_2$

B) Reaction of alcohol with PCl_5

C) Reaction of alcohol with PCl_3

D) Reaction of alcohol with $SOCl_2$ in the presence of pyridine solvent

Q.4 Which of the following alkyl halides cannot be prepared by the direct halogenation of alkanes?

A) R – Cl C) R – I

B) R – Br D) R – F

Q.5 Which of the following is good leaving group?

A) NH_2^- C) OR^-

B) HSO_4^- D) OH^-

Q.6 Which of the following statements is not correct for S_N2 mechanism reaction?

A) It is bimolecular, 2nd order reaction

B) Order of ease of S_N2 mechanism in alkyl halide is 1^o alkyl halide > 2^o alkyl halide > 3^o alkyl halide

C) It takes place in the presence of polar solvent

D) It involves 100% inversion in the products

Q.7 Mark the incorrect statement about alkyl halide:

A) Boiling points of haloalkanes are greater than that of alkanes

B) Order of decreasing boiling points in alkyl halides is

R – I > R – Br > R – Cl > R – F

C) Alkyl halides are soluble in water

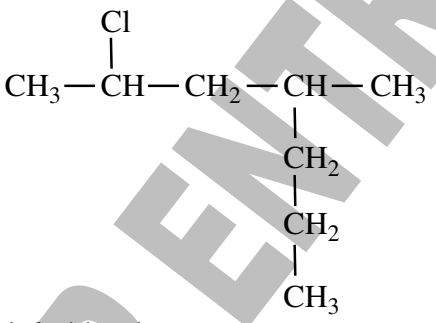
D) Primary alkyl halides can be prepared by reaction of PCl_5 or $SOCl_2$ with alcohols but not aryl halide

Q.8 Which of the following halide ion (X^-) is good nucleophile and good leaving group?

A) I^- C) F^-

B) Cl^- D) Br^-

Q.9 Which one of the following is the correct name according to IUPAC system for the formula given below?



A) 4-Methyl-6-chloroheptane

B) 2-Chloro-4-methylheptane

C) 2-Chloro-4-n propylhexane

D) 2-Chloro-4-n propylpentane

Q.10 CCl_4 has all of the following characteristic features EXCEPT:

A) It is colourless liquid

B) It is used as industrial solvent

C) It is insoluble in water and soluble in alcohol for fat, oil etc

D) It is inflammable

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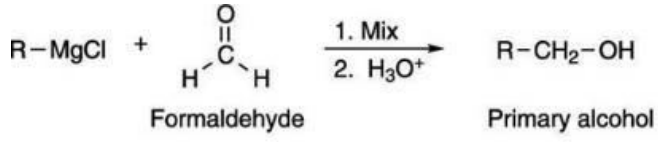
SCRATCH WORK

Q.11 Considered the following reaction of Grignard reagent with methanal (a carbonyl compound) followed by hydrolysis:



The mechanism of reaction before hydrolysis is:

A) Electrophilic addition reaction

B) β-elimination

C) Nucleophilic addition reaction

D) Nucleophilic substitution reaction

Q.12 Which of the following product is obtained by the reaction of Grignard reagent with ketone followed by hydrolysis?

A) 1^o alcohol

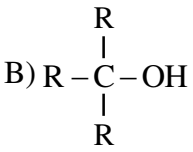
B) 2^o alcohol

C) 3^o alcohol

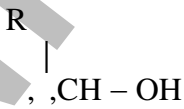
D) Both B and C

Q.13 Which of the following type of alcohols is the most reactive when bond is to be broken between carbon and oxygen atoms?

A) R – OH

B) 

C) $R - CH_2 - OH$

D) 

Q.14 Alkyl halides are considered to be very reactive compounds towards nucleophiles because:

A) They have an electrophilic carbon

B) They have an electrophilic carbon and a good leaving group

C) They have an electrophilic carbon and bad leaving group

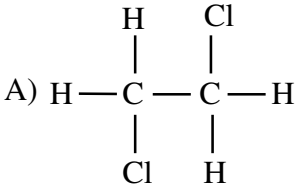
D) They have a nucleophilic carbon and a good leaving group

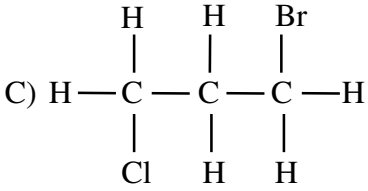
Q.15 Which of the following tests helps us to distinguish between methanol and ethanol?

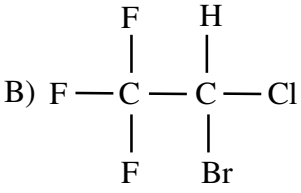
USE THIS SPACE FOR SCRATCH WORK

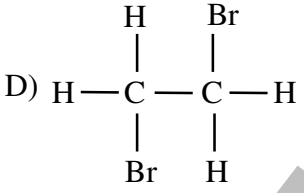
A) Lucas test
C) Tollen's test
B) Iodoform test
D) Baeyer's test

Q.16 Which one of the followings is Halothane?

A) 

C) 

B) 

D) 

Q.17 Which of the following is the weakest acid?

A) Carboxylic acid
C) Phenol
B) Ethanol
D) Ethyne

Q.18 All of the following statements about phenol and ethanol are correctly matched EXCEPT:

Options	Properties	Phenol	Ethanol
A)	Bromination (Br_2/H_2O)	White ppt of 2,4,6-Tribromo phenol	No reaction
B)	H_2/Ni	No reaction	No reaction
C)	Action of organic acid	No reaction	Formation of ester
D)	Iodoform test	No reaction	Yellow ppt of CHI_3

Q.19 Which of the following raw material is/are used to prepare ethyl alcohol?

A) Starch only
C) Both A and B
B) Molasses only
D) Neither A nor B

Q.20 Which of the following drying agent is used to get absolute alcohol from rectified spirit?

USE THIS SPACE FOR SCRATCH WORK

A) Conc. H_2SO_4 C) Al_2O_3

B) CaO D) H_3PO_4

Q.21 Identify the incorrect statement about the use of chloroform:

A) It is used as an anesthetic substance

B) It is used as a solvent for fats waxes and resins

C) It is used in manufacturing freons

D) It is used as preservative for anatomical specimen

Q.22 All of the following are characteristic features of Teflon plastic EXCEPT:

A) It is valuable plastic which resists the action of acid and alkali

B) It is used as coating the electrical wiring

C) It is used as a non-stick coating for cooking pans

D) It reacts with oxidants

Q.23 The phenoxide is more stable than ethoxide ion as:

A) Lone pair on oxygen atom overlaps with the delocalized π-bonding system in benzene

B) Oxygen atom is directly bonded with benzene ring in phenoxide ion

C) The negative charge is localized on oxygen atom of phenoxide ion

D) The negative charge is delocalized on oxygen atom of ethoxide ion

Q.24 Which of the following is the most dangerous factor which damages ozone?

A) Aerosol spray

B) Use of chlorofluorocarbons

C) Effect of SO_2 and NO_2 pollutant

D) Global warming by CO_2

Q.25 Grignard reagent is reactive due to:

A) The presence of halogen atom

B) The polarity of C – Mg bond

C) The presence of Mg atom

D) The polarity of C – X bond

Q.26 In which of the following reactions alcohol is produced?

A) Reaction of alkyl halide with aqueous KOH

B) Reaction of alkyl halide with alcoholic KOH

C) Reaction of alkyl halide with KCN followed by acidic

USE THIS SPACE FOR SCRATCH WORK

hydrolysis

D) Reactions of alkyl halide with sodium alkoxide

Q.27 The type of monohydric alcohols in which –OH group is attached with such carbon atom which is further attached with three carbon atoms and no hydrogen atom is called:

A) 1^o alcohols C) 3^o alcohols

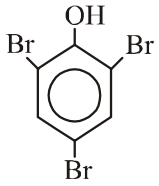
B) 2^o alcohols D) Absolute alcohol

Q.28 Which of the following types of alcohols on oxidation with acidified potassium dichromate gives aldehydes?

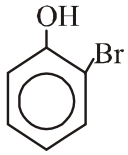
A) 1^o alcohols C) 3^o alcohols

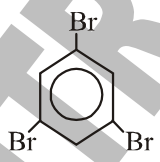
B) 2^o alcohols D) Neo alcohol

Q.29 Aqueous phenol decolorizes bromine water to form white ppt. What is the structure of white ppt formed?

A) 

C) 

B) 

D) 

Q.30 When phenol is treated with concentrated nitric acid at high temperature, which of the following product is obtained?

A) o-nitrophenol C) m-nitrophenol

B) p-nitrophenol D) 2,4,6-trinitrophenol

Q.31 Which of the following reactions shows that phenol acts as an acid?

A) Reaction with conc. nitric acid

B) Reaction with bromine

C) Reaction with NaOH

D) Reaction with H_2

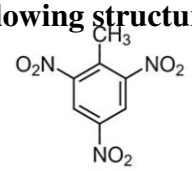
Q.32 Which of the following is the strongest acid?

A) Carboxyl acid C) Water

USE THIS SPACE FOR SCRATCH WORK

B) Phenol D) Alcohol

Q.33 Considered the following structure:



The correct name according to IUPAC of the above structure is:

A) 2,4,6-Trinitrotoulene C) 2,3,4-Trinitrotoulene

B) 1,3,5-Trinitrotoulene D) 1,2,3-Trinitrotoulene

Q.34 Considered the following structure of alcohol:

$$CH_3 - CH = CH - CH_2OH$$

The correct name according to IUPAC of the above structure is:

A) 1-Butene-2-ol C) 2-Butene-1-ol

B) 2-Butene-4-ol D) 1-Butene-4-ol

Q.35 Which of the following type of alcohols is prepared by the reduction of aldehydes?

A) 2^o alcohols C) 3^o alcohols

B) 1^o alcohols D) Both B and C

Q.36 Which of the following methods is used to prepare ethers?

A) Williamson's synthesis

B) Kolbe's electrolytic method

C) Strecker synthesis

D) Wolf Kishner's reduction reaction

Q.37 Which of the following reactions is / are possible with phenol?

A) Reaction with sodium metal only

B) Oxidation of phenol only

C) Both A and B

D) Neither A nor B

USE THIS SPACE FOR SCRATCH WORK

Q.38 Different methods are given to prepare phenol:

I. By the reaction of sodium salt of benzene sulphonic acid with NaOH at 320°C followed by reaction with HCl

II. By the reaction of Chlorobenzene with 10% NaOH at 360°C and 150 atmospheric pressure

III. Oxidation of cumene

IV. Hydrolysis of diazonium salt

Which of the above methods is known as Dow's process?

A) II only C) II and III

B) I only D) I and II

Q.39 Which of the following reactions involves cleavage of O – H bond in alcohol?

A) $C_2H_5OH + SOCl_2 \xrightarrow{Pyridine} C_2H_5Cl + SO_2 + HCl$

B) $C_2H_5OH + CH_3COOH \xrightarrow{Conc.H_2SO_4} CH_3COOC_2H + H_2O$

C) $C_2H_5OH + HCl \xrightarrow{ZnCl_2} C_2H_5Cl + H_2O$

D) $C_2H_5OH + HNH_2 \xrightarrow{ThO_2} C_2H_5NH_2 + H_2O$

Q.40 Oxidative cleavage of 1,2-diol with periodic acid results in the formation of:

A) Two molecules of carbonyls

B) Two molecules of carboxylic acids

C) Two molecules of alcohols

D) Two molecules of ethers

Q.41 Which of the following enzymes is involved in the conversion of sugar (molasses) into glucose and fructose?

A) Diastase C) Maltose

B) Invertase D) Zymase

Q.42 A biochemical process in which large molecules are broken down into smaller molecules in the presence of enzymes secreted by microorganism is called?

A) Fermentation C) Polymerization

B) Cracking D) Reforming

Q.43 Consider the following steps involved in the preparation of ethanol from starch by fermentation process.

I. $2(C_6H_{10}O_5)_n + nH_2O \xrightarrow[\text{Yeast}]{\text{Diastase}} nC_{12}H_{22}O_{11}$

II. $C_{12}H_{22}O_{11} + H_2O \xrightarrow[\text{Yeast}]{\text{Invertase}} 2C_6H_{12}O_6$

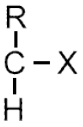
III. $C_6H_{12}O_6 \xrightarrow[\text{Yeast}]{\text{Zymase}} 2C_2H_5OH + 2CO_2$

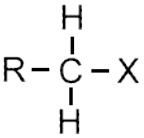
Which of the above statement is incorrect in the preparation of ethanol from starch by fermentation process?

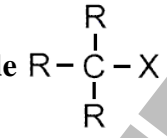
A) 1 only
B) II only
C) II and III
D) I, II and III

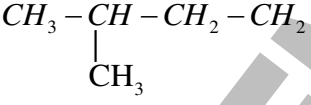
ANSWER KEY (Worksheet-03)							
1	B	12	C	23	A	34	C
2	A	13	B	24	B	35	B
3	D	14	B	25	B	36	A
4	C	15	B	26	A	37	C
5	B	16	B	27	C	38	A
6	C	17	D	28	A	39	B
7	C	18	B	29	A	40	A
8	A	19	C	30	D	41	B
9	B	20	B	31	C	42	A
10	D	21	C	32	A	43	B
11	C	22	D	33	A		

ANSWERS EXPLAINED

Q.1 (B) **2° alkyl halide** 

1° alkyl halide 

3° alkyl halide 

Q.2 (A) 

According to **IUPAC** the **correct name** of the given structure is **1-Bromo-4-methylpentane.**

Q.3 (D) This is the best method to prepare **alkyl halides** because the side products in this reaction are in the gaseous state

Q.4 (C) **Order of reactivity** of **halogens** with **alkane** is as follow $F_2 > Cl_2 > Br_2 > I_2$. This order shows that I_2 is **least reactive** and it **does not react** with **alkane** to form **alkyl halide.** It is clear that **R – I cannot** be prepared from **alkane.**

Q.5 (B)

Good Leaving Group	Poor Leaving Group
Cl^-, Br^-, I^- and HSO_4^-	OH^-, OR^- and NH_2^-
Less polar	More polar
Low bond energy	Greater bond energy
Give fast reaction	Give slow reaction

Q.6 (C) **S_N2 mechanism reaction** takes place in the presence of **non-polar solvent** such as **n-hexane not** in the presence of **polar solvent (e.g. H_2O).**

Q.7 (C) **Alkyl halides** are **soluble** in **non-polar solvent.**

Q.8 (A) **Leaving group** ability can be **explained** on the basis of strength of the **C-X bond.** The **C-I** bond is the **weakest bond** hence iodide is the **best leaving group.**

- Increasing order of the leaving groups:
  $F^- < Cl^- < Br^- < I^-$ ……i
  The greater the electronegativity, the more stable the halide ion (since electrons are tightly held).
- Increasing order of the nucleophiles
  $F^- < Cl^- < Br^- < I^-$ ……ii
- Since iodine is the least electronegative, **it is the least stable halide hence the strongest nucleophile.**
- Another important factor would be **Hard-Soft concept. Alkyl halides** are soft electrophiles so the substitution is favored by soft nucleophiles. The **softness** of the **nucleophiles increases down the group i.e. $F^- < Cl^- < Br^- < I^-$**
- **Other (B, C and D) are weak nucleophile and poor leaving group**

- The relative rate at which a nucleophile ($Nu:^-$) reacts to displace (substitute for) a leaving group is called 'nucleophilicity'. Consider the following nucleophilic substitution reactions:

- $CH_3OH + HI \rightarrow CH_3I + HOH$
- $CH_3OH + HCl \rightarrow CH_3Cl + HOH$
- The first reaction is much faster than the second because I^- is a much better $Nu:^-$ than Cl^-. The leaving group (HOH) was the same in both cases. The nucleophilicity (relative reactivity) of various $Nu:^-$'s is listed in the following table ...

Reactivity	Nu:$^-$	Relative Reactivity
very weak	HSO_4^-, $H_2PO_4^-$, RCOOH	< 0.01
weak	ROH	1
	HOH, NO_3^-	100
fair	F^-	500
	Cl^-, $RCOO^-$	20×10^3
	NH_3, CH_3SCH_3	~ 300×10^3
good	N_3^-, Br^-	~ 600×10^3
	OH^-, CH_3O^-	2×10^6
very good	CN^-, HS^-, RS^-, $(CH_3)_3P:$, I^-, H^-	$> 100 \times 10^6$

- Note that $Nu:^-$'s are electron donors as are Lewis bases and reducing agents. $Nu:^-$'s are either uncharged (with non-bonded electrons) or they are anions, but they are never cations. $Nu:^-$'s are basic, neutral, or sometimes weakly acidic, but not strongly acidic. Strong acids (HCl, H_2SO_4) and Lewis acids ($AlCl_3$, $SnCl_2$) are electrophiles (E^+'s), i.e., electron acceptors as are oxidizing agents.
- Within any given row of the periodic table, nucleophilicity decreases from left to right as polarizability decreases (because electronegativity of the central atom is increasing).

CH_3^-	>	NH_2^-	>	OH^-	>	F^-
	>	NH_3	>	OH_2	>	HF
		PH_2^-	>	SH^-	>	Cl^-
		PH_3	>	SH_2	>	HCl

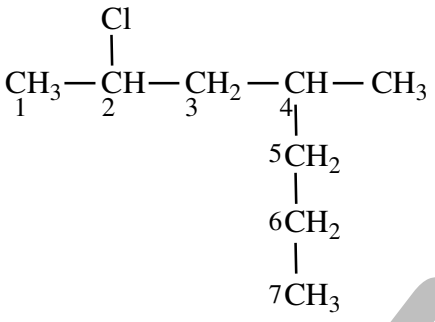
- For nucleophiles with the same attacking atom, the anion is more nucleophilic than the neutral compound.
- $Cl^- > HCl$ $OH^- > HOH$ $RO^- > ROH$ $NH_2^- > NH_3$ $CH_3CO_2^- > CH_3CO_2H$ $CN^- > HCN$
- Nucleophilicity increases down any column of the periodic table; as the polarizability of atoms increases ...

NH_2^-	OH^-	F^-
H_2P^-	HS^-	Cl^-
H_2As^-	HSe^-	Br^-
H_2Sb^-	HTe^-	I^-

- Note the similarities and differences of nucleophiles and bases.
- Nu:-'s and bases are both electron donors
- Basicity deals with equilibrium position (Keq). At equilibrium, a stronger base holds a greater proportion of H^+. Nucleophilicity deals with kinetics. A stronger Nu:- attacks faster than a weaker one.
- Basicity deals with interaction with H^+ while nucleophilicity is broader and also deals with interaction with other atoms, especially, but not only C atom.
- Polarizability of Nucleophiles:
- A polarizable nucleophile, e.g., I-, is large and soft ('teddy bear-like') because its valence (donor) electrons are far from the nucleus (in the 5th period). The electron cloud is readily distorted during bond making and breaking which reduces the energy maximum in the transition state and thus speeds up reactions.

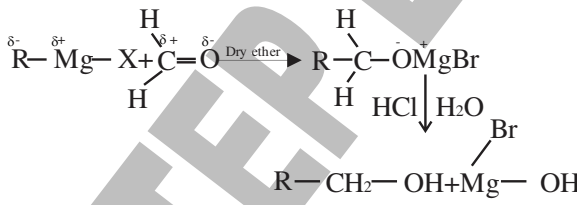
- A non-polarizable nucleophile, e.g., F- is small and hard ("golf ball-like"). Its outer valence electrons are close to the nucleus (in the 2nd period) and tightly held. F-forms strong bonds but its electron cloud is not easily distorted during bond formation and breaking so its transition state is at high energy (slow reaction) state.
- It is generally true that good nucleophiles are also good leaving groups for the same reasons.

Q.9 (B) **The correct name according to IUPAC of the given structure is 2-Chloro-4-methylheptane.**



Q.10 (D) CCl_4 is **non-polar** and is **non-flammable.**

Q.11 (C) Mechanism of reaction in the formation of intermediate product **before** hydrolysis is **nucleophilic addition** reaction as shown below. **Others A, B, and D are not related.**



Q.12 (C)

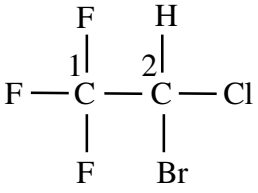
- **A 3^o alcohol** is formed when **ketone** is **treated** with **Grignard reagent** followed by acid **hydrolysis.**
- **A 1^o alcohol is formed when formaldehyde (methanal)** is treated with **Grignard reagent** followed by acid hydrolysis
- **A 2^o alcohols is formed when aldehyde (other than formaldehyde)** treated with Grignard reagent followed by acid **hydrolysis.**

Q.13 (B) **A 3^o alcohol** is more reactive because **3^o carbocation** is **more** stable than **others.**

Q.14 (B) **In alkyl halides the α-carbon is electrophilic in character. When nucleophile attacks the α-carbon, then halogen atom acts as a leaving group.**

Q.15 (B) **Iodoform test (I_2 + NaOH)** helps us to distinguish **between ethanol** and **methanol.** When **ethanol** is treated with **I_2** in the presence of **NaOH** yellow crystal of **iodoform (CHI_3)** are obtained while methanol **does not** give this test as **shown** in the reaction **($C_2H_5OH+4I_2+6NaOH \rightarrow CHI_3+$ $HCOONa+5NaI+5H_2O$).**

Q.16 (B) **The structure of halothane is given below:**



2-Bromo-2-Chloro-1,1,1-triflouroethane

Q.17 (D) From the **K_a value** as **shown** in the **table**, it is clear that **ethyne** is a **weaker acid** because **its K_a** value is **smaller.**

Name of compound	K_a (moldm^3)
Carboxylic acid e.g. (CH_3COOH)	**1.7×10^{-5}**
Phenol	**1.3×10^{-10}**
Water	**10^{-16}**
Ethyne	**10^{-20}**

Q.18 (B) In fact by **hydrogenation** of **phenol, cyclohexanol** is formed but **ethanol does not** react with **hydrogen** in the presence of **Ni.**

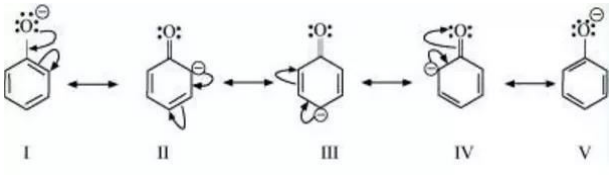
Q.19 (C) **Ethyl alcohol** is obtained by fermentation from **both starch** and **molasses.**

Q.20 (B) **Absolute alcohol (almost 100% pure)** can be obtained by **redistillation** of rectified sprit in the presence of **CaO** which **absorbs** its **moisture.**

Q.21 (C) **A, B and D are the uses of chloroform except C.**

Q.22 (D) **Teflon plastic not only reacts with acid and alkali but also it reacts with oxidant.**

Q.23 (A) **Phenol is much more acidic than alcohol but less acidic than carboxylic acid. The reason why phenol is acidic lies in the nature of the phenoxide ion. The negative charge on oxygen atom can become involved with the π-electron cloud on the benzene ring. The negative charge is thus delocalized in the ring and the phenoxide ion becomes relatively stable. Delocalization of negative charge in the ring of phenoxide is shown below:**



This step of delocalization is not possible with alcohols.

Q.24 (B) **Use of chlorofluorocarbons is the most dangerous for ozone layer** Chlorofluorocarbons used as refrigerants in air conditioning and in aerosol sprays are inert in the troposphere but slowly diffuse into stratosphere, where they are subjected to ultraviolet radiation generating **$Cl^{\bullet}$** free radicals. Chlorofluorocarbons (CFCs) play an effective role in removing O_3 in the stratosphere due to following reactions.

$$CFCl_3 \longrightarrow CFCl_2^{\bullet} + Cl^{\bullet}$$

$$Cl^{\bullet} + O_3 \longrightarrow ClO^{\bullet} + O_2$$

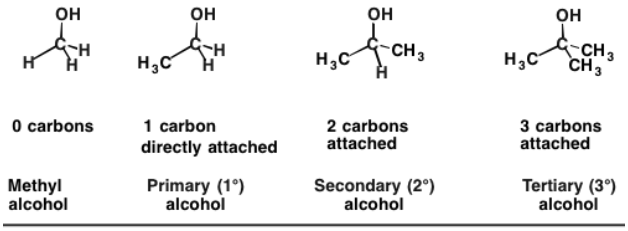
$$ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$$

Q.25 (B) **The greater reactivity of Grignard's reagent is due to the polarity of α-carbon and Mg bond (the electronegative of C = 2.5, Mg = 1.2 and the difference is 1.3 so C – Mg bond is polar). The α-carbon develops the partial negative charge and acts as nucleophilic centre $R^{\delta-} - Mg^{\delta+} - X$.**

Q.26 (A) **As a reaction of alkyl halide with aqueous KOH, alcohol is formed as shown in the reactions:**

A) $R - CH_2 - CH_2 - X + KOH \xrightarrow{H_2O} R - CH_2 - CH_2 - OH + KX$

Q.27 (C) **Structure of primary secondary and tertiary alcohols are shown below:**



Q.28 (A) Detail of the other reactions are given below

A) On oxidation of a 1^o alcohol aldehyde is obtained

$$\text{R-CH}_2\text{OH} + [\text{O}] \xrightarrow[\text{H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7} \text{R-CHO} + \text{H}_2\text{O}$$

1^o alcohol **aldehyde**

B) On oxidation of a 2^o alcohol ketone is obtained

- $\text{R}_2\text{CH-OH} + [\text{O}] \xrightarrow[\text{H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7} \text{R}_2\text{C=O} + \text{H}_2\text{O}$

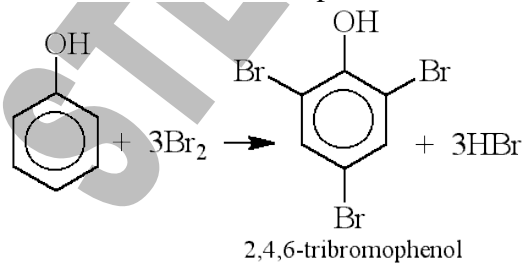
2^o alcohol **ketone**

C) A 3^o alcohols are resistant to oxidation. In the presence of acid dichromate they undergo elimination reactions to give alkenes

- $\text{CH}_3\text{-C(R)}_2\text{-OH} \xrightarrow[\text{H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7} \text{CH}_2\text{=C(R)}_2 + \text{H}_2\text{O}$

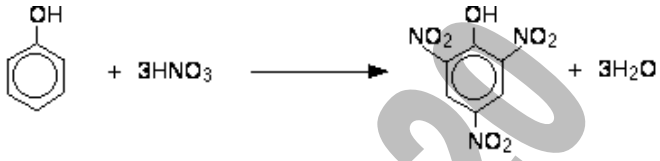
3^o alcohol **Alkene**

Q.29 (A) If **bromine** water is added to a solution of **phenol** in water, the **bromine** water is decolourised and a white precipitate is formed which smells of antiseptic. Notice the multiple substitution around the ring into all the activated positions.



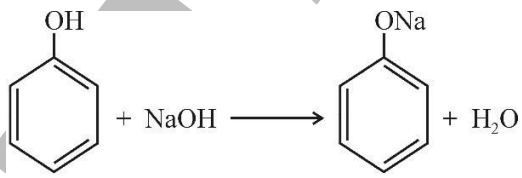
2,4,6-tribromophenol

Q.30 (D) When phenol is treated with concentrated nitric acid at high temperature in the presence of conc. sulphuric acid, 2,4,6-trinitrophenol is obtained as shown in the reaction:



2,4,6-Trinitrophenol

Q.31 (C) Reaction of phenol with alkali (NaOH) results in the formation of salt which show that it is acid base reaction

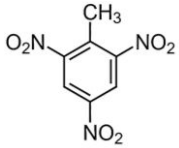


Phenonl **Sodium phenoxide**

Q.32 (A) Relative acidic strength of alcohol, phenol, water and carboxylic acid is as follows.

Carboxylic acid > Phenol > Water > Alcohol

Q.33 (A) The correct name according to IUPAC of the given structure is 2,4,6-Tribnitrotoulene (TNT). It is an explosive material.



Trinitrotoluene (TNT), or more specifically 2,4,6-trinitrotoluene, is a chemical compound with the formula $C_6H_2(NO_2)_3CH_3$. This yellow solid is sometimes used as a reagent in chemical synthesis, but it is best known as an explosive material with convenient handling properties. The explosive yield of TNT is considered to be the standard measure of bombs and other explosives. In chemistry,

TNT is used to generate charge transfer salts.

Q.34 (C) The correct name according to IUPAC of the given structure is 2-buten-1-ol.

$$\overset{4}{CH_3}-\overset{3}{CH}=\overset{2}{CH}-\overset{1}{CH_2OH}$$

Q.35 (B) 1^o alcohol is prepared by the reduction of aldehyde as shown in the reaction.

$$R-\overset{\overset{O}{\|}}{C}-H+H_2 \xrightarrow{Pd} R-CH_2-OH$$

Q.36 (A) An alcohol is treated with metallic sodium to form alkoxides. This alkoxide ion is a strong nucleophile and readily reacts with alkyl halide to produce an ether. e.g.

$$2C_2H_5OH+2Na \longrightarrow 2C_2H_5O^-Na^+ + H_2$$

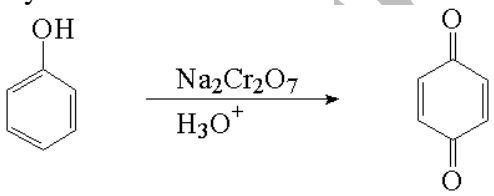
$$C_2H_5O^-Na^+ + C_2H_5Br \longrightarrow C_2H_5OC_2H_5 + NaBr$$

Ethoxy ethane
(Diethyl ether)

Q.37 (C) (1) <u>Reaction with sodium metal:</u> Phenols react with highly electropositive alkali metals such as sodium, potassium etc to yield corresponding phenoxides and hydrogen as shown in the reaction.

$2C_6H_5OH + 2Na \longrightarrow 2\ C_6H_5ONa$ (Sodium phenoxide) $+ H_2$

(2) <u>Oxidation of phenol:</u> Phenols are rather easily oxidized despite the absence of a hydrogen atom on the hydroxyl bearing carbon. Among the colored products from the **oxidation of phenol** by chromic acid is the dicarbonyl compound para-benzoquinone (also known as 1,4-benzoquinone or simply quinone); an ortho isomer is also known. Oxidation of phenol is shown by the reaction as follow:



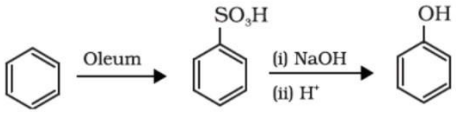
1,4-benzoquinone

Q.38 (A) Detail of all the reactions are given below:

I. By the reaction of sodium salt of benzene sulphonic acid with NaOH at 320^oC followed by reaction with HCl.

<u>From sodium salt of Benzene sulphonic acid:</u>

In this process, **benzene sulfonic acid** is reacted with aqueous sodium hydroxide. The resulting salt is mixed with solid sodium hydroxide and fused at a high temperature. The product of this reaction is sodium phenoxide, which is acidified with aqueous **acid** to yield **phenol**.

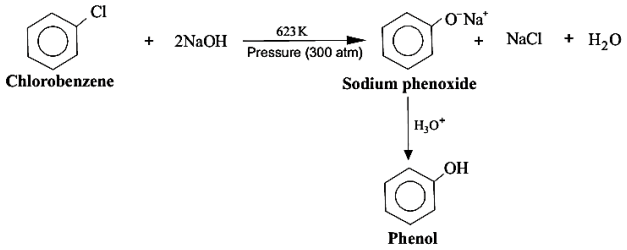


II. By the reaction of Chlorobenzene with 10% NaOH at 360^oC and 150 atmospheric pressure.

<u>Dow's Process:</u>

Hydrolysis of chlorobenzene (the **Dow's process**) Benzene is easily converted to chlorobenzene by a variety of methods, one of which is the **Dow's process**. Chlorobenzene is hydrolyzed by a strong base at high

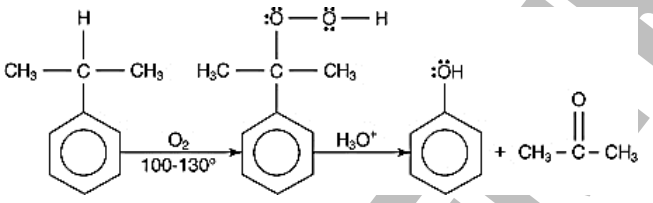
temperatures to give a phenoxide salt, which is acidified to phenol.



III. Oxidation of cumene

Oxidation of Cumene:

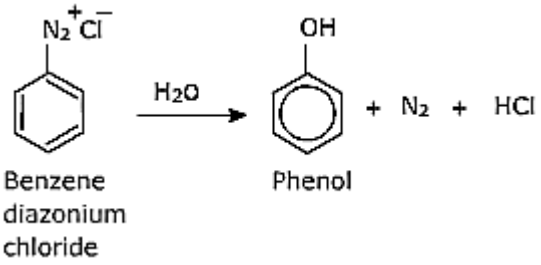
Air **oxidation of cumene**. The air **oxidation of cumene** (isopropyl benzene) leads to the **production** of both **phenol** and acetone, as shown in the following figure. The mechanisms for the formation and degradation of **cumene** hydroperoxide require closer looks, which are provided following the figure.



IV. Hydrolysis of diazonium salt

Hydrolysis of Diazonium salt:

Phenol is dissolved in sodium hydroxide solution to give a solution of sodium phenoxide. The solution is cooled in ice, and cold benzenediazonium chloride solution is added. There is a reaction between the **diazonium** ion and the phenoxide ion and a yellow-orange solution or precipitate is formed.

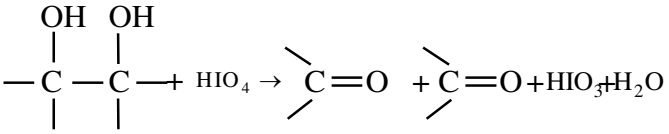


Q.39 (B) Reaction of alcohol with carboxylic acid in the presence of conc. H_2SO_4 (dehydrating agent) ester is formed. This reaction involves O – H bond cleavage in alcohol as shown in the reaction.

$$C_2H_5OH+CH_3COOH \xrightarrow{Conc.H_2SO_4} CH_3COOC_2H_5+H_2O$$

Q.40 (A) Oxidative cleavage of 1,2-diol with periodic acid results in the formation of two molecules of carbonyls as shown in the reaction.

- 1,2- or vicinal diols are cleaved by periodic acid, HIO_4, into two carbonyl compounds.
- The reaction is selective for 1,2-diols.
- The reaction occurs via the formation of a cyclic periodate ester.
- This can be used as a functional group test for 1,2-diols.
- The products are determined by the substituents on the diol.



Q.41 (B) Invertase enzymes is used in the conversion of sugar (molasses) into glucose and fructose as shown in the reaction

- Molasses is the mother liquor left after crystallization of cane sugar from concentrated juice.
- It is dark coloured thick sypry mass.
- Molasses contains 60% fermentable sugars mostly sucrose, glucose and fructose.
- The fermented liquor contains 8 – 10% ethanol

Q.42 (A) A biochemical process in which large molecules are broken down into smaller molecules in the presence of enzymes secreted by microorganism is called?

Q.43 (B) It is incorrect statement. The correct statement is as follow:

I. $2(C_6H_{10}O_5)_n + nH_2O \xrightarrow[\text{Yeast}]{\text{Diastase}} nC_{12}H_{22}O_{11}$

Starch

✓II. $C_{12}H_{22}O_{11} + H_2O \xrightarrow[\text{Yeast}]{\text{Maltase}} 2C_6H_{12}O_6$

Maltose

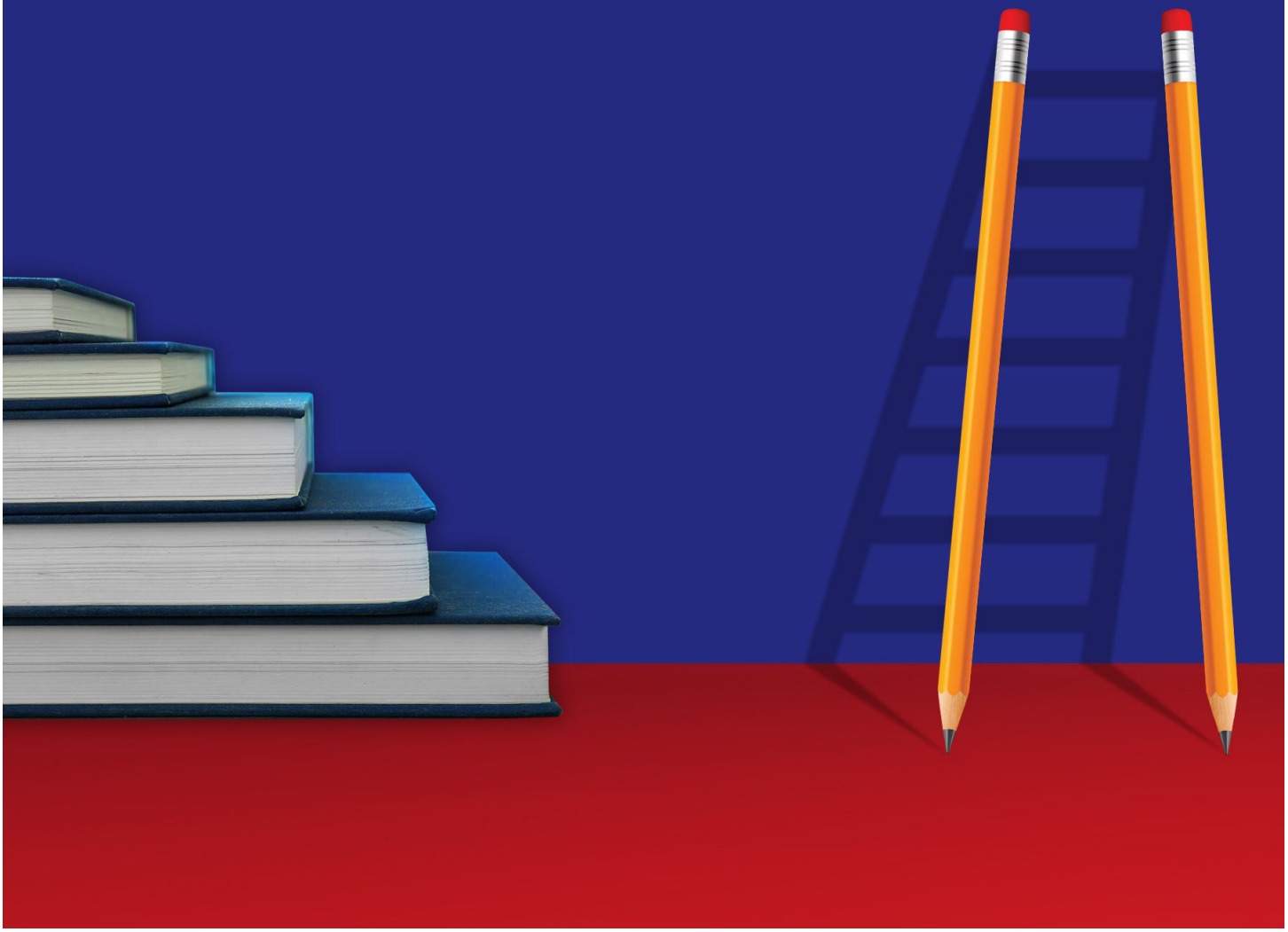
Glucose

III. $C_6H_{12}O_6 \xrightarrow[\text{Yeast}]{\text{Zymase}} 2C_2H_5OH + 2CO_2$

Ethanol

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-4

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-04

(C. Organic Chemistry)

Aldehydes and Ketones

USE THIS SPACE FOR SCRATCH WORK

Q.1 Mark the incorrect statement about aldehydes and ketones:

A) They have higher boiling points than that of alkanes

B) They have lower boiling points than that of alcohols

C) Aldehydes are present in essential oils and ketonic group is present in camphor

D) Aldehydes have H-bonding but ketones do not have

Q.2 All of the following statements are correct about aldehydes and ketones EXCEPT:

A) Aldehydes are easily oxidized while ketones do not

B) Aldehydes show position isomerism while ketones do not

C) Aldehydes can be oxidized easily by Fehling's solution while ketones do not

D) Aldehydes react with alcohols to form acetal while ketones do not

Q.3 Which of the following reactions is not given by ketones?

A) Grignard reagent C) Polymerization

B) 2,4-DNPH D) HCN

Q.4 Which of the following tests is shown by ketones only?

A) Sod. nitroprusside test C) Fehling solution test

B) Tollen's reagent test D) Benedict reagent test

Q.5 Which one of the following organic compounds does not give iodoform test?

A) Ethanal C) Methyl ketones

B) Ethanol D) Methanal

Q.6 All of the following reagents reduce aldehydes and ketones to their respective alcohols EXCEPT:

A) H_2/Ni C) N_2H_2/KOH

B) $LiAlH_4$ D) $NaBH_4$

Q.7 Which of the following aldehydes is the most reactive?

A) Methanal C) Butanal

B) Ethanal D) Propanal

Q.8 Which one of the following does not give iodoform test?

A) Butanone C) 2-Hexnone

B) 2-Pentanone D) 3-Pentanone

Q.9 Aldehydes and ketones show which of the following mechanism of reaction:

A) Electrophilic addition reaction

B) Nucleophilic substitution reaction

C) Nucleophilic addition reaction

D) Acid base reaction

Q.10 The nucleophilic addition reactions of carbonyl group are catalyzed by bases or acids. A base catalyzed reaction:

A) Increases nucleophilic character of attacking reagent

B) Increases electrophilic character of carbon of carbonyl group

C) Increases both electrophilic and nucleophilic character

D) Has no effect on the reactivity of carbonyl groups

Q.11 Which one of the following types of reactions is not shown by aldehydes and ketones?

A) Nucleophilic addition reaction

B) Reduction reaction

C) β-Elimination reaction

D) Oxidation reaction

Q.12 Mark the incorrect statement about Aldehydes and Ketones:

A) Aldehydes on reduction with $NaBH_4/H_3O^+$ give 1° alcohol

B) Ketones on reduction with $NaBH_4/H_3O^+$ gives 2° alcohol

C) Aldehydes on reduction with N_2H_4/KOH gives alkane

D) Ketones on reduction with N_2H_4/KOH gives alkene

Q.13 Which of the following is incorrect statement?

A) 1° alcohol on oxidation gives aldehyde

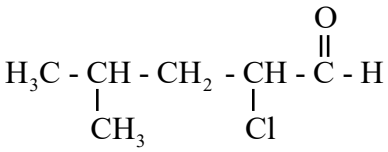
B) 2° alcohol on oxidation gives ketone

C) On dry distillation of calcium methanoate, ethanal is produced

D) On dry distillation of calcium ethanoate, propanone is produced

USE THIS SPACE FOR SCRATCH WORK

Q.14 Consider the following structure of aldehyde:



The correct name according to IUPAC is:

A) 2-Chloro-4-methylpentanal

B) 2-Methyl-4-chloropentanal

C) 2-Chloro-3-methylbutanol

D) 3-Methyl-2-chloropentanal

Q.15 Aldehydes can occur:

A) Anywhere in the carbon chain

B) In the middle of carbon chain

C) Only at the second carbon atom of the carbon chain

D) Only at the terminal carbon atom of the carbon chain

Q.16 Aldehyde acts as _____ when treated with Fehling's solution.

A) Reducing agent only C) Both A and B

B) Oxidizing agent only D) Neither A nor B

Q.17 Aldehydes and ketones react with ammonia derivatives G-NH_2 to form condensation product containing the group C = N – G and water. The reaction is:

A) Base catalyzed only C) Both A and B

B) Acid catalyzed only D) Neither A nor B

Q.18 Which of the following is not easily oxidized?

A) Aldehyde C) Ketone

B) 1° alcohol D) 2° alcohol

Q.19 Ketones are generally resistant to oxidation. But they can be oxidized by strong oxidizing agent such as ($K_2Cr_2O_7$ + conc. H_2SO_4). On oxidation of 2-pentanone, which of the following products are possible?

A) CH_3CH_2COOH only

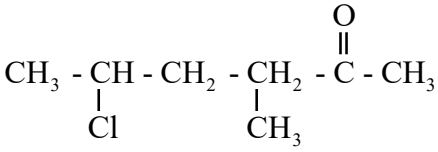
B) CH_3-CH_2-COOH and CH_3COOH

C) CH_3COOH only

D) CH_3COOH and HCOOH

USE THIS SPACE FOR SCRATCH WORK

Q.20 Consider the following structure:



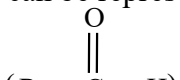
A) 5-Chloro-3-methyl-2-hexanone

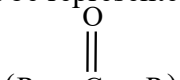
B) 2-Chloro-3-methyl-5-hexanone

C) 4-Methyl-5-chloro-2-hexanone

D) 3-Methyl-2-chloro-2-hexanone

Q.21 Identify the incorrect statement about aldehydes and ketones:

A) An aldehyde can be represented by general formula ()

B) A ketone can be represented by general formula ()

C) Ketone group is present in maltose, camphor and menthone

D) The homologous series of both aldehydes and ketones have general formula $C_nH_{2n}O$

Q.22 Preparatory methods of methanal, ethanal are given below:

I. $2CH_3OH + O_2 \xrightarrow[300^oC]{Ag} 2HCHO + 2H_2O$

II. $2CH_3OH + O_2 \xrightarrow[500^oC]{FeO,Mo_2O_3} 2HCHO + 2H_2O$

III. $CH_3CH_2OH + [O] \xrightarrow[\Delta]{Na_2Cr_2O_7 + dil.H_2SO_4} CH_3CHO + H_2O$

IV. $2CH_2 = CH_2 + O_2 \xrightarrow[H_2O]{PdCl_2 + CuCl_2} 2CH_3CHO$

Which of the following above methods is/are used for the preparation of methanal and ethanal respectively on the industrial scale?

A) I and III C) I and IV

B) II and IV D) III and IV

Q.23 Aldehydes and ketones show which of the following type of structural isomerism:

A) Position isomerism

B) Functional group isomerism

C) Metamerism

USE THIS SPACE FOR SCRATCH WORK

D) Tatoumerism

USE THIS SPACE FOR SCRATCH WORK

Q.24 Which of the following tests is used for the identification of aldehydes only?

Options	Tests	Applications
A)	2,4-DNPH	Aldehydes and ketones form a yellow or red precipitate with 2,4-DNPH solution
B)	Addition of HCN	Aldehyde and ketone react with HCN to give cyanohydrins
C)	Benedict's solution test	Aliphatic aldehydes form a brick-red precipitate with Benedict's solution
D)	Reduction with $NaBH_4$	Aldehydes and ketones are reduced to alcohols with $NaBH_4$

Q.25 Which of the following instruments is used in infrared spectroscopic technique?

A) Photometer C) Polarimeter
B) Spectrophotometer D) Refractometer

Q.26 The infrared spectrum is divided into how many regions:

A) 2 C) 3
B) 4 D) 5

Q.27 Which of the following techniques is used to identify functional groups of various classes of organic compounds?

A) IR C) NMR
B) UV D) X-rays

Q.28 In which of the following wave number range (cm^{-1}) the C = O (carbonyl group) is identified by using IR technique?

A) 3230 – 3550 cm^{-1} C) 3100 – 3500 cm^{-1}
B) 2500 – 3300 cm^{-1} D) 1680 – 1750 cm^{-1}

Q.29 All of the following are applications of IR technique EXCEPT:

A) It is widely used in inorganic and organic chemistry
B) It is used in forensic analysis in criminal
C) It is used to identify unsaturation in organic compounds
D) It is used in measuring the degree of polymerization in polymer manufacture

Q.30 IR spectroscopy can be applied to study and identify a substance if the sample of the substance is in the _____ state.

A) Solid only C) Solid, Liquid, Gas`
B) Liquid only D) Both gas, Liquid

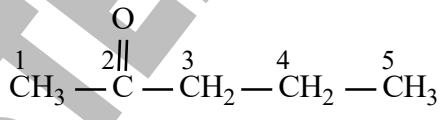
ANSWER KEY (Worksheet-04)					
1	D	11	C	21	C
2	B	12	D	22	B
3	C	13	C	23	B
4	A	14	A	24	C
5	D	15	D	25	B
6	C	16	A	26	C
7	A	17	B	27	A
8	D	18	C	28	D
9	C	19	B	29	B
10	A	20	A	30	C

ANSWERS EXPLAINED

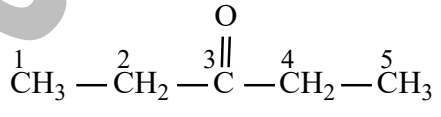
Q.1 (D) In fact, **aldehydes** and **ketones do not** show **hydrogen bonding.** They show dipole-dipole intermolecular forces.

Q.2 (B) It is incorrect statement. In fact, aldehydes **do not** show position isomerism because CHO group is always present at the terminal carbon atom of the carbon chain. However, ketones show position isomerism. It has been explained by examples:

- **Position isomerism.** The isomers having carbonyl group at different locations in the chain are called position isomers. e.g. pentanone can have carbonyl group at two different locations as shown below:



2-Pentanone



3-Pentanone

Q.3 (C) **Ketones do not** give polymerization whereas **aldehydes** such as **methanal** forms metaformaldehyde and **ethanal** form **paraldehyde polymer.**

Q.4 (A) **Ketones produce a wine red or orange red colour on adding alkaline sodium nitroprusside solution dropwise.**

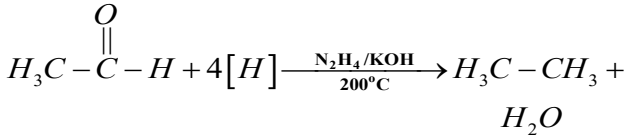
- **While aldehydes do not give this test.**

ADDITIONAL INFORMATIONS

Alkaline sodium nitroprusside (SNP) ($Na_2[Fe(CN)_5NO]$) is used as a medicine to **lower blood pressure.** This may be done if the **blood pressure** is very high and resulting in symptoms, in certain types of heart failure, and during surgery to decrease bleeding. It is used by continuous injection into a vein.

Q.5 (D) Methanal **does not** give iodoform test while all **others A, B and C give iodoform test.**

Q.6 (C) The **Wolff–Kishner reduction** reaction is a reaction used in organic chemistry to convert **carbonyl functionalities** into **methylene** groups as shown in the reaction. In this reaction **aldehyde** is reduced to **alkane** with **hydrazine** in the presence of **KOH.**



Q.7 (A) **Methanal** is the **most reactive aldehyde** because it has **no alkyl group.** Since **alkyl group is electron** donating thus with the increase of **alkyl groups,** polarity of **carbonyl group** of **carbonyl** compounds decreases and

thus reactivity decreases. **Order of the reactivity of aldehyde is as shown:**

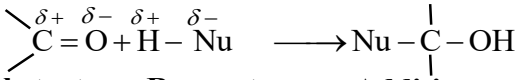
Methanal > Ethanal > Propanal > Butanal.

Q.8 (D) 3-Pentanone

$(CH_2-CH_2-CO-CH_2-CH_3)$

does not give iodoform test because **methyl ketones** can only give **iodoform test. Other A, B and C** give **iodoform test** they are **treated** as **methyl ketone.**

Q.9 (C) **In carbonyl compounds** carbon atom is electrophilic in nature. Therefore, most of the reactions of the carbonyl group will be considered to be nucleophilic addition reactions as shown below.



Substrate Reagent Addition product

In these reactions of aldehydes and ketones, the negative part of the reagent combines with electrophilic carbon of the carbonyl group, whereas the positive part, which is usually hydrogen goes to the oxygen.

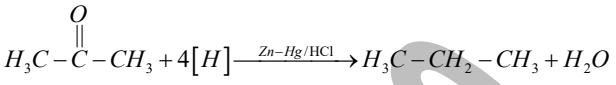
Q.10 (A) A base catalyzed reaction increases **nucleophilic** character of **attacking** reagent as shown in the reaction.

$H-O^- + H^{\delta+}-Nu^{\delta-} \rightleftharpoons Nu^- : + HOH$

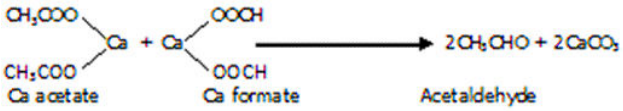
It is clear the Nu^- has more **nucleophilic character** than that of $H^{\delta+}-Nu^{\delta-}$ because Nu^- has **more ionic character.**

Q.11 (C) **Aldehydes do not give β-elimination reaction.**

Q.12 (D) **Ketone** is **less reactive than aldehyde.** So strong **reducing agent** is required for the complete reduction of **ketone** into **alkane** as shown in the reaction



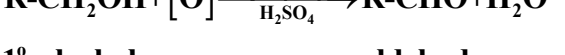
Q.13 (C) **It is incorrect statement. In fact, o**n dry distillation cal.methanoate ethanal cannot be prepared. So in order to prepare ethanal dry distillation of both cal.methanoate and cal.ethanoate is done simultaneously as shown in reaction.



(Calcium ethanoate) (Ethanal)

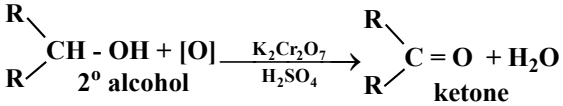
Detail of the other reactions are given below

A) On oxidation of 1° alcohol aldehyde is obtained

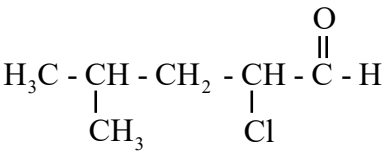


1° alcohol aldehyde

B) On oxidation of 2° alcohol ketone is obtained



Q.14 (A)



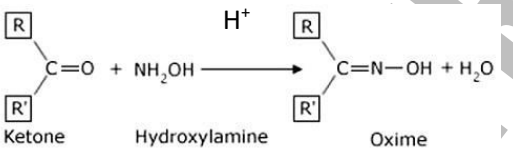
According to IUPAC the correct name of the given structure is 2-Chloro-4-methylpentanal

Q.15 (D) **Carbon is tetravalent.** It can form **four covalent bonds**. Since in aldehyde group carbon atom forms

double bond with oxygen and **single bond** with hydrogen. So there is **one vacancy available** for making bond. That is why **aldehydes group** present **at the terminal carbon atom of carbon chain.** It **cannot** be placed **in the middle** of the carbon chain because in such condition carbon atom should **have two vacancies available** which is **not possible in this case.** Similarly **carboxylic acid group (–COOH)** is **always** present **at the terminal carbon** of the **carbon chain.**

Q.16 (A) **Aldehyde** only **acts** as **reducing agent** when **treated** with **mild oxidizing agents** such as **Fehling's solution, Benedict reagent and Tollen's reagent.**

Q.17 (B) **Aldehydes and ketones react** with **ammonia derivative** in acidic medium as shown in the reaction **e.g.**

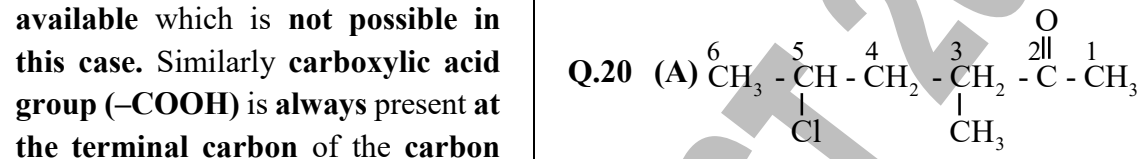


Q.18 (C) **Ketones** are **not easily oxidized** because the **carbonyl group** in ketones is **less polar** in nature. They show oxidative cleavage phenomenon rather than simple oxidation like aldehyde. That is why it **does not** react with mild **oxidizing agents** such as **Fehling's solution, Benedict reagent and Tollen's reagent.** It can only be oxidized in the presence of strong oxidizing agent such as **$K_2Cr_2O_7/H_2SO_4$, $KMnO_4/H_2SO_4$ and conc. HNO_3.**

Q.19 (B) **2-Pentanone** on oxidation in the presence of **strong oxidizing agent** is converted into **propanoic acid** and **ethanoic acid** as shown in the reaction. The oxidation of such ketone is in accordance to **Popoff's rule. This rule states that in the case of ketones, the carbonyl group remains with the smaller alkyl group during oxidation.**

$$CH_3-CO-(CH_2)_2-CH_3+3[O]\xrightarrow{K_2Cr_2O_7/H_2SO_4}CH_3-CH_2-COOH+CH_3COOH$$

Q.20 (A)



According to IUPAC the correct name of the given structure is 5-chloro-3-methyl-2-hexanone.

Q.21 (C) **It is incorrect answer. In fact, ketone group is present only in camphor and menthone but not in maltose.**

Q.22 (B) **Following methods are used to prepare methanal and ethanal on the industrial scale as show by the reaction:**

Methanal is manufactured on the industrial scale by passing mixture of methanol vapours and air over iron oxide-molybdenum oxide at 500°C.

- $2CH_3OH+O_2 \xrightarrow[500^oC]{FeO,Mo_2O_3} 2HCHO+2H_2O$

Ethanal is manufactured on the industrial scale by air oxidation of ethene using **$PdCl_2$ with $CuCl_2$** promoter.

- $2CH_2=CH_2+O_2 \xrightarrow[H_2O]{PdCl_2+CuCl_2} 2CH_3CHO$

Ethene **Ethanal**

Q.23 (B) Aldehydes and ketones show functional group isomerism e.g.

Propanal (CH_3-CH_2-CHO) and propanone (CH_3-CO-CH_3) show functional group isomerism.

Q.24 (C) **<u>Benedict's solution test</u>: (An alkaline solution containing a cupric citrate complex ion) aliphatic aldehydes form a brick-red precipitate with Benedict's solution. To an aldehyde solution, add Benedict's solution and boil, a brick-red precipitate of cuprous oxide are formed.**

$$RCHO+2Cu(OH)_2+NaOH \longrightarrow RCOONa+Cu_2O+3H_2O$$

Q.25 (B) **Spectrophotometry is a method to measure how much a chemical substance absorbs light by measuring the intensity of light as a beam of light passes through sample solution. The basic principle is that each compound absorbs or transmits light over a certain range of wavelength.**

A spectrophotometer measures either the amount of light reflected from a sample object or the amount of light that is absorbed by the sample object.

Q.26 (C) The infrared portion of the electromagnetic spectrum is usually **divided** into **three** regions the **near, mid – and far – infrared named** for their relation to the **visible spectrum.**

Q.27 (A) **Infrared Spectroscopy is the analysis of infrared light interacting with a molecule. This can be analyzed in three ways by measuring absorption, emission and reflection. The main use of this technique is in organic and inorganic chemistry. It is used by chemists to determine functional groups in molecules.**

Q.28 (D)

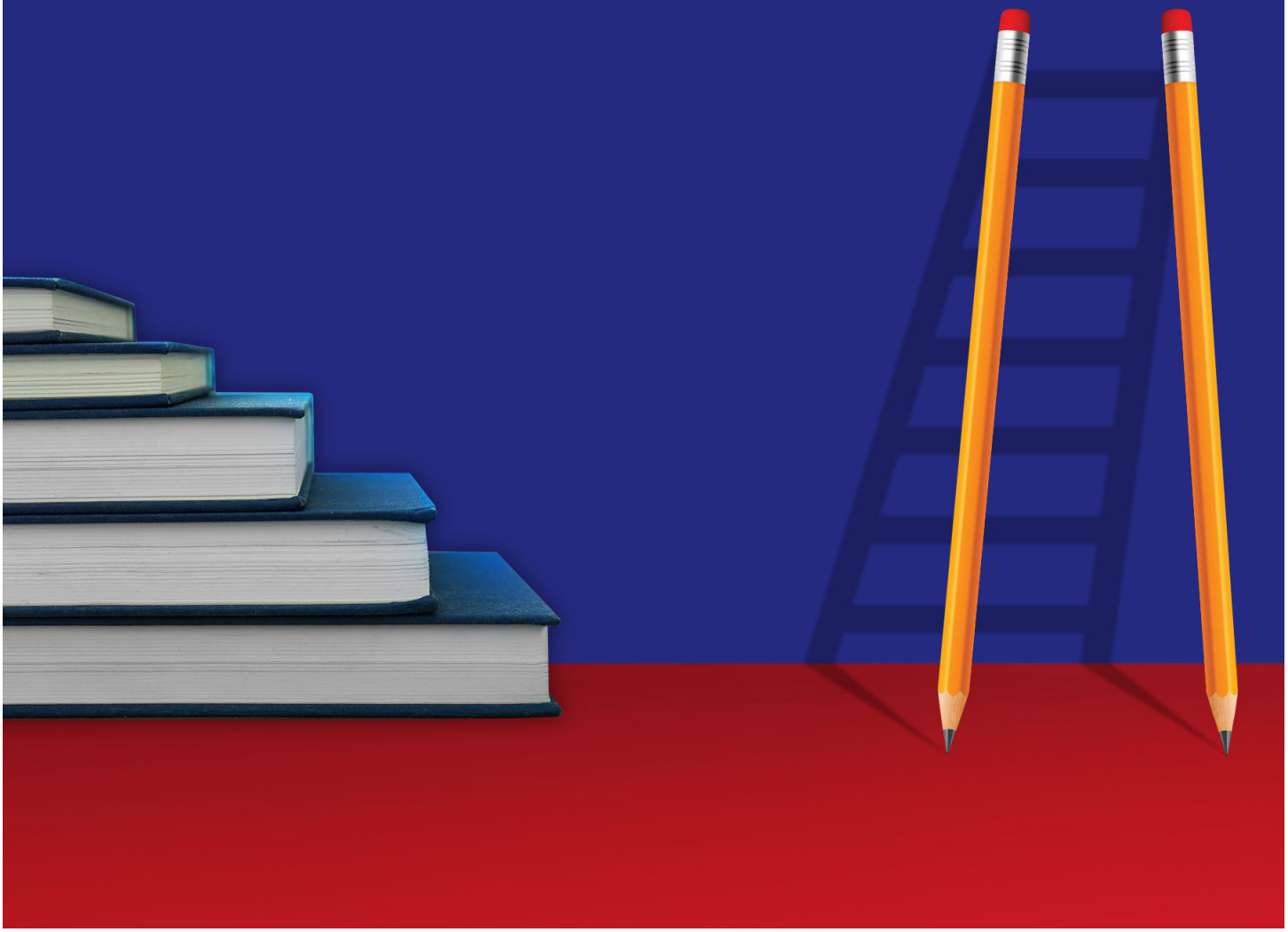
Bond	Functional Alcohols	Wave number / cm^{-1}
O – H	Alcohols	3230 – 3550
N – H	Amines	3100 – 3500
O – H	H – bonded in carboxylic acid	2500 – 3300
C = O	Aldehydes ketone	1680 – 1750

Q.29 (B) **IR-spectroscopy** has been successfully used in analysis and identification of **pigments in paintings** and **other art objects** such as illuminated manuscripts except it is used in **forensic analysis in criminal.**

Q.30 (C) **IR spectroscopy** can be used to identify and study a substance. **Sample** of the substance can be in the **solid, liquid or in the gaseous state.**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-5

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-05

(C. Organic Chemistry)

Carboxylic Acid and Amino Acids

USE THIS SPACE FOR SCRATCH WORK

Q.1 Which of the following is the weakest acid?

A) CH_3COOH C) $Cl_2CHCOOH$

B) $ClCH_2COOH$ D) Cl_3COOH

Q.2 Which of the following acids cannot be prepared directly from carboxylic acid?

A) Acid halide C) Ester

B) Acid amide D) Acid anhydride

Q.3 All of the following methods are used to prepare carboxylic acids EXCEPT:

A) By the oxidation of alcohol

B) By acid hydrolysis of alkane nitrile

C) By the reaction R-Mg-Br with CO_2 followed by acid hydrolysis

D) By the reduction of aldehydes

Q.4 Which one of the following methods is used to prepare acid anhydride?

A) Dehydration of carboxylic acid with P_2O_5

B) Reaction of carboxylic acid with $SOCl_2$

C) Reaction of carboxylic acid with NH_3

D) Reaction of carboxylic acid with alcohol in the presence of conc. H_2SO_4

Q.5 Which one of the following organic acids is the most reactive and the strongest acid?

A) HCOOH C) CH_3CH_2COOH

B) CH_3COOH D) $CH_3CH_2CH_2COOH$

Q.6 Which of the following halosubstituted carboxylic acids is the strongest acid?

A) FCH_2COOH C) $BrCH_2COOH$

B) $ClCH_2COOH$ D) ICH_2COOH

Q.7 Organic compounds X and Y react together to form organic compound (Z). What type of compounds X, Y and Z be?

Options	X	Y	Z
A)	Acid	Ester	Alcohol
B)	Alcohol	Ester	Acid
C)	Ester	Alcohol	Acid
D)	Alcohol	Acid	Ester

Q.8 All of the following are optically active α-amino acids EXCEPT:

A) Glycine C) Valine

B) Aspartic acid D) Alanine

Q.9 When an alkali is added to solution of α-amino acids, _____releases the proton. Therefore, the acidic character is due to?

A) $-NH_2$ C) $-COO^-$

B) $-NH_3^+$ D) $-COOH$

Q.10 Which of the following is correct structural formula of lysine?

A) $H_3C\text{-}\ H_2C\text{-}(CH_2)_2\text{-}CH(NH_2)\text{-}COOH$

B) $CH_3\text{-}CH(CH_3)\text{-}CH(NH_2)\text{-}COOH$

C) $H_2N\text{-}CH(CH_2)_3\text{-}CH(NH_2)\text{-}COOH$

D) $CH_3\text{-}CH(NH_2)\text{-}COOH$

Q.11 α-amino acids are required for the synthesis of proteins. These α-amino acids are sub-classified according to how the properties of other functional groups in the side chain (R-group) influence the system. Which of the following is not justified class of α-amino acid under the given condition:

A) Non-polar (side chain e.g. alkyl group)

B) Polar (side chain e.g. amide, alcohols)

C) Acidic (side chain e.g. HCl)

D) Basic (side chain e.g. amine)

Q.12 All of the following are uses of ethanoic acid EXCEPT:

A) Used as coagulant for latex in rubber industry

B) Used as a local irritant in medicine

C) Used in the manufacture of pickles

D) Used as an antiseptic in nasal infection

USE THIS SPACE FOR SCRATCH WORK

Q.13 Which of the followings has comparatively less acidic character?

A) Ethanoic acid C) Phenol

B) Ethanol D) Water

Q.14 Which reaction does not produce benzoic acid?

A) By hydrolysis of $C_6H_5CO_2C_2H_5$

B) By hydrolysis of C_6H_5CN

C) By oxidation of toluene

D) By oxidation of phenol

Q.15 Which class of organic compounds is used for artificial flavorings in jams?

A) Ester C) Ketone

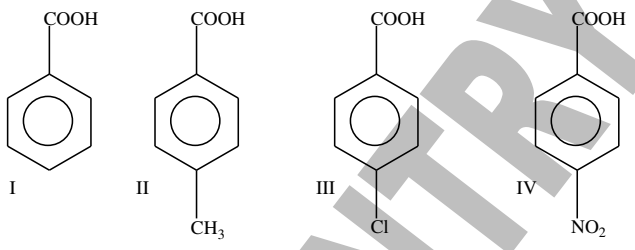
B) Carboxylic acid D) Aldehydes

Q.16 Which of the following compounds would react readily with NaOH?

A) $R - NH_2$ C) RCOOH

B) R – COCl D) $RCH_2 - OH$

Q.17 In the following carboxylic acids:



The decreasing order of acidic character is:

A) III > IV > I > II C) I > IV > III > II

B) II > I > III > IV D) IV > III > I > II

Q.18 Amino acids have all of the following properties EXCEPT:

A) They are colourless, crystalline solids

B) They have low melting points

C) They are soluble in water

D) They behave like salts rather than simple amides and carboxylic acid

Q.19 Which of the following carboxylic acids is prepared by acid hydrolysis of ethane nitrile?

A) Methanoic acid C) Propanoic acid

B) Ethanoic acid D) Butanoic acid

USE THIS SPACE FOR SCRATCH WORK

Q.20 Mark the incorrect statement about α-amino acids:

A) They all have chiral carbon except glycine

B) They are all L-amino acids

C) 10 amino acids are called non-essential or dispensable amino acids

D) Polypeptides act as acid only

Q.21 Which of the following methods is used to prepare amines (mixture of amines) on the commercial scale?

A) Williamson's synthesis

B) Strecker synthesis

C) Wolf Kishner reduction reaction

D) Hofmann's method

Q.22 Dehydration of an acid amide gives:

A) Cyanide C) Amine

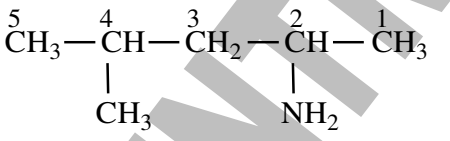
B) Isocyanide D) Fatty acid

Q.23 Hoffmann's bromamide reaction is used to prepare _____ amine from amides.

A) 1° C) 2°

B) 3° D) 1^{o} and 2^{o}

Q.24 Consider the following structure of primary amine:



The correct name of the above structure according to IUPAC is:

A) 4-Methyl pentan-2-amine

B) 3-Methyl butan-2-amine

C) 2-Methyl pentan-2-amine

D) 4-Methyl pentan-3-amine

Q.25 For which of the following type of amines carbylamine test gives positive reaction:

A) Prim. amine C) Tert. amines

B) Sec. amine D) Both B and C

USE THIS SPACE FOR SCRATCH WORK

Q.26 The correct order of basic nature of the following:
CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$ and NH_3 is:

A) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

B) $CH_3NH_2 > (CH_3)_2NH\ (CH_3)_3N > NH_3$

C) $(CH_3)_2NH > (CH_3)_3N > NH_3 > CH_3NH_2$

D) $CH_3NH_2 > (CH_3)_3N > NH_3 > (CH_3)_2NH$

Q.27 Reaction of ethanoic acid with ammonia gives:

A) Ethane amide C) Ethyl amine

B) Ethane nitrile D) Nitro methane

Q.28 Which of the following compounds is expected to be strongest base?

A) Hydroxylamine C) Aniline

B) Methylamine D) Ethylamine

Q.29 Which of the following types of isomerism is not shown by aliphatic amines?

A) Chain isomerism C) Matamerism

B) Position isomerism D) Tautomerism

Q.30 Electrophoresis is not used for the separation of:

A) Nucleic acids C) Proteins

B) Amino acids D) Lipids

Q.31 In gel electrophoresis, how do we make the DNA migrate through the gel?

A) We place a negative electrode away from the walls

B) Large fragments drift to the end of the gel

C) We place a positive electrode away from the walls

D) Gravity

Q.32 In electrophoresis, the electrophoretic mobility ('μ') determines the characteristics of migration of different biomolecules. Which of the following is not having any influence in 'μ':

A) Stereochemistry of molecule

B) Molecular weight

C) Size of molecule

D) Net charge of molecule

Q.33 Which of the following derivatives of carboxylic acid is the most reactive?

A) Acid amide C) Ester

B) Acid halide D) Acid anhydride

USE THIS SPACE FOR SCRATCH WORK

Q.34 In which of the following reactions acid chloride produces aldehyde?

A) Reaction with H_2 C) Hydrolysis

B) Reaction with NH_3 D) Reaction with Alcohol

Q.35 Which of the following method is/are not used to prepare primary amines?

A) By the reduction of acid amide

B) By reductive amination of aldehyde or ketones

C) By catalytic hydrogenation H_2/Pt

D) By the reaction of Grignard reagent with NH_3

Q.36 Each molecule of α-amino acid can interact within itself due to its basic $–NH_2$ group and its acidic –COOH group. This is called zwitter ion:

$$R - \underset{\displaystyle NH_2}{\underset{|}{CH}} - COOH \longrightarrow R - \underset{\displaystyle N^+H_3}{\underset{|}{CH}} - COO^-$$

Which of the following characteristics features is/are shown by zwitterion?

A) In zwitterion the German zwei means two

B) It is amphoteric in nature

C) It is crystalline solid and soluble in water

D) All of these

Q.37 α-amino acid molecules can react with each other, the acid –COOH group in one molecule reacts with the basic $–NH_2$ group in another molecule, when two α-amino acids react together, the resulting molecule is called:

A) Peptide C) Polypeptide

B) Dipeptide D) Tripeptide

Q.38 On the acid hydrolysis of acid amide, which of the following product is obtained:

A) Alkane nitrile

B) Sod. salt of carboxylic acid

C) Primary amine

D) Carboxylic acid

Q.39 Which of the following derivatives of carboxylic acid is least reactive?

A) Acid halide C) Ester

B) Acid amide D) Acid anhydride

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-05)							
1	A	11	C	21	D	31	B
2	B	12	D	22	A	32	A
3	D	13	B	23	A	33	B
4	A	14	D	24	A	34	A
5	A	15	A	25	A	35	D
6	A	16	C	26	A	36	D
7	D	17	D	27	A	37	B
8	A	18	B	28	D	38	D
9	B	19	B	29	D	39	B
10	C	20	D	30	D	40	

ANSWERS EXPLAINED

Q.1 **(A)** Acid strength increases by increasing a number of electron-withdrawing substituents (e.g. Cl- group) on the carbon next to **the –COOH group.** Order of decreasing acidic strength is as follow **Cl_3CCOOH > $Cl_2CHCOOH$ > $ClCH_2COOH$ > CH_3COOH**

- **Greater is K_a value (or less $_pK_a$ value) stronger is the acid**

Carboxylic acid/Substituted carboxylic acid	K_a value	$_pK_a$ value
Cl_3CCOOH	23200×10^{-5}	0.60
$Cl_2CHCOOH$	5530×10^{-5}	1.26
$ClCH_2.COOH$	136×10^{-5}	2.87
CH_3COOH	1.7×10^{-5}	4.76

Q.2 **(B)** Because when **carboxylic acid** is treated with **ammonia, first** of all ammonium salt of carboxylic acid is formed which on heating produces acid amide **as shown in the reaction**

$$RCOOH + NH_3 \longrightarrow RCOO^-NH_4^+$$

$$RCOO^-NH_4^+ \xrightarrow{heat} RCONH_2 + H_2O$$

Q.3 **(D)** In fact, by the reduction of **aldehydes, alcohols** are **obtained instead** of **carboxylic acids. Detail of all preparatory methods of carboxylic acids are given below:**

A) $RCH_2OH \xrightarrow[\{O\}]{K_2Cr_2O_7/H^+} RCOOH$

B) $R-C\equiv N \xrightarrow{2H_2O/HCl} RCOOH + NH_4Cl$

C) $RMgX \xrightarrow[(ii)\ H_2O/H^+]{(i)\ CO_2} RCOOH$

(Carbonation reaction)

D) $R-\overset{O}{\overset{\|}{C}}-H + H_2 \xrightarrow{Pd} ROH$

Q.4 **(A)** Acid anhydride is prepared when carboxylic acids are dehydrated on heating strongly in the presence of phosphorus pentoxide as shown below in the reaction e.g.

$$CH_3\overset{O}{\overset{\|}{C}}OH + HO-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{P_2O_5} CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$$

Acetic anhydride

Q.5 (A) Methanoic acid is very reactive and stronger acid because with the increase of alkyl group polarity of carboxyl group decreases and strength of the acid also decreases.

- **Because alkyl group is electron-donating group and it decreases polarity and thus de-protonation of carboxylic acid decreases with the increase of alkyl group.**
- **Order of reactivity and strength of acid is given below.**

$HCOOH > CH_3COOH > CH_3CH_2COOH > CH_3CH_2CH_2COOH$

- **Their Ka are given as respectively.**

$1.8 \times 10^{-4} > 1.8 \times 10^{-5} > 1.34 \times 10^{-5} > 1.52 \times 10^{-5}$

Q.6 (A) The electron-withdrawing tendency of a substituent depends upon its electronegativity. More electronegative substituent will have **greater electron-withdrawing** tendency.

$FCH_2COOH > ClCH_2COOH > BrCH_2COOH > ICH_2COOH$

Q.7 (D) Compounds **X, Y and Z** stand for **Alcohol, carboxylic acid** and ester respectively. **X and Y** react with each other in the presence of **conc. H_2SO_4** to form **ester.** It is known as esterification or condensation reaction.

Q.8 (A) Glycine is not optically active compound because it **does not** contain asymmetric carbon atom **(Chiral carbon).**

Q.9 (B) When an **alkali** is added to an **α-amino acid, (in the form of zwitter ion) $-NH^+_3$** group releases the proton and therefore, the acidic character is due to this group.

$$R-\underset{\underset{NH_3}{|+}}{CH}COO^- + OH^- \longrightarrow R-\underset{\underset{NH_2}{|}}{CH}-COO^- + H_2O$$

Q.10 (C) The correct structure formula of **lysine** is

$$H_2N\text{-}CH(CH_2)_3\text{-}\underset{\underset{NH_2}{|}}{CH}\text{-}COOH$$

Q.11 (C) It is incorrect statement. The correct statement is as follow:

- **20 α-amino acids can be sub-classified according to how the properties of other functional groups in the 'R' group influence the system.**
- **Non—polar side chains (e.g. alkyl groups)**
- **Polar (e.g. amides alcohols)**
- **Acidic (carboxylic acids, phenols)**
- **Basic (e.g. amines)**

Q.12 (D) In fact it is used as local irritant but not as an antiseptic in nasal infection.

Q.13 (B) Order of strength of acidic character is given as follow:

Ethanoic acid > Phenol > Water > Ethanol

$1.76 \times 10^{-5} > 1.3 \times 10^{-10} > 1.0 \times 10^{-14} > 10^{-16}$

Q.14 (D) Benzoic acid **cannot** be prepared by oxidation of **phenol.** Others **A, B, C methods** are used to **prepare Benzoic acid.**

Q.15 (A) **Ester (a class of organic compounds)** is used for artificial flavorings in **jams.**

Q.16 (C) **Carboxylic acid (RCOOH)** would react readily with **NaOH** as shown in the reaction:

$$RCOOH + NaOH \longrightarrow RCOONa + H_2O$$

Q.17 (D) Their **decreasing order** of acidic character is as follow **IV > III > I > II**

- **The electron releasing group –OH, $-NH_2$,$-CH_3$ etc. tend to decrease strength of benzoic acid.**
- **The electron withdrawing groups such as $–NO_2$, –Cl etc. tend to increase the strength of benzoic acid.**

Q.18 (B) In fact, **amino acid** have **high melting points.**

Q.19 (B) **By acid hydrolysis of ethane nitrile ethanoic acid is obtained as shown in the reaction:**

$$CH_3\text{-}CN + 2HOH \xrightarrow{HCl} CH_3COOH + NH_4Cl$$

Q.20 (D) **Polypeptides** are amphoteric because of the presence of **free $–NH_2$** and **–COOH** groups. Therefore they can be treated as **acids** and **bases.**

Q.21 (D) **Hofmann's method:**

Haloalkanes when heated with an ethanolic solution of ammonia in a sealed tribe at 100°C, a mixture of the three amines and some quaternary ammonium salt are obtained. This reaction is called ammonylsis.

- This method is used for the industrial preparation of amines.
- The three amines so obtained can be separated from the quaternary ammonia salt by boiling with KOH, when the quaternary salt is left behind, and the three amines distil over.
- These can be separated from each other by fractional distillation:

Preparations of amines

- **Primary amine:**

$$RX + NH_3 \xrightarrow[-HX]{} RNH_2$$

- **Secondary amine:**

$$RX + RNH_2 \xrightarrow[-HX]{} R_2NH$$

- **Tertiary amine:**

$$RX + R_2NH \xrightarrow[-HX]{} R_3N$$

- **Quaternary salt:**

$$RX + R_3N \xrightarrow[-HX]{} R_4N^+X^-$$

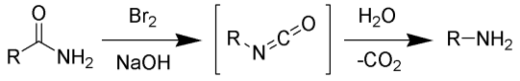
Q.22 (A) **Amides are dehydrated by heating a solid mixture of the amide and phosphorus (V) oxide P_4O_{10}.**

- **Water is removed from the amide group to leave a nitrile group, -CN. The liquid nitrile is collected by simple distillation.**
- **e.g. on the dehydration of ethanamide, in the presence of P_2O_5 ethane nitrile is obtained as shown in the reaction.**

$$CH_3CONH_2 \xrightarrow[-H_2O]{P_4O_{10}} CH_3CN + H_2O$$

Q.23 (A) **Hoffmann's-bromide (or hypobromide) reaction:**

This reaction is also known as Hoffmann's rearrangement of amides. Treatment of acid amides with bromide and caustic potash gives primary amines having one carbon less than the amide.



Isocyanate

The reaction is named after its discoverer - August Wilhelm von Hofmann. This reaction is also sometimes called the Hofmann degradation or the Harmon Process.

Q.24 (A) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-\underset{\underset{NH_2}{|}}{CH}-CH_3$

The correct name of the above structure according to IUPAC is 4-Methyl pentan-2-amine.

Q.25 (A) The carbylamine reaction, also known as Hoffmann's isocyanide test is a chemical test for detection of primary amines. In this reaction, the analyte is heated with alcoholic potassium hydroxide and chloroform. If a primary amine is present, the isocyanide (carbylamine) is formed which are foul smelling substances.

$CH_3\text{-}CH_2\text{-}NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} CH_3\text{-}CH_2\text{-}N^+ \equiv C^- + 3KCl + 3H_2O$

The carbylamine test does not give a positive reaction with secondary and tertiary amines.

Q.26 (A) The basicity of amines is often discussed indirectly in terms of the acidity of their respective conjugate acids.

- **Recall that the conjugate acid of a weak base (e.g. like water) is a strong acid (like hydronium ion), while the conjugate acid of a strong base (like hydroxide ion) is a weak acid (like water).**
- **The concept of pKa has already been developed as a measure of the acidity of Bronsted acids, and we will also see that a corresponding concept, pKb can be used as a measure of the basicity of bases and that these two quantities are very closely related.**
- **Consider the acid dissociation, in dilute aqueous solution, of ammonia and a representative primary, secondary, and tertiary amine.**
- **The correct order of basic nature of the following CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$ and NH_3 is $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$.**
- **The relative decreasing order of basic character can be justified on the basis of K_b and pK_b value as shown in the tabular form.**

Type of amines and ammonia	K_b	pK_b

I. $(CH_3)_2NH$	5.4×10^{-4}	3.27
II. CH_3NH_2	4.5×10^{-4}	3.35
III. $(CH_3)_3N$	0.6×10^{-4}	4.22
IV. NH_3	1.8×10^{-5}	4.74

The observed order of basic strength of amines and ammonia is as follow:

I > II > III > IV

- **Thus the basic strength of aliphatic amines is governed by the following three factors:**
- **Electron-releasing tendency of the alkyl groups**
- **Solvation tendency of the protonated amine**
- **Steric effects of the alkyl groups**

Q.27 (A) By the reaction of ethanoic acid with ammonia, ethane amide is obtained as shown in the reaction:

$$CH_3\text{-}COOH + NH_3 \xrightarrow{\Delta} CH_3\text{-}CO\text{-}NH_2 + H_2O$$

Q.28 (D) The strongest base among the following is ethylamine.

Q.29 (D) Tautomerism is not shown by aliphatic amines **while** chain isomerism, position isomerism and metamerism are **shown by aliphatic amines.**

Q.30 (D) Electrophoresis is the motion of dispersed particles relative to a fluid under the influence of a spatially uniform electric field. It is used for the separation of proteins, amino acids, nucleic acids but not for lipids.

Q.31 (B) Gel electrophoresis is a laboratory method used to separate mixtures of DNA, RNA, or proteins according to molecular size. In gel electrophoresis, the molecules to be separated are pushed by an electrical field through a gel that contains small pores.

Q.32 (A) In electrophoresis, the electrophoretic mobility ('μ') determines the characteristics of migration of different biomolecules by the size of molecule, molecular weight and net charge on the molecule but stereochemistry of molecule is not involved in electrophoresis.

Q.33 (B) Among the derivative of carboxylic acid, acid halide is more reactive because halogen group is good leaving. **Order of reactivity of derivative of carboxylic acid is given below:**

R-CO-Cl > R-CO-OCOR >

R-CO-OR > R-CO-NH_2

Q.34 (A) When acid chloride is treated with hydrogen, aldehyde is produced in the presence of $Pd/BaSO_4$. Detail of all the reactions is given below:

A) $R - \overset{O}{\overset{\|}{C}} - Cl \xrightarrow[Pd/BaSO_4]{H_2} RCHO + HCl$

Aldehyde

B) $R - \overset{O}{\overset{\|}{C}} - Cl \xrightarrow[\text{Ammonolysis}]{NH_3} R-CO-NH_2 + HCl$

Acid amide

C) $R - \overset{\overset{O}{\|}}{C} - Cl \xrightarrow[Hydrolysis]{H_2O} R - CO - OH + HCl$

Carboxylic acid

D) $R - \overset{\overset{O}{\|}}{C} - Cl \xrightarrow[Alcoholysis]{R'OH} R - CO - OR' +$ **Ester**

Q.35 (D) When Grignard reagent is treated with ammonia, alkane is produced along with side product as shown in the reaction:

$$\overset{\delta^-}{R} - \overset{\delta^+}{Mg} - \overset{\delta^-}{X} + \overset{\delta^+}{H} - NH_2 \longrightarrow R - H + Mg\begin{matrix} X \\ NH_2 \end{matrix}$$

Methods which are used to prepare amine are as:

A) By the reduction of acid amide

$$RCONH_2 + 4[H] \xrightarrow[ether]{LiAlH_4} RCH_2NH_2 + H_2O$$

B) Reductive amination of aldehyde or ketones

$$RCHO + NH_3 \xrightarrow[-H_2O]{heat} RCH{=}NH \xrightarrow[reductive]{H_2/Ni} RCH_2NH_2$$

C) By catalytic hydrogenation H_2/Pt

$$RCONH_2 + 2H_2 \xrightarrow{Ni} RCH_2NH_2 + H_2O$$

Q.36 (D) All are the **characteristics** of zwitter ion.

Q.37 (B) Amino acid molecules can react with each other, the acid –COOH group in one molecule reacts with the basic $–NH_2$ group in another molecule. When two amino acids react together, the resulting molecule is **called dipeptide.**

Q.38 (D) On the acidic hydrolysis of acid amide **carboxylic acid** is **obtained** along with side product as **shown** in the **reaction**:

$$RCONH_2 + HCl + H_2O \longrightarrow R - COOH + NH_4Cl$$

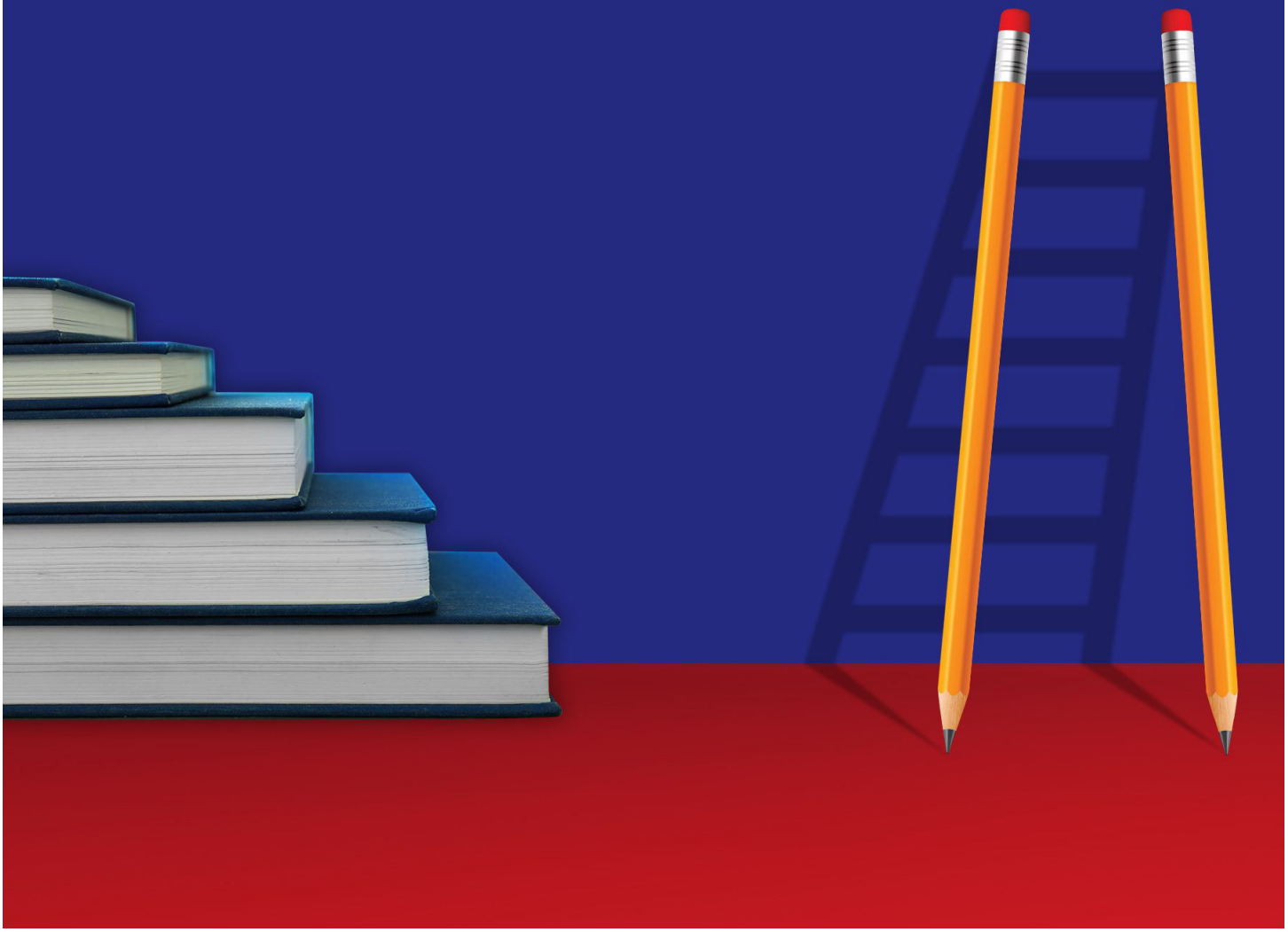
Q.39 (B) The order of reactivity of derivatives of carboxylic acid is as follow:

$R – CO – Cl > R – CO – OCOR > R – CO – OR > R – CO – NH_2$

This order clearly shows that acid amide is the least reactive.

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-6

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-06

(C. Organic Chemistry)

Macromolecules

USE THIS SPACE FOR SCRATCH WORK

Q.1 Nylon-6,6 is a type of condensation polymerization. Its monomers are:

A) Hexane-1,6-diamine and Hexanedioc acid

B) Hexane-1,2-diamine and Hexanedioc acid

C) Hexane-1,4-diamine and Hexanedioc acid

D) Hexane-1,5-diamine and Hexanedioc acid

Q.2 Which of the following intermolecular force is dominant in Nylon-6,6?

A) Dipole dipole forces

B) Hydrogen bonding

C) Debye forces

D) London dispersion forces

Q.3 Nylone-6,6 has all of the followings properties EXCEPT:

A) It is a textile fibre

B) It has high strength

C) It has abrasion resistance

D) It has very low elasticity

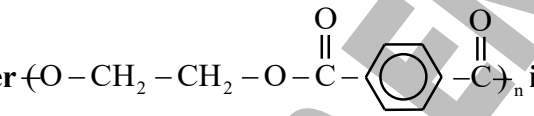
Q.4 There are two types of polymerization i.e. addition and condensation. Condensation polymerization has all of the following properties EXCEPT:

A) It involves two different monomers

B) It take place with the elimination of small molecules

C) It involves catalyst

D) It molar mass is not fixed

Q.5 Polyester  **is a type of condensation polymerization. Its monomers are:**

A) 1,2-Ethanediol and Benzene-1,4-dicarboxylic acid

B) 1,3-Propanediol and Benzene-1,2-dicarboxylic acid

C) 1,1-Ethanediol and Benzene-1,3-dicarboxylic acid

D) 1,4-Butanediol and benzoic acid

USE THIS SPACE FOR SCRATCH WORK

Q.6 Polyester is also known as terylene or Darcon. Identify the incorrect statement about the uses of polyester:

A) It is used as summer suiting by blending with cotton

B) It is used as winter suiting by blending with wool

C) It is used to make bristles for brushes

D) It is used to make seat belts

Q.7 Polymers can be classified on the basis of thermal properties i.e. thermoplastic polymers and thermosetting polymers. Thermosetting polymers show all of the following properties EXCEPT:

A) They are formed by condensation polymerization

B) They do not involve chemical change on heating

C) They decompose on heating

D) They are cross linked polymers

Q.8 Mark the incorrect statement about thermoplastic polymers:

A) They are formed by addition polymerization

B) They melt on heating and harden again on cooling

C) The are more brittle and insoluble in organic solvents

D) They can be remoulded, recast and reshaped

Q.9 All of the following are thermosetting polymers EXCEPT:

A) Polystyrene C) Synthetic varnish

B) Bakelite D) Terylene

Q.10 All of the following are thermoplastic polymers EXCEPT:

A) PVC

B) Teflon

C) High density polyethylene (HDPE)

D) Nylon-6,6

Q.11 Which of the following is a synthetic polymer?

A) Animal fat C) Polyester

B) Starch D) Cellulose

USE THIS SPACE FOR SCRATCH WORK

Q.12 Plastics are pollution problem because many plastics:

A) Are made from petroleum

B) Are very in flammable

C) Burn to produce toxic fumes

D) De compose to produce products

Q.13 A polymeric substance that is formed in the liquid state and then harden to a rigid solid is called a:

A) Animal fibre C) Plastic

B) Mineral fibre D) Polyamide resin

Q.14 Polyvinylchloride (PVC) is an addition polymer obtained by polymerizing vinylchloride at 25°C and 9.0 atmospheric pressure. Which one of the following is not use of PVC?

A) It is used for floor coverings

B) It is used in pipe making

C) It is used in making gramophone recorders

D) It is used for making toys

Q.15 Polystyrene is an addition polymer obtained by polymerization of styrene in the presence of catalyst. Which one of the following is not use of polystyrene?

A) It is used as an adhesive material

B) It is used for making cosmetic bottles

C) It is used for making packing material

D) It is used for making food containers

Q.16 Mark the pair of macromolecules which have same type of linkage:

A) Proteins and nylon C) Nylon and polyethylene

B) Protein and PVC D) PVC and Bakelite

Q.17 Which of the following polymers is formed through free radical mechanism?

A) Nylon-6,6 C) PVC

B) Polyester D) Bakelite

USE THIS SPACE FOR SCRATCH WORK

Q.18 Which of the following is not nitrogen base?

A) Adenine C) Guanine

B) Caesein D) Thymine

Q.19 All of the following have peptide linkage EXCEPT:

A) Nylon-6,6 C) Protein

B) Terylene D) Nylon-6,10

Q.20 Mark the incorrect statement about deoxyribonucleic acid (DNA):

A) It is hereditary material

B) It is double stranded molecule

C) It is present in the nucleus and cytoplasm of a cell

D) It has the property of self-replication

Q.21 All of the following are addition polymers EXCEPT:

A) Polyvinyl chloride C) Polyvinyl acetate

B) Polyethylene D) Polyester

Q.22 Which of the following is not correctly matched?

Options	Polymer	Monomers
A)	Nylon-6,6	Adipic acid and Hexamethylene diamine
B)	Polyester	Terephthalic acid and Ethylene glycol
C)	Polyacrylonitrile	Acrylic acid
D)	Bakelite	Phenol and Formaldehyde

Q.23 The sequence of the amino acids combined in a peptide chain is referred to as the _____ of protein:

A) Primary structure C) Tertiary structure

B) Secondary structure D) Quaternary structure

Q.24 The _____ structure of a protein is a regular coiling or zigzagging of polypeptide chains caused by hydrogen bonding between $\diagdown\!\!\diagup$NH and C = O groups of amino acids near each other in the chains.

A) Primary structure
C) Tertiary structure
B) Secondary structure
D) Quaternary structure

Q.25 Which of the following is not natural polymer?

Options	Types	Examples
A)	Polysaccharides	Starch, Cellulose and Glycogen
B)	Proteins (Polyamides)	Albumins, Glubulins and enzymes
C)	Nucleic acids (Polynucleotides)	DNA and RNA
D)	Natural rubber	Neoprene

Q.26 All of the following co-factors correctly match with their respective enzyme EXCEPT:

Options	Co-factors	Enzymes
A)	Fe^{+2}	Chrome oxidase
B)	Zn^{+2}	Carbonic anhydrase
C)	Mg^{+2}	Glucose-6-phosphatase
D)	Vitamin B1	Thiamine glucose phosphatase

Q.27 Which of the following is not naturally occurring compounds belonging to steroids?

A) Cholesterol
C) Alkaloids
B) Ergosterol
D) Phospholipids

USE THIS SPACE FOR SCRATCH WORK

Q.28 Monosaccharides, disaccharides and polysaccharides differ in the following characteristics EXCEPT:

Opt.	Property	Saccharides		
		Mono	Di	Poly
A)	Hydrolysis	No action	Yields two monosacchrides	Yields a large number of monosaccharides
B)	Solubility in water	Soluble	Soluble	Insoluble
C)	Optical activity	Non-active	Non-Active	Active
D)	Physical state	Crystalline	Crystalline	Amorphous

Q.29 Identify the incorrect statement about oils and fats:

Opt.	Oils	Fats
A)	They are triglycerides of unsaturated fatty acids	They are triglycerides of saturated fatty acids
B)	They are liquids at room temperature	They are solids at room temperature
C)	They are obtained from plants	They are obtained from animals
D)	They are not easily digested	They are easily digested

Q.30 Which of the following is the most abundant carbohydrates?

A) Starch C) Glycogen

B) Cellulose D) Raffinose

Q.31 Which of the following is an example of derived protein?

A) Collagen C) Lipoprotein

B) Oligopeptides D) Lactoglobulin

Q.32 Which of the followings are known as sugars?

A) Monosaccharides only

B) Disaccharides only

C) Both monosaccharides and disaccharides

D) Neither monosaccharides nor oligosaccharides

Q.33 Which of the following is not reducing sugar?

A) Glucose C) Sucrose

B) Maltose D) Galactose

USE THIS SPACE FOR SCRATCH WORK

Q.34 Mark the incorrect statement for starch and cellulose:

Options	Starch	Cellulose
A)	Polymer of α-D glucose	Polymer of β-D glucose
B)	Branched polymer	Unbranched polymer
C)	Used in the photographic film	Used in the sizing of paper
D)	Sources (Wheat, rice, maize, potatoes)	Sources (Cotton is 99% and woody parts has more than 50% cellulose)

Q.35 The specific substance (metabolite) that fits on the enzyme surface and is converted to products is called:

A) Co-factor C) Isoenzyme

B) Prosthetic group D) Substrate

Q.36 Mark the incorrect statement for acid hydrolysis of carbohydrates:

A) Lactose $\xrightarrow{H_2O/H^+}$ Fructose + Galactose

B) Sucrose $\xrightarrow{H_2O/H^+}$ Glucose + fructose

C) Maltose $\xrightarrow{H_2O/H^+}$ 2 Glucose units

D) Starch $\xrightarrow{H_2O/H^+}$ 1st maltose and finally D.Glucose

Q.37 Which is incorrectly matched?

A) Steroids name-perhydrocyclopentanophenanthrene

B) Lipid – Triester

C) Terylene – terephthalic acid and glycerol

D) Polystyrene – styrene

Q.38 Starch has all of the following uses EXCEPT:

A) As an indicator in iodimetry titration

B) As a bread

C) For stiffening of clothes

D) Used as an indicator in acid base titration

USE THIS SPACE FOR SCRATCH WORK

Q.39 Trisaccharide which yields three monosaccharide on hydrolysis have molecular formula:

A) $C_{18}H_{32}O_{16}$ C) $C_{18}H_{34}O_{17}$

B) $C_{18}H_{36}O_{18}$ D) $C_{18}H_{30}O_{15}$

Q.40 Which one of the following is not called "food factor"?

A) Proteins C) Lipids

B) Carbohydrates D) Nucleic acids

Q.41 The enzyme that catalyze the transfer of groups within molecules to yield isomeric forms is called:

A) Lyase C) Hydrolase

B) Ligase D) Isomerase

Q.42 Which one of the following is an exact composition of a carbohydrates?

A) Carbon and hydrogen

B) Carbon, hydrogen and oxygen

C) Carbon and oxygen

D) Hydrogen and oxygen

Q.43 Amylose is soluble in water and gives deep _____ colour with iodine.

A) Yellow C) Blue

B) Pink D) Red

Q.44 The number of milligrams of potassium hydroxide required to neutralize one gram of a fat or an oil is called:

A) Acid number C) Octane number

B) Iodine number D) Saponification number

Q.45 Collagen proteins are present in _____ throughout the body.

A) Muscles C) Tendons

B) Red blood cells D) Blood plasma

Q.46 Many enzymes contain a protein part and non-protein part. The protein part of enzyme is called:

A) Apoenzyme B) Holoenzyme

C) Co-factor D) Co-enzyme

USE THIS SPACE FOR SCRATCH WORK

Q.47 The rate of enzymatic reaction is directly proportional:

A) $[Enzyme]^2$ C) $\sqrt{[Enzyme]}$

B) $[Enzyme]^3$ D) [Enzyme]

Q.48 Which of the following statements about glucose and sucrose is incorrect?

A) Both are naturally occurring

B) Both are water soluble

C) Both are disaccharide

D) Both are carbohydrates

Q.49 Extent of unsaturation in a fat or an oil is expressed in terms of:

A) Acid number C) Saponification

B) Iodine number D) Rancidity

Q.50 Fats are a type of lipid called glycerides, they are esters of long chain carboxylic acids and:

A) Propene-1,2,3-triol C) Propene-1,2,3-diol

B) Propane-1,2,3-diol D) Propane-1,2,3-triol

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-06)									
1	A	11	C	21	D	31	B	41	D
2	B	12	C	22	C	32	C	42	B
3	D	13	C	23	A	33	C	43	C
4	C	14	D	24	B	34	C	44	A
5	A	15	A	25	D	35	D	45	C
6	C	16	A	26	D	36	A	46	A
7	B	17	C	27	C	37	C	47	C
8	C	18	B	28	C	38	D	48	C
9	A	19	B	29	D	39	A	49	B
10	D	20	C	30	B	40	D	50	D

ANSWERS EXPLAINED

Q.1 (A) Its monomers are Hexane-1,6-diamine ($NH_2(CH_2)_6NH_2$) and hexanedioic acid ($HOOC(CH_2)_4COOH$). As a result of condensation polymerization of monomers nylon-6,6 is formed along with side product water. Other options B, C and D are not correct names of monomers required for nylon-6,6.

Q.2 (B) Nylon-6,6 is also known as polyamide. Because it has peptide bond and there is hydrogen bonding in nylon-6,6.

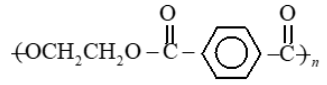
- Other options are irrelevant.

Q.3 (D) It is incorrect statement.

- In fact, it has high elasticity. Other properties are shown by nylon-6,6.

Q.4 (C) Condensation polymerization does not involve catalyst. Catalyst is used in addition polymerization. Other properties are shown by condensation polymerization.

Q.5 (A) Polyester is a type of condensation polymerization. Its monomers are 1,2-ethanediol and Benzene-1,4 dicarboxylic acid. As a result of condensation of the said monomers polyester is formed along with side product water.



Q.6 (C) In fact polyester is not used to make bristles for brushes. Bristles for brushes are made by nylon-6,6. All other properties (A, B, D) are shown by polyesters.

Q.7 (B) Thermosetting polymers become hard on heating. As a result of chemical change they cannot be re-melted. They decompose on heating.

Q.8 (C) In fact they are less brittle and soluble in some organic solvents. Example of thermoplastic polymers are polyethylene, Teflon, Polyacrylonitrile etc.

Q.9 (A) Polystyrene is not an example of thermosetting plastic because it is formed by addition polymerization. Thermosetting polymers are formed as a result of condensation polymerization.

Q.10 (D) In fact, nylon-6, 6 is not an example of thermoplastic polymer. Because on heating it becomes hard and then it can never be re-melted.

Q.11 (C) Polyester is a synthetic polymer. It is formed by condensation of 1,2-ethanediol and Benzene-1,4 dicarboxylic acid. Others animals fat, starch and cellulose are biopolymers because they are formed by living organisms.

Q.12 (C) Plastics are pollution problem because many plastics on burning produce toxic fumes which are very harmful and are one of the major cause of air pollution.

Q.13 (C) Plastic is a synthetic polymer and it is formed in the liquid state and then become hard on cooling.

Q.14 (D) It is incorrect statement. In fact Polystyrene or polyethylene are used to make toys

Q.15 (A) Polystyrene is not used as an adhesive material. In fact polyvinyl acetate (PVA) is used an adhesive material and as a binder for emulsion paints. However other properties are shown by polystyrene.

Q.16 (A) Both proteins and nylons have polypeptide bonds and thus they have same type of linkage. Others do not have peptide bonds.

Q.17 (C) PVC polymer is formed by addition polymerization which involves free radical mechanism. Free radical is formed in the initiation step. Other are propagation and termination steps. (in other words free radical mechanism involves three steps i.e. initiation, propagation and termination.

Q.18 (B) Casein is not nitrogen base. In fact, it is main protein present in milk and (in coagulated form) in cheese. It is used to make buttons, food production, beverage, pharmaceutical, cosmetics, agriculture / animal feed.

Q.19 (B) In the formation of terylene (polyester), ethane 1,2 diol and Benzne 1,4 dicarboxylic acid are used as monomers it does not involve peptide linkage. Peptide linkage is involved in (A, B, D).

Q.20 (C) In fact, DNA is not present in the cytoplasm. It is a hereditary material and carries and transfers information from the parent to the offspring. Although RNA is present in both nucleus and cytoplasm.

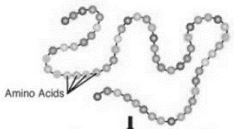
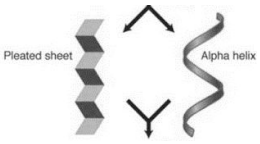
Q.21 (D) **Polyester** is condensed polymer and it is synthesized by the reaction of **terephthalic** acid and **ethylene glycol which are used as monomers.**

Q.22 (C) **It is incorrect statement.** In fact, **polyacrylonitrile** is an addition polymer. Its monomer is acrylonitrile (CH_2=CH-CN) polyacrylonitrile is **used** for the preparation of **synthetic fiber.**

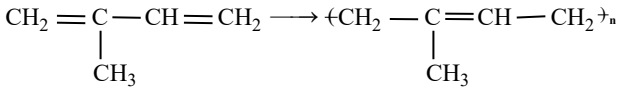
Q.23 (A) The sequence of the amino acids combined in a peptide chain is referred to as the **primary structure.**

Q.24 (B) **Difference between primary and secondary of proteins.**

Primary Protein	Secondary Protein
• The sequence in which amino acids are arranged in a polypeptide chain of the protein is called its primary structure. • Proteins hydrolyze through a number of steps to form α-amino acid • **e.g. Proteins → Proteoses → Peptones → Polypeptides → Simple peptides → α-Amino acids**	• The conformation (or, shape) which the polypeptide chain of a protein molecule acquires due to the secondary bonding such as, hydrogen bonding between the carbonyl and amino groups, is called the secondary structure of the protein. • **e.g. The protein molecules gain addition structural strength by coiling up the polypeptide chains to form a helix. There are two types of helix** • **e.g.** • **I. α-Helix structure (coiled or spiral form)** • **II. β-Flat sheet (in horizontal position) and β-pleated sheet (in the folded form)**

Primary structure of proteins	Secondary structure of proteins
	

Q.25 (D) It is incorrect statement. In fact, Poly(2-methyl-1,3-butadiene is an example of natural rubber. It resembles with synthetic rubber (neoprene) it is obtained by polymerization of 2-Methyl-1,3-butadiene:



Monomer of natural rubber (Isoprene)

Poly(2-methyl-1,3-butadiene) Polymer of natural rubber

Q.26 (D) Also named Thiamine or Thiamine diphosphate (TPP), Vitamin B_1 is a cofactor for oxidative decarboxylation both in the Kreb's Cycle and in converting pyruvate to acetyl-CoA (an important molecule used in the citric acid cycle of metabolism). It is widely available in the human diet and particularly present in wheat germ and yeast. It's functionality results from a thiazole ring which stabilizes charge and electron transfer through resonance.

Q.27 (C) Alkaloids are plant-produced basic compounds which contain one or more nitrogen heterocyclic rings.

Name of alkaloids	Functions
Nicotine	Rising the blood pressure
Caffeine	Stimulating nerves
Atropine	Dialating the pupils of the eyes
Morphine	Relieving pain
Quinine	Cure/prevention of malaria

Q.28 (C) It is incorrect statement. In fact, the correct statement is given in the tabular form:

Options	Property	Saccharides		
		Mono	Di	Poly
A)	Hydrolysis	No action	Yield two monosaccharide	Yields a large number of monosaccharide
B)	Solubility in water	Soluble	Soluble	Insoluble
C)	**Optical activity**	**Active**	**Active**	**Non-active**
D)	Physical state	Crystalline	Crystalline	Amorphous

Q.29 (D) It is incorrect statement. In fact, the correct statement is given in the tabular form:

Options	Oils	Fats
D)	Are easily digested because they are triglycerides of unsaturated fatty acids	Are not easily digested because they are triglycerides of saturated fatty acids

Q.30 (B) Cellulose is the most abundant polysaccharide.

Q.31 (B)

(A) Collagen (Simple protein)
(B) Oligopeptides (Derived proteins)
(C) Lipoprotein (Compound or conjugated proteins)

Q.32 (C) Both monosaccharides and disaccharides are known as sugars. The degree of sweetness varies widely among various sugars as shown in the tabular form:

Sugars	Sweetness value
Sucrose	100
Glucose	74
Fructose	173
Galactose	32
Maltose	32
Lactose	16

Conclusion: From the table it is clear that fructose is the sweetest of sugars and it has **maximum sweetness value (173)** while **lactose has minimum sweetness value (16)**.

Q.33 (C) Sugars (carbohydrates) may also be classified on the basis of their chemical nature, as

- Reducing sugars
- Non-reducing sugars

Reducing sugars	Non-reducing sugars
• All sugars which contain free aldehyde or ketonic group are called reducing sugars.	• All sugars (carbohydrates) which do not contain free aldehyde or ketonic group are called non-reducing sugars.
• They can reduce Fehling's solution or Tollen's reagent.	• They cannot reduce Fehling's solution or Tollen's reagent.
• e.g. All monosaccharides, maltose, Galactose	• e.g. sucrose

Q.34 (C) It is incorrect statement. In fact, the correct statement is given in the tabular form:

Options	Starch	Cellulose
C)	**Used in the sizing of paper**	**Used in the photographic film**

Q.35 (D) The specific substance (metabolite) that fits on the enzyme surface and is converted to products is called substrate.

Q.36 (A) It is incorrect statement. In fact, lactose on hydrolysis gives glucose and galactose.

Q.37 (C) It is incorrect statement. In fact, monomers of terylene polymer are terephthalic acid and ethylene glycol.

Q.38 (D) It is incorrect statement. In fact, starch is used as indicator in iodimetry titration but not in acid base titration.

Q.39 (A) **Raffinose ($C_{18}H_{32}O_{16}$)** is a trisacchride which on hydrolysis gives three monosaccharides.

Q.40 (D) Nucleic acid is not called food factor while carbohydrates, fats and proteins are known as major food factors which are needed for human body.

Q.41 (D) The enzyme that catalyze the transfer of groups within molecules to yield isomeric forms is called **isomerase.**

Q.42 (B) **The composition of carbohydrates is carbon, hydrogen and oxygen.**

Q.43 (C) Amylose is soluble in water and gives deep **blue** colour with iodine.

Q.44 (A) The number of milligrams of potassium hydroxide required to neutralize one gram of a fat or an oil is called **acid number.**

Q.45 (C) Collagen proteins are present in **tendons** throughout the body.

Q.46 (A) Many enzymes contain a protein part and non-protein part. The protein part of enzyme is called **apoenzyme.**

Q.47 (C) The rate of enzymatic reaction is directly proportional $\sqrt{[\text{Enzyme}]}$.

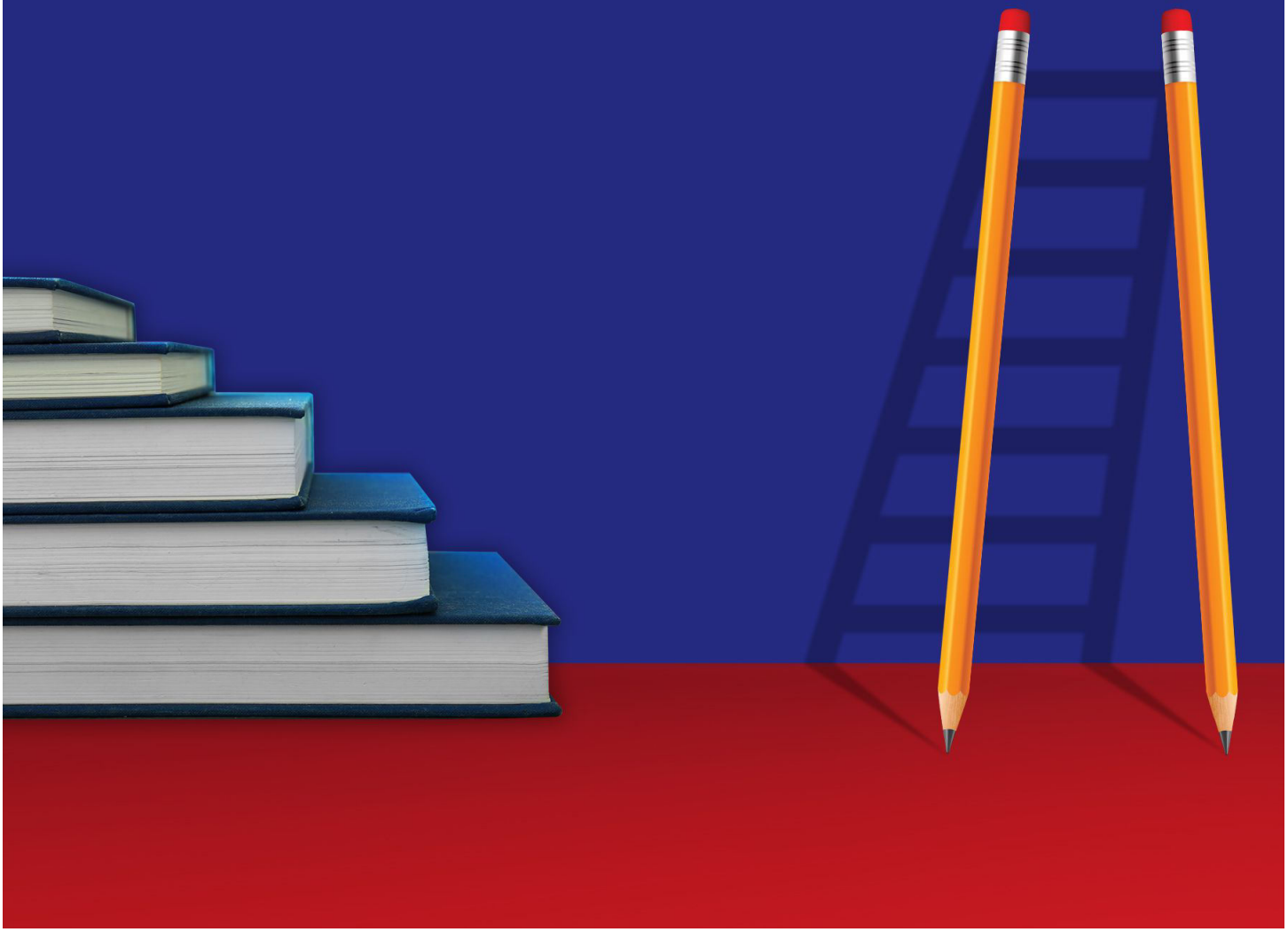
Q.48 (C) **It is incorrect statement. In fact, glucose is monosaccharide and sucrose is disaccharide.**

Q.49 (B) Extent of unsaturation in a fat or an oil is expressed in terms of **iodine number.**

Q.50 (D) Fats are a type of lipids called glycerides, they are esters of saturated fatty acids and **propane-1,2,3-triol.**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-7

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-07

(B. Inorganic Chemistry)

Periods

USE THIS SPACE FOR SCRATCH WORK

Q.1 Which one of the following isoelectronic species has comparatively smaller size?

A) Ar C) Cl^-

B) P^{-3} D) S^{-2}

Q.2 Mark the incorrect statement about ionization energy:

A) It is an index of metallic character

B) Elements having stable electronic configuration have greater ionization energy

C) It is always endothermic process

D) Elements having greater ionization energy have high electron affinity

Q.3 Elements in the periodic table can be classified on the basis of the following EXCEPT:

A) Acidic and basic character

B) Valence orbital

C) Electrical conductivity

D) Valence shell

Q.4 Mark the incorrect statement about the period and group in the modern periodic table:

Opt.	Period	Group
A)	It is horizontal row of elements from left to right	It is vertical column of elements from top to bottom
B)	It is the number of shells involved in the electronic configuration of an element	It is the number of electrons present in the valence shell of atom of an element
C)	There are eight periods	There are sixteen groups
D)	It is shown by Arabic numerals	It is shown by Roman numerals

Q.5 All of the following periodic properties increase along

the period EXCEPT:

A) Ionization energy
C) Electron affinity
B) Atomic size
D) Electronegativity

Q.6 All of the following statements about 1st ionization energy of elements are incorrect EXCEPT:

A) O > N
C) Al > Mg
B) Be > B
D) Ne > He

Q.7 The periodic table provides a basic framework to study the periodic behaviour of:

A) Physical properties only
B) Chemical properties only
C) Physical and chemical properties of elements as well as their compounds
D) Metal and non – metals

Q.8 Magnesium (Mg) is a metal while Chlorine (Cl) is a non-metal, but even then they both:

A) Belong to the same period
B) Belong to the same group
C) Are oxidizing agent
D) Are reducing agent

Q.9 Atomic size of an element depends on:

A) Number of inner shells only
B) Nuclear charge only
C) Both A and B
D) Neither A nor B

Q.10 Which one of the following elements has less electronegativity value?

A) N
C) F
B) O
D) C

Q.11 Which of the following is polar molecule?

A) CO_2
C) BF_3
B) NO
D) SO_3

Q.12 Which of the following periodic properties has no unit?

USE THIS SPACE FOR SCRATCH WORK

A) Ionization energy
C) Atomic radius
B) Electron affinity
D) Electronegativity

Q.13 Mark the incorrect statement about electronegativity (E.N)?

A) The maximum E.N is that of F element in the periodic table

B) The minimum E.N is that of Cs element in the periodic table

C) It is the property of an element in the isolated form

D) It has no unit

Q.14 Consider the following applications of electronegativity (E.N):

I. If the E.N difference between two bonded atoms is zero or less than 0.5, then the bond is said to be non-polar covalent bond

II. If the E.N difference between two bonded atoms is 1.7, then the bond is said to be 50% covalent and 50% ionic bond

III. If the E.N difference between two bonded atoms is 1.6 or more than 0.5, then the bond is said to be polar covalent bond

IV. If the E.N difference between two bonded atoms is greater than 1.7, then the bond is said to be covalent in nature

Which one of the above statements is incorrect?

A) I only
C) IV only
B) II and III only
D) I, II, III and IV

Q.15 Which of the following statements does not match correctly for electron affinity and electronegativity?

USE THIS SPACE FOR SCRATCH WORK

Opt.	Electron Affinity	Electronegativity
A)	It is the energy released or absorbed, when an electron is added to a gaseous atom to form a negative ion	It is the power of an atom to attract shared pair of electrons in a molecule. It is concerned with the attraction for electrons of atoms in molecules
B)	It is concerned with the attraction for electrons of single gaseous atoms	It is associated with atom of element in the molecule
C)	Its unit is $kJmol^{-1}$	It has no unit
D)	It cannot be measured directly. It has relative value	It can be measured directly

USE THIS SPACE FOR SCRATCH WORK

Q.16 Which of the following transition element does not have oxidation number according to group number?

A) Mn (VII) C) Zn (II)

B) Cu (I) D) Cr (V)

Q.17 Which of the following is true about Na, Si and S?

A) Their chlorides are ionic solid

B) Covalent bond is found in most of the compounds

C) They are in the same period of the periodic table

D) They are in the same group of the periodic table

Q.18 The apparent charge that an atom would have in a compound is called oxidation state (O.S).

Consider the following statements about O.S:

I. In ionic compounds, the number of electrons which an atom loses or gains is its O.S

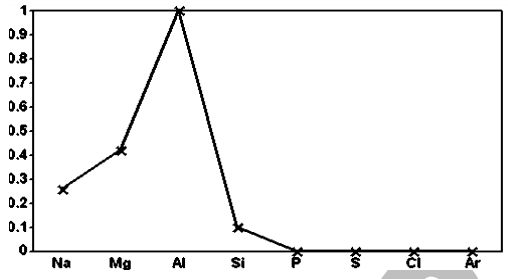
II. In a covalent compounds, the O.S of an element is decided by the difference of electronegativity between two atoms In a covalent compound, the element with greater electronegativity has negative O.S

III. In a covalent compound, the element with less electronegativity has positive O.S

Which of the above statement about O.S is / are correct?

A) III only
C) I and II
B) II only
D) I, II and III

Q.19 The trend shown by the following graph is for:



A) Electrical conductivity
C) Ionization energy
B) Boiling point
D) Atomic size

Q.20 Electrical conductivity in metal increases down the group.

What is the correct order of conductivity in IB?

A) Cu > Ag > Au
C) Cu < Ag < Au
B) Ag > Cu > Au
D) Ag > Au > Cu

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-07)					
1	A	11	B		
2	D	12	D		
3	D	13	C		
4	C	14	C		
5	B	15	D		
6	B	16	D		
7	C	17	C		
8	A	18	D		
9	C	19	A		
10	D	20	B		

ANSWERS EXPLAINED

Q.1 **(A)** Argon (Ar) has comparatively smaller size as shown in the tabular form:

Species	Radius (om)
P^{-3}	212
S^{-2}	184
Cl^{-}	181
Ar	94

- Order of decreasing size of isoelectronic species is as follow:

$$P^{-3} > S^{-2} > Cl^{-} > Ar$$

Q.2 **(D)** In fact, elements having stable electronic configuration have greater ionization energy and lower electron affinity e.g. **N** atom has half-filled **p-subshell** electronic configuration ($_7N = 1s^2, 2s^2, 2p^3$) and its **$I.E_1$** is **1402kJmol^{-1}** whereas its **electron affinity** is **-7kJmol^{-1}.**

Q.3 **(D)** Elements in the periodic table **cannot** be classified into four blocks **(s, p, d and f)** on the basis of valence shell because valence shell is the outermost shell. The number of electrons present in the valence shell determine group of the elements.

- Elements in the periodic table can be classified into four blocks. This classification is based upon the valence orbital of the element involved in chemical bonding.

Q.4 **(C)** **It is incorrect statement. In fact, there are seven periods and eighteen groups in the modern periodic table.**

Q.5 **(B)** Along the period as the **nuclear charge** increases with the **increase** in **atomic number,** electrons in the valence shell are pulled closer to the **nucleus**. Thus the overall **size** of the atom **decreases.**

Q.6 **(B)** **Be > B.** In fact first **ionization energy ($I.E_1$)** of **Be** is greater than that of **B** because in **$_4Be$ ($1s^2, 2s^2$)** s-subshell is completely filled and has stable electronic configuration and has comparatively greater **$I.E_1$** than that of **$_5B$ ($1s^2, 2s^2, 2p^1$). B** has one electron in 2p-subshell and is comparatively less stable and has lower **$I.E_1$.**

Be ($I.E_1$ = 900kJmol^{-1}),

B ($I.E_1$ = 801kJmol^{-1})

Q.7 **(C)** The periodic table provides a basic framework to study the periodic behaviour of physical and chemical properties of elements as well as their compounds.

Q.8 **(A)** Both belong to the same period

$_{12}Mg$ (2,8,2) number of shells involved

= 3 (period = 3)

$_{17}Cl$ (2,8,7) number of shells involved

= 3 (period = 3)

Q.9 **(C)** **With the increase** of **number of inner shells**, atomic size of an atom increases because nucleus hold on the valence electrons decreases. e.g. in IIA group size of Mg is greater

than that of Be. This happens in a **group**.

With the increase of **nuclear charge**, size of atom decreases e.g. size of Be is smaller than that Li. This happens in a **period**.

Q.10 (D) Carbon has less electronegativity value as shown in the tabular form.

Elements	E.N
N	3.0
O	3.5
F	4.0
C	2.5

Q.11 (B) NO is a polar molecule because it has electronegativity difference 0.5 (O = 3.5, N = 3.0).

Q.12 (D) Electronegativity has no unit.

Q.13 (C) It is the property of an element in the associated form (i.e. in the molecular form.

Q.14 (C) It is incorrect statement. The correct statement is as follow.

- If the E.N difference between two bonded atoms is greater than 1.7, then the bond is said to be ionic in nature

Q.15 (D) It is incorrect statement.

The correct statement is as follow:

Opt.	Electron Affinity	Electronegativity
D)	It can be measured directly	It cannot be measured directly. It has relative value

Q.16 (D)

Elements	Groups	Examples	O.S per atom
Mn	VIIB	$K^{+7}MnO_4$	Mn (VII)
Cu	IB	$Cu^{+2}{}_2O^{-2}$	Cu (I)
Zn	IIB	$Zn^{+2}O^{-2}$	Zn (II)
Cr	VIB	$K^{+2}{}_2Cr^{+12}{}_2O^{-14}{}_7$	Cr (VI)

Q.17 (C) They are in the same period of the periodic table.

Q.18 (D)

- In ionic compounds, the number of electrons which an atom loses or gains is its O.S
- In a covalent compounds, the O.S of an element is decided by the difference of electronegativity between two atoms In a covalent compound, the element with greater electronegativity has negative O.S
- In a covalent compound, the element with less electronegativity has positive O.S

Q.19 (A)

- Electrical conductivity increases from Na to Al because it depends on number of free electrons.
- From Na to Al number of free electrons increase and thus electrical conductance increases upto Al.

Prop.	Metals	Metalloid	Non-metals
Examples	Na, Mg and Al	Si	P, S, Cl and Ar
Conductor/ Non-conductor	Good conductor	Poor conductor	Non-conductor
Electrical Conductance (ohm^{-1} cm^{-4})	10^{-3}	10^{-5}	10^{-10}
Effect of increase in temperature	Conducti-vity slowly falls	Conductivi-ty usually increase	No effect

Q.20 **(B)** The correct order of conductivity of IB is as follow: Ag > Cu > Au

STEP

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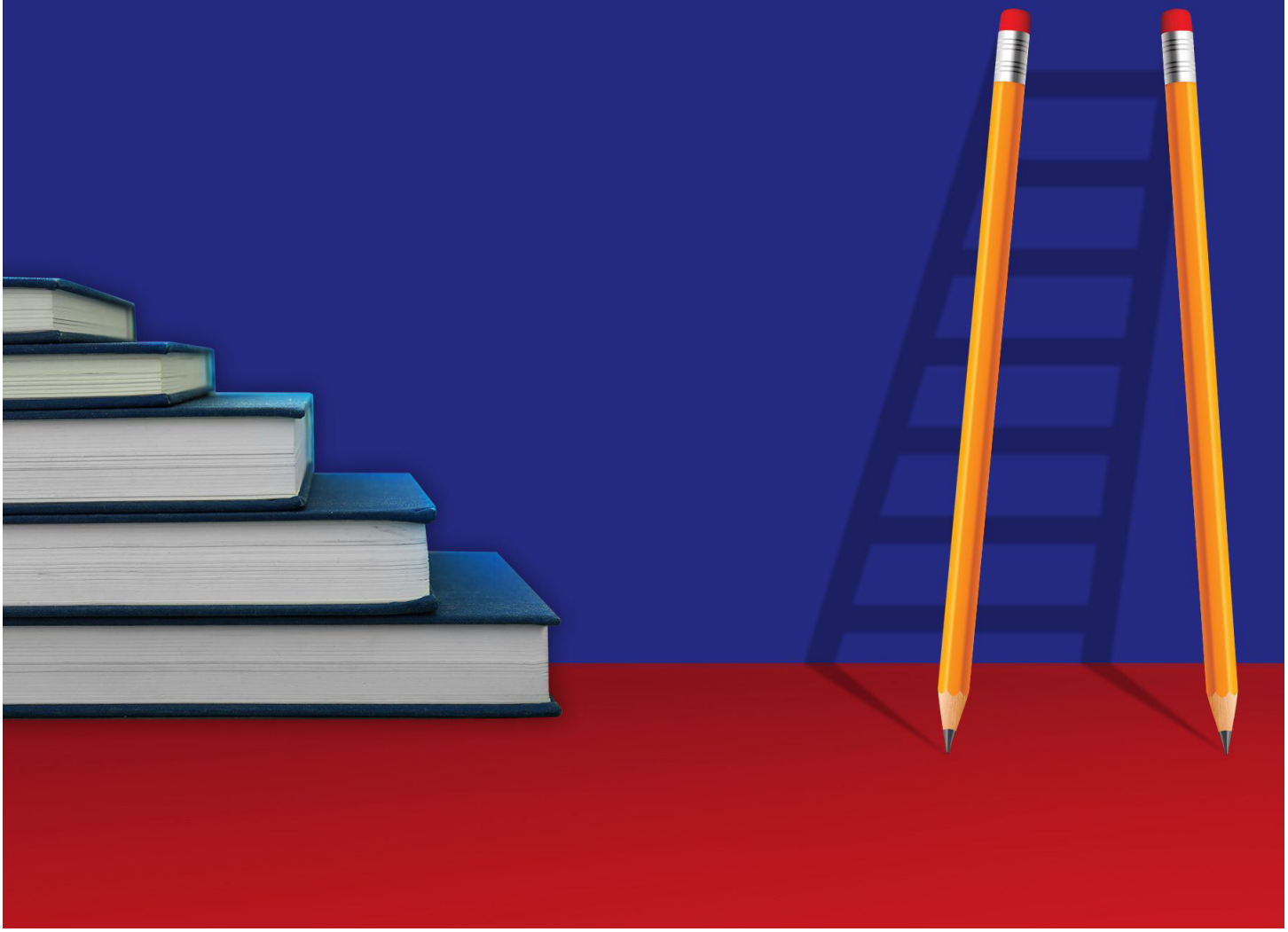

CHEMISTRY

WORKSHEET-8

STEP

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Worksheet-08

(B. Inorganic Chemistry)

Groups

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Q.1 Which one of the following properties of IIA group elements increases down the group?

A) Melting points and boiling points
C) Reducing power
B) ΔH_{hyd}
D) Electron affinity

Q.2 Which of the following elements of IIA group is so reactive that it must be stored under oil to keep it out of contact with air?

A) Mg
C) Sr
B) Ca
D) Ba

Q.3 Which of the following statements is incorrect about IIA and VIIA group elements?

Opt.	IIA group elements	VIIA group elements
A)	They are metals	They are non-metals
B)	They form acidic oxide	They form basic oxides
C)	They have tendency to lose electrons	They have tendency to gain electrons
D)	They have general electronic configuration in the valence shell ns^2	They have general electronic configuration in the valence shell ns^2, np^5

Q.4 Which of the following elements of IIA group does not react with water even at red hot temperature?

A) Mg
C) Ca
B) Be
D) Ba

Q.5 Which of the following elements reacts with cold water slowly but reacts with steam vigorously. General reaction of a metal is shown in the given equations?

- $M_{(s)} + 2H_2O(l) \xrightarrow{\text{Slow reaction}} M(OH)_{2(aq)} + H_{2(g)}$
- $M_{(s)} + H_2O_{(g)} \xrightarrow{\text{steam}} MO_{(s)} + H_{2(g)}$

A) Mg
C) Sr

B) Ca D) Ba

Q.6 Which of the following elements of IIA forms amphoteric oxide when treated with oxygen at 800°C?

A) Be C) Sr

B) Ca D) Mg

Q.7 Which one of the following halogens cannot displace all the other halogens in redox reactions?

A) F_2 C) Br_2

B) Cl_2 D) I_2

Q.8 In which of the following pair of halogens, first halogen is least volatile and second is the most volatile?

A) I_2, F_2 C) Br_2, Cl_2

B) F_2, Br_2 D) I_2, Br_2

Q.9 Mg is a metal while chlorine is a non-metal, but even then they have a common property. Which of the following is that property?

A) Both are reducing agents

B) Both belong to the same period

C) Both are oxidizing agents

D) Both belong to the same group

Q.10 Halogens show all of the following properties EXCEPT:

A) Among the halogens, F_2 is the strongest oxidizing agent

B) Among the halogens acids, HI is the strongest acid

C) Among the oxyacids of Cl, $HClO_4$ is the strongest acid

D) Among halogens, F has maximum electron affinity

Q.11 All of the following are uses of halogens EXCEPT:

A) Chlorination of water is used to kill germs

B) Fluoridation of water is done to stop dental decay process in human beings

C) Flame-retardant plastics do not contain chlorine

D) Tincture of iodine is used for dressing of wounds as an antiseptic

Q.12 Which of the following is not use of helium (He)?

A) It is used to fill fluorescent tubes

B) It is used in weather balloons

C) A mixture of 80%, He and 20% O_2 is used for breathing by the sea divers

D) It is used as a cooling medium for nuclear reactors

USE THIS SPACE FOR SCRATCH WORK

Q.13 Consider the following reaction of chlorine with aqueous sodium hydroxide in the cold state:

$$2NaOH_{(aq)} + Cl_{2(g)} \xrightarrow[15^oC]{\text{cold state}} NaCl_{(aq)} + NaClO_{(aq)} + H_2O$$

Which of the following is type of above reaction?

A) Acid base reaction

B) Disproportionation reaction

C) Elimination reaction

D) Double displacement reaction

Q.14 Which of the following halogens acts as a bleaching agent?

A) F_2 C) Br_2

B) Cl_2 D) I_2

Q.15 Which one of the following is use of radon?

A) It is used in radiotherapy for cancer treatment

B) It is used in electric light bulb

C) It is used in bactericidal lamps

D) It is used in making advertising sign

Q.16 Which of the following oxides is unlikely to be dissolved in sodium hydroxide?

A) MgO C) Al_2O_3

B) SiO_2 D) NO_2

Q.17 Which of the following properties decreases down the group in case of halogens?

A) Covalent and ionic radii

B) Van der waal's forces

C) Electronegativity

D) Melting points and boiling points

Q.18 When chlorine (Cl_2) is heated with hot concentrated aqueous NaOH solution at 70^oC, a disproportionation reaction takes place as shown below?

$$NaOH + Cl_2 \xrightarrow{70^oC} \ldots\ldots$$

Which of the following products are formed?

A) NaCl, NaClO C) $NaClO_3$, NaCl, H_2O

B) $NaClO_3$, H_2O D) $NaClO_3$, NaClO

Q.19 Identify the incorrect statements about IIA group

USE THIS SPACE FOR SCRATCH WORK

elements:

A) They are known as alkaline earth metals

B) They have two electrons in the outermost shell and occupy s sub-shell

C) Their atomic radii increase down the group

D) Ionization energy of Ca is higher than that of Mg

Q.20 When small amount of chlorine is added to water supply, it will kill bacteria and make water safe to drink. As a result of reaction of Cl_2 with water HOCl and HCl are produced. One theory suggests that HOCl produces reactive _____ species that will kill bacteria in water.

A) [H] C) [O]

B) [Cl] D) [HCl]

Q.21 Which of the following halogen acids is the least stable thermally?

A) HF C) HBr

B) HCl D) HI

Q.22 Beryllium becomes passive on reaction with conc. HNO_3 because:

A) It is non-reactive metal

B) It forms stable layer of oxide

C) It has non-reactive nature with the acid

D) It has small size

Q.23 Oxidizing power of halogens does not depend on:

A) Electron affinity of atom

B) Hydration energies of ions

C) Energy of dissociation

D) Density

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-08)					
1	C	11	C	21	D
2	D	12	A	22	B
3	B	13	B	23	D
4	B	14	B		
5	A	15	A		
6	A	16	A		
7	D	17	C		
8	A	18	C		
9	B	19	D		
10	D	20	C		

ANSWERS EXPLAINED

Q.1 **(C)** Reducing power of IIA group elements increases down the group because down the group number of inner shells increase, atomic radii increase, and shielding effect increases. As a result ionization energy decreases and metallic character increases and thus reducing power of IIA group elements increases.

Q.2 **(D)** **In IIA group chemical reactivity of elements increases because atomic size increases with the increase of shielding effect. As a result, nucleus hold on the valence electrons decreases. That is why Ba element of IIA group is so reactive that it must be stored under oil to keep it out of contact with air.**

Q.3 **(B) It is incorrect statement. In fact,**

- **The elements of IIA group form basic oxide e.g. MgO, CaO.**
- **The elements of VIIA group form acidic oxide e.g. Cl_2O_7.**

Q.4 **(B)** This is because Be has **smaller size**, **stronger nucleus** hold on the valence shell electrons and thus has **less** chemical reactivity.

Q.5 **(A)** **Mg** reacts with cold water slowly but reacts vigorously with steam as shown in the reaction:

- $Mg_{(s)} + 2H_2O_{(l)} \xrightarrow{Slow} Mg(OH)_{2(aq)} + H_{2(g)}$
- $Mg_{(s)} + H_2O_{(g)} \xrightarrow{steam} MgO_{(s)} + H_{2(g)}$

Q.6 **(A)** In IIA group, beryllium is the least reactive metal. It is resistant to complete oxidation and stable in air at ordinary temperature but oxidizes rapidly at about 800^oC and forms amphoteric oxide as shown in the reaction:

$$2Be + O_2 \xrightarrow{800^oC} 2BeO$$

- BeO is amphoteric in nature

Q.7 **(D)** I_2 is the weakest oxidizing agent among all the halogens because it has smaller standard reduction potential (+0.54V) value and smaller electronegativity (2.5). So it cannot displace all the halogens such as F_2, Cl_2 and Br_2 in the redox reactions. Order of decreasing oxidizing power of halogens is as follow:

$$F_{2(g)} > Cl_{2(g)} > Br_{2(l)} > I_{2(s)}$$

Q.8 **(A)** There are only weak van der waal's forces between their diatomic halogen molecules. These forces increase as the number of electrons in the molecules increases with increasing atomic number. Greater is the number of electrons greater are the opportunities for instantaneous dipole arising within molecules, and for induced dipole to be produced on neighboring molecules. So the larger the molecular size, stronger the van der waal's forces between molecules and thus making iodine the least volatile and fluorine the most volatile of the halogens.

Q.9 (B) **Mg and Cl** have only common property that they belong to the same period i.e. **3rd period** as shown by their electronic configuration:

- **$_{12}$Mg ($1s^2$, $2s^2$, $2p^6$, $3s^2$)**
- **$_{17}$Cl ($1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^5$)**

This configuration clearly shows that these two elements belong to same period (i.e. 3rd period).

Q.10 (D) In fact, among the halogens, **chlorine** element has **greater electron affinity. Order** of **decreasing** electron affinity in halogens is as follow (unit of electron affinity $kJmol^{-1}$).

Cl (-349) > Br (-325) > F (-322) > I (-295)

Q.11 (C) In fact, flame-retardant plastics often contain **bromine and chlorine.**

Q.12 (A) In fact, **Krypton (Kr)** is used to fill fluorescent tubes and in flash lamps for high speed photography not **Helium (He)**.

Q.13 (B) It is self-oxidation reduction reaction. One Cl-atom is reduced from **Cl^0 to Cl^-** (such as in $Na^{+1}Cl^{-1}$) and other atom of Cl is oxidized from **Cl^0 to Cl^{+1}** (such as in $Na^{+1}Cl^{+1}O^{-2}$) in the redox reaction.

Q.14 (B) **Cl_2 gas acts as a bleaching agent.**

- **Other bleaching agents are O_3, ClO_2, H_2O_2, NaOCl and SO_2 (temporary bleaching agent)**

Q.15 (A) **Radon being radioactive is used in radiotherapy for cancer and for earth quake prediction**.

Q.16 (A) **MgO** is basic in nature and it **does not** dissolve in **NaOH solution**. **A** is **amphoteric** while **B** and **D** are **acidic in nature. They (A, B and D) can react with NaOH except MgO.**

Q.17 (C) **Electronegativity of halogens decreases down the group, because atomic size and shielding effect increase.**

Property	F	Cl	Br	I
Electronegativity	4.0	3.0	2.8	2.5

Q.18 (C) **$6NaOH + 3Cl_2 \xrightarrow{70^oC} 5NaCl + NaClO_3 + H_2O$.** The reaction **clearly shows** that the **product formed** are **NaCl, $NaClO_3$, H_2O.**

Q.19 (D) Ionization energy of **Ca** is **lower** than that of **Mg (first ionization energy 738$kJmol^{-1}$)** because the size of **Ca (first ionization energy 595$kJmol^{-1}$)** is **greater** than that of **Mg**. **Greater** is the **size, smaller** is the **ionization energy.**

Q.20 (C) **When Cl_2 is added in water then as a result of reaction HCl and HOCl are produced as shown in the equation**

$$Cl_{2(aq)} + H_2O_{(l)} \longrightarrow HCl_{(aq)} + HClO_{(aq)}$$

HOCl is unstable and decomposes slowly in solution. One theory suggests that it produces reactive oxygen atoms that can kill bacteria in water as shown in the equation.

$$HClO \longrightarrow HCl + [O]$$

Q.21 (D) The halogen acids get less thermally stable going down the group as explained below.

- The hydrogen halides formed differ in their thermal stability.
- Hydrogen iodide can be decomposed by inserting a red-hot wire into a sample of hydrogen iodide gas. The purple fumes seen are iodine vapour:

$$2HI_{(g)} \longrightarrow H_{2(g)} + I_{2(g)}$$

- By contrast, **HF** and **HCl** are not decomposed in temperatures upto **1500°C.**

- Hydrogen bromide is not as stable as HF and HCl, but it is more resistant to decomposition than hydrogen iodide. At 430°C in a closed container, 10% of a sample of HBr will decompose, whereas around 20% of HI decompose at that temperature.
  - **Order of thermal stability of hydrides of halogens (halogen acids):**
  - **HF > HCl > HBr > HI**
- We can explain this by looking at the bond energies of the hydrogen-halogen bonds as shown in the tabular form.

Halogen acids	Bond energy ($kJmol^{-1}$)
HF	**566**
HCl	**431**
HBr	**366**
HI	**299**

- **Conclusion:**

  From the bond energy value it is clear thermal stability decreases downward.

- **Reason: HI** decomposes because of low bond energy
- On the other hand **HF** and **HCl** have high bond energy so they **cannot** decompose easily.

Most thermally stable **HF**

Bond energy decreases downward ↓ **HCl**

HBr

Least thermally stable **HI**

Q.22 (B) Beryllium becomes passive on reaction with conc. HNO_3 because it forms stable layer of oxide.

Q.23 (D) If a halogen has a low energy of dissociation, a high electron affinity and a higher hydration energy of its ions, it will have a high oxidizing power.

- **Oxidizing power of halogens does not depend upon density.**

STEP

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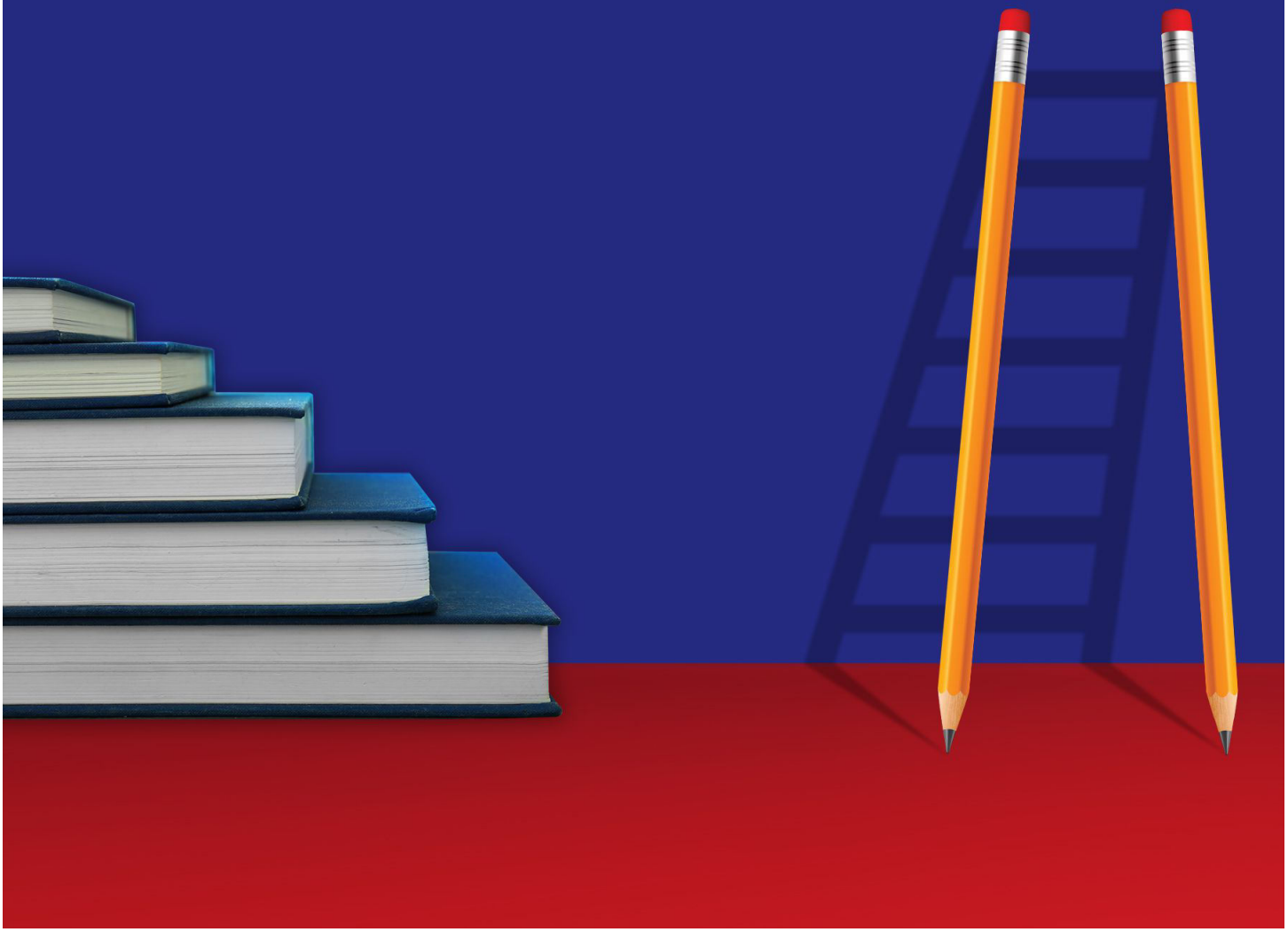

CHEMISTRY

WORKSHEET-9

STEP

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Worksheet-09

(B. Inorganic Chemistry)

Transition Elements

Q.1 Which of the following is correct formula for general electronic configuration of d-block elements?

A) $(n-1)d^{1-10}\ ns^{1-2}$ C) $(n-1)d^{1-5}\ ns^{1-2}$

B) $(n-1)d^{10}\ ns^{2}$ D) $(n-1)d^{1-10}\ ns^{2}$

Q.2 All of the following transition elements show variable oxidation state EXCEPT:

A) Fe C) Zn

B) Cr D) Cu

Q.3 Mark the incorrect statement about transition elements of 3d-series:

A) All the elements show +2 oxidation state

B) They show variable oxidation because of the involvement of the unpaired d-electrons in addition to s-electrons

C) Fe^{+3} ion is more stable than Fe^{+2} ion

D) First four elements in the highest oxidation state use all of the s and d electrons for bonding

Q.4 Which of the following is the correct electronic configuration of gold (atomic number of Au = 79)?

A) $[_{54}Xe]4f^{14}5d^{10}6s^{1}$ C) $[_{54}Xe]4f^{14}5d^{9}6s^{2}$

B) $[_{54}Xe]4f^{14}5d^{9}6s^{1}$ D) $[_{54}Xe]4f^{14}5d^{10}6s^{2}$

Q.5 Transition elements show all of the following characteristic properties EXCEPT:

A) They are good conductor of heat and electricity

B) Those metals which form coloured compounds must have at least one unpaired electron in d-sub shell

C) Their ions and compounds are coloured in the solid state only

D) They act as a catalyst

Q.6 Which of the following complex ions shows tetrahedral geometry?

A) $[MnCl_4]^{-2}$ C) $[Fe(CN)_6]^{-4}$

B) $[Cu(NH_3)_4]^{+2}$ D) $[PtF_6]^{-2}$

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Q.7 Transition elements mostly show _____geometry.

A) Linear C) Square planar

B) Trigonal bipyramid D) Octahedral

Q.8 Correct name of $\left[Pt(OH)_2(NH_3)_4\right]SO_4$ is:

A) Tetraammine dihydroxo-platinum (IV) sulphate

B) Dihydroxo tetraammine-platinum (V) sulphate

C) Tetra-ammine dihydroxo-platinum (II) sulphate

D) Dihydroxo tetraammine-platinum (IV) sulphate

Q.9 Which of the following transition elements has maximum number of unpaired electrons in its ground state?

A) Mn C) Fe

B) Cr D) Ni

Q.10 In copper sulphate pentahydrate ($CuSO_4.5H_2O$), the number of water molecules attached with Cu^{+2} ion through coordinate covalent bond is:

A) 2 C) 4

B) 3 D) 5

Q.11 In $[Ti(H_2O)_6]^{3+}$, _____ light is absorbed, while most of the blue and red lights are transmitted, therefore the solution of $[Ti(H_2O)_6]^{3+}$ ions looks violet in colour. Violet is a complementary colour of yellow:

A) Yellow C) Blue

B) Green D) Red

Q.12 The catalysts used for the following processes are correctly matched EXCEPT:

Options	Catalysts	Processes	Used to prepare
A)	Fe	Haber's process	NH_3
B)	V_2O_5	Contact process	H_2SO_4
C)	Co	Catalytic oxidation of methane	HCOOH
D)	Pt + Rh	Ostwald's method	HNO_3

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Q.13 3d-series of transition elements contains elements in the range:

A) Sc ----- Zn C) Y ----- Cd

B) La ----- Hf D) Ce ----- Lu

Q.14 Which of the following 3d-series elements shows the highest oxidation state in its compounds?

A) Cr C) Zn

B) Cu D) Fe

Q.15 Which of the following transition metal ions has five unpaired electrons in 3d sub-shell?

A) Zn^{+2} C) Mn^{+2}

B) Sc^{+3} D) Cr^{+3}

Q.16 The number of lone pair of electrons provided by the ligands to the central transition metal atom or ion is called:

A) Oxidation number C) Effective atomic number

B) Coordination number D) Coordination complex

Q.17 All of the following are monodentate ligands EXCEPT:

A) OH^- C) CO

B) CN^- D) N_2H_4

Q.18 Geometry of the transition elements depends upon type of orbital hybridization. Which of the following type of orbital hybridization shows square planar geometry?

A) sp^3 C) dsp^3

B) dsp^2 D) d^2sp^3

Q.19 All the elements of 3d-series show correct electronic configuration EXCEPT:

Options	Elements	Electronic configuration
A)	$_{22}Ti$	$(Ar)3d^24s^2$
B)	$_{29}Cu$	$(Ar)3d^94s^2$
C)	$_{24}Cr$	$(Ar)3d^54s^1$
D)	$_{25}Mn$	$(Ar)3d^54s^2$

Q.20 All of the following first row of the transition elements (3d-series) show the most common oxidation states. Mark the incorrect statement:

Options	Elements	Most common oxidation states
A)	Ti	+3,+4
B)	V	+2,+3,+4,+5
C)	Mn	+3,+5,+6,+7
D)	Fe	+2,+3

Q.21 Which of the following elements are used as a catalyst

USE THIS SPACE FOR SCRATCH WORK

in the chemical reactions?

A) Alkali metals
B) Transition elements
C) Alkaline earth metal
D) Element which form border line compounds

Q.22 Elements of 3d-series generally show which of the following stable oxidation states?

A) +1, +2 C) +4, +5
B) +2, +3 D) +6, +7

Q.23 The correct formula of Tetraammine aqua bromocobalt (III) nitrate is:

A) $Co[Br(NH_3)_4(H_2O)](NO_3)_2$
B) $Co[Br(NH_3)_4(H_2O)Br](NO_3)_2$
C) $Co[Br(H_2O)(NH_3)_4](NO_3)_2$
D) $Co[(NO)(NH_3)_4(H_2O)Br](NO_3)_2$

Q.24 Pair of transition elements which show abnormal electronic configuration in the first 3d-series are:

A) Cr and Ni C) Cr and Cu
B) Fe and Ni D) Cu and Co

Q.25 Scandium has atomic number 21. Which one of the following will be its electronic configuration?

A) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$
B) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^1$
C) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$
D) $1s^2\ 2s^2\ 2p^6\ 3s^2$ 3p6 4s1 $4p^2$

Q.26 The central transition metal atom along with ligands is called:

A) Complex ion
B) Ligand
C) Coordination sphere
D) Complex compound

Q.27 All of the following are typical transition elements EXCEPT:

A) Cr C) Cu
B) Fe D) Zn

Q.28 Transition elements show all of the following properties EXCEPT:

A) They are all metals in true sense
B) They show variable oxidation state
C) They have high melting and boiling points
D) Their ionization energy is less than that of IIA group elements

USE THIS SPACE FOR SCRATCH WORK

Q.29 Which of the following statements is correct about covalent radii in 3d-series of transition elements?

A) It decreases continuously

B) First it decreases then increases rapidly

C) First it decreases in the start, constant in the middle and then increases at the end of series

D) It remains almost constant in the series

Q.30 In moving from left to right in any transition series, the number of unpaired electrons increases upto groups:

A) IIB and IIIB C) VB and VIB

B) IVB and VB D) VIB and VIIB

Q.31 Which groups of transition elements are known as non-typical transition elements?

A) IIB and IIIB C) IVB and VB

B) IB and IVB D) VIB and VIIB

Q.32 All of the following non-metals enter in the interstices of transition metals and impart useful features to them EXCEPT:

A) H C) N

B) B D) Br

Q.33 Mark the incorrect statement about the general characteristic features of 3d-series of transition metals:

A) Binding energy …… depends on unpaired electrons

B) M.Ps and B.Ps …… show irregular trend in 3d-series

C) Diamagnetic substances …… are weekly repelled by the strong magnetic field

D) Ionic radii …… changes in the ionic radii along the series are regular

Q.34 Which of the following transition metal ions shows the strongest paramagnetic behaviour?

A) Fe^{+3} C) Ti^{+3}

B) Cr^{+3} D) Cu^{+2}

Q.35 In alloy steels (substitutional alloys), which of the following transition metal cannot be substituted in place of iron:

A) Cr C) Mn

B) Ni D) Ti

USE THIS SPACE FOR SCRACTH WORK

Q.36 The type of structural isomerism which occurs when the counter ion (the ion outside the square bracket) is itself a potential ligand:

A) Ionization isomerism C) Linkage coordination

B) Coordination isomerism D) Solvate isomerism

Q.37 **In an octahedral geometry having coordination number 6, which of the following shows trans-position:

A) 1 – 2 C) 3 – 4

B) 1 – 3 D) 1 – 4

Q.38 Coordination compounds show which of the following principal types of isomerism:

A) Stereoisomerism C) Both A and B

B) Structural isomerism D) Neither A nor B

ANSWER KEY (Worksheet-09)							
1	A	11	A	21	B	31	A
2	C	12	C	22	B	32	D
3	D	13	A	23	A	33	D
4	A	14	A	24	C	34	A
5	C	15	C	25	C	35	D
6	A	16	B	26	C	36	A
7	D	17	D	27	D	37	D
8	A	18	B	28	D	38	C
9	B	19	B	29	C		
10	C	20	C	30	C		

ANSWERS EXPLAINED

Q.1 **(A)** **d-block** are the **elements** of groups **3, 4, 5, 6, 7, 8, 9, 10, 11** and **12**. They are also known as outer transition elements. Their general electronic configuration is **$(n-1)d^{1-10}\ ns^{1-2}$.**

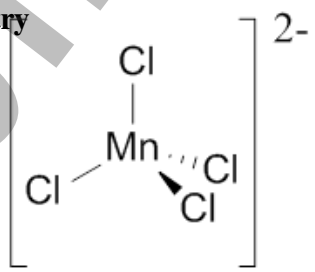
Q.2 **(C)** **Zn** shows **+2** oxidation state only because **Zn^{+2}** has completely filled 3d-sub-shell while other elements of **A, B,** and **D** show variable oxidation state. Such as **Fe (Fe^{+2}, Fe^{+3}), Cr (Cr^{+3}, Cr^{+6}), Cu (Cu^{+1}, Cu^{+2}).**

Q.3 **(D)** In fact **first five elements** are in the **highest oxidation state** and use all of the **s** and **d** electrons for bonding **not first four elements.**

Q.4 **(A)** **$_{79}$Au (gold)** shows the **correct** electronic configuration as **$[_{54}Xe]4f^{14}, 5d^{10}, 6s^{1}$**.

Q.5 **(C)** Transition metal ions and their compounds are **not** only **coloured** in the solid state **but they also show colour** in the **aqueous solution.**

Q.6 **(A)** $[MnCl_4]^{-2}$ shows **tetrahedral geometry**



while others **B) square planar C), tetrahedral and D) shows trigonal bipyramidal geometry.**

Q.7 **(D)** Transition elements mostly show **octrahedral geometry.** The concept of octahedral geometry was developed by **Alfred Werner** to explain the stoichiometries and isomerism in coordination compounds.

Q.8 **(A)** $[Pt(OH)_2(NH_3)_4]SO_4$ correct name is **Tetraammine dihydroxo-platinum (IV) sulphate. Other** options B, C and D **are incorrect.**

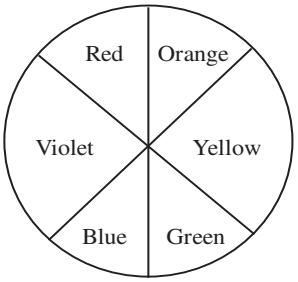
Q.9 **(B)** $_{24}Cr$ (Ar) $\uparrow\uparrow\uparrow\uparrow\uparrow$ (3*d*) $\uparrow$ (4*s*).

From the electronic configuration of **Cr** it is clear that it has **maximum 6 unpaired electrons.**

Q.10 **(C)** The number of water molecules attached with **Cu^{+2} ions** through coordinate covalent bond is **4** because it follows effective atomic number rule (EAN rule) and one water molecule is bonded with sulphate ion as shown **$Cu.4H_2O.SO_4.H_2O$.**

Q.11 **(A)** Transition elements show complementary colours as shown in the diagram**. $[Ti(H_2O)_6]^{3+}$** absorbs yellow colour and in return transmits violet colour. So **yellow** and **violet** are **complementary colours.**

- **Complementary colours of each other are shown in the figure.**



Complementary Colours:

Q.12 **(C)** In fact, **Cu** is used as a catalyst for oxidation of **methane not cobalt.** Lower alkanes when burnt in the

presence of metallic catalyst copper, at **high** temperature and pressure, results in the formation of useful product. Catalytic oxidation of alkanes is used industrially to prepare **higher fatty acids** which are used in **soap** and **vegetable oil industries.**

Q.13 (A) **3d-series** lies in the **4th period** of the periodic table. It contains **10** elements ranges from **$_{21}$Sc …. $_{30}$Zn.** **In the first row of the transition metals, the ten elements that can be found are: Scandium (Sc), Titanium (Ti), Vanadium (V), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu), and Zinc (Zn).**

Q.14 (A) **Cr shows highest oxidation state in its compound such as in $K_2Cr_2O_7$**

- **In $K_2Cr_2O_7$, Cr shows +6 oxidation state.**

Q.15 (C) **$_{25}Mn^{+2}$ (Ar)** $\underset{\uparrow\uparrow\uparrow\uparrow\uparrow}{3d}\ \underset{\square}{4s}$. From the electronic configuration of **Mn^{+2}**, it is clear that there are **five unpaired electrons in 3d-orbitals.**

Q.16 (B) **Examples of Coordination number are shown below.**

Type of orbital hybridization	Geometry	Coordination Number	Complex
sp	**Linear**	2	$[Ag(NH_3)_2]^+$, $[CuCl_2]^-$
sp^3	**Tetrahedral**	4	$[MnCl_4]^{-2}$
dsp^2	**Square planar**	4	$[Zn(NH_3)_4]^{2+}$, $[Ni(CN)_4]^{2-}$
dsp^3	**Trigonal bipyramidal**	5	$[Ni(CN)_5]^{3-}$, $Fe(CO_5)$
d^2sp^3	**Octahedral**	6	$[Cr(H_2O)_6]^{3+}$, $[Fe(CN)_6]^{3-}$

Q.17 (D) **N_2H_4 (hydrazine) NH_2-NH_2.** It is bidentate ligand. It can donate **two** lone pair of electrons.

Q.18 (B) **dsp^2 (Square planar geometry e.g. $[Cu(NH_3)_4]^{+2}$.**

Type of orbital hybridization	Geometry	Coordination Number	Complex
dsp^2	**Square planar geometry**	4	$[Cu(NH_3)_4]^{+2}$

Q.19 (B) In fact **$_{29}$Cu** shows abnormal electronic configuration such as **(Ar) $3d^{10}4s^1$**, but **not (Ar) $3d^9 4s^2$.**

Q.20 (C) Common oxidation states shown by **Mn** are **+2, +4, +6, +7** but **not +3, +5.**

Q.21 (B) **Transition elements act as a good catalyst because of**

- **Presence of vacant d-orbital**
- **The tendency to show variable oxidation states**
- **The tendency to form reaction intermediates with reactants**
- **The presence of defects in their crystal lattice**

Examples:

i. **Most of the transition metals [Fe, Ni, Pt]**

ii. **Alloys [Fe - Mo]**

iii. **Compounds [V_2O_3, V_2O_5, MnO_2, Co^{+2} salt] are used as catalysts in various processes.**

Q.22 (B) **Elements of 3d-series generally show stable oxidation state +2 and +3. The elements in the beginning**

of the 3d-series have comparatively +3 more stable oxidation state such as Sc^{+3}, Cr^{+3} whereas the elements at the end of the series mostly show +2 stable oxidation state such as Cu^{+2}, Zn^{+2}, Ni^{+2} etc.

Q.23 (A) The correct formula of Tetrammine aqua bromocobalt (III) nitrate is $Co[Br(NH_3)_4(H_2O)](NO_3)_2$.

Q.24 (C) Cr and Cu show abnormal electronic configuration just to gain stable electronic configuration in 3d-sub shell as shown in the tabular form.

Element	Atomic number	Electronic configuration
Cr	24	$[Ar]3d^5 4s^1$
Cu	29	$[Ar]3d^{10} 4s^1$

Q.25 (C) Scandium has atomic number 21. It has electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$.

Q.26 (C) The central transition metal atom along with ligands is called coordination sphere. It is usually placed in square bracket e.g.

$$K_4\left[Fe(CN)_6\right], \left[Cu(NH_3)_4\right]SO_4, \left[Ni(CO)_4\right]$$

In the above examples:

$\left[Fe(CN)_6\right]^{4-}, \left[Cu(NH_3)_4\right]^{2+}, \left[Ni(CO)_4\right]^{0}$ **are anionic, cationic and neutral coordination spheres, respectively.**

Q.27 (D) Zn is non-typical transition element

- It is present in IIB group
- It shows +2 oxidation only
- It does not form coloured compound
- It is diamagnetic in atomic or ionic form
- It does not give borax bead test

Q.28 (D) The elements of 3d-series are known as transition elements because they lie in between s-block elements and p-block elements. When we move from left to right in the periodic table ionization energy increases because nuclear charge increases. That is why ionization energy of 3d-series of transition elements is greater than that of s-block elements but less than that of p-block elements.

Q.29 (C) First it decreases in the start, remains constant in the middle and then increases at the end of the series.

Explanation:

- **At the beginning of the 3d series of transition elements, due to smaller number of electrons in the 3d-orbitals, the effect of increased nuclear charge predominates, and the covalent radii decrease.**
- **Later in the series, when the number of 3d-electrons increase, the increased shielding effect and the increased repulsion between the electrons tend to increase the covalent radii. Somewhere in the middle of the series, therefore, the covalent radii almost remains constant.**
- **At the end of 3d-series of transition elements d-sub shell is completely filled**

and nucleus hold on the valence electrons decreases. As a result atomic radii <u>increases</u>.

Atomic radii of transition elements of 3d-series

Elements	Sc	Ti	V	Cr	Mn	Fe	CO	Ni	Cu	Zn
Atomic radii (pm)	144	132	122	118	117	117	116	115	117	125

Decreases Constant Increases

Q.30 (C) In moving from left to right in any transition series, the number of unpaired electrons increase upto groups VB and VIB. After that pairing takes place and number of unpaired electrons goes on decreasing until it becomes zero at IIB.

Q.31 (A) The transition elements of IIB and IIIB groups are known as non-typical transition elements.

Groups	Non-typical Elements
IIB	Zn, Cd and Hg
IIIB	Sc, Y and La

Properties:

- **They show non-variable oxidation state**
- **They do not form coloured compounds**
- **They do not give "Borax-bead Test"**

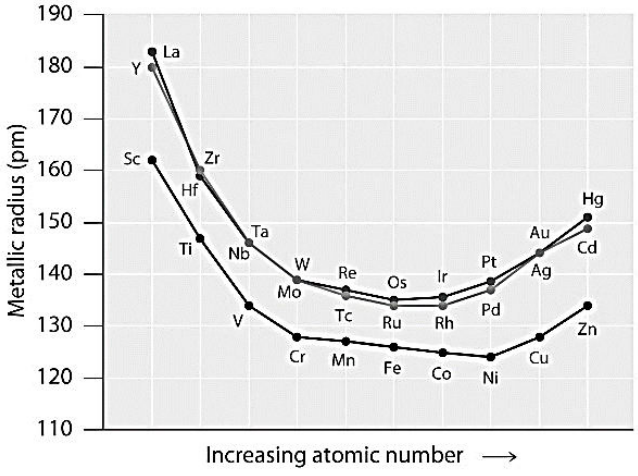
Q.32 (D) When small non-metal atoms like **(H, B, and N)** enter the interstices of transition metals and impart useful features to them, they are **called interstitial compounds.** But **bromine (Br) cannot enter the interstices of transition metals because it has comparatively greater size.**

Q.33 (D) It is incorrect statement. In fact, the correct statement is as follow.

Changes in the ionic radii along the series are much less regular, so that periodic trends in the properties of these ions are difficult to rationalize.

Q.34 (A) Greater is the number of unpaired electrons in 3d-atomic orbitals of transition metal ions, greater is the paramagnetic behaviour. Since Fe^{+3} ion has maximum five unpaired electrons, so that is why it shows maximum paramagnetic behaviour. Other transition metal ions have comparatively less number of unpaired electrons.

Q.35 (D) In alloy steels (substitutional alloys), titanium (Ti) transition metal cannot be substituted in place of iron because it has comparatively greater size (covalent radius), as shown in the graph:



Q.36 (A)

- **IONIZATION ISOMERISM**

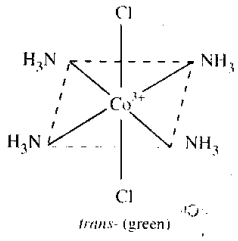
  The type of structural isomerism which occurs when the counter ion (the ion outside the square bracket) is itself a potential ligand.

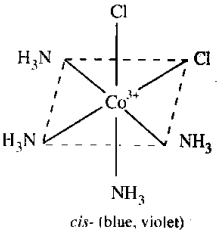
$\left[CoCl_2(NH_3)_4\right]NO_2$ and $\left[CoCl(NH_3)_4(NO_2)\right]Cl$

Ion in solution NO_2^- (no ppt. with $AgNO_3$) **Ion in solution Cl^- (white ppt. with $AgNO_3$)**

- **COORDINATION ISOMERISM**

  This type of isomerism is shown by the compounds which contain complex cation, and a complex anion. Coordination isomerism is caused by the interchange of ligands between the complex cation and complex anion.





- For examples

$\left[Co(NH_3)_6\right]\left[Cr(CN)_6\right]$

and $\left[Cr(NH_3)_6\right]\left[Co(CN)_6\right]$

- **LINKAGE COORDINATION**

  The compounds which have the same molecular formula, but differ in the mode of attachment of ligand to the central atom / ion are called linkage isomes.

- For examples NO_2^- ion, the nitrogen atom as well as the oxygen atom can donate their lone-pairs.

NO_2^- Nitro

$\left[Co(NH_3)_5 NO_2\right]Cl_2$

pentaaminnitrocobalt (III) chloride

and

$O-NO^-$ nitrito

$\left[Co(NH_3)_5 ONO_2\right]Cl_2$

pentaaminenitrocobalt (III) chloride

- **SOLVATE ISOMERISM**

Solvate isomerism is a special form of ionization isomerism. Solvate isomerism occurs when water is present in the inner coordination sphere or outside it.

- For examples $\left[Cr(H_2O)_6\right]Cl_3$ and $\left[CrCl(H_2O)_5\right]Cl_2.H_2O$

Q.37 (D) Ma_4b_2:

- A well known octahedral complex which shows cis-trans isomerism tetraaminedichloridecobalt (III).
- Two isomers of this complex are cis-form (violet) and trans-form (green).
- The structures of these two isomers are shown below in figure $[Co(NH_3)_4(NO_2)_2]^+$ is example of $[Ma_4b_2]$ type octahedral complex which shows geometrical isomerism.

Q.38 (C): Coordination compounds show the following principal types of isomerism

- Stereoisomerism
- Structural isomerism

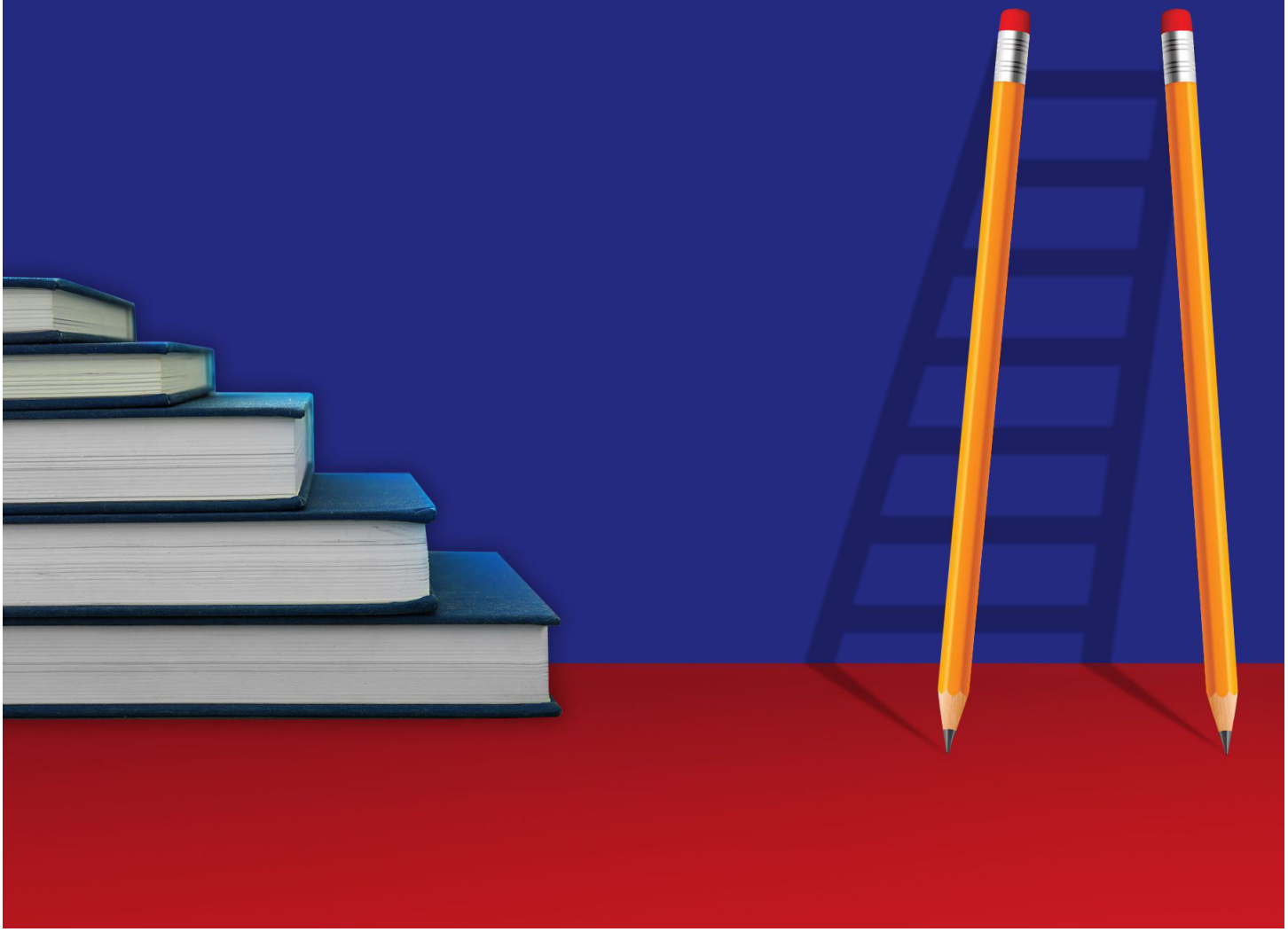
REF. QUESTION # 20

Below is a table of the oxidation states that the transition metals can or cannot form. As stated in the boxes, the "No" indicates that the elements are not found with that oxidation state. The "Rare" signifies the oxidation states that the elements are rarely found in. Lastly, the "Common" identifies the oxidation states that the elements readily found in.

Element Symbol	Atomic Number	+1	+2	+3	+4	+5	+6	+7
Sc	21	No	Rare	Common	No	No	No	No
Ti	22	No	Rare	Rare	Common	No	No	No
V	23	Rare	Common (black)	Common (green)	Common (blue)	Common (yellow)	No	No
Cr	24	Rare	Common	Common (most stable)	Rare	Rare	Common	No
Mn	25	Rare	Common (most stable pink/red)	Common (purple/red)	Common	Rare (blue)	Common (green)	Common (purple)
Fe	26	Rare	Common (ferrous)	Common (ferric)	Rare	Rare	Rare	No
Co	27	Rare	Common	Common	Rare	Rare	Rare	No
Ni	28	Rare	Common	Rare	Rare	No	No	No
Cu	29	Rare	Common (blue/green)	No	No	No	No	No
Zn	30	No	Common	No	No	No	No	No

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-10

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-10

(B. Inorganic Chemistry)

Compounds of Nitrogen and Sulphur And Environmental Chemistry

Q.1 Contact process for the preparation of H_2SO_4 on the commercial scale has following steps.

I. Sulphur burners

II. Drying tower

III. Contact tower

IV. Absorption unit

In which one of the following above steps, SO_2 is oxidized to SO_3?

A) I only C) III only

B) II only D) IV only

Q.2 Which of the following is not secondary pollutant?

A) PAN C) Peroxybenzol

B) Ketones D) SO_2

Q.3 All of the following are physical properties of NH_3 gas EXCEPT:

A) It is colourless gas with pungent odour

B) It is lighter than air

C) When it is inhaled suddenly, it brings tears into the eye

D) It is insoluble in water

Q.4 Which of the following is not use of ammonia?

A) It is used to prepare nitric acid by Birkeland and Eyde's process

B) It is used in the manufacture of urea and rayon

C) It is used as a refrigerant in ice plants

D) It is used in the manufacture of Na_2CO_3 by Solvay's process

Q.5 The second most widely used fertilizer in Pakistan is:

A) Potassium nitrate C) Diammonium phosphate

B) Ammonium nitrate D) Urea

USE THIS SPACE FOR SCRATCH WORK

Q.6 Mark the correct statement about SO_2:

A) It is colorless gas with irritating smell

B) It can act as an oxidizing as well as reducing agent

C) Both A and B

D) Neither A nor B

Q.7 Which of the following is not correctly matched statement?

Options	Name of fertilizer	%age of nitrogen
A)	Urea	46
B)	Diammonium phosphate	14
C)	Ammonium nitrate	33 – 33.5
D)	Liquid ammonia	82

Q.8 SO_3 crystals on warming change directly to a gas. This is called:

A) Diffusion C) Evaporation

B) Sublimation D) Decomposition

Q.9 Which one is incorrect about $H_2S_2O_7$?

A) It is obtained by dissolution of SO_3 in water

B) It is obtained by dissolution of SO_3 in conc. H_2SO_4

C) It is called oleum (pyrosulphuric acid)

D) It contain one O-O bond in its molecule

Q.10 Which one of the following is not property of a good fertilizer?

A) It may not be stable

B) It is not injurious to the plants

C) It is soluble in water

D) It is readily available to the plants

Q.11 Which of these is not a property of dilute sulphuric acid?

A) It is an electrolyte

B) It reacts with some metals to give off hydrogen gas

C) Its sulphate salts are always soluble in water

D) It contains ions

Q.12 All of the following properties shown by nitrogen and other elements of group VA are correct EXCEPT:

USE THIS SPACE FOR SCRATCH WORK

Options	Nitrogen	Other elements
A)	(N_2) Gas	Solid
B)	Diatomic ($N \equiv N$)	Tetra atomic molecules
C)	Has no allotropic form	Have allotropic forms
D)	Low ionization energy	High ionization energy

USE THIS SPACE FOR SCRATCH WORK

Q.13 Identify the property which is not shown by sulphuric acid:

A) It is called oil of vitriol

B) It is manufactured by contact process

C) The purification unit consists of dust removers, scrubbers conc. sulphuric acid and arsenic purifier

D) It acts as a food preservative

Q.14 Ammonia is commercially prepared by Haber's process as shown by the reaction:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Which of the following is not optimum condition to get maximum yield of ammonia?

A) High pressure (200 – 300 atm)

B) High temperature (500°C)

C) Continuous withdrawal of ammonia

D) Use of iron catalyst along with promoters MgO, Al_2O_3 and SiO_2

Q.15 Identify the incorrect statement about anhydrides of respective acids:

Options	Acids	Anhydrides
A)	H_2SO_4	SO_3
B)	HNO_3	N_2O_5
C)	H_3PO_4	P_2O_3
D)	$HClO_4$	Cl_2O_7

Q.16 Which of the following is / are uses of SO_2 gas?

A) It acts as food preservative

B) It is used to prepare H_2SO_4

C) Both A and B

D) Neither A nor B

Q.17 All of the following are the optimum conditions in order to get maximum yield of SO_3 by contact process EXCEPT:

A) High pressure (1atm)

B) Catalyst V_2O_5 or Ni

C) Low temperature (400 – 500°C)

D) Continuous withdrawal of SO_3 after intervals

Q.18 Which of the following fertilizers is not useful for paddy rice?

A) Urea C) Ammonium nitrate

B) Ammonia in liquid form D) Ammonium phosphate

Q.19 When sulphuric acid is treated with glucose it acts as?

A) Drying agent C) Dehydrating agent

B) Oxidizing agent D) Reducing agent

Q.20 Sulphuric acid (H_2SO_4) is commercially prepared by contact process. All of the following purification units with their functions are correctly matched EXCEPT:

Options	Purification units	Uses
A)	Dust remover	Dust particles are removed from gases by steam wash
B)	Scrubber	Soluble impurities are removed by water
C)	Conc. H_2SO_4	Acts as drying agent to remove moisture
D)	Arsenic purifier	$Fe(OH)_2$ is used to remove As_2O_3 as impurity

Q.21 All of the following elements are macronutrients EXCEPT:

A) N C) Ca

B) S D) Mn

Q.22 Which of the following is pair of oxides of non-metals are the major cause of acid rain?

USE THIS SPACE FOR SCRATCH WORK

A) CO, NO_2 C) CO_2, SO_2

B) SO_2, NO_2 D) NO_2, O_2

Q.23 Which of the following fertilizers is used for direct application to soil in the liquid state and injected into the soil upto 6 inches?

A) NH_3 C) $CO(NH_2)_2$

B) NH_4NO_3 D) $(NH_4)_2HPO_4$

Q.24 Which one of the following is not the cause of inertness of nitrogen gas?

A) Its smaller size C) Its low dissociation constant

B) Its high bond order D) d-subshell is absent

Q.25 Which of the following is raw material for the preparation of ammonia (NH_3)?

A) Methane gas only C) Both A and B

B) Nitrogen gas only D) Neither A nor B

Q.26 Mark the incorrect statement:

A) The gases in the atmosphere absorb only cosmic rays

B) Oxygen (O_2) gas in the atmosphere is essential for sustaining life on the earth

C) Carbon dioxide (CO_2) gas is required for plant photosynthesis

D) Nitrogen (N_2) gas is used for nitrogen fixing bacteria

Q.27 The harmful substances pollute the atmosphere. They damage which of the following:

I. Damage the environment

II. Human health

III. Quality of life

A) I, II Only C) I, III Only

B) II, III Only D) I, II, III

Q.28 Which of the following is not primary pollutant?

A) SO_2 C) O_3

B) NH_3 D) CO

Q.29 Sulphur dioxide (SO_2) is the most culprit pollutant in the atmosphere. The percentage of SO_2 produced by volcanoes eruption is:

A) 67% C) 63%

B) 65% D) 62%

Q.30 Large quantities of hydrocarbons are emitted by different trees and plants in the atmosphere. Which of the following hydrocarbons is produced by paddy fields?

A) Methane C) Ethene

B) Ethane D) Ethyne

Q.31 The residence time of NO and NO_2 in the atmosphere are _____ and _____ are respectively.

A) 2 and 1 days only C) 4 and 3 days only

B) 3 and 2 days only D) 5 and 4 days only

Q.32 SO_2 and SO_3 have which of the following harmful effects:

I. Are irritating

II. Are suffocating

III. Form sulphate aerosols which cause respiratory troubles

IV. Are major source of acid deposition

A) I, II C) I, II, III

B) II, III, IV D) I, II, III, IV

Q.33 Methane has a mean residence time of about _____ in the atmosphere.

A) 2 – 4 Years C) 3 – 7 Years

B) 3 – 5 Years D) 2 – 6 Years

Q.34 Which of the following is the major source of hydrocarbons emission?

A) Petroleum C) Automobiles

B) Coal D) Wood

Q.35 The pH of unpolluted water should be upto:

A) 5.0 C) 5.4

B) 5.6 D) 5.2

Q.36 The acid deposition involves:

A) Wet acidic deposition (rain, fog and snow) only

B) Dry acid deposition only

C) Both A and B

D) Neither A nor B

Q.37 All of the following statements about ozone (O_3) layer are correct EXCEPT:

A) Its thickness has been decreasing over Antarctica during autumn time since the mid-1970s

B) It ranges from 25 – 28km high in stratosphere

C) It is a blue gas having irritating smell

D) It is an allotropic form of oxygen

Q.38 The stratosphere where the ozone exists is approximately at:

A) 10 – 30km altitudes C) 20 – 50km altitudes

B) 15 – 40km altitudes D) 25 – 60km altitudes

Q.39 Ozone is produced in most of the tropical regions, from where it is transported to polar region. When the concentration of ozone (O_3) exceeds 100 ppm in the polar region, it causes all of the following health problems EXCEPT:

A) It damages eyes

B) It decreases the elasticity of lung tissues

C) It acts as reducing agent and causes fabric dyes to fade

D) It aggravates asthma

Q.40 Ozone is produced in most of the tropical regions by the process of:

A) Oxidation C) Redox reaction

B) Reduction D) Photochemical reaction

Q.41 The amount of ozone in atmosphere is expressed in Dobson units (DU). The normal amount of overhead ozone is about _____ in stratosphere:

A) 330DU C) 350DU

B) 340DU D) 360DU

Q.42 The region in which ozone depletes substantially in every

year during _____ is now termed as ozone hole.

A) Sept - Nov
C) Sept - Oct
B) Oct - Dec
D) Aug – Nov

Q.43 A single chloride free radical can destroy how many ozone molecules:

A) 100
C) 100000
B) 10000
D) 10

Q.44 Mark the incorrect statement about effect of acid rain:

A) It can leach nutrients
B) It can increase pH of the soil
C) It can damage building material
D) It can damage growth of forest

Q.45 Temporary acid rain in some countries is due to release of _____ by volcano eruption:

A) HCl
C) H_2SO_4
B) H_2CO_3
D) HNO_3

Q.46 The ozone layer 25 – 28 km high in the stratosphere surrounds the globe and filters most of the harmful _____ before they reach on the earth:

A) UV rays
C) Gamma rays
B) IR rays
D) Cosmic rays

Q.47 Peeling of ozone layer is due to:

A) CO_2
C) PAN
B) CFCs
D) Coal burning

Q.48 Heavy metals (Pt, Cd, As and Hg) are highly toxic and do not have any safe limits. When ingested through food or water and cause all of the following health problems EXCEPT:

A) Kidney diseases
C) Neutrons disorder
B) Diabetes mellitus
D) High blood pressure

Q.49 Leather tanneries are the big source of chromium

pollution in the environment. Which of the following oxidation state of chromium (Cr) is highly toxic and is known to cause cancer:

A) Cr (II) C) Cr (VI)

B) Cr (III) D) Cr (IV)

Q.50 Chemical and bacterial contents in livestock waste can contaminate surface and ground waters and cause all of the following diseases EXCEPT:

A) Dysentery C) Hepatitis

B) Typhoid D) Malaria

Q.51 Sea water gets polluted by accidental oil spills. Many petroleum products are poisonous and pose serious health problems to humans, animals and aquatic life. Which of the following petroleum products are known to be carcinogenic even at low concentration.

A) Polycyclic aromatics C) Alicyclic

B) Monocyclic aromatics D) Heterocyclic aromatics

Q.52 Soaps and detergents are excessively used in industries and household as cleaning agents. Which of the following is the most dangerous pollutant:

A) Soap only C) Both A and B

B) Detergents only D) Neither A nor B

Q.53 Which of the following methods is used to remove permanent hardness of water?

A) Aeration C) Ion exchange method

B) Coagulation D) Chlorination

Q.54 The materials which are suspended or present in the colloidal form are removed by coagulation. The

coagulant hydroxides from potash alum is precipitated and suspended particles get adsorbed over it and settle at the bottom. Which of the following is that coagulant?

A) KOH
C) $Al(OH)_3$
B) $Fe(OH)_3$
D) $Cu(OH)_2$

Q.55 The quality of raw water is improved by aeration. Aeration of water serves all of the following functions EXCEPT:

A) It is used to remove the dissolved gases

B) It oxidizes Fe^{+2} to Fe^{+3}

C) It improves the oxygen level of raw water

D) It reduces organic matter with air

Q.56 Pesticides have been used for the eradication of following diseases EXCEPT:

A) Malaria
C) Tuberculosis
B) Sleeping sickness
D) Yellow fever

Q.57 Water is considered as polluted water if it contains dissolved oxygen less than:

A) 4ppm
C) 6ppm
B) 5ppm
D) 8ppm

Q.58 All of the following are harmful effect of chlorination of water EXCEPT:

A) It produces harmful chloramines by the reaction HOCl with dissolved ammonia in water

B) It is frequently used to disinfect water

C) It forms $CHCl_3$ when HOCl reacts with humic acid

D) Risk of liver cancer increases by drinking chlorinated water

Q.59 To avoid the formation of toxic compounds with chlorine which substance is used for disinfection of water:

A) $KMnO_4$ C) Alum

B) Chloroamine D) O_3

Q.60 The term greenhouse effect was first of all used by Nils Gustaf Ekholm in 1901. All of the following gases from a thick cover around the earth and it does not allow infra-red rays emitted by earth to escape EXCEPT:

A) CO_2 C) CH_4

B) O_3 D) CO

Q.61 Green chemistry refers to:

A) Chemistry of plants

B) Development of chemical product and process is less harmful to humans

C) Chemistry of green pigments

D) Chemistry of greenhouse effect

Q.62 Global warming is expected to be greatest in the:

A) Land C) Arctic

B) Oceans D) Antarctic

Q.63 Global warming and climate changes are terms used for the observed century-scale rise in the average temperature of the earths climate system. Global means surface temperature change from 1880 to 2016. An increase in average global temperature results in the following incidence of infectious diseases EXCEPT:

A) Malaria C) Dengue, yellow fever

B) Sleeping sickness D) Asthma

Q.64 The lowest region of the atmosphere extending from the earth's surface to a height of about 6 – 10 km (the lower boundary of the stratosphere) is called:

A) Troposphere C) Mesosphere

B) Stratosphere D) Thermosphere

Q.65 In all of the following reactions concentrated shulphric acid act as a dehydrating agent EXCEPT:

A) $HCOOH(aq) \xrightarrow{conc.H_2SO_4} CO(g) + H_2O(\ell)$

B) $C_2H_5OH \xrightarrow[100^oC]{conc.H_2SO_4} C_2H_4 + H_2O$

C) $C_{12}H_{22}O_{11} \xrightarrow{conc.H_2SO_4} 12C + 11H_2O$

D) Moisture of gases $\xrightarrow{conc.H_2SO_4}$ gases + moisture

Q.66 In which of the following reactions shulphuric acid does not act as an oxidizing agent:

A) $Cu_{(aq)} + 2H_2SO_4(conc.) \longrightarrow CuSO_{4(aq)} + 2H_2O_{(\ell)} + SO_{2(aq)}$

B) $2NaHCO_{3(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(\ell)} + CO_{2(g)}$

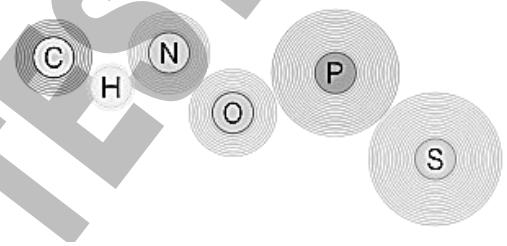
C) $Hg_{(\ell)} + 2H_2SO_4(conc.) \longrightarrow HgSO_{4(aq)} + 2H_2O_{(\ell)} + SO_{2(aq)}$

D) $2Ag_{(aq)} + 2H_2SO_4(conc.) \longrightarrow Ag_2SO_{4(aq)} + 2H_2O_{(\ell)} + SO_{2(aq)}$

ANSWER KEY (Worksheet-10)							
1	C	18	C	35	B	52	B
2	D	19	C	36	C	53	C
3	D	20	D	37	A	54	C
4	A	21	D	38	B	55	D
5	B	22	B	39	C	56	C
6	C	23	A	40	D	57	A
7	B	24	D	41	C	58	D
8	B	25	C	42	A	59	D
9	A	26	A	43	C	60	D
10	A	27	D	44	B	61	B
11	C	28	C	45	A	62	C
12	D	29	A	46	A	63	D
13	D	30	A	47	B	64	A
14	B	31	C	48	B	65	D
15	C	32	D	49	C	66	B
16	C	33	C	50	C		
17	B	34	C	51	A		

STRIKING INFORMATIONS

- **CHON is a mnemonic acronym for the four most common elements in living organisms: carbon, hydrogen, oxygen, and nitrogen.**
- **The acronym CHNOPS, which stands for carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur, represents the six most important chemical elements whose covalent combinations make up most biological molecules on Earth.**
- **Sulphur is used in the amino acids cysteine and methionine. Phosphorus is an essential element in the formation of phospholipids, a class of lipids that are a major component of all cell membranes, as they can form lipid bilayers, which keep ions, proteins, and other molecules where they are needed for cell function, and prevent them from diffusing into areas where they should not be.**
- **Phosphate groups are also an essential component of the backbone of nucleic acids and are required to form ATP – the main molecule used as energy powering the cell in all living creatures.**
- **Carbonaceous asteroids are rich in CHON elements.**
- **These asteroids are the most common type, and frequently collide with Earth as meteorites.**
- **Such collisions were especially common early in Earth's history, and these impactors may have been crucial in the formation of the planet's oceans.**
- **The simplest compounds to contain all of the CHON elements are fulminic acid and isocyanic acid (the latter of which is much more stable), having one of each atom.**



ANSWERS EXPLAINED

Q.1 **(C)** In contact tower preheated gases at 400-500°C are passed through vertical iron columns packed with the catalyst V_2O_5. Here SO_2 is oxidized to SO_3 as shown in the equation:

$$2SO_2 + O_2 \overset{V_2O_5}{\rightleftharpoons} 2SO_3$$

Q.2 **(D)** SO_2 is not secondary pollutant. **In fact** it is primary pollutant. Primary pollutants are given out from chimneys of industrial units and exhaust of automobiles.

- Other examples of primary pollutants SO_3, (NOx), CO etc.

Q.3 **(D)** **It is extremely soluble in water due to hydrogen bonding.** It can be easily liquefied at room temperature by applying a pressure of about **8 – 10 atmosphere**.

Q.4 (A) **NH_3** is used in **Ostwald's method to prepare nitric acid** but **not** in **Birkeland and Eyde's process**.

Q.5 (B) **Ammonium nitrate (NH_4NO_3)** is the **second most widely** used **fertilizer in Pakistan.** It is a white crystalline solid and is **highly soluble in water.** It is predominantly used in agriculture as a high-nitrogen fertilizer. Its other uses are component of explosive mixtures, in **mining, quarrying,** and in **civil construction**. **90% NH_4NO_3** is used as fertilizer while 10% of it is used for making explosive material.

Q.6 (C) **SO_2 gas has following properties:**

- It is colorless gas with irritating smell.
- It can act an oxidizing as well as reducing agent.
- **As an oxidizing agent:**

$$2H_2S + SO_2 \longrightarrow 3S + 2H_2O$$

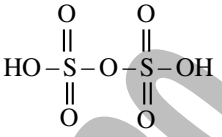
- **As a reducing agent:**

$$Cl_2 + SO_2 + 2H_2O \longrightarrow 2HCl + H_2SO_4$$

Q.7 (B) In fact, **$(NH_4)_2HPO_4$** contains P_2O_5 **16% nitrogen** and **48% P_2O_5**. This product contains about **75% plant nutrients** and is deemed suitable for use either alone or in the mixed form with other fertilizers.

Q.8 (B) **It is such process in which a solid, when heated, vaporizes directly without passing through the liquid phase and these vapors can be condensed to form the solid again. Other examples of such solids are NH_4Cl, I_2, naphthalene, benzoic acid.**

Q.9 (A) **A dense, corrosive liquid consisting of concentrated sulphuric acid containing excess sulphur trioxide in solution. Structure of oleum $H_2S_2O_7$ is**



Q.10 (A) It is incorrect statement. In fact, it must be stable so that it is available for a longer time to the growing plants.

Q.11 (C) **In fact, its salts, sulphates are not always soluble in water. All the alkali metals give sulphate and they are all soluble in water. The solubilities of sulphate of alkaline earth metals, gradually decrease down the group. Because the lattice energy decreases marginally down the group whereas ΔH_{hyd} energy decreases significantly. Because of this reason $BeSO_4$ and $MgSO_4$ are fairly soluble in water. $CaSO_4$ is slightly soluble, while $SrSO_4$ and $BaSO_4$ are almost insoluble.**

Q.12 (D) **It is incorrect statement.** In fact, ionization energy of **nitrogen** is **greater than** those of other elements because of its **smaller size** and greater electronegativity **($I.E_1$ = 1402kJmol^{-1} and electronegativity 3.0).**

Q.13 (D) **H_2SO_4 cannot act as food preservative because it is dehydrating agent, corrosive in nature as well as poisonous in nature. It can denature the food therefore, it cannot be used for this purpose.**

Q.14 (B) **It is incorrect statement. In fact, in order to get maximum yield of NH_3. Optimum conditions are:**

- High pressure (200 – 300atm),

- **Low temperature**: (400°C), continues withdrawal of ammonia
- Use of catalyst Fe along with promoters **(MgO, Al_2O_3, SiO_2).**

Q.15 (C) **Anhydrides** of H_3PO_4 is **P_2O_5 or P_4O_{10}.**

Q.16 (C) **SO_2** has all of the following properties:

- It acts as food preservative
- It is used to prepare H_2SO_4

Q.17 (B) In **contact process V_2O_5** is used as a catalyst or platinum but **not Ni.**

Q.18 (C) **It is useful for many crops except paddy rice. The microbial bacteria in flooded fields decomposes it to nitrogen gas. So in this way it is not useful for paddy rice because it is converted into free nitrogen which escapes into the atmosphere.**

Q.19 (C) When **conc. H_2SO_4** is treated with glucose, carbon and water are produced. In this case **H_2SO_4** act as dehydrating agent as shown in the reaction.

$$C_6H_{12}O_6 \xrightarrow{\text{Conc. } H_2SO_4} 6C + 6H_2O$$

Q.20 (D) **$Fe(OH)_3$ (Ferric hydroxide)** acts as **arsenic purifier** to remove **As_2O_3** as impurity but **not $Fe(OH)_2$.**

Q.21 (D) **Mn** is micronutrients like **Cu, Cl, B, Zn and Mo, because they are used in smaller amount ranges from 6g to 200g per acre.**

Q.22 (B) **SO_2 and NO_2 are worst pollutant because in atmosphere SO_2 and NO_2 are transformed by reactions with oxygen and water into H_2SO_4 and HNO_3 respectively. These acids get mixed with rain. In this way they become major cause of harmful effect as acid rain.**

Q.23 (A) NH_3 is used for direct application to soil in the liquid state and injected into the soil upto 6 inches.

Q.24 (D) Absence of d-subshell has **no effect** on inertness of nitrogen gas. Nitrogen shows inert behaviour because of high bond order ($N \equiv N$) and **greater bond** energy **($941 kJmol^{-1}$)** and it has also **smaller size.**

Q.25 (C) **<u>Raw Material</u>: Natural gas (methane gas) and, nitrogen gas are raw material for the preparation of ammonia.**

- **Natural gas has 83% CH_4. A mixture of steam and methane is passed over heated nickel at 900°C to produce CO_2 and H_2**

$$CH_4 + 2H_2O \xrightarrow[900^oC]{Ni} CO_2 + 4H_2 :$$

- **<u>Nitrogen gas:</u> Nitrogen gas is obtained from the air:**
- **<u>Preparation of ammonia:</u> Ammonia is prepared by Haber's process:**

The Haber process is a reversible reaction:

For the synthesis of **ammonia** by **Haber's process,** nitrogen and hydrogen gases react with each other to form ammonia gas shown in the reaction.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

$$\Delta H^{0,f} = -92kJ$$

$$= -46kJmol^{-1}$$

NH_3 is also known as queen of chemicals.

Q.26 (A) In fact, the gases in the atmosphere **not** only absorb most of the cosmic

rays but also the major portion of harmful **electromagnetic radiations coming form the sun.** The absorption of these harmful radiation protects the life of the earth.

Q.27 (D) The gases present in the **atmosphere** are **essential** for **sustaining life on the earth i.e. O_2** is required for **breathing, CO_2** is required for **plant photosynthesis, N_2** is used by **nitrogen fixing bacteria** and **water** vapours are responsible for sustaining various forms of **life** on the **earth.** Atmosphere also maintains the **heat balance of the earth like global warming and green house effect.**

Q.28 (C) The waste products given out from chimneys of industrial units and exhaust of automobiles may contain gases such as **sulphur dioxide (SO_2),** sulphur trioxide (SO_3), nitrogen oxides (NO_x), **carbon monoxide (CO) ammonia (NH_3),** hydrocarbons, compounds of fluorine, and radioactive material. All these waste products are called primary pollutant. But **O_3** is **secondary pollutant** because it is formed by the **photochemical reaction** of **oxygen** in the **polar region.**

Q.29 (A) **Sulphur dioxide (SO_2)** is the most culprit pollutant in the **atmosphere.** The **percentage** of **SO_2** produced by **volcanoes eruption is 67%.**

Q.30 (A) **Hydrocarbon (methane)** is produced from the **paddy fields. Methane is also known as marsh gas.**

Q.31 (C) The residence time of **NO** and **NO_2** in the atmosphere are **4 and 3 days** respectively.

Q.32 (D) **SO_2** and **SO_3** have **harmful effects such irritating, suffocating, form sulphate aerosols which cause respiratory troubles and are major source of acid deposition.**

Q.33 (C) **Methane** has a mean **residence time** of about **3 – 7 years** in the **atmosphere.**

Q.34 (C) **Automobiles** are the major source of hydrocarbons emission.

Q.35 (B) **pH of unpolluted water should be upto 5.6.**

Q.36 (C) **The acid deposition includes both** wet **(rain, fog and snow)** and dry acidic deposition.

Q.37 (A) In fact, its thickness has been decreasing over Antarctica during spring time since the mid-1970s**.** Antarctica, the southernmost continent and site of the South Pole, is a virtually uninhabited, ice-covered landmass. Most cruises (sail about in an area without a precise destination, especially for pleasure) to the continent visit the Antarctic Peninsula, which stretches toward South America.

Q.38 (B) The stratosphere where the ozone exists is approximately at **15 – 40km altitudes.**

Q.39 (C) In fact, ozone (**O_3**) acts as **oxidizing agent.**

Q.40 (D) **Ozone** is produced in most of the tropical regions by the process of **photochemical reaction of oxygen.**

Q.41 (C) The **normal amount** of overhead ozone is about **350DU** in stratosphere.

Q.42 (A) The region in which ozone depletes substantially **in every year during Sept – Nov** is **now** termed as **ozone hole.**

Q.43 (C) A single **chloride free** radical can destroy upto **100,000 ozone molecules.**

Q.44 (B) It is incorrect statement. In fact, **acid rain decreases pH of the soil.**

Q.45 (A) Temporary acid rain in some countries is due to release of **HCl** by volcano eruption.

Q.46 (A) The ozone layer **25 – 28 km** high in the stratosphere surrounds the globe and filters most of the harmful **UV rays** before they reach on the earth.

- So ozone is very useful for human being because it has useful effect to absorb harmful radiation. Harmful effect of UV radiation are as follow:
- It is particularly effective at damaging DNA.
- It is a cause of melanoma and other types of skin cancer.
- Therefore, if there is substantial reduction in the ozone layer, the life on earth would be threatened.
- In 1980's large hole in the ozone layer over Antarctic was discovered which represented a major environmental crisis.

Q.47 (B) Chlorofluorocarbons (CFCs) used as refrigerants in air conditioning and in aerosol sprays are inert in the troposphere but slowly diffuse into stratosphere where they are subjected to ultraviolet radiation generating Cl^{o} free radicals. Chlorofluorocarbons (CFCs) play an effective role in removing O_3 in the stratosphere due to following reactions.

$$CFCl_3 \longrightarrow CFCl_2^{\bullet} + Cl^{\bullet}$$

$$Cl^{\bullet} + O_3 \longrightarrow ClO^{\bullet} + O_2$$

$$ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$$

Q.48 (B) Diabetes, often referred to by doctors as diabetes mellitus, describes a group of metabolic diseases in which the person has high blood glucose **(blood sugar),** either because insulin production is inadequate, or because the body's cells do not respond properly to insulin, or both. Patients with high blood sugar will typically experience polyuria **(frequent urination),** they will become increasingly thirsty **(polydipsia)** and hungry **(polyphagia).**

Q.49 (C) **Postassium dichromate ($K_2Cr_2O_7$)** is largely used in leather tanneries which **Cr** has oxidation state **+6.** This chemical is very dangerous for human beings is the cause of many diseases.

Q.50 (C) **Hepatitis C** is a disease **caused** by a virus that infects the liver. The virus, called the **Hepatitis C** virus or **HCV** for short, is just one of the **hepatitis** viruses. The other common **hepatitis** viruses are A and B, which differ somewhat from **HCV** in the way they are spread and treated.

Q.51 (A) **Polycyclic aromatics petroleum products are known to be carcinogenic even at low concentration.**

Q.52 (B) The most dangerous pollutant is detergents because it is **non-biodegradable** while soap is not **harmful** because it is **biodegradable.**

Q.53 (C) **Permanent hardness of water** is due to Cl^- and SO_4^{-2} **of** Ca^{+2} and Mg^{+2} **ions.** It is removed by ionic exchange method in which (Analcites) sodium zeolite **NaAl** $(SiO_3)_2$**.** H_2O is used in the column through which hard water is run through. Here Ca^{+2} **and** Mg^{+2} **ions** from hard water are **replaced** by Na^+ **ions**. Which makes its **soft water. By ions exchange method permanent hardness of water is removed.**

Q.54 (C) $Al(OH)_3$ from potash alum acts as a coagulant. It is insoluble in water and forms white gelatinous ppt on which colloidal particles **(sand and clay)** are get adsorbed over it and settle at the bottom in water.

Q.55 (D) In fact, it **oxidizes organic** matter with **air** but **not** reduces organic matter.

Q.56 (C) **Tuberculosis is caused** by bacteria **(Mycobacterium tuberculosis)** that spreads from person to person through microscopic droplets released into the air. This can happen when someone with the untreated, active form of **tuberculosis coughs, speaks, sneezes, spits,** laughs or sings. Although **tuberculosis** is contagious, it's not easy to catch.

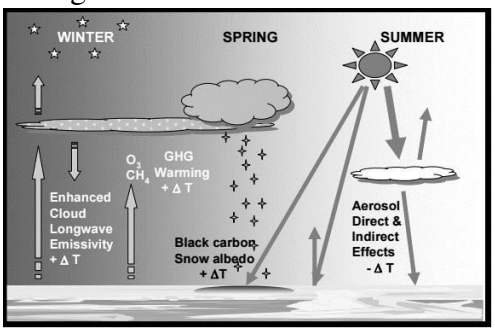
Q.57 (A) Water is considered as polluted water if it contains dissolved oxygen less than **4ppm.** Normal amount of dissolved oxygen should be in the range from **4 – 8 ppm.**

Q.58 (D) The risk of bladder and rectal cancer increases by drinking chlorinated water.

Q.59 (D) To avoid the formation of toxic compounds with **chlorine, ozone** is used for the disinfection of **water.**

Q.60 (D) **Greenhouse gases** is a **mixture** of CO_2**,** O_3**,** CH_4**,** water vapours and **CFCs but does not** contain **CO.**

Q.61 (B) Green chemistry refers to development of chemical products and process is less harmful to humans but not related to chemistry of plants, chemistry of green pigments and chemistry of greenhouse effect.



Q.62 (C) **Arctic temperatures have increased at almost twice the global average rate over the past 100 years (IPCC, 2007). Arctic warming is primarily a manifestation of global warming, such that reducing global-average**

warming will reduce Arctic warming and the rate of melting.

- Reductions in the atmospheric burden of CO_2 are the backbone of any meaningful effort to mitigate climate forcing.
- But even if swift and deep reductions were made, given the long lifetime of CO_2 in the atmosphere, the reductions may not be achieved in time to delay a rapid melting of the Arctic.

- Hence, the goal of constraining the length of the melt season may best be achieved by targeting shorter lived climate forcing agents.
- Addressing these species have the advantage that emission reductions will be felt immediately. These species include methane, tropospheric ozone, and tropospheric aerosols. Calculations indicate that the forcing due to these short-lived pollutants lead to a positive surface temperature response indicating the need to reduce emissions of these species within and outside the Arctic. Additional aerosol species may also lead to surface warming if the aerosol is coincident with thin, low lying clouds.

Q.63 (D) Asthma is a chronic disease of the airways. It cannot be cured, but can be controlled with medication. It can come on suddenly with symptoms of shortness of breath, wheezing, and coughing, and a tight feeling of the chest.

Q.64 (A) The lowest region of the atmosphere, extending from the earth's surface to a height of about 6–15 km (the lower boundary of the stratosphere) is called troposphere.

Troposphere:

- This is the part of atmosphere in which we live. It is approximately 15km above the surface of the earth. Very small amount of ozone is present in it.

- Stratosphere
- This is the layer is from 15km to 50km above the surface of earth. Stratosphere has a thick layer of ozone in it, which absorbs ultraviolet radiations of the sun. Thickness of ozone layer is above 25-28km

Mesosphere:

- This layer is 50km to 80km above the surface of the earth.

Thermosphere

- This layer is 80km above the surface of the earth.

Q.65 (D)

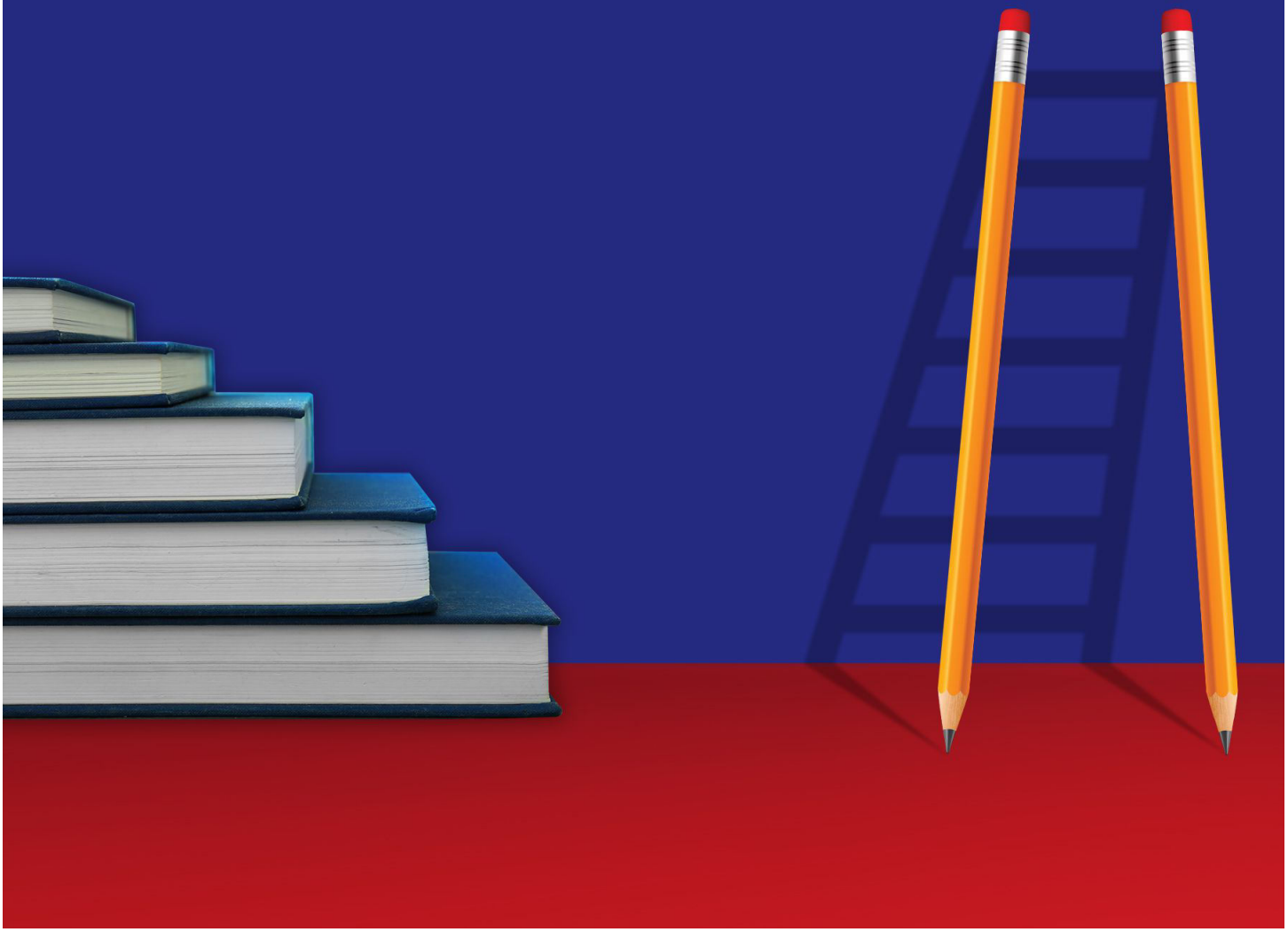
- In this case shulphuric acid act as drying agent. All though moisture is removed by conc. H_2SO_4 to purify SO_2 gas but it is not a chemical reaction
- In first three cases (A, B and C) H_2SO_4 acts as dehydrating agent because water is removed along with a chemical change.

Q.66 (B)

- **This is acid base reaction in this reaction H_2SO_4 does not act as oxidizing agent because oxidation number of sulphur in H_2SO_4 does not change.**
- **In all other three reactions (A, C and D) sulphuric acid act as oxidizing agent while metals (Cu, Hg and Ag) act as reducing agent so these are redox reactions.**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-11

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-11

(A. Physical Chemistry)

Fundamental Concepts

USE THIS SPACE FOR SCRATCH WORK

Q.1 Avogadro's number represents the number of:

A) Atoms in 1g of helium gas

B) Atoms in 24g of Mg

C) Molecules in 35.5g of chlorine gas

D) Electrons needed to deposit 24g Mg

Q.2 Which one of the following terms is not used for ionic compounds?

A) Formula unit C) Molecular formula

B) Empirical formula D) Formula mass

Q.3 98g H_2SO_4 contains number of moles of ions:

A) 4.0 moles of ions C) 2 moles of ions

B) 1 mole of ions D) 3.0 moles of ions

Q.4 Cationic molecular ions are produced by:

A) Radio waves C) Beam of electrons

B) α-rays D) Both B and C

Q.5 Isotopes differ in:

A) Properties which depend upon mass

B) Arrangement of electrons in orbitals

C) Chemical properties

D) The extent to which they may be affected by electromagnetic field

Q.6 Which one of the following mathematical relationships is correct for (m/e) in connection with Dempster's mass spectrometer?

A) $\frac{m}{e} = \frac{H^2r^2}{2E}$ C) $\frac{m}{e} = \frac{H^2r}{E}$

B) $\frac{H^2r^2}{E^2}$ D) $\frac{H^2r}{2E}$

Q.7 Symbol indicates not only the name of elements but also represents all of the following EXCEPT:

A) One atom of an element

B) Number of parts by mass of an element

C) 1 gram atom of an element

D) 1 amu

USE THIS SPACE FOR SCRATCH WORK

Q.8 Which of the following is not mono-isotopic element?

A) F C) Au

B) Cl D) As

Q.9 Which of the following statements is incorrect?

A) Formation of uni-negative ion is exothermic

B) Number of positive ions having group of atoms is less than number of negative ions having group of atoms

C) X – rays and beam of electrons are used to produce positive ions of Ne

D) Number of cationic molecular ions is less than number of anionic molecular ions

Q.10 What volume of oxygen gas is required for the complete combustion of $5cm^3$ of ethyne (C_2H_2)?

A) $12.5cm^3$ C) $13.5cm^3$

B) $13.0cm^3$ D) $14.0cm^3$

Q.11 The relative atomic mass of boron, which consists of isotopes $^{10}_{5}B$ and $^{11}_{5}B$ is 10.8amu. What is the percentage of $^{10}_{5}B$ atoms in the isotopic mixture?

A) 0.8% C) 8.0%

B) 20% D) 80%

Q.12 How many carbon atoms are present in 34.2g of sucrose ($C_{12}H_{22}O_{11}$) $M_r = 342$)?

A) 6.0×10^{22} C) 7.2×10^{23}

B) 3.6×10^{25} D) 3.6×10^{24}

Q.13 What is the number of molecules in $1000cm^3$ of nitrogen gas under room conditions?

A) 2.5×10^{22} C) 4.0×10^{23}

B) 3.5×10^{22} D) 4.5×10^{26}

Q.14 Which is the correct sequence of stages in mass spectrometer?

A) Ionization, amplification, recording, detection, separation

B) Ionization, amplification, detection, separation, recording

C) Recording, detection, amplification, separation, ionization

D) Ionization, separation, detection, amplification, recording

Q.15 How many total number of atoms are present in 49.0g of sulphuric acid (H_2SO_4)?

A) $7 \times 3 \times 10^{23}$ C) $5 \times 6 \times 10^{23}$

B) $7 \times 8 \times 10^{23}$ D) $6 \times 6 \times 10^{23}$

USE THIS SPACE FOR SCRATCH WORK

Q.16 **An organic compound has empirical formula CH_2O. If molar mass of the compound is 90 grams, then molecular formula of this organic compound would be (A_r of C = 12, H = 1.008 and O = 16):**

A) $C_6H_6O_2$ C) $C_9H_9O_3$

B) C_3H_3O D) $C_3H_6O_3$

Q.17 **How many bromine (Br) atoms are in 3 moles of bromine (Br) element?**

A) $3 \times 6.022 \times 10^{-23}$ atoms C) 81 x 3 x 10^{23} atoms

B) 79 x 3 x 6 x 10^{23} atoms D) $3 \times 6.022 \times 10^{23}$ atoms

Q.18 **Carbon dioxide (CO_2) gas produced during combustion analysis of given organic compound is absorbed in 50% of KOH solution. It is a:**

A) Chemical change only

B) Physical change only

C) May be physical or chemical change

D) Neither physical nor chemical change

Q.19 **In the experimental determination of the percentage of carbon and hydrogen in an organic compound, water is absorbed by:**

A) KOH C) K_2SO_4

B) $MgCl_2$ D) $Mg(ClO_4)_2$

Q.20 **12g of magnesium (Mg) reacts with dilute sulphuric acid (H_2SO_4) to produce hydrogen (H_2) gas. The amount of hydrogen (H_2) gas produced is:**

A) 4g C) 2g

B) 3g D) 1g

Q.21 **5.6g of potassium hydroxide (KOH) has been dissolved in 100cm^3 of aqueous solution, molarity of the solution is:**

A) 1.0M C) 1.5M

B) 2.0M D) 2.5M

Q.22 **Which of the following units of concentration of solution change with the increase of temperature?**

I. Molality **III. Molarity**

II. Mole Fraction **IV. %age composition (v/v)**

A) I, II C) III, IV

B) I, II, III D) II, III

USE THIS SPACE FOR SCRATCH WORK

Q.23 **Mark the incorrect statement about mole fraction:**

A) It is used for three components of a solution

B) It is independent of temperature

C) Its value is always less than 1

D) Sum of mole fractions is ≥ 1

Q.24 **Which of the following is unit of molarity?**

A) $moldm^{-3}$ C) $molkg^{-1}$

B) gram equivalent L^{-1} D) gcm^{-3}

Q.25 **What is the percentage by (v/v) of ethanol, if 5.0cm^3 of ethanol is dissolved in 45.0cm^3 of water?**

A) 10% C) 6%

B) 8% D) 4%

Q.26 **Silicon carbide (SiC) is an important ceramic material. It is produced by allowing silica (SiO_2) to react with carbon at high temperature as shown in the reaction:**

$$SiO_2 + 3C \longrightarrow SiC + 2CO$$

When 0.3kg sand is reacted with excess of carbon, 0.1kg of silicon carbide (SiC) is produced. What is the percentage yield of silicon carbide (SiC)?

A) 35% C) 50%

B) 40% D) 45%

Q.27 **All of the following terms are correctly matched with the given data EXCEPT:**

Options	Terms	For which it is used	Example
A)	Relative atomic mass (A_r)	Element	H=1.008amu
B)	Relative isotopic mass	Isotopes or elements	$^{12}_{6}C$, $^{13}_{6}C$, $^{15}_{6}C$
C)	Relative molecular mass (M_r)	Covalent compounds	H_2O=18.0amu
D)	Relative formula mass	Ionic compound	KCl=74.5amu

USE THIS SPACE FOR SCRATCH WORK

Q.28 All of the following terms are correctly matched w.r.t their definition EXCEPT:

Options	Term	Definition
A)	Relative atomic mass	It is the mass of one atom of an element as compared to the mass of an atom of carbon taken as 12
B)	Relative formula mass	It is sum of relative atomic mass of atoms of one formula unit of an ionic compound
C)	Relative molecular mass	It is the sum of relative atomic mass of atoms of one molecule of a covalent compound
D)	Mass number	It is sum of proton and neutrino

Q.29 Identify the incorrect statement about yield:

A) Actual yield is less than theoretical yield

B) Percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

C) Experimental error does not affect actual yield

D) Efficiency of a chemical reaction depends on the amount of product

Q.30 A solution contains three components A, B and C in the molar ratio 3 : 6 : 1. The percentage of mole fraction of component A is:

A) 20% C) 30%

B) 25% D) 35%

Q.31 Isotopes of an element have all of the following different properties EXCEPT

A) They have different chemical properties

B) They have difference mass number

C) They have different number of neutrons

D) They have different half life

Q.32 The combustion analysis of an organic compound shows 60% carbon, 8% hydrogen and 32% oxygen. If the molecular mass of the given organic compound is 200, then the molecular formula of the organic compound is (Ar of C = 12 amu, H = 1 amu and O = 16 amu):

A) $C_{10}H_{16}O_4$ C) $C_{10}H_{14}O_4$

B) $C_8H_{16}O_4$ D) $C_5H_8O_2$

USE THIS SPACE FOR SCRATCH WORK

Q.33 Ascorbic acid (vitamin C) contains 48% carbon, 4% hydrogen and 48% oxygen. Which of the following is empirical formula of ascorbic acid?

A) $C_2H_4O_3$ C) $C_2H_2O_3$

B) CH_2O D) $C_4H_4O_3$

Q.34 The number of moles of sodium hydroxide present in 2.5dm^3 of 0.5M aqueous solution is:

A) 1.25 C) 0.5

B) 12.5 D) 5.0

Q.35 Molarity of pure water is:

A) 5.55 C) 55.5

B) 55.0 D) 55.1

Q.36 Calcium reacts with excess oxygen to form calcium oxide (CaO) as shown in the equation:

$$2Ca + O_2 \longrightarrow 2CaO$$

The maximum mass of CaO formed when 4.0g of calcium is burnt in excess oxygen is (A_r values Ca = 40amu, O = 16amu):

A) 3.6g C) 2.6g

B) 5.6g D) 4.6g

Q.37 If we know the mass of one substance, we can calculate the volume of other substance and vice versa with the help of a balanced chemical equation, which is called:

A) Mass-mass relationship

B) Mass-volume relationship

C) Mole-volume relationship

D) Mass-mole relationship

Q.38 By using the value of Avogadro's number (N_A = 6.0 x 10^{23})mol^{-1}, calculate the total number of atoms in 7.1g of Cl-element (A_r value Cl = 35.5):

A) 1.2 x 10^{23} Cl-atoms C) 1.0 x 10^{23} Cl-atoms

B) 1.6 x 10^{23} Cl-atoms D) 1.5 x 10^{23} Cl-atoms

Q.39 Which one of the followings has same number of molecules as present in 11g of CO_2?

A) 4g of O_2 C) 4g of O

B) 4.5g of H_2O D) ¼ moles of NaCl

Q.40 28g of N_2 gas at STP will occupy the volume of:

A) 22.41dm^3 C) 44.82cm^3

B) 44.82dm^3 D) 2.241dm^3

ANSWER KEY (Worksheet-11)							
1	B	11	B	21	A	31	A
2	C	12	C	22	C	32	A
3	D	13	A	23	D	33	D
4	D	14	D	24	A	34	A
5	A	15	A	25	A	35	C
6	A	16	D	26	C	36	B
7	D	17	D	27	B	37	B
8	B	18	A	28	D	38	A
9	D	19	D	29	C	39	B
10	A	20	D	30	C	40	A

ANSWERS EXPLAINED

Q.1 (B) The number of particles present in one mole of a substance is called **Avogadro's number**.

(N_A = 6.022 x 10^{23}) Statement (B) fulfills the condition of N_A such as. 24g of Mg = 1 mole

Molar mass of Mg = 24g

= **6.022 x 10^{23} Mg atoms**

Q.2 (C) The term **molecular formula cannot** be used for ionic compounds because molecular formula term is used for covalent compounds. In fact, molecule is an aggregation of atoms whereas **ionic compounds involve ions not atoms**.

Q.3 (D) **Given amount of H_2SO_4 = 98g**

Number of moles of H_2SO_4 = $\frac{98}{98}$

= 1mole

H_2SO_4 on dissociation splits up into ions such as

$$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{-2}$$

1mole 2mole 1mole

= 2 + 1 = 3moles of ions

Conclusion: From the equation it is clear that 1mole of **H_2SO_4** produces **3 moles of ions.**

Q.4 (D) **Cationic molecular ions** can be generated by passing high energy beam of electrons, **α-particles or X-rays** through a gas.

Q.5 (A) All the isotopes of an element have **same number of protons and electrons** but they have **different mass number**. **e.g. Cl element has two isotopes** $^{35}_{17}Cl$, $^{37}_{17}Cl$

Q.6 (A) **Where H stands** for **magnetic field, r stands** for **radius of circular path, E stands** for **strength of electric field**

- If **E** is **increased** by keeping **H constant** then r will **increase**

$$\therefore \mathbf{E \propto r \ldots i}$$

and positive ion of a particular m/e will fall at a different place as compared to the first place.

- If **H** is **increased** by keeping **E constant**, the **r** will **decrease**

$$\therefore \mathbf{H \propto \frac{1}{r} \ldots ii}$$

Overall equation $\frac{m}{e} = \frac{H^2r^2}{2E}$ **… iii**

Q.7 (D) **Symbol does not represent amu.**

$$\mathbf{1amu} = \frac{1}{6.026\times10^{23}}g = 1.661\times10^{-24}g$$

$\therefore$ **1amu = 1.661 x 10^{-24}g**

= 1.661 x 10^{-27}kg

= 1.661 x 10^{-21}mg

Q.8 (B)

Opt.	Elements	No. of isotopes
A)	F	Mono-isotopic
B)	Cl	Di-isotopic
C)	Au	Mono-isotopic
D)	As	Mono-isotopic

Q.9 (D) Because **cationic molecular** ions are comparatively **more stable** than **anionic molecular ions.**

Q.10 (A) $2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$ ...

Volume ratio b/w **C_2H_2** and O_2 = **2:5**

$2cm^3$ of **C_2H_2** requires O_2 = **$5cm^3$**

$1cm^3$.....$= \frac{5}{2}$

$5cm^3$..... $= \frac{5}{2} \times 5 = 12.5$ **cm^3**

Total volume of oxygen gas required for complete combustion of ethyne = $12.5cm^3$

Q.11 (B) $B = 10.8$ amu (relative atomic mass of boron)

^{11}B ^{10}B

x $100 - x$

$$\frac{11(x) + 10(100 - x)}{100} = 10.8$$

$$11x + 1000 - 10x = 10.8 \times 100$$

$$x + 1000 = 1080$$

$$x = 1080 - 1000 = x = 80\%$$

$\therefore$ %age of $^{10}B = 100 - 80 = 20\%$

Q.12 (C) **Number of C-atoms in sucrose**

$$= \frac{34.2}{342} \times 6 \times 10^{23} \times 12$$

$= 7.2 \times 10^{23}$

Q.13 (A) **Given data**

Volume of nitrogen gas at

RTP = $1000cm^3$

Number of nitrogen molecules (N_2)

$$= \frac{1000}{24000} \times 6 \times 10^{23}$$

$= 2.5 \times 10^{22}$

Q.14 (D) **Sequence of stages in mass spectrometer are as:**

Ionization, separation, detection, amplification, recording

Q.15 (A) Total numbers of atoms in **H_2SO_4**

$$= \frac{49}{98} \times 6 \times 10^{23} \times 7$$

$$= 7 \times 3 \times 10^{23}$$

Q.16 (D) **Given data:**

Empirical formula mass of organic compound **(CH_2O = 30g)**

Molecular mass of organic compound = **90g**

Molecular formula of organic compound = **n (Empirical formula)**

$$n = \frac{\text{molecular mass}}{\text{empirical formula mass}} = \frac{90}{30} = 3$$

Molecular formula = $3(CH_2O) = C_3H_6O_3$

Q.17 (D) Number of Br-atoms = 3 x 6.022 x 10^{23}

Q.18 (A) When **CO_2 is absorbed** in **pre-weighed 50% KOH solution**, reaction, take place as shown below:

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

From this reaction, it is clear that the absorption of CO_2 in KOH solution is a **chemical change**.

Q.19 (D) **$Mg(ClO_4)_2$** acts as **drying agent** and absorbs water**.** Conc. **H_2SO_4** and **CaO** also act as **drying agent.**

Q.20 (D) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$

Mg : H_2

1 : 1

0.5 : 0.5mole

- Number of moles of Mg = $\frac{12}{24} = 0.5$
- Amount of H_2 gas = Number of moles of H_2 x molar mass of hydrogen gas **= 0.5 x 2 = 1.0g**
- **Amount of H_2 = 1.0g**

Q.21 (A) $\mathbf{M = \frac{W_2 \text{ x } 1000}{M_2 \text{ x Volume of Solution } (cm^3)}}$

$\mathbf{M = \frac{5.6 \times 1000}{56 \times 100} = 1.0M}$

Q.22 (C) In fact, both **molarity** and **percentage composition (v/v) involve volume of solution.** Since volume changes with the **increase of temperature ($V \propto T$). Both molarity and percentage composition (v/v) change with the increase in temperature.**

Q.23 (D) **In fact, sum of mole fractions = 1**

i.e. $x_1 + x_2 + x_3 = 1$

In general all the solutions which have concentration in terms of volume are temperature depended and all the solutions which have concentration in terms of mass are temperature independent.

Q.24 (A) **Mathematically molarity of solution**

$= \frac{\text{Number of moles of solute}}{\text{Volume of solution in dm}^3}$

$= \text{mol dm}^{-3}$

Q.25 (A) **Volume of ethanol : 5.0cm^3**

Volume of water = 45.0cm^3

Volume of solution = 5 + 45 = **50.0cm^3**

%age of ethanol by volume

$= \frac{5}{50} \times 100 = 10\%$ **(v/v)**

Q.26 (C) $SiO_2 + 3C \longrightarrow SiC + 2CO$

Mass of sand (SiO_2) is treated with

C = 0.3kg = 300g

Mass of Silicon carbide produced (actual yield)

= 0.1kg = 100g … i

Molar mass of sand (SiO_2) = 28 + 32

= 60.0gmol^{-1}

Molar mass of silicon carbide = 28 + 12

= 40gmol^{-1}

Theoretical Yield = $\frac{40}{60} \times 300 = 200g \ldots$ ii

$\mathbf{\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \text{ x } 100}$

$= \frac{100}{200} \times 100 = 50\% \ldots$iii

∴ **Percentage Yield of silicon carbide (SiC) = 50%**

Q.27 (B)

- **Relative isotopic mass term is used only for isotopes**
- **Moreover, carbon element has three isotopes $^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{16}C$ but not $^{15}_{16}C$**

Q.28 (D) **In fact, the term mass number is used for isotopes of an element. Mass number is sum of protons and**

neutrons but it is not sum of protons and electrons.

Q.29 (C) In fact, **both** experimental error and human error **affect actual yield.**

Q.30 (C) Given data A = 3 mole, B = 6 mole,

C = 1 mole

Mole fraction (x) of component A = ?

Percentage of mole fraction of component **A** = $\frac{3}{10}\times 100$ **= 30%**

Q.31 (A) Since all the isotopes of an element **have same proton number**, therefore, they have **same electronic configuration**. So isotopes of an element have same chemical properties but have **different** physical properties because they have different **mass numbers.**

Q.32 (A) Given data

C%	:	H%	:	O%
60	:	8.0	:	32
$\frac{60}{12}$	:	$\frac{8.0}{1}$	:	$\frac{32}{16}$
5	:	8	:	2
2.5	:	4	:	1
2(2.5	:	4	:	1)

Empirical formula = $C_5H_8O_2$

Empirical formula mass = 100

Molecular formula = n(empirical formula)

$$\mathbf{n = \frac{200}{100} = 2}$$

∴ Molecular formula = $C_{10}H_{16}O_4$

Q.33 (D)

C%	:	H%	:	O%
48	:	4	:	48
$\frac{48}{12}$	:	$\frac{4}{1}$	:	$\frac{48}{16}$
$\frac{4}{3}$	:	$\frac{4}{3}$	:	$\frac{3}{3}$
3(1.33	**:**	**1.33**	**:**	**1)**
4	**:**	**4**	**:**	**3**

Empirical Formula of ascorbic acid = $C_4H_4O_3$

Q.34 (A) Number of moles of NaOH.

2.5 x 0.5 = 1.25moles.

Q.35 (C) Molality of pure water

$$= \frac{\text{number of moles of solute}}{\text{volume of solution in dm}^3}$$

$$= \frac{1000/18}{1} = \mathbf{55.5 moldm^{-3}}.$$

∴ molarity of pure water = 55.5moldm^{-3}

Q.36 (B) From the balanced equation

	Ca	:	CaO
Molar ratio	**2**	**:**	**2**
	0.1	**:**	**0.1**

Molar mass of CaO = 56amu

Mass of CaO formed = 0.1 x 56 = 5.6g

Q.37 (B) If we know the mass of one substance, we can calculate the volume of other substance with the help of balanced chemical equation and this relationship **is called mass – volume relationship.**

Q.38 (A) Number of chlorine atoms

$$= \frac{7.1}{35.5} \times 6 \times 10^{23}$$

$$= 1.2 \times 10^{23}$$

Q.39 (B)

	CO_2	:	H_2O
Molar mass	44g	:	18g
According to Condition	11g	:	?
Amount of water			= 4.5g

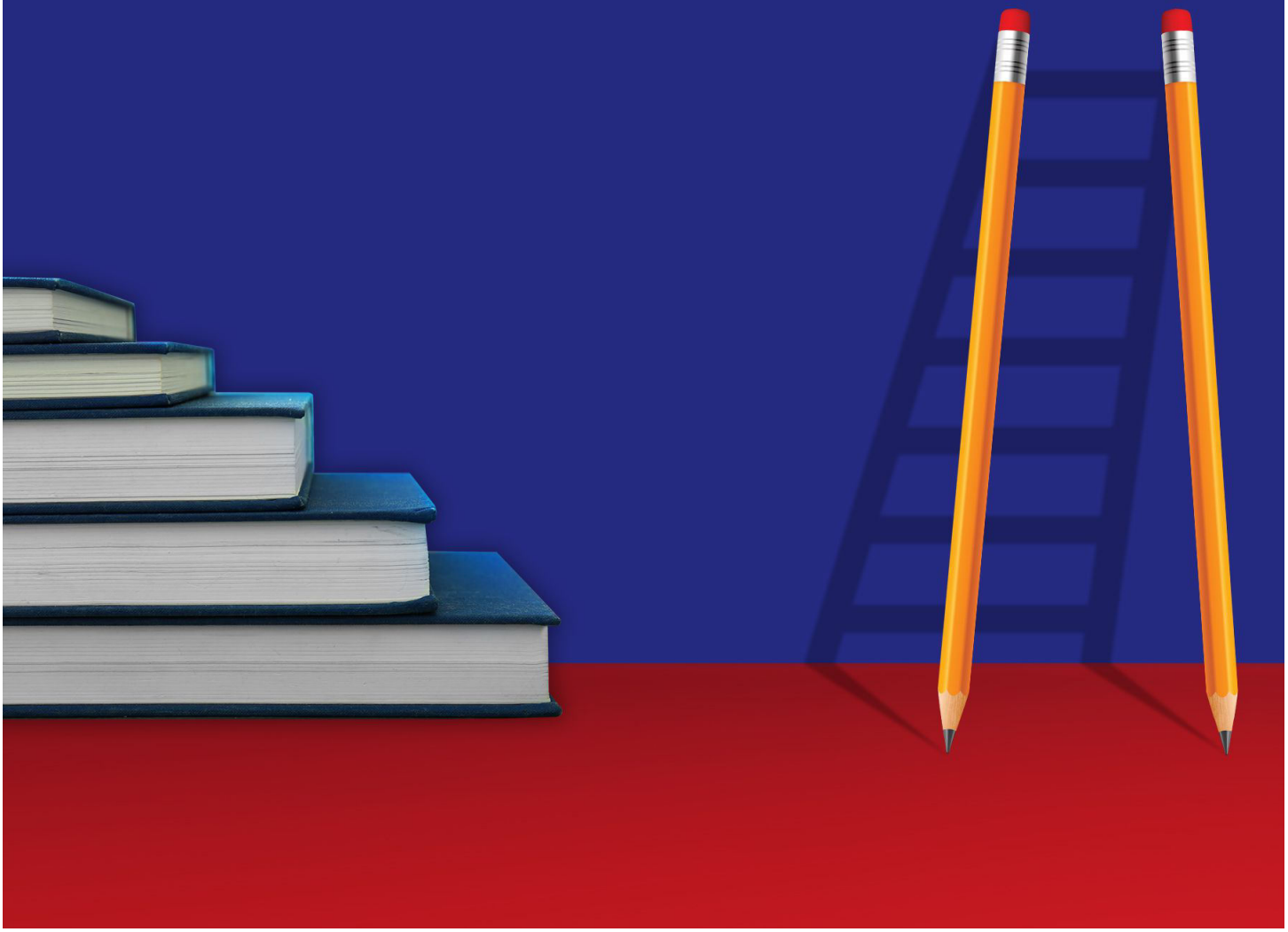
∴ **4.5g of water has same number of water molecule as present in 11g of CO_2**

Q.40 (A) 1mole of N_2 gas = 28g

= 22.41dm^3 at STP

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-12

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-12

(A. Physical Chemistry)

States of Matter (Gaseous + Liquid)

USE THIS SPACE FOR SCRATCH WORK

Q.1 **When sample of a gas is compressed at constant temperature from 15 atm to 60 atm, its volume changes from 76.0cm^3 to 20.5cm^3?**

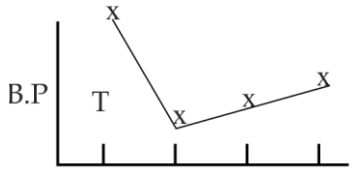
A) The gas behaves ideally

B) The gas behaves non-ideally

C) The volume of gas decreases

D) Gas is absorbed on the vessel walls

Q.2 **The diagram shows the variation of the boiling points of hydrogen halides.**



What explains the higher boiling point of HF?

A) The high bond energy of HF

B) In HF there is H- bonding between HF molecules

C) The electronegativity difference between F and H is much higher than that of other halides

D) The effect of nuclear charge is much reduced in fluorine which polarizes HF molecule

Q.3 **Real gases show deviation from which of the following postulates of kinetic molecular theory (KMT) of gases:**

A) Gases exert pressure

B) With the increases of temperature, kinetic energy of the gas molecule increases

C) The collision among the gas molecules are perfectly elastic

D) The molecules of a gas a have no forces of attraction for each other

Q.4 **When oxygen gas volume decreases from 4.0dm^3 to 2.0dm^3, the pressure increases from 400 kP$_a$ to?**

A) 600 kP$_a$ C) 200 kP$_a$

B) 800 kP$_a$ D) 500 kP$_a$

Q.5 **All of the following factors affect vapour pressure of a liquid EXCEPT?**

A) Nature of liquid
C) Surface area
B) Temperature
D) Intermolecular forces

Q.6 **Which one of the following gases shows more non-ideal behaviour?**

A) O_2
C) N_2
B) CO_2
D) H_2

Q.7 **Which of the following equations is used for real gases?**

A) PV = nRT

B) $PV=\frac{1}{3}mNC^{\bar{2}}$

C) $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$

D) $\left(P_{obs}+\frac{n^2a}{v^2}\right)\left(V_{vessel}-nb\right)=nRT$

Q.8 **The gas laws can be summarized in the ideal gas equation PV = nRT. Which of the following statements is / are incorrect?**

A) One mole of any ideal gas occupies the same volume under the same condition of temperature and pressure

B) The density of an ideal gas at constant pressure is inversely proportional to temperature

C) Volume of a given mass of a gas increases two times if temperature is raised from 25°C to 50°C at constant pressure

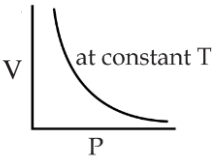
D) Both A and B

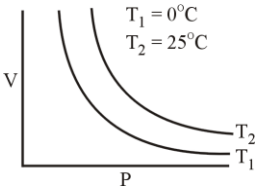
Q.9 **Which one of the following mathematical expression does not correctly represent the behavior of an ideal gas?**

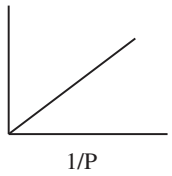
A) $PV_m \propto T$
C) $PM \propto dT$
B) $P \propto CT$
D) $P \propto \frac{1}{d}$

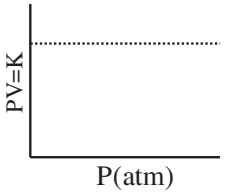
USE THIS SPACE FOR SCRATCH WORK

Q.10 **In which of the following isotherms volume increases?**

A) 

C) 

B) 

D) 

Q.11 **Which one of the following postulates of kinetic molecular theory (KMT) of gases explains Charles's law?**

A) Gases exert pressure

B) With the increase of temperature kinetic energy of the gas molecule increases

C) Gas molecules show elastic collision

D) No attractive forces among gas molecules

Q.12 **Under what conditions of temperature and pressure will a real gas behave like an ideal gas?**

Options	Temperature	Pressure
A)	Low	Low
B)	Low	High
C)	High	High
D)	High	Low

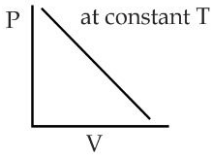
Q.13 **Which one of the following substances shows more than one kind of chemical bonding?**

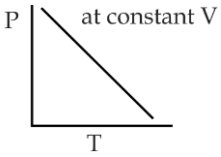
A) Brass C) Copper

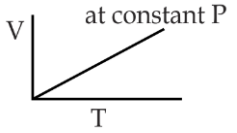
B) Diamond D) Water

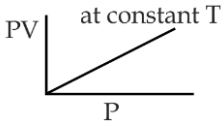
USE THIS SPACE FOR SCRATCH WORK

Q.14 **Which of the following diagram correctly describes the behavior of fixed mass of an ideal gas (T is measured in k)?**

A) 

C) 

B) 

D) 

Q.15 **Which of the following liquids has greater boiling point?**

A) Acetone C) Diethyl ether

B) Water D) Glycerol

Q.16 **Calculate the density of carbon dioxide (CO_2) gas at 0^oC and 1atm pressure.**

A) $=\frac{1\times44}{0.0821\times273}gdm^{-3}$ C) $=\frac{1\times44}{8.3143\times273}gdm^{-3}$

B) $=\frac{1\times44}{0.0821\times298}gdm^{-3}$ D) $=\frac{1\times44}{1.987\times273}gdm^{-3}$

Q.17 **Which of the following molecules cannot form hydrogen bonding with each other?**

A) NH_3 C) CH_3OH

B) CH_3NH_2 D) CH_3COCH_3

Q.18 **London dispersion forces are the only forces present among the:**

A) Molecules of water in liquid state

B) Atoms of helium in gaseous state at high temperature

C) Molecules of solid iodine

D) Molecules of hydrogen chloride gas

Q.19 **All of the following molecules show hydrogen bonding EXCEPT:**

A) HF molecules

B) Acetone and chloroform molecule

C) Water molecules

D) HCl molecules

USE THIS SPACE FOR SCRATCH WORK

Q.20 **Which one of the following types of intermolecular forces is the strongest one?**

A) Hydrogen bonding C) Debye forces

B) London dispersion forces D) Dipole dipole forces

Q.21 **According to Boyle's law, the volume of a given mass of a gas is inversely proportional to pressure at constant temperature. Mathematically PV = k. The value of k depends on all of the following factors EXCEPT:**

A) Amount of the gas C) Nature of the gas

B) Rate of diffusion of the gas D) Temperature

Q.22 **Which one of the following gas laws can only be explained on the basis of Kelvin scale?**

A) Boyle's law C) Dalton's law

B) Charles's law D) Avogadro's law

Q.23 **Which of the following is/are application of general gas equation. It is used to determine?**

A) Molecular mass of a gas only

B) Density of a gas only

C) Both A and B

D) Neither A nor B

Q.24 **Although HF is more polar than H_2O, but even then boiling point of H_2O is greater than that of HF. It is because of:**

A) HF is in the gaseous state

B) H_2O has two hydrogen bonds per molecule

C) HF is a weak acid

D) HF has one hydrogen bond per molecule

Q.25 **Which of the following is correct decreasing order of boiling point of given liquids?**

A) Water > Ethanol > HF > NH_3

B) Ethanol > HF > NH_3 > Water

C) NH_3 > HF > Water > Ethanol

D) HF > NH_3 > Ethanol > Water

Q.26 **Which one of the following relationship is correct regarding van der waal's gas equation?**

A) $a_{NH_3} > a_{N_2}$ but $b_{NH_3} < b_{N_2}$

B) $a_{NH_3} < a_{N_2}$ but $b_{NH_3} < b_{N_2}$

C) $a_{NH_3} < a_{N_2}$ but $b_{NH_3} > b_{N_2}$

D) $a_{NH_3} > a_{N_2}$ but $b_{N_2} \geq b_{NH_3}$

USE THIS SPACE FOR SCRATCH WORK

Q.27 **The spontaneous change of a liquid into its vapours is called evaporation. Identify the incorrect statement about evaporation:**

A) It is natural and continuous

B) It is exothermic

C) It causes cooling

D) It is surface phenomenon

Q.28 **Equal volumes of all the ideal gases at the same temperature and pressure contain equal number of molecules. This is in accordance to:**

A) Boyle's law C) Charles's law

B) Avogadro's law D) Dalton's law

Q.29 **Mark incorrect statement about boiling point of water:**

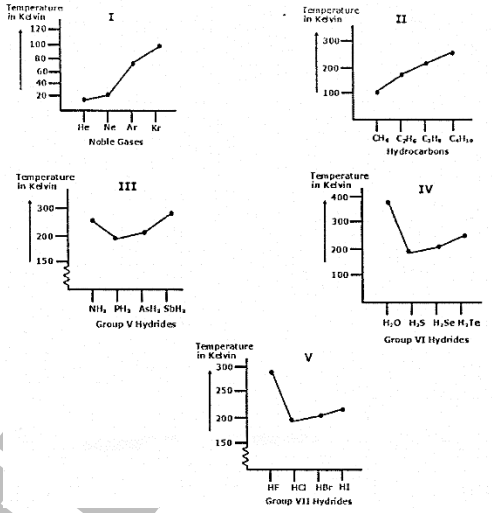
A) Boiling point of water is 120°C at 1489 torr pressure

B) Boiling point of water is 25°C at 23.7 torr pressure

C) Boiling point of water is 98°C at 700 torr pressure at the top of Murree Hills

D) Boiling point of water is 70°C at 323 torr pressure at the top of Mount Everest

Q.30 **Study the following graphs of boiling points of some substances:**



Which of the above graphs show that some members of the graph have hydrogen bonding?

A) I + V C) III + IV + V

B) II + IV D) I + II + III

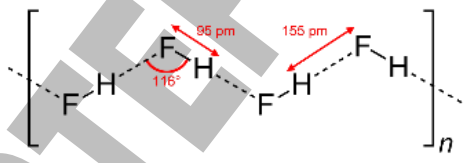
USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-12)							
1	B	11	B	21	B		
2	B	12	D	22	B		
3	D	13	D	23	C		
4	B	14	B	24	B		
5	C	15	D	25	A		
6	B	16	A	26	A		
7	D	17	D	27	B		
8	C	18	C	28	B		
9	D	19	D	29	D		
10	C	20	A	30	C		

ANSWERS EXPLAINED

Q.1 **(B)** With reference to **Boyle's law** with the **increase of pressure** form **15 atm to 60 atm (4 times),** then the volume of a gas should be **decreased ¼ times**. But in this case the decrease in volume is not according to **Boyle's law**. Therefore, the gas behaves **non-ideally**.

Q.2 **(B)** The highly electronegative atoms responsible for making hydrogen bonding are **Fluorine, Oxygen**, Nitrogen and rarely chlorine. The **size of Fluorine is small** and it is the most electronegativity element in the periodic table. Electronegativity of Fluorine is 4. **Hydrogen bonding** in **HF** is shown below.



- Since **hydrogen bonding is stronger than** dipole dipole forces therefore, HF exists in the liquid state **(BP of HF is 19.5°C)** while other halogen acids exist in the gaseous state.

Q.3 **(D) Real gases show deviation from the following postulates of KMT:**

The molecules of a gas a have no forces of attraction for each other. In fact, at high pressure and low temperature real gases deviate from above postulate as explained below:

i. **At high pressure** gas molecules come close to each other and in such condition effective volume of a gas molecules cannot be neglected which is against the postulates of KMT of a ideal gas **(Gases are ideal at low pressure and non-ideal at high pressure)**

ii. **At low temperature** K.E decreases and attractive forces develop between the gas molecules which is also against the postulates of KMT **(Gases show ideal behavior at high temperature and non-ideal behavior at low temperature)**

Q.4 **(B)** According to **Boyle's law,** mathematically

$$P_1V_1 = P_2V_2 \text{ (at constant n \& T)}$$

$$\therefore P_2 = \frac{P_1V_1}{V_2}$$

$$P_2 = 4 \times \frac{400}{2} = 800 \text{ kPa}$$

Q.5 **(C) Vapour pressure** of a liquid is an intensive property which depends on nature of the substance and it does not depend on surface area. Other examples of intensive properties are M.P, B.P, viscosity, surface tension etc.

Q.6 (B) Greater is the **molar mass,** greater is the size. Therefore, greater is the **polarizability, stronger are intermolecular forces.** Thus greater is the deviation from the **ideal gas** behaviour. That is why **CO_2** gas shows more **non-ideal** behaviour as its molar mass is greater as compared to other gases.

Q.7 (D) $\left(P_{obs}+\frac{n^2a}{v^2}\right)(V_{vessel}-nb)$ This equation is van der Waal's gas equation. A real gas obeys this equation because real gas shows deviation from ideal gas behaviour at low temperature and high pressure.

Q.8 (C) **Charles's law** can only be explained on the basis of **Kelvin scale**, not on the basis of centigrade scale. Therefore, under the given condition the volume of a given mass of a gas would not increase two times by **increasing temperature** from **25°C to 50°C**.

Q.9 (D) **It is incorrect statement.** In fact, with the **increase of pressure** under the given condition **density of a gas also increases** i.e. $P \propto d$.

Q.10 (C) **Two isotherms** are obtained, one at **0°C** and other at **25°C** as shown in the figure. By keeping the temperature constant and again vary the pressure and volume and plot the isotherm. **It goes away from both the axes**. The reason is that at **higher temperature**, the volume of given mass of a gas increases. Similarly if we increase the temperature further, make it constant and plot another isotherm, it further goes away from the axis and thus volume of a gas increases as the isotherms move away from the axes.

Q.11 (B) According to **KMT** the average kinetic energy of a gas molecules varies directly as the absolute temperature of the gas. **i.e. ($T \propto$ K.E)**. This **postulates** clearly explains **Charles's law**. According to this law, the volume of the given mass of a gas is directly proportional to the absolute temperature, when the **pressure** is kept **constant**.

Q.12 (D) A real gas behaves like an ideal gas under two conditions.

i. At high temperature kinetic energy of gas molecules increases, and intermolecular forces become almost negligible. (a = 0 i.e. "a" constant becomes insignificant) in van der waal's gas equation:

$$\left(P_{obs}+\frac{n^2a}{v^2}\right)(V_{vessel}-nb)=nRT \quad \textbf{(i)}$$

When a = 0 then $(P_i)\,(V_{vessel} - nb) = nRT$ **(ii)**

ii. At low pressure gas molecules move away from each other (b = 0 i.e. "b" constant becomes insignificant) in van der Waal's gas equation:

$(P_i)\,(V_{vessel} - nb) = nRT$ **(iii)**

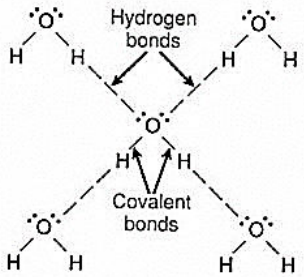
- When b = 0 then $(P_i)\,(V_{vessel}) = nRT$

$(PV) = nRT$ **(iv)**

The van der Waal's gas equation approaches the ideal gas equation PV = nRT as the values of these constants approach zero. The constant "a" provides a correction for the intermolecular forces. Constant "b" is a correction for finite molecular size and its value is the volume of one mole of the atoms or molecules of a gas.

- Under these two conditions **van der Waal's gas equation** reduces to general gas equation (**PV = nRT**).

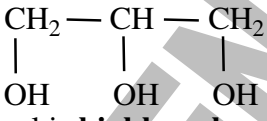
Q.13 (D) Water molecules have **covalent bonds** and **H-bondings** as shown in figure.



Hydrogen bonding in water.

Q.14 (B) **PV = nRT,** since **P, n** and **R** are **constant,** we have V = aT, a = $\frac{nR}{P} > 0$. Therefore, a plot of **V** vs **T** gives a **straight line** with a **positive gradient** $(\frac{nR}{P})$ passing through the **origin.**

Q.15 (D) In glycerol there are three **OH-groups** attached with **three carbon** atoms as shown in the structure.



As glycerol is **highly polar molecule** due to the presence of **three OH-groups.** Thus they form stronger hydrogen bonds. So boiling point of **glycerol (290°C)** is higher than that of other liquids mentioned in the question. Boiling points of other liquids are, **acetone (56°C), diethyl ether (34.5°C) and water (100°C).**

Q.16 (A) **Density of CO_2 gas**

$$= \frac{1\times44}{0.0821\times273} gdm^{-3}$$

= 0.7138g dm^3

Q.17 (D) **Propanone** shows dipole dipole forces but it does not show **hydrogen bonding** because **H-atom is not bonded** directly to a small and highly electronegative atom **such as N, O, and F**. While all others **A, B and C** show **hydrogen bonding.**

Q.18 (C) **London dispersion forces** are **weakest forces.** They are more significant in **non-polar molecules.** The elements of **VIIA and VIIIA groups** show London dispersion forces. All the halogens are non-polar diatomic molecules, but there is a **big difference** in their **physical states** at **room temperature. Fluorine** is a **gas** and boils at (**-188.1°C**) while iodine is a solid at room temperature which **boils** at **+184.4°C.** The polarizability of iodine molecule is **much greater than that of fluorine.**

Halogens	F_2	Cl_2	Br_2	I_2
Colours	Pale Yellow	Greenish Yellow	Reddish Brown	Greyish Black
Physical State	Gas	Gas	Liquid	Solid
Melting Points (°C)	–220	–101	–7.2	114
Boiling Points (°C)	–188.0	–34.6	58.5	184.4

Q.19 (D) **Hydrogen bonding** is the **electrostatic force** of attraction **between** a highly **electronegative (N, O and F)** atom and partial positively charged hydrogen atom. **e.g. HF(ℓ), H_2O(ℓ), and in between Acetone (ℓ) and Chloroform (ℓ)** exist hydrogen bonding.

However **HCl shows** dipole dipole forces.

Q.20 (A) Hydrogen bonding is the strongest electrostatic force of attraction among all the others except ion dipole forces.

Q.21 (B) Rate of diffusion does not affect the value of k (proportionality constant).

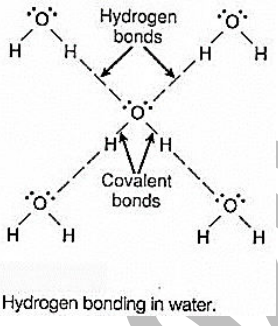
Q.22 (B) Charles's law can only be explained on the basis of Kelvin scale. It cannot be explained on the basis of centigrade scale.

Q.23 (C) General gas equation in the form of (PM = dRT) can be used to determine

- **Molecular mass of the gas** $(M = \frac{dRT}{P})$
- **Density of a gas by the formula** $(d = \frac{PM}{RT})$**.**

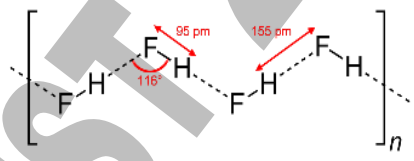
Q.24 (B) Greater is the number of hydrogen bondings, stronger are intermolecular forces and **greater** is the **boiling point of a liquid.** Since water molecules have **two hydrogen bonds** per molecule **as compared** to **HF** molecule (which has only one hydrogen bond), therefore the **boiling point of water (B.P = 100°C) is greater than that of HF liquid (B.P = 19.5°C) as shown in the structure.**

- **Hydrogen bonding in water as shown below:**



Hydrogen bonding in water.

- **Hydrogen bonding in HF as shown below:**



Q.25 (A) Boiling point of a liquid depends on the strength of intermolecular forces. So **stronger** are the intermolecular forces, **greater** is the **boiling point of a liquid.** The correct order of **decreasing boiling points of liquids** as shown in the tabular form:

Formula	Reason	Boiling point
(H_2O)	• **In water there are two hydrogen bonds per molecule.**	**B.P = 100°C (greater than the rest)**
Ethanol C_2H_5OH	• **Involves hydrogen bonding** • **Weaker than that of water**	**B.P = 78.26°C**
(HF)	• **In HF there is one hydrogen bond per molecule**	**B.P = 19.5°C**

(NH_3)	• **In NH_3 there is one hydrogen bond per molecule**	**B.P = -33.34°C**

Conclusion:

The correct decreasing order of boiling point of given liquids is as follow:

Water > Ethanol > HF > NH_3

Q.26 (A) Since there is **hydrogen bonding in ammonia** and **London dispersion forces** in **nitrogen gas.**

- As hydrogen bond is **stronger than** London dispersion forces, therefore, the value of "a" constant of **ammonia** is greater than that of "**a" constant of nitrogen (a constant is a measure of strength of intermolecular forces). Intermolecular forces develop at high pressure and low temperature in the real gases.**
- On the other hand the value of "b" **constant** of nitrogen is **greater than that** of "**b" constant of ammonia (b constant is excluded volume at high pressure).**
- As we known that in **nitrogen molecules** there are weaker London dispersion forces as compared to hydrogen bonding in **ammonia,** so that is why **value of constant "b" for ammonia is less than that of constant "b" of nitrogen gas as shown in the table.**

Gas	"a" (atm dm^6 mol^{-2})	"b" (dm^3 mol^{-1})
NH_3	4.170	0.371
N_2	1.390	0.391

Q.27 (B) In fact, it is endothermic process, water molecules absorb energy from the surrounding. As a result higher energy molecules come on the surface of a liquid from where they change into vapours. That is why evaporation causes cooling because temperature of the environment decreases.

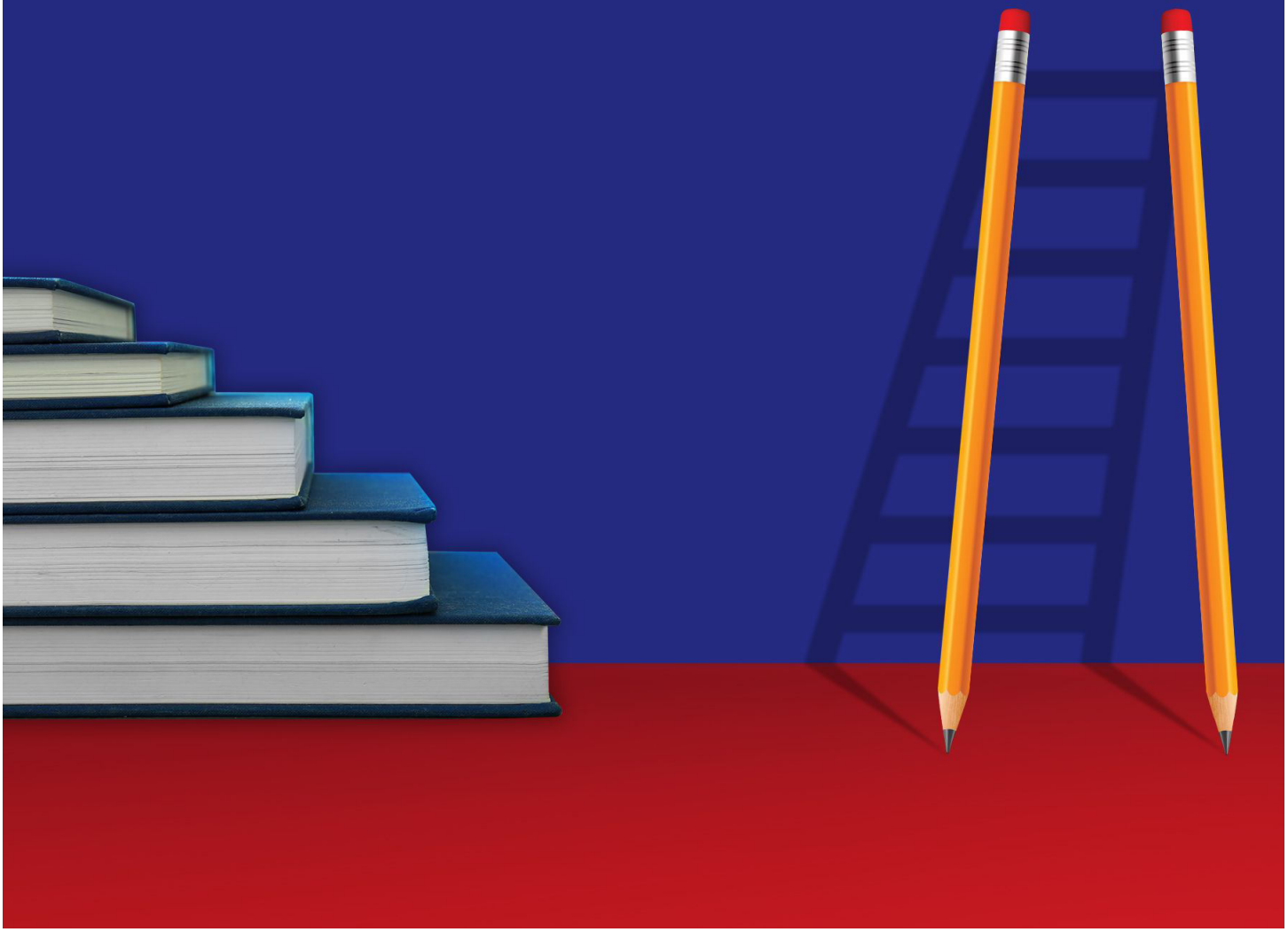
Q.28 (B) Actually it is **definition** of **Avogadro's law. Mathematically it is shown as** $\mathbf{V \propto n(at\ constant\ T\ and\ P)}$.

Q.29 (D) It is incorrect statement. In fact, boiling point of water is 69°C at 323 torr pressure at the top of Mount Everest.

Q.30 (C) There is hydrogen bonding in option **"C" denoted by Roman letter III+IV+V.**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-13

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-13
(A. Physical Chemistry)
States of Matter (Solids)
Atomic Structure

USE THIS SPACE FOR SCRATCH WORK

Q.1 **A phenomenon in which a compound exists in more than one crystalline forms is called:**

A) Polymorphism C) Isomorphism

B) Allotropy D) Isomerism

Q.2 **Which of the following sets of solid elements A, B, C and D includes a giant metallic structure, a macromolecular structure and a simple molecular structure?**

A) Na, Mg, A*l* C) Al, S*i*, S

B) C, S*i*, Sn D) A*l*, S, Si

Q.3 **Face centered cubic structure is shown by:**

A) Cd C) Ag

B) Na D) Mg

Q.4 **Iodine is in the solid state and has greyish black colour. It has all of the following properties EXCEPT:**

A) It is a molecular solid

B) It shows face centered cubic structure

C) It has strong London dispersion forces

D) I – I bond distance in the crystal lattice is less than that of iodine in the gaseous state

Q.5 **Mark the incorrect statement about diamond which is allotropic form of carbon:**

A) It has two dimensional structure

B) It shows face centered cubic structure

C) It is a type of covalent solid

D) It is a non-conductor

Q.6 **Identify the incorrect statement about giant structure of NaCl:**

A) It shows face centered cubic structure

B) It has four formula units per unit cell in the crystal lattice

C) The distance between two adjacent ions of different kind in the crystal lattice is $2.75A^{o}$

D) It is non-conductor in the solid state

Q.7 All of the following pair of crystalline solids are correctly matched w.r.t type of bonding EXCEPT:

Options	Crystalline solids	Nature of bonding
A)	Diamond, SiC	Covalent bond
B)	MgO, NaCl	Ionic bond
C)	Al, Zn	Metallic bond
D)	I_2, HCl	London dispersion forces

Q.8 Which one of the following properties is not shown by molecular crystalline solids?

A) They are soft

B) They have low densities

C) They all are soluble in non-polar solvents

D) They are mostly volatile

Q.9 Which of the following statements about ionic solids, covalent solids and molecular solids is incorrect?

Opt.	Properties	Ionic solids	Covalent solids	Molecular solids
A)	Example	NaCl, CaO	Diamond, SiC	I_2, CO_2, HCl, Ice
B)	Basic component	Ions	Atom	Molecule
C)	Electrical conductivity	Non-conductor in solid state	Non-conductor except graphite	Non-conductor except HCl in H_2O
D)	M.P and B.P	Very high M.Ps and B.Ps	Very low M.Ps and B.Ps	High M.Ps and B.Ps

Q.10 In crystal lattice of ice, each O-atom of water molecule is attached to:

A) Four H-atoms C) Two H-atoms

B) One H-atom D) Three H-atoms

Q.11 The nucleus of an atom contains:

A) Always neutrons

B) Always protons and neutrons

C) Always protons only

D) Usually protons and neutrons

USE THIS SPACE FOR SCRATCH WORK

Q.12 In the periodic table elements are arranged in order of increasing their:

A) Mass number C) Proton number

B) Reactivity D) Density

Q.13 An atom with proton number of 19 and mass number of 40 is/has:

A) Found in the Group - IIA

B) Found in the third period

C) Same number of protons and electrons

D) Same number of protons and neutrons

Q.14 The neutron particle has:

A) A mass of 1 gram

B) A mass approximately equal to that of proton

C) A charge equal but opposite to that of electron

D) It is present in all the atoms

Q.15 Proton numbers of certain elements are given. Which represents an element which would not be in the same period as rest of the elements?

A) 3 C) 9

B) 10 D) 12

Q.16 Which of the following particles contains 20 neutrons 19 protons and 18-electrons?

A) $^{39}_{19}K^{+}$ C) $^{39}_{19}K$

B) $^{40}_{18}Ar$ D) $^{39}_{20}Ca$

Q.17 Which of the following statements is incorrect?

A) Metals have 1 – 3 valence electrons

B) Non-metals have 4 – 7 valence electrons

C) Noble gases have 2 or 8 valence electrons

D) All the elements of IIIA group are metals

Q.18 All of the following statements are correct EXCEPT:

A) Group number is based on valence electrons

B) Period is based on number of shells involved in the electronic configuration

C) Electrons present in the inner shells are called valence electrons

D) Block of the elements in the modern Periodic table is

USE THIS SPACE FOR SCRATCH WORK

based on partially filled atomic orbitals

Q.19 Which of the following species has maximum number of unpaired electrons?

A) Fe^{+3} C) Zn

B) Ni^{+2} D) Cu^{+}

Q.20 The lowest principal quantum number that an electron can have is:

A) 0 C) 1

B) 2 D) 3

Q.21 The relative energy of 4s, 4p and 3d orbitals are in the order of:

A) 3d < 4p < 4s C) 4s < 4p < 3d

B) 4s < 3d < 4p D) 4p < 3d < 4s

Q.22 With the increase of value of principal quantum number (n), the shape of the s-orbitals remain same although their sizes:

A) Increase

B) Decrease

C) Remain the same

D) May or may remain the same

Q.23 All of the following are applications of quantum numbers EXCEPT:

A) To find group of elements

B) To find block of elements

C) To find period of elements

D) To determine 1^{st} ionization energy of elements

Q.24 In a multi-electron atoms, the energy of the electrons in a particular orbital is determined by:

A) n C) n + *l*

B) n + *l*, m D) n, *l*, m, s

Q.25 The fact that the two electrons in an atomic orbital must have opposite spin as deduced from:

A) Hund's Rule

B) Pauli's Exclusion Principle

C) Aufbau Rule

D) Heisenberg's Uncertainty Principle

USE THIS SPACE FOR SCRATCH WORK

Q.26 **All of the following statements about ionization energy are correct EXCEPT:**

A) Successive ionization energies of an element increase

B) Atom of the element must be in the gaseous state before loss of electron

C) Elements which have stable electronic configuration have greater ionization energy

D) Ionization energy may or may not be endothermic process

Q.27 **Which of the following elements has greater first ionization energy?**

A) Si C) P

B) C*l* D) A*l*

Q.28 **Consider the following thermo-chemical equation:**

$$\underset{(s)}{Na} \longrightarrow \underset{(g)}{Na^+} + e^-$$

The enthalpy change involved in the above ionization of the solid sodium into gaseous Na^+ ion is:

A) ΔH_i C) $\Delta H_{at} + \Delta H_i$

B) ΔH_{sub} D) ΔH_{at}

Q.29 **An atomic orbital may never be occupied by:**

A) 1 electron C) 2 electrons

B) 3 electrons D) Zero electron

Q.30 **Where in a periodic series do you find strong based formers?**

A) Inert gases C) Right

B) Middle D) Left

Q.31 **Which of the following is proper order of characteristic features of quantum numbers?**

A) Size, Shape, Orientation C) Shape, Size, Orientation

B) Orientation, Size, Shape D) Shape, Orientation, Size

Q.32 **Which of the following formula is used to determine number of electrons in a sub-shell?**

A) $2n^2$ C) $2(2l + 1)$

B) $l = n - 1$ D) $m = 2l + 1$

USE THIS SPACE FOR SCRATCH WORK

Q.33 **Which of the following ions have more electrons than protons and more protons than neutrons?**

A) D^{-1} C) OD^-

B) He^+ D) OH^-

Q.34 **Identify the incorrect statement about electron affinity:**

A) Elements having stable electronic configuration have high electron affinity

B) Elements of 3rd period have greater electron affinity than that of 2nd period

C) It is associated with element

D) Element must be in the gaseous state before gain of electron

Q.35 **In which of the following pair of elements, first element of the pair has comparatively greater electron affinity?**

A) F, Cl C) N, P

B) S, O D) B, Al

Q.36 **In which of the following pair of elements, 1st element of the pair has lower ionization energy?**

A) N , O C) Mg , Al

B) Ne, F D) S, P

Q.37 **Which of the following is correct electronic configuration of Copper (atomic number of Cu = 29)?**

A) [Ar] $3d^9, 4s^2$ C) [Kr] $3d^9, 4s^2$

B) [Ar] $3d^{10}, 4s^1$ D) [Kr] $3d^{10}, 4s^1$

Q.38 **Correct electronic configuration of potassium (atomic number K=19) is:**

A) [Ar] $4s^1$ C) [Kr] $4s^2$

B) [Ne] $4s^2$ D) [Kr] $4s^1$

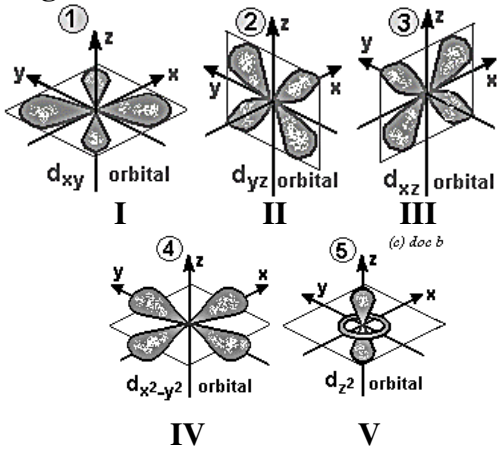
Q.39 **Which of the following atoms represent isotones?**

A) $^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$ C) $^{40}_{18}Ar$, $^{42}_{20}Ca$, $^{43}_{21}Sc$

B) $^{40}_{18}Ar$, $^{40}_{20}Ca$, $^{41}_{21}Sc$ D) $^{14}_{7}N$, $^{16}_{8}O$, $^{18}_{9}F$

USE THIS SPACE FOR SCRATCH WORK

Q.40 Followings are all the d-atomic orbitals.



Which of the following is collar shaped d-atomic orbital?

A) I and II
C) III and IV
B) V only
D) IV only

Q.41 Mark the incorrect statement:

A) Number of protons in the nucleus of an atom is called proton number and it is shown by Z

B) Sum of protons and neutrons in the nucleus of an atom is called nucleon number (mass number) and is shown by A

C) Number of neutrons = A – Z

D) Number of protons and electrons in a cation is equal

Q.42 Properties of three fundamental particles are given in the tabular form:

	Particles	Charge	Relative charge	Mass (kg)	Deflection under electric field
I	Proton	$+1.6022 \times 10^{-19}$	+1	1.6726×10^{-27}	Deflects toward negative pole
II	Neutron	0	0	1.6705×10^{-27}	Undeflected
III	Electron	-1.6022×10^{-19}	-1	9.1095×10^{-31}	Deflects towards positive pole

Identify which one is not correctly matched:

A) I
C) III
B) II
D) I and III

USE THIS SPACE FOR SCRATCH WORK

Q.43 **Rutherford's model of atom failed because:**

A) The atom did not have a nucleus and electrons

B) It did not account for the attraction between protons and neutrons

C) It did not account for the stability of the atom

D) There is actually no space between the nucleus and the electrons

Q.44 **Bohr's hydrogen atomic model of atom is contradicted by:**

A) Planck's quantum theory

B) Heisenberg's uncertainty principle

C) Photoelectric effect

D) Dual nature of electrons

Q.45 **All of the following statements about Rutherford's atomic model are correct EXCEPT:**

A) Most of the part of atom is empty

B) Central part of the atom is positively charged which is called nucleus

C) He proposed the planetary model of atom (similar to the solar system)

D) All the particles are present in the nucleus except electrons

Q.46 **According to Planck's quantum theory of radiation, all of the following mathematical relationships are correct EXCEPT:**

A) $E \propto v$

B) $E \propto \frac{1}{\lambda}$

C) $\bar{v} = \frac{1}{\lambda}$

D) $E \propto \frac{1}{\bar{v}}$

Q.47 **According to Bohr's hydrogen atomic model, if electron is present in 2nd shell (n = 2), the value of radius (for 2nd orbit) is:**

A) $2.116A^o$

B) $2.216A^o$

C) $2.135A^o$

D) $2.345A^o$

Q.48 **Bohr's hydrogen atomic model theory is applicable for all of the following species EXCEPT:**

A) H

B) He^{+1}

C) Li^{+2}

D) Be^{+2}

USE THIS SPACE FOR SCRATCH WORK

Q.49 **Which of the following statements about Bohr's hydrogen atomic model is incorrect?**

A) $r_2 - r_1 < r_3 - r_2 < r_4 - r_3$

B) $E_2 - E_1 > E_3 - E_2 > E_4 - E_3$

C) Energy of electron is directly proportional to n^2 (n = shell number)

D) According to him electrons not only revolve round the nucleus in circular orbit but also in elliptic orbit

Q.50 **X-rays show all of the following properties EXCEPT:**

A) They are electromagnetic radiations

B) They travel with the velocity of light

C) They have greater frequency than gamma rays

D) They are used to diagnose fracture in the bones

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-13)							
1	A	14	B	27	B	40	B
2	C	15	D	28	C	41	D
3	C	16	A	29	B	42	B
4	D	17	D	30	D	43	C
5	A	18	C	31	A	44	B
6	C	19	A	32	C	45	C
7	D	20	C	33	D	46	D
8	C	21	B	34	A	47	A
9	D	22	A	35	B	48	D
10	A	23	D	36	D	49	D
11	D	24	C	37	B	50	C
12	C	25	B	38	A		
13	C	26	D	39	C		

ANSWERS EXPLAINED

Q.1 (A) **A phenomenon in which a compound exists in more than one crystalline forms is called polymorphism.** That compound which exists in more than one crystalline forms is called a polymorphic, and these forms are called polymorphs of each other. Polymorphs have **same chemical properties** but they **differ in the physical properties**. **e.g. $CaCO_3$** shows **two crystalline** forms **trigonal and orthorhombic**. Polymorphs have same chemical properties, but they differ in the physical properties. The difference in physical properties is due to different structural arrangement of their particles.

Q.2 (C) **These substances** fulfill the condition because **Al** shows a giant **metallic structure**, **Si** shows **macromolecular structure** while **S** shows a simple **molecular structure.**

Q.3 (C) **Ag** shows **face centered cubic structure** while **Na** shows **body centered cubic structure, Cd** and **Mg** show **hexagonal closed packing structure.**

Q.4 (D) It is incorrect statement. **In fact, I – I bond distance in the crystal is greater than that of iodine in the gaseous state.**

- **Iodine** in the **solid** state is in the form of **crystal lattice.** Since **iodine molecules** have **greater size** so there is **greater polarizability greater charge** separation and thus there are stronger intermolecular force in the **iodine molecules.** So in the crystal lattice there is stretching in the iodine molecules due to greater polarizability.
- But in case of iodine in the gaseous state there is no polarizability, so iodine molecules are independent from each other.
- That is why **I – I (271.5ppm) bond length in crystal lattice is greater than that of iodine in the gaseous state i.e. (I – I)** has comparatively less bond length value **(266.6pm).**

Q.5 (A) In fact, **diamond has three dimensional** structure **but not two dimensional structure. Two dimensional structure** is **shown by graphite** (which is allotropic form of carbon).

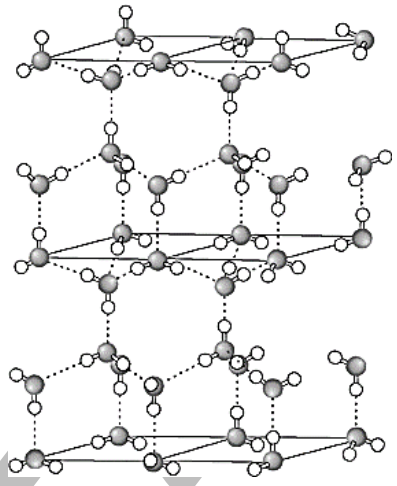
Q.6 (C) In crystal lattice of **NaCl,** the **distance between two nearest ions of the same kind i.e., Cl^- ions is 5.63A^o. So the distance between two adjacent ions of different kind is 5.63/2 = 2.815A^o, but not 2.75A^o.**

Q.7 (D) In fact, iodine molecules **have stronger London dispersion forces** in the **solid state.** But **HCl** has dipole-dipole forces because it is polar molecule whereas **iodine is a non-polar molecule.**

Q.8 (C) It is incorrect option. In fact **polar molecular** crystals are **soluble** in **polar solvents e.g. HCl** in **H_2O** while **non-molecular solids** are **soluble** in **non-polar solvents e.g. iodine** is **soluble** in **carbon tetrachloride solvent.**

Q.9 (D) Covalent solids like **diamond, SiC, $(SiO_2)_n$** have **high melting and boiling point** as **compared** to **ionic compounds e.g. melting boiling** of **diamond is 3550^oC** whereas **melting point of NaCl** is **801^oC.**

Q.10 (A) The presence of two hydrogen atoms and two lone electron pairs in each water molecule results in a three-dimensional tetralhedral structure in ice. Each oxygen atom in ice is surrounded tetrahedrally by four others. Hydrogen bonds link each pair of oxygen atoms shown in figure.



- That is why in crystal lattice of ice each O-atom of water molecule is attached to four H-atoms.
- Empty spaces are created in the structures as shown in the figure. That is why when water freezes, it occupies 9% more space and its density decreases.
- The result in that ice floats on water. The structure of ice is just like that of a diamond because each atom of carbon in diamond is at the center of tetrahedron just like the oxygen of water molecules in ice.

Q.11 (D) The nucleus of an atom usually contains protons and neutrons **except hydrogen (protium)** which **does not have neutrons.** All the other elements have protons and neutrons.

Q.12 (C) In the modern periodic table elements are arranged in order of increasing proton number which is shown by Z.

Q.13 (C) The element with **proton number 19** and **mass number 20** is isotope of K. It has same number of protons and electrons.

Q.14 (B) Neutron particle has a mass approximately equal to that of proton as shown below.

- **Mass of neutrons = 1.6750 x 10^{-27} kg**
- **Mass of protons = 1.6726 x 10^{-27} kg**

{By comparison it is clear that mass of neutron is almost equal to that of proton}

Q.15 (D) The element having **atomic number 12** belongs to **third period** because it involves three shells in its electronic configuration such as **2, 8, 2 (K, L, M) i.e three shells.**

Q.16 (A) It has been explained in the tabular form **i.e.**

Specie	Protons	Electrons	Neutrons
$^{39}_{19}K^{+}$	19	18	20

Q.17 (D) In fact all the elements of **IIIA group** are metals **(except Boron)** which is **non-metal.**

Q.18 (C) Electrons present in the inner shells are called core electrons which are responsible for shielding effect (screening effect). This effect is responsible for the decrease in force of attraction of the nucleus for the electrons present in the valence shell.

Q.19 (A) $^{26}Fe^{+3}_{(23e^-)}$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5$.

From the electronic configuration of a Fe^{+3}, it shows that there are five unpaired electrons in 3d-sub shell and it has the maximum number of unpaired electrons while others species has less number of unpaired electrons.

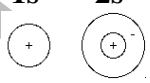
Q.20 (C) **Principal quantum number is shown by n. Its possible values are 1,2,3,4,5,6,7 so it is clear that it cannot be zero.**

Q.21 (B)

Name of sub-shell	n	ℓ	$n+\ell$	Order of filling of sub-shell
4s	4	0	4+0=4	4s < 3d < 4p
4p	4	1	4+1=5	
3d	3	2	3+2=5	

Q.22 (A) **With the increase n value (principal quantum number), the size of s-orbital increases whereas the shape remains the same. e.g. the size of 2s-orbital is greater than 1s-orbital**

1s **2s**



Q.23 (D) **e.g. it can be explained on the basis of electronic configuration as in nitrogen element $_7N$:**

- w.r.t… n value two shells (2,5) are involved (distribution of electron in shells), it shows that N belongs to 2nd period and VA group.
- w.r.t… $n+\ell$ rule ($1s^2$, $2s^2$, $2p^3$) it shows that nitrogen is p-block element
- By applying Hund's rule $\left(\mathbf{1s^2},\ \mathbf{2s^2},\ \mathbf{2\overset{\uparrow}{p}_x},\ \mathbf{2\overset{\uparrow}{p}_y},\ \mathbf{2\overset{\uparrow}{p}_z}\right)$ valency of **N = 3**
- It is clear that quantum numbers help us to determine **period, group, block, and valency** of the element but quantum numbers have no concern with ionization energy

Q.24 (C) In a multi-electron atoms, the energy of the electrons in a particular orbital is determined by $n + \ell$ rule, which is in accordance to Aufbau principle **which states that the electrons should be filled in the energy sub-shells in order of increasing energy values.** It can be explained with the help of following example.

Rule	3d	4s
$n + \ell$	$n = 3, \ell = 2$	$n = 4, \ell = 0$
	$n + \ell = 3 + 2 = 5$	$n + \ell = 4 + 0 = 4$

Conclusion:

$n + \ell$ rule shows that energy of 4s sub-shell is less than that of 3d. So 4s sub-shell is preferentially filled first than that of 3d.

Q.25 (B) **This principle can be stated as follows. It is impossible for two elections residing in the same atomic orbital of a poly-electrons atom to have the same values of four quantum numbers or two electrons in the same atomic orbital should have opposite spins $(\uparrow\downarrow)$.**

Q.26 (D) **Ionization energy is always endothermic process because energy always has to be supplied to remove electron from the outermost shell of an isolated atom in the gaseous state. Atom can be neutral or it may carry positive charge. In either case energy has to be supplied.**

Q.27 (B) Electronic configuration of **$_{17}Cl$ ($1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^5$)** shows that p-sub shell is near to completion and it is very close to electronic configuration of **Ar**. That is why chlorine (Cl) element has greater first ionization energy than that of other elements. First ionization energy of elements are given in the tabular form for comparison:

Elements	First ionization energy ($kJmol^{-1}$)
Cl	**1251**
P	**1012**
Si	**787**
Al	**578**

Q.28 (C)

$Na_{(s)} \longrightarrow Na(g) \qquad \Delta H^\circ_a = +108 kJmol^{-1}$

$Na_{(g)} \longrightarrow Na^+_{(g)} + e^- \qquad \Delta H^\circ_i = +496 kJmol^{-1}$

$\therefore \underset{(s)}{Na} \longrightarrow \underset{(g)}{Na^+} + e^-$

$\Delta H^\circ_{at} + \Delta H^\circ_i = +108 kJmol^{-1} + 496 kJmol^{-1}$

Conclusion:

It shows that for the conversion of sodium atom from its solid state into gaseous cationic form, sum of $\Delta H^o_{at} + \Delta H_i$ is required.

Q.29 (B) The volume of space in which there is 95% chance of finding an electron is called atomic orbital'. An atomic orbital can accommodate maximum two electrons with opposite spin according to **Pauli's Exclusions Principle.** It can never accommodate three electrons.

Q.30 (D) The elements which lie on the extreme left side of the periodic table form the strongest bases such as the elements of **IA group (NaOH, KOH, RbOH, CsOH).**

Q.31 (A)

n	ℓ	m
It tells about **size** of atomic orbitals	It shows **shape** of atomic orbital	It tells about **orientation** of atomic orbitals
Conclusion: So three quantum numbers n, ℓ, m depicts **size, shape and orientation.**		

Q.32 (C) This formula helps us to determine number of electrons in a sub-shell e.g.

Formula	Example
$2(2\ell+1)$	ℓ value of d-sub shell = 2 so d-sub shell has number of electrons = 2 (2 x 2 +1) =10 Electrons

Q.33 (D) It can be explained with the help of table.

Ions	Protons	Electrons	Neutrons
D^-	1	2	1
He^+	2	1	2
OD^-	9	10	9
OH^-	**9**	**10**	**8**

Q.34 (A) Those elements which have stable electronic configuration have comparatively low electron affinity

- e.g. Neon has stable electronic configuration and its first electron affinity value is only +29 $kJmol^{-1}$. On the other hand its first ionization energy value is **+2081$kJmol^{-1}$** which shows that it is comparatively greater value.

Q.35 (B) The elements of third period have comparatively greater electron affinity than that of second period elements.

- Because each atom of the elements of the second period has comparatively smaller size due to stronger nucleus hold and overcrowding of electrons.
- Due to these reasons electron affinity of second period elements is comparatively less than that of third period elements as shown in the tabular form.

Electronic affinity ($kJmol^{-1}$) of 2^{nd} Period	Electronic affinity ($kJmol^{-1}$) of 3^{rd} Period
O = -141	**S = -200**
F = -322	**Cl = -342**

Q.36 (D) Ionization energy of **phosphorus (P) is greater than** that of **sulphur (S)** because in case of phosphorus **3p-sub** shell is half filled as shown in the electronic configuration ($_{15}$**P=1s^2, 2s^2, 2p^6, 3s^2, 3p^3**) whereas in case of **sulphur (S)** it has four electrons in **3p sub**-shell which is not half filled as shown in electronic configuration of **($_{16}$S = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4).**

- By comparison it is clear that the element which has half-filled p-sub shell has stable electronic configuration and has greater first ionization energy.

Elements	Electronic configuration (E.C)	Cause of stability	First I.E $kJmol^{-1}$
$_{15}P$	$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^3$	p-sub shell is Half filled more stable E.C	(1012) More first I.E
$_{16}S$	$1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^4$	p-sub shell is not half filled	(1000) Less first I.E

Conclusion: Greater is the stable electronic configuration, more is first ionization energy.

Q.37 (B) In 3d-series Cr and Cu show abnormal electronic configuration. General configuration of **Cr** should be **(Ar) 3d^4, 4s^2,** since **3d sub**-shell is near to half filled, so that is why 3d orbital snatches one electron from 4s and shows electronic configuration **(Ar) 3d^5, 4s^1.**

- **Similarly** general electronic configuration of **Cu** should be **(Ar) $3d^9$, $4s^2$,** since **3d sub-shell** is near to complete filled, so that is why 3d orbital snatches one electron from 4s and shows electronic configuration **(Ar) $3d^{10}$, $4s^1$. This detail is shown in tabular form**.

Elements	Electronic configuration
$_{24}Cr$	(Ar) $3d^5$, $4s^1$
$_{29}Cu$	(Ar) $3d^{10}$, $4s^1$

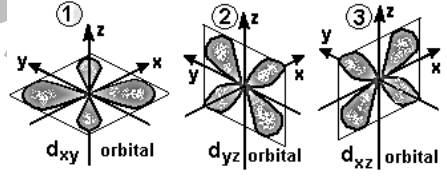
Q.38 (A) Detail electronic configuration of $_{19}K$ is shown as $(\frac{1s^2,2s^2,2p^6,3s^2,3p^6}{Ar(core)},4s^1)$ so overall shortly it can be shown as **[Ar] $4s^1$.**

Q.39 (C) $^{40}_{18}Ar, ^{42}_{20}Ca, ^{43}_{21}Sc$ are **isotones as shown in the tabular form for comparison.** $^{14}_{6}C$ **and** $^{16}_{8}O$ **are also known as isotones, because they have same number of neutrons.**

Nuclide	Protons (Z)	Mass number (A)	Neutrons (A-Z)
$^{40}_{18}Ar$	18	40	22
$^{42}_{20}Ca$	20	42	22
$^{43}_{21}Sc$	21	43	22

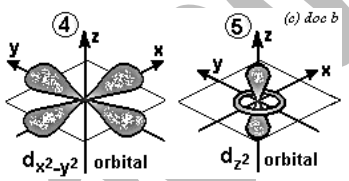
Q.40 (B) **d sub-shell has five atomic orbitals such as d_{xy}, d_{yz}, d_{xz}, d_{z^2}, and $d_{x^2-y^2}$.**

- **Out of these five d-atomic orbitals, three atomic orbitals d_{xy}, d_{yz}, d_{xz} lie in between the axes.**



I. II. III.

- **Whereas two d-atomic orbitals $d_{x^2-y^2}$ and d_{z^2} are present on the axes as shown in the diagram.**
- **d-orbitals which lie on the x-axes**



Collar shaped

IV V

- **From the diagram it is clear that d_{z^2} atomic orbital is collar shaped.**

Q.41 (D) In any cation number of electrons is always less than that of protons. The number of protons in a neutral atom or its cation is always same.

- In a chemical reaction there is always exchange of electrons. In a cation number of electrons decreases than that of protons, because in a cation formation there is loss of electron.
- In anion the number of electrons exceeds than that of protons, because in this case atom gains electrons.

Q.42 (B) The mass of a neutron is always greater than that of a proton as shown by the value. The mass of proton is (1.6726×10^{-27}kg) and that of neutron is (1.6750×10^{-27}kg) as shown in the table.

Particles	Mass (kg)	Mass (amu)
Proton	1.6726×10^{-27}	1.0073
Neutron	1.6750×10^{-27}	1.0087

Q.43 (C) **Rutherford's planet-like picture** was defective and **unsatisfactory** because the **moving electron** must be accelerated **towards** the nucleus. Therefore, the radius of the shell having electron should become

smaller and **smaller** and the **electron should fall into the nucleus.** Thus, an atomic structure as proposed by Rutherford would collapse. **Due to this reason, Rutherford failed to explain the stability of atom.**

Q.44 (B) According to Bohr's theory, an electron is a material particle and its position as well as momentum can be determined with great accuracy. But with the advent of the concept of wave nature of electron, it has not been possible for us to measure simultaneously the exact position and velocity of electron. This was **suggested by Heisenberg, in 1927.** Due to above mentioned reason, Bohr's H-atomic model is contradicted by Heisenberg's uncertainty principle.

Q.45 (C) In fact, Rutherford **planet like picture** was **defective** and **unsatisfactory.**

- **Solar** system follows **Newton's law** of **gravitation which states that a particle attracts every other particle in the universe using a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. i.e. mathematical equation of Gravitational force between two objects is shown below:**

$$F = G\frac{m_1 m_2}{r^2}$$

- **But protons and electrons** are **charged** particles. **Protons** are present in the **nucleus** and **electrons revolve** around the **nucleus.** They attract each other (unlike solar system) by the columbic force of attraction.
- **According to Coulomb's law, the coulombic force is directly proportional to the product of charges and inversely proportional to square of distance between them as shown by the equation:**

$$\mathbf{F_c = \frac{Ze^2}{4\pi\varepsilon_o r^2}}$$

Q.46 (D) In fact, the amount of energy (E) is directly proportional to wave number ($\bar{v}$).

Term	Symbol	Definition	Unit
Frequency	v	It is the number of wave passing through a point per second.	Hz, s^{-1}
Wave length	λ	It is the distance between two consecutive crests or troughs	cm, mm etc
Wave number	$\bar{v}$	It is the number of waves per unit length and is reciprocal to wavelength ($\bar{v} = \frac{1}{\lambda}$).	cm^{-1}, mm^{-1} etc

The SI unit of frequency is the hertz (Hz), named after the German physicist Heinrich Hertz; one hertz means that an event repeats once per second. A previous name for this unit was cycles per second (cps). The SI unit for time period is the second.

Q.47 (A) According to **Bohr's hydrogen atomic model,** mathematically radius $\mathbf{r_n = 0.529A^o\ (n^2)}$**.** For hydrogen atom if **n = 2** then the value of radius for $\mathbf{n_2}$ **(2^{nd} shell)** from the nucleus of an atom is $\mathbf{2.116A^o}$**.**

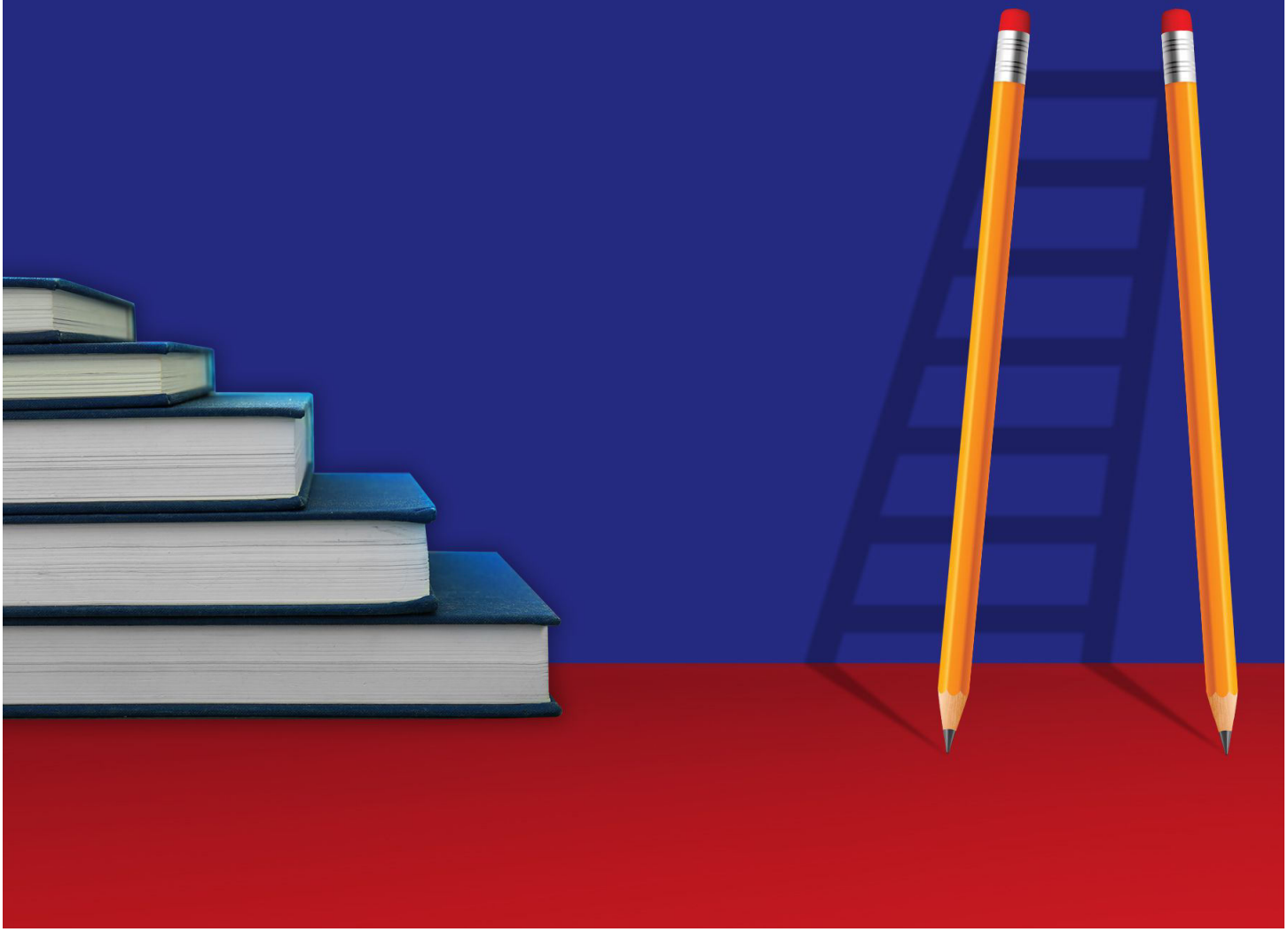
Q.48 (D) **Bohr's hydrogen atomic model theory is applicable only for single electron system. But Be^{+2} has two electrons, so for Be^{+2} ion it is not applicable.**

Q.49 (D) This was stated by **Sommerfeld in 1915** but **not** by Bohr. **Sommerfeld** suggested the moving electrons might describe in addition to the circular orbits elliptic orbits as well wherein the nucleus lies at one of the focii of the ellipse.

Q.50 (C) **In fact,** frequency of **gamma rays** is **greater** than that **of X-rays.**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-14

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-14

(A. Physical Chemistry)

Chemical Bonding

USE THIS SPACE FOR SCRATCH WORK

Q.1 Which of the following molecules does not have planar geometry?

A) Benzene C) Ethene

B) Boron trifluoride D) Phosphorous trichloride

Q.2 Which one of the following pair of compounds contains one that is giant ionic and one that is simple molecule?

A) Al_2O_3 and Al_2Cl_6 C) SiO_2 and $SiCl_4$

B) P_4O_{10} and PCl_3 D) HF and $PbCl_4$

Q.3 Which of the following molecules has only non-coplaner tetrahedral geometry?

A) NF_3 C) C_2Cl_4

B) C_3H_8 D) C_3H_6

Q.4 Ionic compounds show all of the following properties EXCEPT:

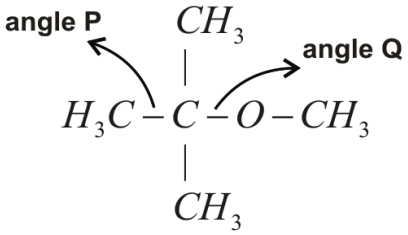
A) All are present in the solid state

B) All conduct electricity in the molten state

C) All show polymorphism and isomerism

D) All have non-directional and non-rigid bond

Q.5 MTBE (Methyl tertiary butyl ether) is a constituent of Petrol. Its structural formula is shown below.



What are the values of angle P and angle Q in a molecule of MTBE?

Options	Angle P	Angle Q
A)	90°	105°
B)	90°	180°
C)	109°	105°
D)	90°	180°

Q.6 According to VSEPR theory, which of the following is not the basic condition for the regular geometry:

A) Central atom is surrounded by similar atoms

B) Central atom has no lone pair

C) Molecule has similar bonds

D) The electronegativity of central or surrounding atoms affect the bond angle

Q.7 Majority of the compounds in nature have:

A) Electrovalent bond C) Ordinary covalent bond

B) Dative covalent bond D) Hydrogen bond

Q.8 Which property is not shown by covalent compounds?

A) They are present in the gas, liquid or solid state

B) They are more reactive than ionic compounds

C) They show resonance and isomerism

D) They have low melting points and boiling points as compared to ionic compounds

Q.9 Which one of the following molecules shows a linear geometry?

A) H_2O C) HCN

B) Cl_2O D) C_2H_4

Q.10 Second and higher electron affinity values are positive because of:

A) Repulsion between electrons and negatively charged ions

B) Attraction between electrons and positively charged ions

C) First repulsion between electrons and then attraction

D) Both A and B

Q.11 In which of the following ionic bond is formed between atoms of elements?

A) Al and Cl C) B and F

B) H and Cl D) Na and H

Q.12 Which of the following molecules has six bonding electrons?

A) C_2H_4 C) CO_2

B) H_2S D) NCl_3

USE THIS SPACE FOR SCRATCH WORK

Q.13 If two atoms are bonded in such a way that one member of the covalently bonded molecule donates both electrons that are shared, then what is this type of bond called?

A) H-bonding
C) Coordinate covalent bond
B) Covalent bond
D) Electrovalent bond

Q.14 Which of the following molecules shows tetrahedral geometry?

A) $\overset{oo}{N}H_3$
C) SO_4^{-2}
B) SO_3
D) SO_2

Q.15 Which type of bonding is responsible for intermolecular forces in liquid CCl_4?

A) Covalent bonding

B) Hydrogen bonding

C) Instantaneous dipole – induced dipole forces

D) Dipole – Dipole forces

Q.16 The C_2H_2 molecule is linear which can be deduced from the numbers of σ and π bonds present in the molecule?

Options	σ	π
A)	2	2
B)	2	3
C)	3	2
D)	3	1

Q.17 Which one of the following giant solids have greater melting and boiling points on the basis of type of bonding?

A) Metallic solids
C) Ionic solids
B) Covalent solids
D) Molecular solids

Q.18 With the increase of which one of the following factors bond energy of a molecule decreases:

A) Electronegative difference

B) Bond order

C) s-character

D) Number of lone pair

USE THIS SPACE FOR SCRATCH WORK

Q.19 **Which of the following molecules has greater bond energy?**

A) H - H C) O - O

B) N - N D) F - F

Q.20 **Which of the following has trigonal planar geometry?**

A) SO_2 C) SO_3

B) CCl_4 D) H_2O

Q.21 **Mark the incorrect statement about the type of intermolecular forces present in the indicated molecule:**

Option	Molecule	Type of intermolecular forces
A)	HCl	Debye forces
B)	$CHCl_3$	Dipole Dipole forces
C)	Halogens in liquid state	London Dispersion forces
D)	Noble gases in liquid state	London Dispersion forces

Q.22 **All of the following molecules have H–bonding EXCEPT:**

A) Ethanol C) Aminoethane

B) Ethanoic acid D) Propanone

Q.23 **Which of the following will not form H-bond with another of its own molecule?**

A) CH_3CHO C) CH_3OH

B) CH_3NH_2 D) NH_3

Q.24 **Solid carbon dioxide (dry ice) is used as a refrigerating agent because it readily changes directly from the solid into the vapor state at low temperature. What does this indicate the main intermolecular bonding / forces in $CO_{2(s)}$ to be?**

A) Covalent bonding C) Hydrogen bonding

B) Ionic bonding D) London dispersion forces

Q.25 **Which of the following theories was put forward by Drude and extended by Loren (1923) to explain the properties of metallic solid?**

A) Electron gas theory C) Band theory

B) Valance bond theory D) Crystal field theory

USE THIS SPACE FOR SCRATCH WORK

Q.26 **When heated solid iodine readily forms iodine vapors. What does this information suggest about the nature of particles in these two physical states of iodine?**

Option	Solid	Vapor
A)	Ionic	Atomic
B)	Ionic	Molecular
C)	Molecular	Atomic
D)	Molecular	Molecular

Q.27 **Magnesium oxide is used to line industrial furnaces because it has a very high melting point. Which type of bond needs to be broken for magnesium oxide to melt?**

A) Co-ordinate bond C) Covalent bond

B) Ionic bond D) Metallic bond

Q.28 **All of the following are correct statements regarding difference between polar and non-polar bonds EXCEPT:**

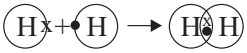
Option	Non-Polar	Polar
A)	It is a covalent bond which exists between two similar atoms or those having negligible electronegativity difference	It is a covalent bond which exists between two dissimilar atoms or those having appreciable electronegativity difference but less than 1.7
B)	It is a weaker bond	It is a stronger bond
C)	It has no polarity	It has always polarity in the molecule
D)	It is more reactive	It is less reactive

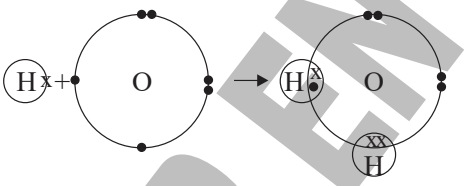
USE THIS SPACE FOR SCRATCH WORK

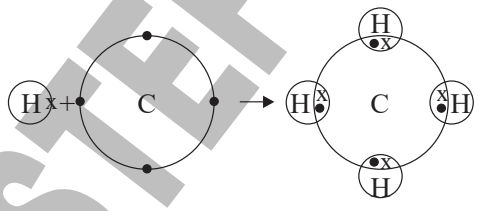
Q.29 **All of the following are correct statements regarding difference between sigma bond and pi-bond EXCEPT:**

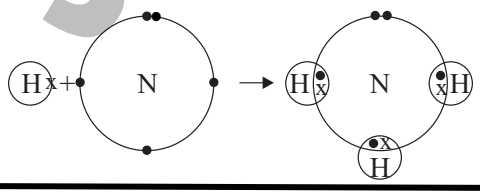
Option	Sigma bond	Pi bond
A)	It is formed by linear overlapping of two half-filled atomic orbitals	It is formed by sidewise overlapping of two half-filled parallel atomic orbitals
B)	It has restricted rotation about the inter-nuclear axis	It has free rotation about the inter nuclear axis
C)	It has only lobe of electron density between the nuclei	It has two lobes of electron density on opposite sides of inter nuclear axis
D)	It has symmetrical charge density about the inter-nuclear axis	It has no symmetrical charge density about the inter-nuclear axis

Q.30 **Which of the following molecules does not obey dot-and-cross model diagram?**

A) 

B) 

C) 

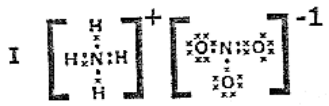
D) 

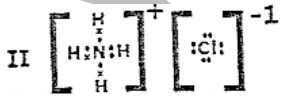
USE THIS SPACE FOR SCRATCH WORK

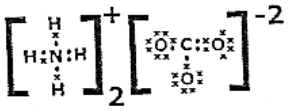
Q.31 **The distance between the nuclei of two atoms forming a covalent bond is called the bond length. All of the following statements are correctly matched EXCEPT:**

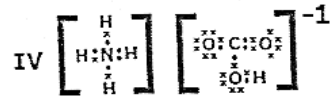
Options	Compound	Hybridization	Bond	Bond Length (pm)
A)	SiH_4 (Monosilane)	sp^3	Si – H	148
B)	C_2H_4 (Ethene)	sp^2	C = C	154
C)	BF_3 (Boron trichloride)	sp^2	B – Cl	175
D)	C_2H_2 (Ethyne)	sp	C ≡ C	120

Q.32 **Observe the given dot and cross structures for the following molecules or ionic species:**

I 

II 

III 

IV 

The co-ordinate covalent bond exists between:

A) N and C atoms in structure III and IV

B) N and one H ion in all four structure

C) N and Cl atom so structure II

D) N and N atoms of structure I

USE THIS SPACE FOR SCRATCH WORK

Q.33 **All of the following statements are correctly matched for ionic and covalent bonds EXCEPT:**

Opt.	Ionic bond (Electrovalent bond)	Covalent bond (Electron pair bond)
A)	It is formed by complete transfer of electron/ electrons from one atom of element to the other.	It is formed by mutual sharing of electrons between two atoms.
B)	The migrated electron/ electrons belongs to only one of the two bonded atoms.	The shared electrons pair belongs to both the bonded atoms.
C)	It is directional bond.	It is non-directional bond.
D)	It is shown by positive and negative charge on the bonded atoms (+ , -).	It is shown by small line (–) drawn between the two bonded atoms.

Q.34 **No electrovalent bond is 100% ionic in nature. This is because of:**

A) When cations and anions approach each other, polarizability increases only

B) Sharing of electrons takes place to some extent only

C) Highest ionic character is present in CsF only

D) Both A and B

Q.35 **The compound which contains both ionic and covalent bond:**

A) CH_4 C) H_2

B) KCN D) KCl

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-14)							
1	D	11	D	21	A	31	B
2	A	12	D	22	D	32	B
3	B	13	C	23	A	33	C
4	C	14	C	24	D	34	D
5	C	15	C	25	A	35	B
6	D	16	C	26	D		
7	C	17	B	27	B		
8	B	18	D	28	D		
9	C	19	A	29	B		
10	A	20	C	30	B		

ANSWERS EXPLAINED

Q.1 (D) PCl_3 is **not planar structure** due to the presence of lone pair on the central **"P" atom** of phosphorous. It is **LAB_3** type molecule and shows **pyramidal geometry** (i.e. irregular geometry) while others are A, B and C have planar structure.

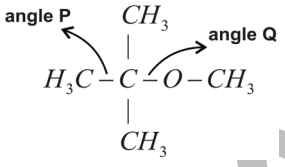
Q.2 (A) **Al_2O_3 is giant ionic and Al_2Cl_6 is simple molecule**

- (B) P_4O_{10} and PCl_3 are simple molecules
- (C) SiO_2 and $SiCl_4$. SiO_2 is a giant molecule while $SiCl_4$ is simple molecule
- (D) HF and $PbCl_4$ both are simple molecules

Q.3 (B) **In C_3H_8 (H_3C-CH_2-CH_3), all the carbon atoms** are **sp^3 hybridized** and show **non-coplanar tetrahedral structure.**

Q.4 (C) All the ionic compounds show **polymorphism** and **isomorphism** but **do not show isomerism**. **Isomerism** is shown by **covalent compounds.**

Q.5 (C) **MTBE (Methyl tertiary butyl ether) is a constituent of petrol and it has following structure.**



From the structure it is clear that the value of **bond angle P is 109°** like alkane because the carbon atom is bonded with four other atoms while the value of **bond angle Q is 105°** just like water because oxygen is bonded with two atoms and has two lone pairs. The presence of two lone pair decreases the bond angle.

Options	Angle P	Angle Q
C)	109°	105°

Q.6 (D) In fact, the electronegativity of **central or surrounding atoms** have **no** affect on the **bond angle.**

Q.7 (C) **Majority of the compound in nature are ordinary covalent compounds due to the following reason.**

- Carbon is tetravalent. It can form four covalent bonds at a time
- It has unique property of catenation
- It shows isomerism
- It does not form ionic compound

Q.8 (B) Covalent compound are less reactive than ionic compounds, because first old bonds are broken then new bonds are formed by covalent compounds.

Q.9 (C) **HCN** molecule shows linear geometry like **$BeCl_2$, $HgCl_2$, and CO_2**.

Q.10 (A) Formation of uninegative ion is exothermic process while **2nd, 3rd,** and so on are **endothermic process. 2nd and higher electron affinities** values are positive because when **2nd electron** is added to uninegative ion the

incoming electron is repelled by the already present negative charge and thus energy has to supply to counter the effect of repulsion between incoming electron and negatively charged ion. This clearly explains that second and high electron affinity are positive.

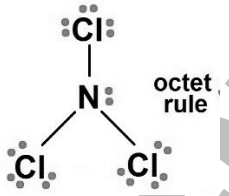
Q.11 (D) For the formation of ionic bond, there are two conditions.

- One element should have low ionization energy
- **e.g first ionization energy of Na**

  $= +496 kJmol^{-1}$
- Other element should have high electron affinity. It has high first ionization energy ($1313 kJmol^{-1}$)
- **e.g. electron affinity of H**

  $= -73 kJmol^{-1}$
- **e.g Na and H form ionic bond and fulfill the above two conditions**

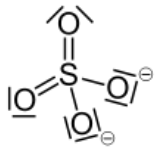
Q.12 (D) NCl_3 has six bonding electrons as shown in the structure.



Q.13 (C) It is coordinate covalent bond. A covalent bond in which shared electron pair is donated by only one atom is called coordinate covalent bond. It is shown by an arrow ($\rightarrow$)

$$H_3N^+ \longrightarrow \bar{B}F_3$$

Q.14 (C) SO_4^{-2} shows tetrahedral geometry as shows in diagram.



Q.15 (C) CCl_4 is non-polar molecule and it **shows tetrahedral geometry.** It is in the liquid state because its molecules involve **instantaneous dipole induced dipole forces** (a type of intermolecular force).

Q.16 (C) $H-C\equiv C-H$**. From the structure it is clear that it has three sigma bonds and two pi bonds having linear structure.**

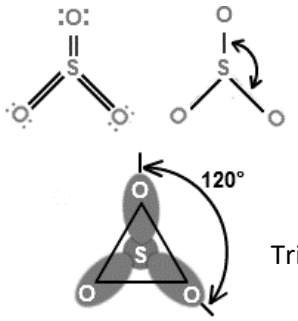
Q.17 (B) Covalent solids are giant molecules and have large number of covalent bonds. Due to their cumulative effect the **strength** of the bond is **very high e.g. diamond (3550°C) graphite (3700°C) and silicon carbide SiC (2730°C)** have high melting points.

Q.18 (D) Bond energy of the molecule is greater if the **bonded atoms have greater electronegative** difference, high bond order and more **s-character.** But the presence of lone pair decreases bond energy because they **produce repulsion**.

Q.19 (A) [H – H ($436 kJmol^{-1}$)] H_2 molecule has greater bond energy because it have **no lone pair** and **smaller atomic size.**

Option	Bond	Bond energy ($kJmol^{-1}$)
A)	H – H	436
B)	N – N	163
C)	O – O	146
D)	F – F	154.8

Q.20 (C) SO_3 shows **trigonal planar geometry.** It is AB_3 type molecule. It shows regular geometry. Double bond are treated as single bond like **BF_3, $AlCl_3$ as shown in structure**.



Trigonal Planar geometry

Q.21 (A) HCl is polar molecule and it has permanent dipoles. In HCl molecules there are dipole dipole forces. Debye forces are those forces which exist between polar and non-polar molecules e.g in HCl and Ar there are present debye forces which are also called dipole-induced dipole forces.

Q.22 (D) In propanone **(CH_3COCH_3)** there is no hydrogen bonding because hydrogen bonding is the electrostatic force between a highly electronegative atom **(N, O, F, and rarely Cl)** and partial positively charged hydrogen atom.

- In propanone there is no covalently bonded polarized hydrogen atom which is directly associated with more electronegative atoms such as **N, O and F**. That is why propanone does not show hydrogen bonding. **It shows dipole dipole forces.**

Q.23 (A) In ethanal (CH_3CHO), hydrogen atom is not covalently bonded with more electronegative atom such as N, O, F. That is why it does not show hydrogen bonding. It shows dipole dipole forces.

Q.24 (D) CO_2 is non-polar molecule and its dipole moment value is zero ($\mu = 0$). It has only London dispersion forces because in any non-polar molecule London dispersion forces are present which are the weakest and temporary forces.

Q.25 (A) The force which binds a metal cation to a **number of electrons** within its **sphere** of influence is **known as metallic bond** (in term of lattice of positive ions surrounded by mobile electron). Electron gas theory was **put forward** by **Drude** and **extended by Loren (1923).** This theory is based on the following postulates:

- **Each atom in a metal crystal loses all of its valence electron**
- **The valence electrons form a electron pool**
- **Valence electrons are not attached to any individual ion in the sphere of crystal**
- **Electrons are free to move within sphere of crystal**

Q.26 (D) Since the solid iodine (I_2) readily sublimes when heated as shown below:

$$I_{2(solid)} \underset{}{\overset{Heat}{\rightleftharpoons}} I_{2(vapours)}$$

This shows that the forces of attraction between the iodine molecules are very weak (London dispersion forces). As the sublimation process does not require a high temperature, the covalent bonds in the iodine molecules are not broken in the vapour states. Iodine vapours are still in the discrete simple molecular form (I_2).

Q.27 (B) The type of bond **needs** to be broken for magnesium oxide to melt is ionic bond. Ionic bond is comparatively stronger that covalent bond. **That is why ionic compounds have higher melting points and boiling points**. Magnesium oxide is used to line industrial furnaces because it has a very high melting point. Melting point of **MgO** is **2,852°C**.

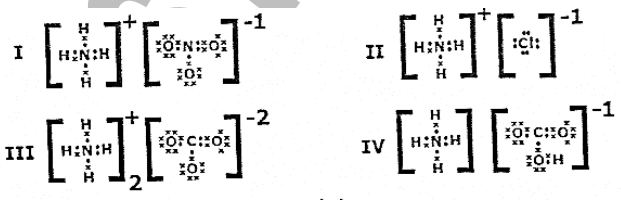
Q.28 (D) In fact, polar bond is more reactive than non-polar bond. Greater is the electronegative difference between two covalently bonded atoms in a molecule, greater is the polarity, greater is the reactivity. That is why polar molecules are more reactive than non-polar molecule.

Q.29 (B) **Sigma bond** has free rotation about the inter-nuclear axis but pi bond has restricted rotation about the **inter-nuclear axis.**

Q.30 (B) Dot-and-cross model is not followed by water molecule as shown in the diagram in option B.

Q.31 (B) In **ethene C_2H_4** there is **sp^2** orbital hybridization in the central carbon atom and **C = C bond length is 133 pm and it is not 154 pm.**

Q.32 (B) **The co-ordinate covalent bond exists between N and one H ion in all four structure as shown below.**



Q.33 (C) **It is incorrect statement. In fact, the correct statement about ionic and covalent bond is as given in the tabular form:**

Opt.	Ionic bond (Electrovalent bond)	Covalent bond (Electron pair bond)
C)	It is non-rigid and non-directional bond	It is rigid and directional bond

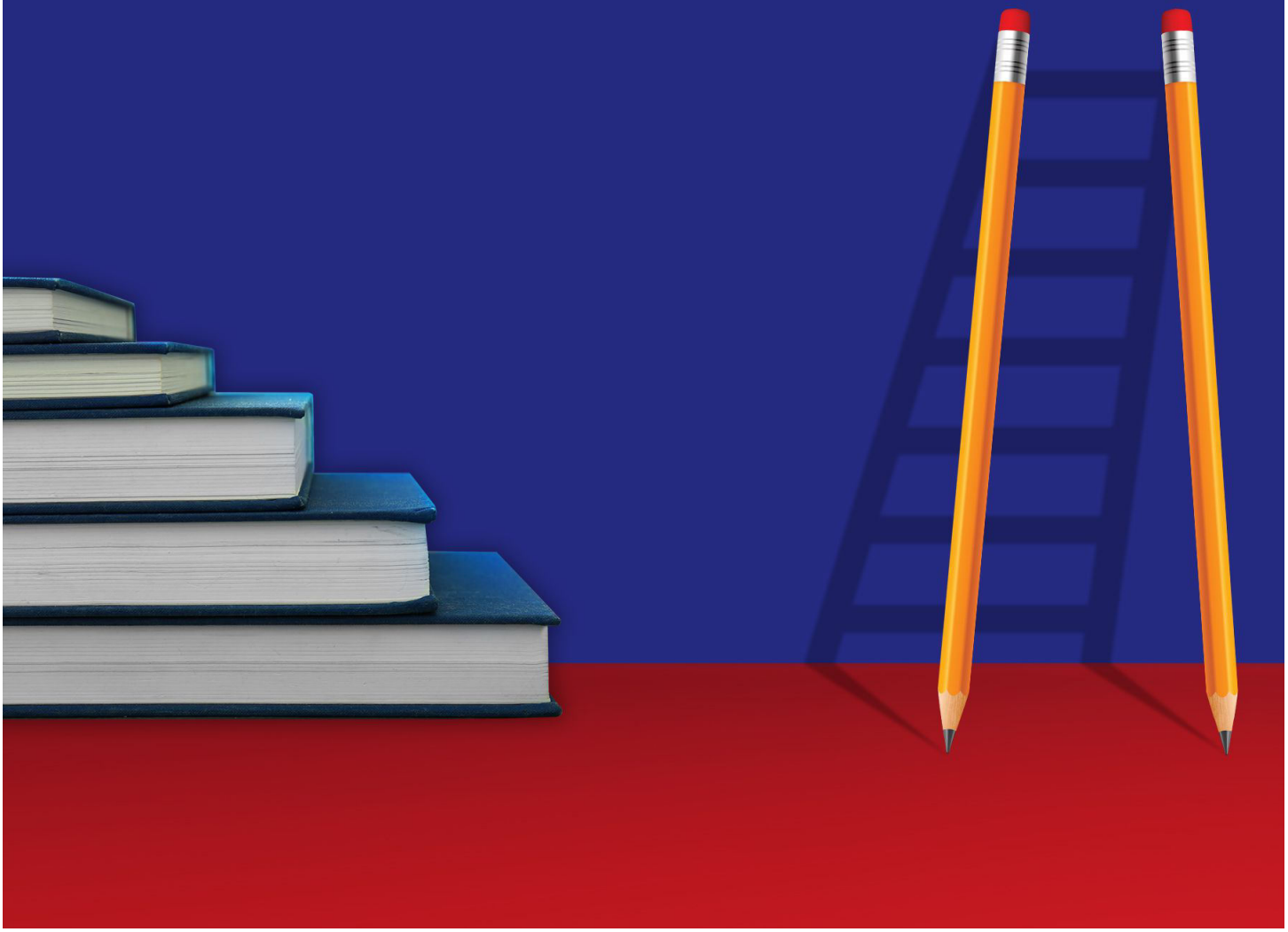
Q.34 (D) **No electrovalent bond is 100% ionic in nature. This is because of:**

- When cations and anions approach each other, polarizability increases only
- Sharing of electrons takes place to some extent only

Q.35 (B) **In KCN there is ionic bond between potassium ion (K^+) and cyanide ion (CN^-). In cyanide ion there is covalent bond between carbon and nitrogen. So overall in KCN two bonds are involved i.e. ionic and covalent ($K^+C^-\equiv N$).**

STEP

A PROGRAM BY PUNJAB GROUP



CHEMISTRY

WORKSHEET-15

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-15

(A. Physical Chemistry)

Chemical Energetics

Q.1 **For the reaction $NaCl_{(s)} \rightleftharpoons^{water} Na^{+}_{(aq)} + Cl^{-}_{(aq)}$ the change in enthalpy is called:**

A) Heat of reaction
C) Heat of formation
B) Heat of combustion
D) Heat of solution

Q.2 **Evaporation of water is an exceptional case of:**

A) Spontaneous
C) Non-spontaneous
B) Decomposition
D) Hydrolysis

Q.3 **Which statement is contrary to the first law of thermodynamics?**

A) Energy can neither be created nor destroyed
B) One form of energy can be converted into other form of energy
C) In an adiabatic process the work done is independent of its path
D) Continuous production of mechanical work without supplying an equivalent amount of heat is possible

Q.4 **Born Haber's cycle enables us to calculate:**

A) Heat energy
C) Lattice energy
B) Heat of hydration
D) Heat of solution

Q.5 **Which statement is not correct about ΔH^{o}?**

A) ΔH^{o} of the reaction depends on temperature
B) ΔH^{o} of reaction can be > or < zero
C) ΔH^{o} of catalyzed and uncatalyzed reaction is same
D) ΔH^{o} is always < 0

Q.6 **Which of the following processes is always endothermic?**

A) Atomization
C) Neutralization
B) Combustion
D) Solution

Q.7 **Which one of the following statements is correct for the neutralization of a strong acid by a strong alkali in aqueous solution at 25°C?**

A) It is an endothermic process
B) It can be represented as $H_3O^{+}_{(aq)} + OH^{-}_{(aq)} \longrightarrow 2H_2O_{(l)}$
C) The enthalpy change per mole of H_2O formed is independent of the acid or alkali used as they are strong
D) Both B and C

USE THIS SPACE FOR SCRATCH WORK

Q.8 **According to Born Haber cycle, ΔH_ℓ^o of ionic compound is determined by the formula ΔH_ℓ^o.**

A) $\Delta H_\ell^o = \Delta H_f^o - \Delta H_x$

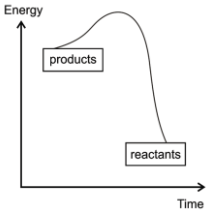
B) $\Delta H_\ell^o = \Delta H_x - \Delta H_f^o$

C) $\Delta H_\ell^o = \Delta H_x + \Delta H_f^o$

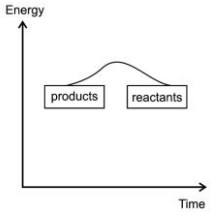
D) $\Delta H_\ell^o = \Delta H_{at}^o - \Delta H_x$

Q.9 **Which of the following energy profile diagrams best shows an endothermic reaction?**

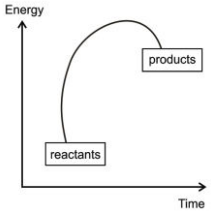
A)



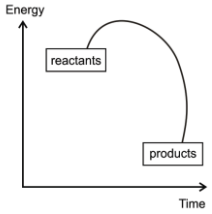
C)



B)



D)



Q.10 **Lattice energy (ΔH_ℓ^o) helps to explain all of the following properties of ionic compounds EXCEPT:**

A) Structure

B) Properties

C) Bonding

D) Dipole Moment

Q.11 **In azeotropic mixture showing positive deviation from Raoult's law, the volume of the mixture is:**

A) Slightly more than the total volume of the components

B) Slightly less than the total volume of the components

C) Equal to the total volume of the components

D) Difficult to predict

USE THIS SPACE FOR SCRATCH WORK

Q.12 **All of the following reactions are exothermic EXCEPT:**

A) $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

B) $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$

C) $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$

D) $H_{2(g)} + \frac{1}{2} O_{2(g)} \longrightarrow H2O_{(l)}$

Q.13 **For which one of the following compounds standard enthalpy change (ΔH^o) can be measured directly by calorimeter?**

A) CCl_4 C) B_2O_3

B) Al_2O_3 D) MgO

Q.14 **All of the following are state functions EXCEPT?**

A) E C) H

B) G D) q

Q.15 **All of the following standard enthalpy change (ΔH^o) have only positive value EXCEPT:**

A) ΔH_v C) ΔH^o_{BDE}

B) ΔH^o_{sol} D) ΔH_i

Q.16 **12.0g of graphite is burnt in a bomb calorimeter and temperature recorded is 5K. Calculate the enthalpy of combustion (ΔH^o_c) of graphite if the heat capacity of the calorimeter is 90.0kJmol^{-1}?**

A) -440kJmol^{-1} C) -450kJmol^{-1}

B) -445kJmol^{-1} D) -455kJmol^{-1}

Q.17 **Glass calorimeter is used to determine:**

A) ΔH^o_n C) ΔH^o_{sol}

B) ΔH^o_{at} D) ΔH^o_f

Q.18 **Neutralization of 50cm^3 of 0.5M NaOH at 25^{o}C with 50cm^3 of 0.5M HCl 25^{o}C is raised to 31^{o}C. Find enthalpy of neutralization (ΔH^o_n). Specific heat of water (q) = 5kJ^{-1}kg^{-1}:**

A) -125kJmol^{-1} C) -120kJmol^{-1}

B) -130kJmol^{-1} D) -135kJmol^{-1}

Q.19 **If an endothermic reaction is allowed to take place very rapidly in the air, the temperature of the surrounding air:**

A) Remains constant C) Increases

B) Decreases D) Remains unchanged

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Q.20 **Which of the following statements is not correct for ΔE and ΔH?**

Options	ΔE (Change in internal energy)	ΔH (Change in enthalpy)
A)	$\Delta E = q_v$	$\Delta H = q_p$
B)	$\Delta E = q + P\Delta V$	$\Delta H = \Delta E + P\Delta V$
C)	ΔE is measured at constant volume	ΔH is measured at constant pressure
D)	$q_v > q_p$	$q_p = p_v$

Q.21 **The nature of an aqueous solution of ammonia (NH_3) is:**

A) Amphoteric C) Neutral

B) Basic D) Acidic

Q.22 **An aqueous solution of ethanol in water may have vapour pressure:**

A) Equal to that of water C) More than that of water

B) Equal to that of ethanol D) Less than that of water

Q.23 **The solution which has lower osmotic pressure is called:**

A) Hypotonic solution C) Isotonic solution

B) Hypertonic solution D) Saturated solution

Q.24 **Molal boiling point constant (K_b) is related to:**

A) m C) M

B) ppm D) x

Q.25 **All of the followings are examples of pair of partially miscible liquids except:**

A) Iodine water system C) Nicotine water system

B) Triethyamine water system D) Phenol water system

Q.26 **Which of the following aqueous solutions has the lowest vapour pressure at room temperature?**

A) 0.1m NaCl solution C) 0.1m glucose solution

B) 0.1m $CaCl_2$ solution D) 0.1m urea solution

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Q.27 **To observe the colligative properties, following conditions should be fulfilled by the solution EXCEPT:**

A) Solution should be dilute

B) Solute should be non-electrolyte

C) Solute should be non-volatile

D) Solute can be volatile and non-electrolyte

Q.28 **Which of the following is colligative property?**

A) Osmotic-pressure C) Boiling point

B) Freezing point D) Melting point

Q.29 **Two solutions of NaCl and KCl having 0.1m (molal concentration) of each are prepared separately. Which of the following statement is true for the solution:**

A) KCl solution will have higher boiling point than NaCl solution

B) Both the solutions have different boiling points

C) KCl and NaCl solutions possess same vapour pressure

D) KCl solution possesses lower freezing point than NaCl solution

Q.30 **Mark the correct statement about the relative lowering of vapour pressure:**

A) It is independent of the temperature

B) It depend on the concentration of solute

C) It is constant when equimolecular proportions of different solutes are dissolved in the same mass of same solvent

D) All of these

Q.31 **Internal energy of a system depends on all the factors EXCEPT:**

A) Chemical nature of a substance

B) Temperature

C) Pressure and volume

D) Path

Q.32 **Ionic solid is dissolved in water if:**

A) $\Delta H_{\ell}^{o} > \Delta H_{hyd}$ C) $\Delta H_{hyd} = \Delta H_{\ell}^{o}$

B) $\Delta H_{hyd} > \Delta H_{\ell}^{o}$ D) $\Delta H_{\ell}^{o} \leq > \Delta H_{hyd}$

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Q.33 **The number of moles of solute in 1000g (1kg) of solvent is called:**

A) Molarity
C) Mole fraction
B) Molality
D) ppm

Q.34 **The colligative property that is generally applied preferably for the determination of molecular mass of macromolecule is:**

A) π
C) ΔT_f
B) ΔT_b
D) $\Delta P/P^o$

Q.35 **Which of the following is an example of solution in which solute is in the solid state while solvent is in the liquid state?**

A) Paint
C) Fog
B) Steel
D) Milk

Q.36 **The temperature at which two conjugate solutions merge into one another is called:**

A) Upper consulate temperature
B) Optimum temperature
C) Transition temperature
D) Absolute temperature

Q.37 **If mass of solvent is 100g and molal concentration of its solution is 0.2, the amount of urea dissolved in solvent (molar mass of solute is 60gmol^{-1}) is:**

A) 1.2g
C) 0.5g
B) 1.0g
D) 0.75g

Q.38 **A sample of tooth paste having 100g, was found to contain 0.5g fluoride ions. The concentration of fluoride ions in ppm is:**

A) 1.5×10^3
C) 5×10^3
B) 1.25×10^3
D) 2.5×10^3

Q.39 **18g glucose is dissolved in 90g of water. The relative lowering of vapour pressure is equal to:**

A) $\frac{1}{51}$
C) $\frac{1}{5}$
B) 5.1
D) 6

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Q.40 **A pure solvent has a vapour pressure of 120 torr at 25°C. When 20g of non-volatile solute was dissolved in 300g of benzene, a vapour pressure of 115 torr was observed (molar mass of benzene = 80). What is the molar mass of solute?**

A) 128g C) 140g

B) 160g D) 180g

Q.41 **A colloidal system involves**

A) A state of dissolution

B) A state of homogenous mixture

C) A state of dispersion

D) A state of suspension

Q.42 **Solvent loving colloids are called:**

A) Lyophobic acid C) Lyophilic colloids

B) Hydrophobic colloids D) Mesophobic colloids

Q.43 **The fresh precipitate can be passed in colloidal state by**

A) Peptization C) Coagulation

B) Diffusion D) Effusion

Q.44 **A colloidal solution of $Fe(OH)_3$ in water is:**

A) Hydrophilic colloid C) An emulsion

B) A hydrophobic colloid D) Lyophilic colloid

Q.45 **Which of the following properties is not shown by suspension, colloidal solution and true solution?**

Opt	Properties	Suspension	Colloidal solution	True solution
A)	Particle size	$> 10^{-5}$cm	10^{-7}cm	$< 10^{-7}$cm
B)	Separation with filter paper	Possible	Not possible	Not possible
C)	Nature	Homogenous	Homogeneous	Heterogeneous
D)	Appearance	Opaque	Turbid	Clear

Q.46 **The addition of alcohol to a saturated aqueous solution of calcium acetate first forms a sol and then sets to a gelatinous mass called solid alcohol which is a:**

A) Solid sol C) Aerosol

B) Solid form D) Gel

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Q.47 **A sol is a colloidal solution suspension of very small solid particles (10^{-7} to 2 x 10^{-5} cm) in a continuous liquid medium (dispersion medium). Sols are quite stable. Which of the following is not example of sol:**

A) Blood C) Cell fluid

B) Paint D) Marbles

Q.48 **The colloidal solution of gold prepared by different methods have different colours due to:**

A) Difference in the size of colloidal particles

B) Fact that gold exhibit variable valency

C) Different conc. of gold

D) Presence of different type of foreign particles

Q.49 **Classification of colloidal solution or dispersion can be done on the basis of nature of dispersion medium. Which of the following is not considered colloidal dispersion:**

Options	Dispersion medium (DM)	Type of sols
A)	Water	Hydrosols
B)	Acetone	Acylosols
C)	Alcohol	Alcosols
D)	Air	Aerosol

Q.50 **The amount of solute present in a fixed amount of solvent or solution is called:**

A) Concentration of solution C) Molal solution

B) Molar solution D) ppm Solution

Q.51 **Which of the following is example of colloidal solution in which dispersion phase is in the liquid state and dispersion medium is in the solid state?**

A) Muddy water C) Blood

B) Cheese D) Fog

ANSWER KEY (Worksheet-15)											
1	D	11	A	21	B	31	D	41	C	51	B
2	A	12	C	22	C	32	B	42	C		
3	D	13	D	23	A	33	B	43	A		
4	C	14	D	24	A	34	A	44	B		
5	D	15	B	25	A	35	A	45	C		
6	A	16	C	26	B	36	A	46	D		
7	C	17	A	27	D	37	A	47	D		
8	A	18	C	28	A	38	C	48	A		
9	B	19	B	29	C	39	A	49	B		
10	D	20	D	30	D	40	A	50	A		

ANSWERS EXPLAINED

Q.1 **(D)** The **standard enthalpy of a solution (ΔH^o_{sol})** is the amount of heat absorbed or evolved when one mole of a substance is dissolved in so much solvent that further dilution results in no detectable heat change. **e.g.** ΔH_{sol} of **NaCl** is **(+4.98kJmol^{-1}).**

Q.2 **(A)** **Evaporation is a spontaneous, unidirectional, irreversible, and real process**. It takes place continuously and it is **surface phenomena**.

Q.3 **(D)** Continuous production of mechanical work without supplying an equivalent amount of heat is **not** possible, because **input ≠ output.**

Q.4 **(C)** **Born Haber's cycle** is an application of **Hess's law.** It enables us to calculate the ΔH_{latt} of **binary ionic compounds** such as $M^+ X^-$.

Q.5 **(D)** The value of **ΔH is < 0** in case of **exothermic reaction** but not always, because in **endothermic reaction ΔH is > 0**. So heat of reaction **$\Delta H > 0$ or < 0.**

Q.6 **(A)** ΔH^o_{at} is the amount of heat **absorbed** when **one mole** of gaseous atoms are formed from the element under standard condition. **e.g. ΔH^o_{at} of hydrogen is given below.**

$$\tfrac{1}{2}H_{2(g)} \longrightarrow H_{(g)} \qquad \Delta H^o_{at} = 218 kJmol^{-1}$$

Q.7 **(C)** The enthalpy change per mole of **H_2O** formed is independent of the acid or alkali used as they are strong, because **ΔH_n** is merely the heat of formation of one mole of water from neutralization its strong acids and strong bases. Its value is always negative.

$$H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)}$$

$$\Delta H^o_n = -57.4 \text{ kJ mol}^{-1}$$

ΔH_n for any strong acid with a strong base is approximately the same i.e. - 57.4kJmol^{-1}.

Q.8 **(A)** **Lattice energy (ΔH^o_ℓ)** of binary ionic compound is determined by the formula $\Delta H^o_\ell = \Delta H^o_f - \Delta H_x$

Q.9 **(B)** It is **endothermic reaction** in which products are at **higher energy level than reactants** as shown in diagram and for such reactions a continuous **source of energy** is needed to complete the reaction.

Q.10 **(D)** **The polarity of a polar molecule is quantitatively measured in term of dipole moment. The dipole moment (μ) of a molecule may be defined as the product of the electric charge (q) and the distance between the positive and negative centers (r).**

Mathematically it can be shown as $\mu_{diatomic} = q \times r$

The unit of dipole moment is Debye 1D = 3.336 x 10^{-30}mC.

Q.11 **(A)** In azeotropic mixture showing positive deviation from Raoult's law the volume of the mixture is slightly more than the total volume of the components.

Q.12 **(C)** To predict whether the reaction is **endothermic** or **exothermic,** it all depends on enthalpy change **i.e.** if ΔH = + value then it is endothermic

reaction and if **ΔH = -** then it is exothermic reaction. In options **A, B** and **D ΔH have negative values,** so they are **exothermic** reaction. **Only in case C ΔH is positive** so it is **endothermic as shown in the reaction.**

$$N_{2(g)}+O_{2(g)} \rightarrow 2NO_{(g)} \Delta H=+180.51 kJmol^{-1}$$

Q.13 (D) **Calorimeter** is that **device** which is used to **measure ΔH°.** It is only used for those reactions which **complete** in **one step.** Since **in case of A, B and C** reactions **do not** complete in **one step,** so their **ΔH cannot** be measured **directly.** But **in case of option D formation** of **MgO completes** in **one step. So its ΔH° can be measured by calorimeter.**

Q.14 (D) **A state function** is a **macroscopic property** of a system which has some definite values for **initial** and **final states** and which is independent of the path **followed by the system. A, B and C** are state functions **because** they only **depend** on **initial** and **final** state **whereas q and w** are **not state function** because they **depend** on the **path followed by the system.**

Q.15 (B) The standard enthalpy of a solution is the amount of heat **absorbed or evolved** when **one mole** of a substance is dissolved in so much solvent that further dilution **results in no** detectable heat change.

e.g. ΔH_{sol} of LiCl = -35.0kJmol^{-1} and for ΔH_{sol} of NaCl = + 4.98kJmol^{-1}.

Q.16 (C) **Given data:**

- Heat capacity of calorimeter (c)

$$= 90.0 kJmol^{-1}$$

$$\Delta T = 5K$$

Heat gained by the system q = c x ΔT

= 90.0 x 5 = 450kJ

Number of moles of graphite = $\frac{12}{12} = 1$

ΔH^{o}_{c} of graphite per mol = $\frac{450}{1}$

= 450kJmol^{-1}

Since heat is evolved during combustion, so sign of the answer would be negative

i.e. ΔH^{o}_{c} = - 450kJmol^{-1}

Q.17 (A) Glass calorimeter is used to measure heat of neutralization.

Q.18 (C) **Solution: Specific heat of water (s) = 5JK^{-1}g^{-1}**

Density of water is around 1gcm^3, so 100cm^3 (50 cm^3+50cm^3 =100cm^3) of total solution is approximately = 100g (m = d x V = 1 x 100 =100g)

- Total mass of reaction mixture = 100g

Rise in temperature (ΔT) = $T_2 - T_1$ **= 31.0°C – 25.0°C = 6°C = 6K**

Amount of total heat evolved

q = m x s x ΔT (i)

$=100 \times 5 \times 6$

= 3000J

= 3.0kJ

So the reaction is exothermic

q = -3.0kJ

So 50cm^3 of 0.5M solution is = 0.05moles of HCl and NaOH respectively

($M_1 \times 1000 = 0.5 \times 50$)

$\therefore$ **M_1** = $0.5 \times \frac{50}{1000}$ **= 0.025M**

= 0.025mole (ii)

When this heat is divided by number of moles, the ΔH^{o}_{n} is for one mole

Heat of neutralization

(ΔH^{o}_{n}) = $\frac{-3.0kJ}{0.025mol} = -120 kJmol^{-1}$ **(iii)**

Q.19 (B) Since in endothermic reaction heat energy is absorbed by the system from the surrounding that is why energy of

the surrounding decreases while the energy of the system increases **i.e.** $\Delta H > 0$.

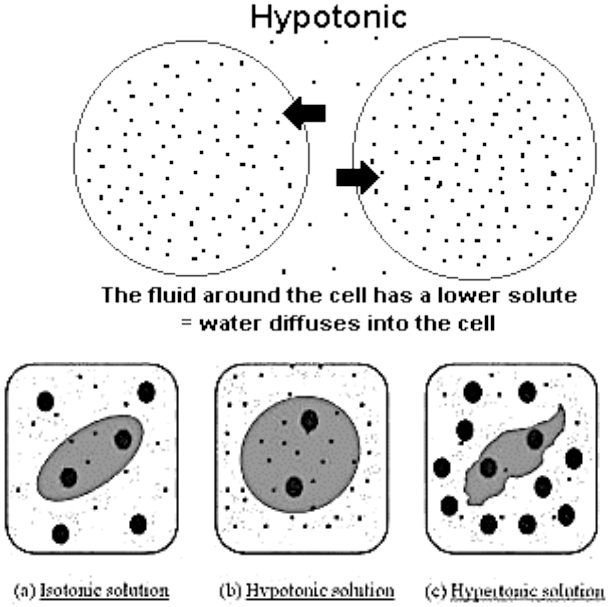
Q.20 (D)

- $\Delta E = q_v$ This shows that a change in internal energy of a system, at constant volume is equal to heat absorbed by the system **(q_v).**
- $\Delta H = q_p$ This shows that change in enthalpy is equal to heat of reaction at constant pressure. The reactions are carried out at constant pressure more frequently than at constant volume. So, working with ΔH is more convenient rather than ΔE.
- In fact, $\Delta H = \Delta E + P\Delta V$.
- Therefore it can be concluded that $q_p > q_v$.

Q.21 (B) Since ammonia is a base so when it is dissolved in water, the solution becomes basic in nature. It turns red litmus paper blue. It has pH greater than 7.

Q.22 (C) Since alcohol is more volatile than **water** because **boiling point** of **alcohol (78.5°C)** is **less than** that of **water (100°C)** and it has **weaker** hydrogen bonding. Because of this reason an aqueous solution of **ethanol** in **water** has more vapour pressure more than that of **water.**

Q.23 (A) The solution which has lower osmotic pressure is called hypotonic solution.



Q.24 (A) K_b is related to **molality.** The molal **boiling point constant (K_b)** is the ratio of the elevation in boiling point to molality. **Mathematically** it can be shown as $K_b = \frac{\Delta T_b}{m}$. Kb **depends** upon the **nature of solvent** and **not upon** the **nature of solute. e.g. K_b of water (0.52°C/m).**

Q.25 (A) Iodine is a **non-polar** while **water** is a **polar.** So **iodine** is **not** soluble in **water** because like is **dissolved** by like. Those **liquids** which **do not** dissolve into each other in any proportion are called immiscible liquids. **Examples of immiscible liquid pair is as follow:**

- **Water and benzene ($H_2O + C_6H_6$)**
- **Water and carbon disulphide ($H_2O + CS_2$)**

Q.26 (B) As **0.1m $CaCl_2$** solution has **greater number** of solute particles as **compared** to other solutions **(A, C and D),** therefore **0.1m $CaCl_2$** solution has **low** vapour pressure as compared to others **at room temperature.**

Q.27 (D) If the solute is volatile and non-electrolyte it would not follow **colligative properties** because it **does**

not fulfill the **conditions** of colligative properties.

Q.28 (A) **Osmotic pressure** is a colligative property like **elevation** in **boiling point (ΔT_b),** depression in **freezing point (ΔT_f)** and **lowering** in **vapour pressure (ΔP). But melting point, boiling point and freezing point are not colligative properties.**

Q.29 (C) Since **two solutions (NaCl and KCl)** have same number of solute particles. **Therefore they possess same vapour pressure.**

Q.30 (D) **All of the following statements are correct about relative lowering of vapour pressure:**

- It is independent of the temperature
- It depend on the concentration of solute
- It is constant when equimolecular proportions of different solutes are dissolved in the same mass of same solvent

Q.31 (D) Since **internal energy** is a state **function** like **P, T, V, G, H, and S** and they all depend upon **initial** and **final stage** of the system **but not** on the **path** of the **system.**

Q.32 (B) **Ionic solid** is **soluble** in **water** if $\Delta H_{hyd} > \Delta H_{latt}$.

Q.33 (B) The number of moles of solute in 1000g (1kg) of solvent is called molality. The **symbol** for molality is **"m"**.

$$\text{Molality (m)} = \frac{\text{Mass of solute}}{\text{Molar mass of solute}} \times \frac{1}{\text{Mass of solvent in kg}}$$

Q.34 (A) For determining the **molecular mass** of the **polymers (macromolecules), osmotic pressure** is preferred over other **methods** as the **pressure measurement** is around the **room temperature.** Its mainly because **biomolecules** are **not stable** at **higher temperatures** and the polymers have poor solubility.

Q.35 (A) **Paint** is an example of solution in which solute is in the solid state while solvent is in the liquid state.

Q.36 (A) **For example phenol** and **water** are partially **miscible** liquids. **At 25°C** the upper layer is **5%** solution of **phenol in water** and the **lower layer** is **30% water** in **phenol. These two solutions** are conjugate solution to **each other.** When the temperature of **water phenol** system is **increased,** the compositions of **both layer change. Water starts travelling from upper** to the **lower layer** and **phenol travels** from **lower** to the **upper layer.** When the temperature of this system approaches **65.9°C,** a homogeneous mixture of **two components** is **obtained.** This homogenous **mixture contains 34% phenol and 66% water.** The temperature of **65.9°C** at which two conjugate solutions merge into **one another,** is **called critical solution temperature or upper consulate temperature.**

Q.37 (A)

$$W_2 = \frac{\text{m} \times \text{molarmass of solute} \times \text{mass of solvent}}{1000}$$

$$= \frac{0.2 \times 60 \times 100}{1000} = 1.2 \text{ g}$$

$\therefore$ **the amount of urea dissolved = 1.2g.**

Q.38 (C) $\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$

$$= \frac{0.5}{100} \times 10^6 = \frac{5}{1000} \times 10^6 = 5 \times 10^3$$

$\therefore$ **Concentration of fluoride in ppm = 5×10^3**

Q.39 (A)

Glucose		Water
$\frac{18}{180}$		$\frac{90}{18}$
0.1	**:**	**5.0**

$n_t = 0.1 + 5.0 = 5.1$

∴ **relative lowering of vapour pressure of glucose solution**

$$\frac{\Delta p}{p^o} = x_2 = \frac{n_2}{n_1 + n_2} = \frac{0.1}{5.1} = \frac{1}{51}$$

Striking Information

In chemistry, the **mole fraction** or **molar fraction** (x_i) is defined as the amount of a constituent (expressed in moles), n_i, divided by the total amount of all constituents in a mixture (also expressed in moles), n_{tot}.

The sum of all the mole fractions is equal to 1:

$$\sum_{i=1}^{N} n_i = n_{tot}; \sum_{i=1}^{N} x_i = 1$$

Q.40 (A) $M_2 = \frac{p}{\Delta p} \times \frac{W_2 M_1}{W_1}$

$$M_2 = \frac{120}{5} \times \frac{20 \times 80}{300} = 128g$$

Molar mass of solute = 128g

Q.41 (C) **Colloidal system** or **colloidal** dispersion is a heterogeneous **system** which is made up of dispersed phase and dispersion medium. In **colloidal** dispersion one substance is dispersed as very fine particles in another substance called dispersion medium.

Q.42 (C) **Solvent loving** colloids are called **lyophilic collides.**

Q.43 (A) **Peptization** is the process responsible for the formation of stable dispersion of colloidal particles in dispersion medium. In other words, it may be **defined** as a process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of small amount of electrolyte.

Q.44 (B) **A colloidal solution of $Fe(OH)_3$ in water is a hydrophobic colloid. A hydrophobic colloid**, or emulsion, is **defined** as a **colloid** system where the **colloid** particles are hydrophobic particle. **Hydrophobic colloids** do not interact with water, so they are inherently unstable and generally do not form spontaneously.

Q.45 (C) **The statement about suspension colloidal solution and true solution are as:**

- Suspension is heterogeneous
- Colloidal solution is heterogeneous
- True solution is homogenous

Q.46 (D) **The addition of alcohol to a saturated aqueous solution of calcium acetate first forms a sol and then sets to a gelatinous mass called solid alcohol which is a gel. Gels are a dispersion of molecules of a liquid within a solid in which the solid is the continuous phase and the liquid is the discontinuous phase. The word gel was coined by 19th-century Scottish chemist Thomas Graham.**

Q.47 (D) **It is incorrect statement. In fact, Marbles is a example of solid sol (in which dispersion medium is in the solid state), while in blood, paint and cell fluid the dispersion medium is in the liquid state.**

Q.48 (A) The colloidal solution of **gold** prepared by **different methods** have **different colours due** to **difference** in the **size of colloidal particles.**

Q.49 (B) **Acetone is not sol which is mentioned in the form of acylosol.**

Q.50 (A) **The amount of solute present in a fixed amount of solvent or solution is called concentration of solution.**

Q.51 (B) Cheese is a example of colloidal solution in which **dispersion medium (D.M)** is in the solid state while water contents are in the **dispersed phase (D.P).**

Opt.	DP States	DM States	Colloidal name	Example
A)	Solid	Liquid	Sols	Muddy water
B)	Liquid	Solid	Gels	Cheese
C)	Liquid	Liquid	Emulsion	Blood
D)	Liquid	Gas	Aerosol of liquid	Fog

Colloidal solution can be classified on the basis of:

- **Dispersion medium.**
- **Nature of charge.**
- **Affinity of D.P for D.M.**
- **Physical state of D.P and D.M.**

Note:

- **D.P stands for internal phase or dispersion phase.**
- **D.M stands for dispersion medium.**

STEP

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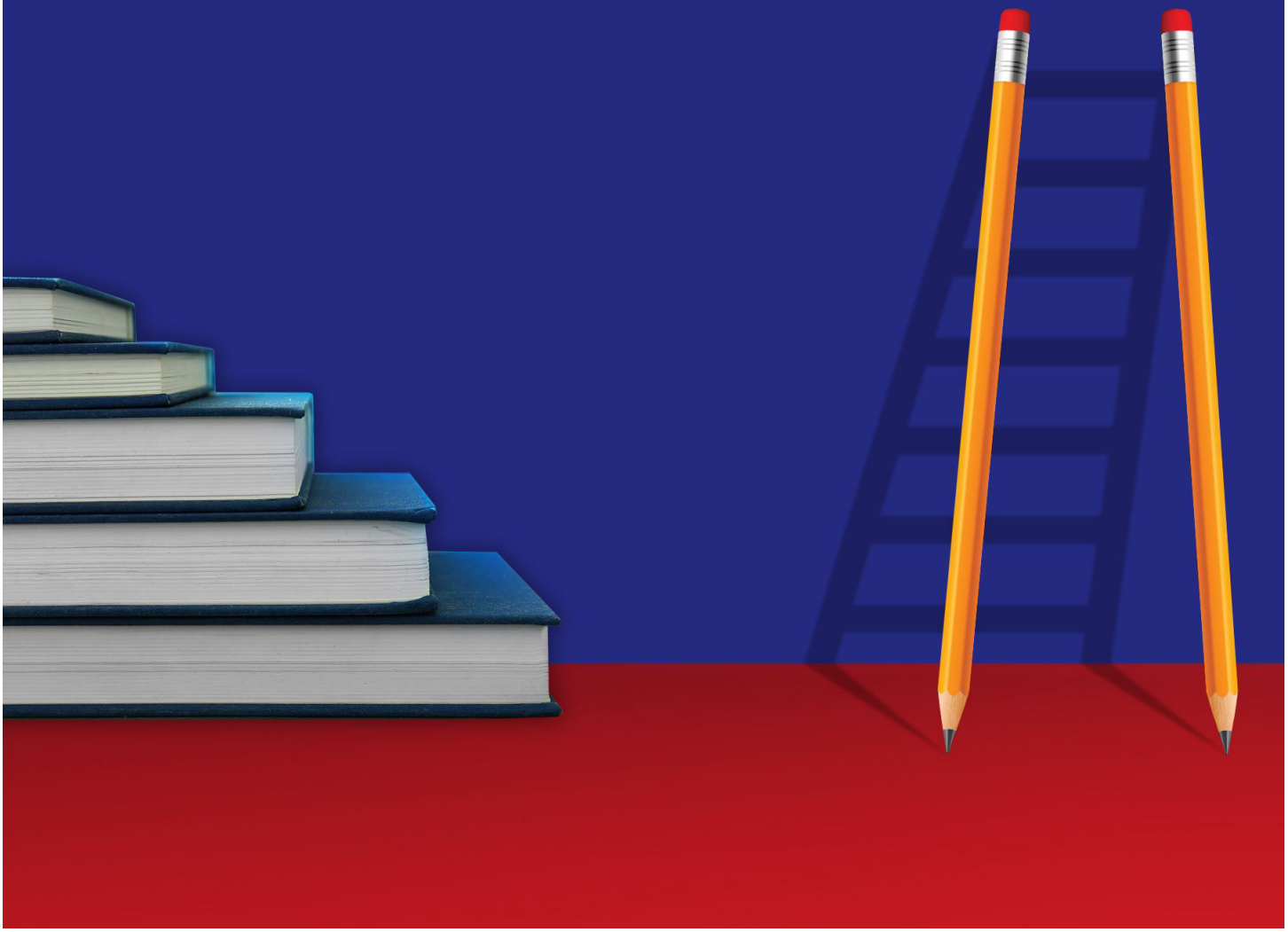

CHEMISTRY

WORKSHEET-16

STEP

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Worksheet-16

(A. Physical Chemistry)

Electrochemistry

Q.1 **By electrolysis of brine solution, which of the following is deposited/released at anode?**

A) H_2 C) Cl_2

B) O_2 D) Na

Q.2 **Which of the following is reducing agent?**

A) $(COOH)_2$ C) CO_2

B) F_2 D) HNO_3

Q.3 **Oxidation number of nitrogen in NO_3^{-1} is:**

A) + 2 C) + 4

B) + 6 D) + 5

Q.4 **Which of the following elements in glucose has zero oxidation state?**

A) C C) H

B) O D) Both A and B

Q.5 **All of the following statements about (oxidation) state is / are correct EXCEPT:**

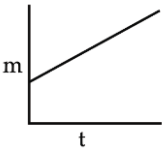
A) It is apparent charge on an atom in a compound

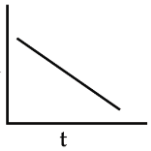
B) Its value is either zero, positive or negative

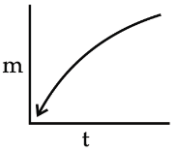
C) It can be variable

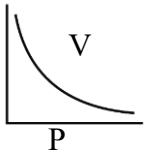
D) Xenon (Xe) can show maximum oxidation state +6 in its compounds

Q.6 **Electrolysis of $CuSO_{4(aq)}$ was carried out using Cu – electrode and a steady current. Which graph shows the change in mass of the cathode with time.**

A) 

C) 

B) 

D) 

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Q.7 In the extraction of A*l* by electrolysis, why is it necessary to dissolve Al_2O_3 in molten cryolite?

A) Cryolite provides the ions needed to carry current

B) To decrease high melting point of the electrolyte

C) Cryolite reacts with Al_2O_3 to form ions

D) Molten Al_2O_3 would not conduct electricity

Q.8 In $FeCl_3$ the oxidation state of C*l* is:

A) Zero C) – 1

B) + 1 D) – 2

Q.9 The process of decomposition of an electrolyte in solution or molten states by the passage of electric current is called electrolysis? All of the following statements about products as a result of electrolysis are correct EXCEPT:

A) They may be get deposited/released on the electrode surface

B) They may go out in the form of gases

C) Electrolytic material may get dissolved into the solution as ions

D) In Nelson cell, Na metal is a primary product

Q.10 Which of the following is not conductor of electricity?

A) $NaCl_{(aq)}$ C) $NaCl_{(s)}$

B) $NaCl_{(molten)}$ D) Silver metal

Q.11 Li^+ has a smaller ionic mobility than K^+ because of the:

A) Larger size of Li^+

B) Greater degree of hydration of Li^+

C) Larger radius to charge ratio of Li^+

D) Smaller nuclear charge of Li^+

Q.12 All of the following is / are characteristics properties of electrolytic cell EXCEPT:

A) It involves conversion of electrical energy into chemical energy

B) In it anode has negative charge and cathode has positive charge

C) It is reverse of addition reaction

D) It is endothermic process

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Q.13 When there is more than one cations in the aqueous solution of an electrolyte, the ions discharge at the cathode can be predicted from the reactivity order of elements given in the electrochemical series. Which of the following is correct order of discharge of positive ions at cathode?

A) $Ag^{+} > Cu^{+2} > H^{+} > Pb^{+2}$ C) $Ag^{+1} > H^{+} > Pb^{+2} > Cu^{+2}$

B) $Cu^{+2} > Ag^{+1} > H^{+} > Pb^{+2}$ D) $H^{+} > Ag^{+1} > Cu^{+2} > Pb^{+2}$

Q.14 Which of the following is correct order of discharge of negative ions on the anode electrode in case of electrolysis of mixture of electrolytes?

A) $I^{-} > Br^{-} > OH^{-} > NO_3^{-1}$ C) $OH^{-} > Br^{-} > I^{-1} > NO_3^{-1}$

B) $Br^{-} > OH^{-} > NO_3^{-1} > I^{-1}$ D) $NO_3^{-1} > Br^{-} > OH^{-} > I^{-1}$

Q.15 Na metal cannot be produced by electrolysis of aqueous solution of NaC*l*.

A) Na reacts with water

B) Na^{+} is more stable than Na atom

C) Na^{+} reacts with Cl^{-} ion in the solution

D) Reduction of H_2O is preferred to Na^{+}

Q.16 Which of the following is wrong about electrolysis?

A) Extraction of sodium by the electrolysis of fused NaCl is carried in Down's cell

B) Ca and Mg metals are extracted by the electrolysis of their fused chlorides

C) It is used for the extraction of blistered copper from electrolytic copper

D) Aluminium is extracted by electrolyzing fused bauxite ($Al_2O_3.2H_2O$) in the presence of fused cryolite (Na_3AlF_6)

Q.17 In which one of the following reactions, hydrogen behaves as an oxidizing agent?

A) $H_2 + Cl_2 \rightarrow 2HCl$ C) $2Na + H_2 \rightarrow 2NaH$

B) $C_2H_4 + H_2 \rightarrow C_2H_6$ D) $N_2 + 3H_2 \rightarrow 2NH_3$

Q.18 When a dilute solution of salt is electrolyzed, a colourless gas is given off at the anode. The gas is:

A) Hydrogen C) Steam

B) Oxygen D) Chlorine

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Q.19 Coinage metals (Cu, Ag and Au) are the least reactive because they have:

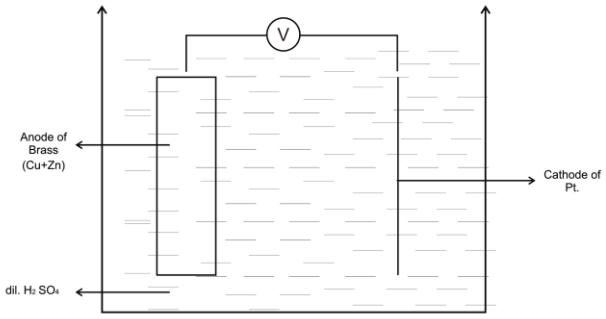
A) Negative reduction potential

B) Negative oxidation potential

C)Positive reduction potential

D) Positive oxidation potential

Q.20 The circuit shown in diagram was set up:



Which electrode reaction will occur?

Options	Anode Reaction	Cathode Reaction
A)	Cu dissolves preferentially	Cu is precipitated
B)	Cu dissolves preferentially	Hydrogen gas is evolved
C)	Zn and Cu both dissolves	Hydrogen gas is evolved
D)	Zn dissolves preferentially	Hydrogen gas is evolved

Q.21 Consider the following redox reaction

$K_2Cr_2O_7+7H_2SO_4+6FeSO_4 \rightarrow$

$K_2SO_4+Cr_2(SO_4)_3+3Fe_2(SO_4)_3+7H_2O$

In this reaction

I) $FeSO_4$ acts as a reducing agent

II) $K_2Cr_2O_7$ acts as an oxidizing agent

III) $Cr^{+6}{}_{(aq)}$ is reduced to Cr^{+3}

IV) Fe^{+3} is oxidized to Fe^{+2}

Which of the following statements is/are correct regarding this redox reaction?

A) I and II only

B) II and III only

C) I , II , III

D) I , II , III , and IV

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Q.22 **All of the following are reducing agents EXCEPT:**

A) $FeSO_4$ C) $(COOH)_2$

B) H_2S D) CO_2

Q.23 **The potential set up when an electrode is in contact with 1M solution of its own ions at 298 K is known as standard electrode potential (or standard reduction potential denoted by E°). All of the following statements about standard electrode potential are correct EXCEPT:**

A) Smaller is the $E°_{red}$, greater is the reducing power of a metal

B) $E°_{red}$ of Li^+ is minimum (-3.04V)

C) Greater is the $E°_{red}$, greater is the oxidizing power of a non-metal

D) $E°_{red}$ of Cl_2 is maximum (+2.87V)

Q.24 **Identify incorrect statement about standard hydrogen electrode:**

A) It is used as a reference electrode

B) Its $E°_{red}$ is zero or less than zero

C) When it is connected to zinc electrode in a galvanic cell, it act as cathode

D) When it is connected to Cu electrode in a galvanic cell, it act as anode

Q.25 **If in a Galvanic cell:**

- **Zn^{+2}/Zn^o E^o_{red} = -0.76 V**
- **Cu^{+2}/Cu^o E^o_{red} = +0.34 V**

Then the standard cell potential (E^o_{cell}) of this Galvanic cell is:

A) + 1.10 volts

B) – 0.42 volts

C) -1.10 volts

D) + 0.42 volts

Q.26 **On the basis of knowledge of electrochemical series, which reaction is not feasible:**

A) $Zn + H_2SO_{4\,(dil)} \rightarrow ZnSO_4 + H_2$

B) $F_2 + KCl \rightarrow 2KF + Cl_2$

C) $Cu + H_2SO_{4\,(dil)} \rightarrow CuSO_4 + H_2$

D) $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

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Q.27 **When elements are arranged in the order of their standard electrode potential on the basis of hydrogen scale, the resulting list of elements is known as Electrochemical series. Mark the incorrect statement about electrochemical series:**

A) Every top metal can displace lower one in redox reaction

B) Every lower non-metal can displace higher one in redox reaction

C) $E^o_{cell} = E^o_{oxid} + E^o_{red}$

D) E^o_{red} increases from bottom to top

Q.28 **Identify the incorrect statement:**

A) Every top metal acts as anode

B) Every lower metal acts as cathode

C) Oxidizing power of an element decreases from top to bottom

D) Reducing power of an element decreases from top to bottom

Q.29 **On the electrolysis of aqueous solution of Na_2SO_4 by using inert electrode, which of the following is deposited/released on the cathode electrode?**

A) Na is deposited

B) O_2 gas is released

C) Either Na or H_2 is released

D) H_2 gas is released

Q.30 **On the electrolysis of H_2SO_4 (dil) solution by using inert electrode, which of the following is deposited or released at anode electrode**

A) H_2 gas is released

B) O_2 gas is released

C) SO_2 gas is released

D) Either O_2 or SO_2 gas is released

Q.31 **A redox reaction is shown below:**

$$\mathbf{C^o + 4HNO_3\ (Conc.) \rightarrow CO_2 + 4NO_2 + 2H_2O}$$

In this reaction oxidation number of N from nitric acid to NO_2 is decreased from ____ to _____.

A) +5 to +2

B) +5 to +4

C) +3 to + 2

D) + 4 to +2

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Q.32 **In sodium sulphate (Na_2SO_4) what is the oxidation number of sulphur:**

A) +2 C) +6

B) +4 D) +8

Q.33 **Solid potassium halides react with concentrated sulphuric acid, according to the following equations.**

Reaction-1:

$$2KCl + H_2SO_4 \longrightarrow K_2SO_4 + 2HCl$$

Reaction-2:

$$2KBr + 2H_2SO_4 \longrightarrow K_2SO_4 + SO_2 + Br_2 + 2H_2O$$

Reaction-3:

$$8KI + 5H_2SO_4 \longrightarrow 4K_2SO_4 + H_2S + 4I_2 + 4H_2O$$

What is the largest change in the oxidation number of sulphur in each of these reactions?

Options	Reaction-1	Reaction-2	Reaction-3
A)	0	0	4
B)	0	2	4
C)	0	2	8
D)	0	4	8

Q.34 **Salt bridge has all of the following functions EXCEPT:**

A) It keeps separate both solutions

B) It maintains electrical neutrality in the cell

C) It maintains flow of electric current through external circuit

D) The positive charge around cathode electrode would prevent the electrons to flow from it

Q.35 **To measure the standard electrode potential of Zinc, it is coupled with:**

A) SHE C) F_2

B) Cl_2 D) Cu

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Q.36 **Which one of the following is not redox reaction?**

A) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B) $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

C) $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

D) $2Mg + O_2 \rightarrow 2MgO$

Q.37 **The element which has greatest value of standard reduction potential (E^o_{red}) in the redox reaction acts as:**

A) Strongest reducing agent

B) Strongest oxidizing agent

C) Weakest oxidizing agent

D) Weakest reducing agent

Q.38 **When a Zn strip is placed in $CuSO_4$ solution, Cu gets precipitated, because standard oxidation potential of Zn is?**

A) < Cu

B) > Cu

C) < SO_4^{-2}

D) > SO_4^{-2}

Q.39 **Which of the following has highest reduction potential?**

A) Zn

B) Al

C) Au

D) Pb

Q.40 **The reaction which takes place at electrode when electricity is passed through the solution of an electrolyte is called _____.**

A) Hydrolysis

B) Neutralization

C) Electrolysis

D) Galvanizing

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ANSWER KEY (Worksheet-16)							
1	C	11	B	21	C	31	B
2	A	12	B	22	D	32	C
3	D	13	A	23	D	33	C
4	A	14	A	24	B	34	D
5	D	15	D	25	A	35	A
6	A	16	C	26	C	36	B
7	B	17	C	27	D	37	B
8	C	18	B	28	C	38	B
9	D	19	C	29	D	39	C
10	C	20	D	30	B	40	C

ANSWERS EXPLAINED

Standard reduction potentials (E°) of substances at 298K

oxidised form A_{Ox}	$+ n e^-$	reduced form A_{Red}	E°/ V
$Li^+_{(aq)} + e^-$	$\rightleftharpoons$	$Li_{(s)}$	-3.04
$K^+_{(aq)} + e^-$	$\rightleftharpoons$	$K_{(s)}$	-2.92
$Na^+_{(aq)} + e^-$	$\rightleftharpoons$	$Na_{(s)}$	-2.71
$Zn^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Zn_{(s)}$	-0.76
$Pb^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Pb_{(s)}$	-0.13
$2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$H_{2(g)}$	0.00
$N_{2(g)} + 8H^+_{(aq)} + 6e^-$	$\rightleftharpoons$	$2NH^+_{4(aq)}$	+0.27
$Cu^{2+}_{(aq)} + 2e^-$	$\rightleftharpoons$	$Cu_{(s)}$	+0.34
$I_{2(s)} + 2e^-$	$\rightleftharpoons$	$2I^-_{(aq)}$	+0.54
$O_{2(aq)} + 2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$H_2O_{2(aq)}$	+0.68
$Fe^{3+}_{(aq)} + e^-$	$\rightleftharpoons$	$Fe^{2+}_{(aq)}$	+0.77
$NO^-_{3(aq)} + 4H^+_{(aq)} + 3e^-$	$\rightleftharpoons$	$NO_{(g)} + 2H_2O_{(l)}$	+0.96
$O_{2(g)} + 4H^+_{(aq)} + 4e^-$	$\rightleftharpoons$	$2H_2O_{(l)}$	+1.23
$Cl_{2(g)} + 2e^-$	$\rightleftharpoons$	$2Cl^-_{(aq)}$	+1.36
$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^-$	$\rightleftharpoons$	$2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$	+1.36
$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^-$	$\rightleftharpoons$	$Mn^{2+}_{(aq)}$	+1.49
$H_2O_{2(aq)} + 2H^+_{(aq)} + 2e^-$	$\rightleftharpoons$	$2H_2O_{(l)}$	+1.78
$F_{2(g)} + 2e^-$	$\rightleftharpoons$	$2F^-_{(aq)}$	+2.87

Q.1 (C) Chlorine gas (Cl_2) is released at anode.

- In the electrolysis of aqueous solution containing a mixture of ions, following is the increasing order of discharge of negative ions at anode electrode.

$$SO_4^{2-} < NO_3^- < Cl^- < OH^- < Br^- < I^-$$

- In the electrolysis of brine solution, the relative concentration of chloride ions (Cl^-) and hydroxide ions (OH^-) affect the result.
- The concentration of OH^- ions in water is only 10^{-7} moldm^{-3}. In the aqueous solution concentration of Cl^- ions is 0.1 moldm^{-3}.
- Which clearly shows that the concentration of chloride ions is 10^6 times greater than that of OH^- ions.
- Because of this reason chloride ions are preferentially discharged at anode electrode than that of OH^- ions (concentration effect).

	Cations	Anions
$NaCl_{(aq)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$	$Na^+_{(aq)}$	Cl^-
$HOH \longrightarrow H^+_{(aq)} + OH^-_{(aq)}$	$H^+_{(aq)}$	OH^-

At anode $2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$

At cathode $2H^+ + 2e^- \longrightarrow H_2$

Q.2 (A) Oxalic acid **$(COOH)_2$** is reducing agent and oxidation number of carbon **increases** from **+3** to **+4** in **redox reaction**.

Q.3 (D) (NO_3^{-1})

$$x + (-2 \times 3) = -1$$
$$x - 6 = -1$$
$$x = +5$$

so oxidation number of **N** in **NO_3^{-1} = +5**.

Q.4 (A) Oxidation of carbon is zero in glucose such as. **Formula of glucose = $C_6H_{12}O_6$.**

$$x\times 6+1\times 12-2\times 6=0$$
$$6x+12-12=0$$
$$6x+0=6$$
$$x=0$$

$\therefore$ Oxidation number of carbon is zero.

Q.5 (D) Oxidation state of **Xe** can be not only **+6** but it can also be **+8** as shown in the compound **XeO_4**. In this compound oxidation state of **Xe** is **+8**. Therefore, maximum oxidation state of Xenon is +8 not +6.

e.g.

- O.S of Xe in $XeOF_4$ is +6
- O.S of Xe in XeO_4 is +8

Q.6 (A) According to **Faraday's second law** of electrolysis, mass of the metal deposited on the electrode is directly proportional to the quantity of electricity **(i.e. $m \propto Q$)** where **Q = It**. Option A justifies the statement. At the cathode, **Cu^{2+}** ions migrate there and is reduced to form **Cu**. $Cu^{+2}+2e^{-}\rightarrow Cu$. Hence the mass of the cathode electrode increases with time.

Q.7 (B) The main purpose of cryolite is to reduce the melting point of **Al_2O_3 (M.P = 2072°C)**. The minimum melting point is achieved when a mixture of substances is formed **(M.P of mixture = 1009°C)**.

Q.8 (C) In **$FeCl_3$** oxidation of **Fe = +3** while total negative charge on chlorine **= -3**. Charge on chlorine per atom **= -1**. So oxidation number of chlorine in **$FeCl_3$ is -1**.

Q.9 (D) In **Nelson cell** water is reduced preferentially to **Na^{+1}** i.e. **Na** metal is not extracted by electrolysis of brine. **Na metal** is obtained by electrolysis of molten **NaCl** in **Down's cell**.

Q.10 (C) **NaCl** in the solid state does not conduct electricity because free ions are not available. For the passage of electricity, free ions of **NaCl** are obtained when **NaCl** is in the molten state or in the solution form.

Q.11 (B) **Li^+** has a smaller ionic mobility than that of **K^+** because size of **Li^+** is a smaller and **ΔH_{hyd} of Li^+ = -499kJmol^{-1}** which is greater than that of **K^+ ion (ΔH_{hyd} = -305kJmol^{-1}).** So greater is the **ΔH_{hyd}**, smaller is the mobility of ion.

Q.12 (B) In the **electrolytic cell** cathode is shown by **negative (-)** sign while anode is shown by **positive (+)** sign. However, in **galvanic cell** cathode is shown by **positive (+)** sign while anode is shown by **negative sign (-).**

Q.13 (A) Greater is the **E^o_{red}** value, more the ions are preferentially deposited or released at the cathode.

Order of increasing discharge of positive ions = $Pb^{+2} < H^+ < Cu^{+2} < Ag^+$

Q.14 (A) In the electrolysis of a solution containing a mixture of ions.

Following increasing order of discharge of negative ions at anode electrode is given below.

$SO_4^{2-} < NO_3^- < Cl^- < OH^- < Br^- < I^-$

Therefore, the decreasing order of discharge of given negative ions in the given question is:

$I^- > Br^- > OH^- > NO_3^{-1}$.

Q.15 (D) Because E^o_{red} of H_2O is greater **i.e. (H^+ ions = 0.0V)** than that of

Na^+ (E^o_{red} = -2.71V).

Q.16 (C) In fact, electrolytic copper is obtained from blistered copper. **Blistered copper** is obtained by bessemerisation of ore of copper **(Chalcopyrite $CuFeS_2$).** It is impure one. Pure copper obtained by electrolysis of blistered copper is known as electrolytic copper.

Q.17 (C) In this **redox reaction hydrogen** acts as an oxidizing agent because it gains electrons during redox reaction. It is more electronegative **(H = 2.1) than that of Na (0.9).** $\underset{R.A}{2\overset{0}{Na}} + \underset{O.A}{\overset{0}{H_2}} \rightarrow 2\overset{+1}{N}a\overset{-1}{H}$

Q.18 (B) When a dilute solution of salt and water is electrolyzed, a colourless O_2 gas is given off at the anode. Generally OH^- ions are preferentially released in the form of oxygen gas at anode. Because generally it is preferentially released than most of the other negative ions of the salts in dilute solution.

Q.19 (C) Coinage metals **Cu, Ag, Au,** are the least reactive because they have high positive E^o_{red} values as shown **(Cu^{+2} = +0.34V, Ag^+ = 0.78V, Au^{3+} = +1.50V)** greater is the E^o_{red} value of a metal, least is the reactivity.

i.e. $E^o_{red} \propto \frac{1}{\text{reducing power of a metal}}$

Q.20 (D)

- **At anode oxidation takes place such as** $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$. It shows that **Zn** metal is **continuously consumed** and converted into

  Zn^{+2} (E^o_{oxi} of Zn^o =+0.76V).

- **At cathode reduction takes place such as** $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$ ions whereas hydrogen gas is **continuously released at cathode**.

Q.21 (C) In this redox reaction $FeSO_4$ acts as a reducing agent and it is oxidized from Fe^{+2} ($FeSO_4$) to Fe^{+3} {$Fe_2(SO_4)_3$}. $K_2Cr_2O_7$ acts as oxidizing agent. In this redox reaction Cr^{+6} ($K_2Cr_2O_7$) is reduced to Cr^{+3} {$Cr_2(SO_4)_3$}. In this redox reaction Fe^{+3} is not oxidized to Fe^{+2} (which is incorrect statement). In fact, it is reduced from Fe^{+3} to Fe^{+2}.

Q.22 (D) CO_2 is an oxidizing agent while all others are A, B and C are reducing agent. CO_2 has tendency to gain electrons.

Q.23 (D) In fact, $E°_{red}$ of F_2 is maximum (+2.87V). In the electrochemical series F_2 is the strongest oxidizing agent because it can displace all the halogens in the redox reaction i.e F_2 can displace Cl_2, Br_2 and I_2.

Q.24 (B) Standard hydrogen electrode is used as a reference electrode and its E^o_{red} is zero volt.

Q.25 (A) The standard cell potential (E^o_{cell}) of this Galvanic cell is +1.10V. Since it is positive value, so the reaction is spontaneous and feasible. E^o_{cell} can be calculated as:

Given data

- **Zn^{+2}/Zn^{o} E^{o}_{red} = -0.76 V**
- **Cu^{+2}/Cu^{o} E^{o}_{red} = +0.34 V**
- **Since Zn^{+2} ion has smaller E^{o}_{red} value therefore Zn is more electropositive than Cu. So Zn act as reducing agent and loses electron.**
- **On the other hand Cu^{+2} ion has greater reduction potential value therefore, Cu^{+2} is less electropositive than Zn^{+2}.**

E^{o}_{oxid} Zn^{o}/Zn^{+2} = +0.76V

$E^{0}_{cell} = E^{0}_{oxid} + E^{0}_{red}$

$= Zn/Zn^{+2} + Cu^{+2}/Cu^{0}$

= 0.76 + 0.34V

= +1.10V

E^{o}_{cell} of this Galvanic cell = +1.10V which shows that reaction is feasible.

Q.26 (C) **$Cu + H_2SO_{4(dil.)} \rightarrow$ No reaction. According to applications of electrochemical series every top metal can displace lower metal but lower metal cannot displace higher one. Since reduction potential of Cu^{+2}/Cu is +0.34V and that of hydrogen is zero volt, so hydrogen cannot be displaced by Cu. So this is not feasible reaction. Greater is the E^{o}_{red} value, less is electropositive character.**

Q.27 (D) **In fact, E^{o}_{red} decreases from bottom to top. That is why from bottom to top electropositive character (reducing power) of an element increases.**

Conclusion:

- **$E^{o}_{red} \propto \frac{1}{\text{Reducing Power}}$.**

(e.g. Li^{+1} has minimum standard reduction potential (E^{o}_{red} = -3.04V) and it is the strongest reducing agent in the electrochemical series)

Q.28 (C) In fact, oxidizing power of an element **increases** from **top to bottom. i.e. F_2 is the strongest oxidizing agent in the electrochemical series.**

Conclusion:

- **i.e. $E^{o}_{red} \propto$ Oxidizing power (e.g. F_2 has maximum standard reduction potential (E^{o}_{red} = +2.87V) and it is the strongest oxidizing agent in the electrochemical series)**

Q.29 (D) **On electrolysis of aqueous solution of Na_2SO_4 by using inert electrode. H_2 gas is released at cathode electrode while O_2 is released at anode. Its detail is shown below.**

$$Na_2SO_{4(aq)} \rightleftharpoons 2Na^{+1}_{(aq)} + SO^{-2}_{4(aq)}$$

$$HOH \rightleftharpoons H^{+} + OH^{-}$$

- **At cathode**

Since E^{o}_{red} of H^+ ions is greater than that of Na^+ ions. That is why, H^+ ions are preferentially reduced at cathode electrode and hydrogen H_2 gas is released at cathode as shown below

Order of discharge of positive ion = H^+ > Na^+

= E^{o}_{red} = 0.000V > E^{o}_{red} = -2.714V

$\therefore 2H^+ + 2e^- \rightleftharpoons H_{2(g)}$ … (i)

- **At anode**

Order of discharge of an anion at cathode electrode is as follow

$= I^- > Br^- > OH^- > Cl^- > NO_3^{-1} > SO_4^{-2}$

So OH^- ions are preferentially oxidized at anode and O_2 gas is released as shown below

$\therefore\ 4OH^- \rightarrow O_2 + 2H_2O + 4e^- ....(ii)$

Q.30 (B) O_2 is released at anode by electrolysis of dil. H_2SO_4 as shown below

$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{-2}$

$HOH \rightleftharpoons H^+ + OH^-$

OH^- ions are preferentially discharged at anode electrode and oxygen gas is released as shown below.

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

Q.31 (B) In this redox reaction, decrease in oxidation number of N from HNO_3 to NO_2 is from +5 to +4, as shown below.

$C^o + 4HN^{+5}O_3(conc.) \rightarrow C^{+4}O_2 + 4N^{+4}O_2 + 2H_2O$

R.A O.A

Q.32 (C)

Na_2SO_4	
We know that the oxidation number of one atom of Na is +1. There are two atoms of Na. $2 \times +1 = +2$	We know that one atom of O is assigned -2. There are four atoms of O. $4 \times -2 = -8$

Since the sum of positive charges plus the sum negative charges must be equal 0,

$(+2) + x + (-8) = 0$

$x + 2 - 8 = 0$

$x = +6$

Q.33 (C) In reaction I, II and III, change in the oxidation state of sulphur is 0, 2 and 8 respectively as shown in the table:

Opt.	Reaction-1	Reaction-2	Reaction-3
C)	0	2	8

Q.34 (D) The progress of cell reaction results in the development of positive charge around the anode due to increase in the concentration of Zn^{2+} ion.

- And negative charge around cathode due to decrease in the concentration of Cu^{2+} ions.
- The positive charge around anode would prevent the electrons to flow from it and negative charge around cathode will check the electrons to reach copper rod.
- This would stop the working of the cell.
- The salt bridge does not allow the solution around the electrode to acquire charge. The anions from the electrolyte in the salt bridge move towards anode and the cations move towards cathode to maintain the electrical neutrality of the solutions in anodic as well as cathodic compartments.

Q.35 (A) To measure the standard electrode potential of zinc is coupled with **standard hydrogen electrode (SHE)**.

Q.36 (B) In a redox reaction, there is always transfer of electron/electrons from a reducing agent to an oxidizing agent. But in case of option "B" since there

is no change in oxidation number in overall reaction, so it is not redox reaction.

Q.37 (B) The element which has the greatest value of standard reduction potential is used as strongest oxidizing agent e.g. maximum reduction potential is that of fluorine in electrochemical series as shown in the tabular form:

Element	Electrode	Standard reduction potential (E^o)
F_2	$F_2 + 2e^- \rightarrow 2F^-$	+2.87volts

Q.38 (B) When a Zn strip is placed in $CuSO_4$ solution, Cu gets precipitated, because standard oxidation potential of **Zn > Cu as shown in the tabular form.**

E^o_{oxd} of Zn = +0.76V	E^o_{oxd} of Cu = -0.34V
$Zn \rightarrow Zn^{+2} + 2e^-$	$Cu \rightarrow Cu^{+2} + 2e^-$

Q.39 (C) Au has highest standard reduction potential as compared to other given in the question.

Element	Electrode	Standard reduction potential (E^o)
Zn	$Zn^{+2} + 2e^- \rightarrow Zn$	-0.76V
Al	$Al^{+3} + 3e^- \rightarrow Al$	-1.66V
Au	$\mathbf{Au^{+3} + 3e^- \rightarrow Au}$	**+1.50V**
Pb	$Pb^{+2} + 2e^- \rightarrow Pb$	-0.126V

Q.40 (C) The reaction which takes place at electrode when electricity is passed through the solution of an electrolyte **is called electrolysis.**

STEP

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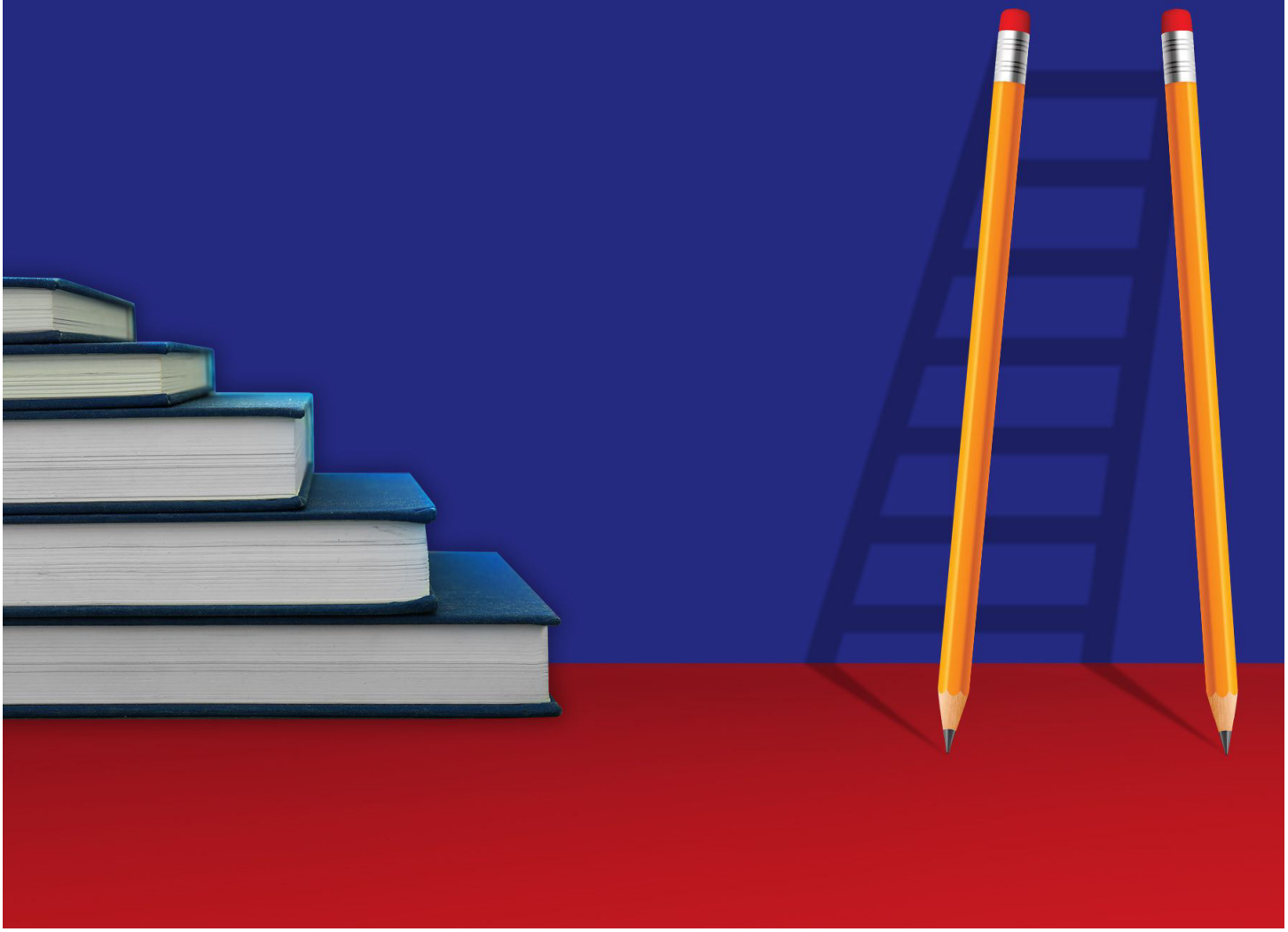

CHEMISTRY

WORKSHEET-17

STEP

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Worksheet-17

(A. Physical Chemistry)

Chemical Equilibrium

USE THIS SPACE FOR SCRATCH WORK

Q.1 **A reversible reaction shows all of the following characteristic features EXCEPT:**

A) It can proceed in both directions

B) In it the whole amount of reactant does not change into product

C) Chemical equilibrium can establish in it

D) It is applicable to stoichiometric calculation

Q.2 **Chemical equilibrium is not associated with:**

A) It is macroscopic property

B) At equilibrium the amount of reactant = the amount of product

C) It is established in closed system

D) It can establish from either side of reactant or product

Q.3 **If the reaction A + B → AB. If concentration of A and B are doubled, the rate of reaction will:**

A) Increase two times

B) Decrease to one half

C) Increase four times

D) Decrease to one

Q.4 **Which one of the following factors can change the value of Kc?**

A) Temperature

B) Pressure

C) Concentration of reactants

D) Concentration of products

Q.5 **Which of the following principle / rule is applicable at equilibrium?**

A) Law of mass action

B) Pauli's Exclusion Principle

C) Le-Chatelier's Principle

D) Hund's Rule

Q.6 **In which of the following reactions decrease or increase in pressure has no effect in the change of direction of reaction?**

A) $N_2 + O_2 \rightleftharpoons 2NO$ C) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

B) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ D) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

Q.7 **In which of the following reactions, K_c value has no unit?**

A) $H_2 + I_2 \rightleftharpoons 2HI$ C) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

B) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ D) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

Q.8 **Consider the following reaction $2SO_2 + O_2 \overset{V_2O_5}{\rightleftharpoons} 2SO_3$ the unit of K_c is:**

A) mol dm^{-3} C) dm^3mol^{-1}

B) dm^3mol^{-2} D) dm^6mol^{-2}

Q.9 **In which of the following reactions, heterogeneous equilibrium is established?**

A) $H_2 + I_2 \rightleftharpoons 2HI$ C) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

B) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ D) $MgCO_3 \rightleftharpoons MgO + CO_2$

Q.10 **Which one of the following statements is correct about a reaction for which the equilibrium constant is independent of temperature?**

A) The activation energies for both forward and reverse reactions are zero

B) The enthalpy change is zero

C) Its rate constants do not vary with temperature

D) There are equal number of moles of reactants and products in it

Q.11 **Which of the following is the strongest acid?**

A) HI C) $HClO_3$

B) HNO_3 D) H_2SO_4

Q.12 **Which one of the following groups of elements forms strongest bases?**

A) IVA C) IIA

B) IIIA D) IA

Q.13 **Which one of the following statements is incorrect?**

A) Strong acid has greater concentration of hydrogen ions

B) Strong acid has low pH value

C) Greater is pK_a value, stronger is the acid

D) Smaller is concentration of OH^- ions weaker is the base

Q.14 **Which of the following is not buffer solution?**

A) $CH_3COOH + CH_3COONa$ C) HCl + NaCl

B) $H_2CO_3 + NaHCO_3$ D) $H_3PO_4 + Na_2HPO_4$

USE THIS SPACE FOR SCRATCH WORK

Q.15 **If K_a value is 10^{-6} then Kb value is:**

A) 10^{-4} C) 10^{-6}

B) 10^{-8} D) 10^{-10}

Q.16 **Which one of the following statements is incorrect for K_c?**

A) It may or may not have unit

B) It depends on equilibrium concentration

C) It is associated with ΔH

D) It tells us about rate of reaction

Q.17 **All of the following are characteristic features of solubility product EXCEPT?**

A) If solubility is known, then K_{sp} can be calculated

B) If K_{sp} is known, then solubility can be calculated

C) It is applicable if the molar concentration of ions is greater than 0.1M

D) The term K_{sp} is related with reversible process

Q.18 **Which one of the following statements is correct about the effect of a catalyst?**

A) It increases the equilibrium constant for the forward reaction

B) It increases the rate constant for the forward reaction but not that of the reverse reaction

C) It increases the yield of product at equilibrium

D) It provides an alternative route for a reaction

Q.19 **Water dissociates as shown:**

$$H_2O_{(g)} \rightleftharpoons H^+ + OH^-$$

At 25°C the equilibrium value of $[H^+]$ is 10^{-7} mol dm^{-3}, $[H_2O]=\frac{1000}{18}$ mol dm^{-3}. What is the order of increasing numerical value of pH, $_pK_a$ and $_pK_w$ for this equilibrium at this temperature? $[_pK_w = -\log K_w]$

Options	Smallest	Larger	Largest
A)	pH	$_pK_a$	$_pK_w$
B)	pH	$_pK_w$	$_pK_a$
C)	pK_a	$_pK_w$	pH
D)	pK_w	$_pK_a$	pH

USE THIS SPACE FOR SCRATCH WORK

Q.20 **In order to get maximum yield of NH_3, all of the following are optimum conditions EXCEPT?**

A) High pressure

B) Continuous withdrawal of NH_3

C) High temperature

D) Use of catalyst

Q.21 **Which of the following is Henderson's equation for acidic buffer solution?**

A) $pH=pK_a+\log\frac{[Salt]}{[Acid]}$ C) $pH=pK_b+\log\frac{[Salt]}{[Acid]}$

B) $pH=K_a+\log\frac{[Salt]}{[Acid]}$ D) $pH=pK_a-\log\frac{[Salt]}{[Acid]}$

Q.22 **Which of the following statements is incorrect about Henderson's equation for acidic buffer solution?**

A) pH = pKa if [Salt] = [Acid]

B) pH > pKa if [Salt] > [Acid]

C) pH < pKa if [Salt] < [Acid]

D) pH = Ka if [Salt] = [Acid]

Q.23 **The decrease in the solubility of an electrolyte by adding another electrolyte having common ion is called common ion effect. Identify incorrect statement about common ions effect:**

A) It is an application of Le-Chatelier's Principle

B) It is always in the reverse direction

C) The term electrolyte, acid or base is used for it

D) It is used for the purification of a substance

Q.24 **The equilibrium constant for the reaction between acetic acid and ethyl alcohol is 4.0. A mixture of 2.0 moles of acetic acid and 2.0 moles of C_2H_5OH is allowed to come to equilibrium. Calculate the number of moles of ethyl acetate at equilibrium**

$$C_2H_5OH + CH_3COOH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

A) 1.5 moles C) 1.6 moles

B) 1.3 moles D) 1.4 moles

USE THIS SPACE FOR SCRATCH WORK

Q.25 **Given that pKa of acetic acid is 4.7, what is pH of solution of 0.01 M acetic acid and 0.1 sodium acetate is:**

A) 3.7 C) 4.7

B) 5.7 D) 2.7

Q.26 **The Le-Chatlier principle states that if a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify as far as possible, the effect of that stress. Which of the following effect of change is not according to this principle:**

Opt.	Change at equilibrium	Effect of change
A)	Increase in concentration of reactant	Reaction moves in the forward direction
B)	Increase in pressure	Reaction moves in that direction which has less number of moles
C)	Increase in temperature	Reaction always moves in the exothermic side
D)	Increase in the concentration of the product	Reaction moves in the reverse direction

Q.27 **Different relationship between K_c and K_p are given:**

Cond.	Case	Example	Conclusion
I	If $\Delta n = 0$ ($n_p = n_r$)	$H_2 + I_2 \rightleftharpoons 2HI$	$K_p = K_c$
II	If $\Delta n = +ve$ ($n_p > n_r$)	$PCl_5 \rightleftharpoons PCl_3 + Cl_2$	$K_p > K_c$
III	If $\Delta n = -ve$ ($n_p < n_r$)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$	$K_p < K_c$

Which of the following relationship between K_c and K_p is/are correct?

A) I only C) III only

B) II only D) I, II, III

Q.28 **pH of an aqueous solution is 10.0 Its pOH is:**

A) 7 C) 4

B) 9 D) 10

Q.29 **Mark the correct statement:**

A) Greater is the Ka value, stronger is the acid

B) Greater is pH value, stronger is the acid

C) Greater is pKa value, stronger is the acid

D) Smaller is H^+ ion concentration, stronger is the acid

USE THIS SPACE FOR SCRATCH WORK

Q.30 **The phenomenon of interaction of cations and anions of a salt with water in order to produce acidity or alkalinity is known as salt hydrolysis. Which of the following salts is not hydrolyzed?**

A) $CuSO_4$ C) Na_2SO_4

B) Na_2CO_3 D) $AlCl_3$

Q.31 **Which of the following is acidic salt?**

A) Na_2SiO_3 C) K_2SO_4

B) $Na_2B_4O_7$ D) $FeCl_3$

Q.32 **According to Lewis theory:**

- **Acid is electron pair acceptor**
- **Base is electron pair donor**

All of the following are Lewis acids EXCEPT:

A) H^+ C) BF_3

B) $AlCl_3$ D) PCl_3

Q.33 **Which of the following halide ions is stronger Lewis base?**

A) F^- C) Br^-

B) Cl^- D) I^-

Q.34 **An indicator is a substance which is used to determine the end point of a reaction. All of the following statements are correctly matched regarding indicators EXCEPT:**

Options	Type of Titration	Name of Indicator
A)	Acid base indicators	Phenolphthalein, methyl orange
B)	Redox titration	$K_3[Fe(CN)_6]$ an internal indicator, $KMnO_4$ an external indicator
C)	Iodimetry titration	Starch indicator
D)	Argentometry	K_2CrO_4

Q.35 **Phenolphthalein is used as an indicator in acid base titration. For which of the following acid base titration it is used as an indicator:**

A) Strong base and strong acid

B) Weak acid and weak base

C) Strong acid and weak base

D) Very weak base and strong acid

USE THIS SPACE FOR SCRATCH WORK

ANSWER KEY (Worksheet-17)							
1	D	11	A	21	A	31	D
2	B	12	D	22	D	32	D
3	C	13	C	23	C	33	A
4	A	14	C	24	B	34	B
5	C	15	B	25	B	35	A
6	A	16	D	26	C		
7	A	17	C	27	D		
8	C	18	D	28	C		
9	D	19	B	29	A		
10	B	20	C	30	C		

ANSWERS EXPLAINED

Q.1 (D) **It is not applicable to stoichiometric calculation** because in the assumptions of **stoichiometric calculations,** the **whole amount** of **reactant** is converted into **product** but in case of **reversible** reaction the **whole amount** of reactant **does not** convert into **product.**

Q.2 (B) **At equilibrium the amount of reactant ≠ amount of product. However at equilibrium the rate of forward reaction = rate of reverse reaction.**

Q.3 (C) In reaction **A + B → AB**

Rate of forward reaction = k[A][B]

According to condition if concentration of **A** and **B** are **doubled,** then rate of forward reaction will increases four times as shown below.

Rate of forward reaction

= k[A][B] = k [2][2] = 4k

Q.4 (A) The numerical value of K_c and K_p for a reaction changes with change of temperature. There are three possibilities.

- **Case # I** If $\Delta H = 0 \rightarrow K_c$ **remains same** at different **temperature**.
- **Case # II** If $\Delta H = + \rightarrow K_c$ **increases** with the **increase** of **temperature**.
- **Case # III** If $\Delta H = - \rightarrow K_c$ **decreases** with the **increase** of **temperature**.

Q.5 (C) **"Le-Chatelier's Principle states that if a stress is applied to system at equilibrium, the system acts in such a way so as to nullify, as far as possible, the effect of that stress.**

Q.6 (A) **Since the number of moles of reactants = number of moles of products, so there is no effect of increase or decrease in pressure in the given reversible reaction.**

Q.7 (A) In this reaction K_c has no unit

$H_2 + I_2 \rightleftharpoons 2HI$

$$\mathbf{K_c} = \frac{[HI]^2}{[H_2][I_2]} = \frac{(moldm^{-3})^2}{(moldm^{-3})(moldm^{-3})} \rightarrow$$

So K_c has no unit.

Q.8 (C) $2SO_2 + O_2 \overset{V_2O_5}{\rightleftharpoons} 2SO_3$

$$\mathbf{K_c} = \frac{[SO^3]^2}{[SO^2]^2[O^2]}$$

$$= \frac{(moldm^{-3})^2}{(moldm^{-3})^2(moldm^{-3})} = dm^3 mol^{-1}$$

Q.9 (D) $MgCO_{3(s)} \rightleftharpoons MgO_{(s)} + CO_{2(g)}$

In this reaction heterogeneous equilibrium is established because **reactant** and **products** are **not** in the **same phase**.

Q.10 (B) **$\Delta H = 0$** then the value of **K_c** is constant, independent of temperature i.e the value of K_c neither **increases** nor **decreases**.

Q.11 (A) **The pKa values of acids HI, $HClO_3$, HNO_3 and H_2SO_4 are -10, -1.0, -1.3 and -3.0 respectively. Smaller** is **pK_a** value **stronger** is the **acid** so **HI** is **stronger acid than that of $HClO_3$, HNO_3 and H_2SO_4.**

Q.12 (D) The elements of IA group form the **strongest bases i.e NaOH, KOH, CsOH etc.**

Q.13 (C) **In fact greater is pKa value, weaker is the acid, as already explained in Q#11.**

Q.14 (C) Acidic buffer solution is prepared by **mixing weak acid** and salt of it with strong base. So **HCl + NaCl cannot** form acidic buffer solution because **HCl** is **strong acid** and it **does not** fulfill the condition of acidic buffer solution.

Q.15 (B) **As we know that** $K_a.K_b = 10^{-14}$

$K_a = 10^{-6}$ $K_b \times 10^{-6} = 10^{-14}$

$$K_b = \frac{10^{-14}}{10^{-6}}$$

$$K_b = 10^{-14+6}$$

$$\therefore K_b = 10^{-8}$$

Q.16 (D) The **equilibrium constant** for a reversible reaction indicates the extent of a reaction. It gives no information about the rate of reaction. K_c tells us how far, but not how fast the reaction goes. In fact, **the extent and the rate of a reaction are quite independent.**

Q.17 (C) In fact, **K_{sp}** concept is valid only for saturated solutions in which the total concentration of ions is no more than about 0.01 $moldm^{-3}$. This means that it is quite inappropriate to use the **solubility product** concept for **soluble compounds** such as **NaCl, $CuSO_4$ etc. It is applicable for sparingly soluble salts.**

Q.18 (D) A catalyst provides an alternative route for a reaction to take place with a **lower activation energy,** so that the **speed** of the **reaction increases**.

Q.19 (B) **$pH = -\log(10^{-7}) = 7$, … i**

$pK_w = -\log(10^{-14}) = 14$, … ii

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$K_a = \frac{[H^+][OH^-]}{[H_2O]} \Rightarrow [H_2O]K_a = [H^+][OH^-] = K_w$$

$$\therefore K_a = \frac{K_w}{[H_2O]} \quad \text{… iii}$$

$$-\log K_a = -\log K_w + \log[H_2O],$$

$$pK_a = pK_w + \log\frac{1000}{18}$$

where $\log\frac{1000}{18} = \log 55.5 = 1.74$ **...iv**

$\therefore pKa$ **=14 + 1.74 = 15.74** **...v**

Option	Smallest	Larger	Largest
B	pH	pK_w	pK_a
	7	14	15.74

Conclusion in case (B) the values of pH, pK_w and pK_a increase respectively.

Q.20 (C) **In is not optimum condition in order to get maximum yield of ammonia. In the given reaction as shown below:**

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

$\Delta H = -92$ kJ

$\Delta H = -46$ kJ mol^{-1}

Since the forward reaction is exothermic, the temperature should be kept low (400°C), so that reaction should remain in the forward direction.

- **Other optimum condition:**

i. **High pressure (200 – 300 atm):** With increase in pressure reaction moves in the forward direction

ii. **Continuous withdrawal** of **ammonia**

As a result, continuous withdrawal of ammonia the reaction moves in the forward direction because concentration of product decreases continuously. That is why reaction continuously moves in the forward direction.

iii. Use of **catalyst Fe** along with promoters **(MgO, Al_2O_3, SiO_2)** speeds up the reaction.

Q.21 (A) Henderson's equation for acidic buffer solution is $pH=pK_a+\log\frac{[Salt]}{[Acid]}$

Other options B, C and D are incorrect.

Q.22 (D) pH = Ka is incorrect option. All the other options A, B and C are correct because they fulfill the conditions of Henderson's equation for acidic buffer solution.

Q.23 (C) For common ion effect only the term electrolyte is used because for common ion effect that substance is taken which must be ionized in the solution. There are many acids and bases which do not dissociate into ions. So they cannot be treated as electrolytes.

Q.24 (B)

$$C_2H_5OH + CH_3COOH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

$$2\text{moles} \quad 2\text{moles} \rightleftharpoons 0\text{mole} \quad 0\text{mole}$$

$$2-x \quad 2-x \quad x\text{mole} \quad x\text{mole}$$

Eq. molar conc. $\frac{2-x}{v} \quad \frac{2-x}{v} \quad \frac{x}{v} \quad \frac{x}{v}$

$$K_c = \frac{[CH_3COOC_2H_3][H_2O]}{[CH_3COOH][C_2H_5OH]}$$

$$K_c = \frac{\frac{x}{v}\cdot\frac{x}{v}}{\frac{(2-x)}{V}\cdot\frac{(2-x)}{V}} = \frac{x^2}{(2-x)^2}$$

$$4 = \frac{x^2}{(2-x)^2}$$

$$= \frac{x^2}{(2-x)^2} = 4 \text{ ... (i)}$$

By taking under root on both side in equation (i) we get

$$\frac{x}{2-x} = 2$$

$$x = 4 - 2x$$

$$x = 2(2-x)$$

$$x + 2x = 4$$

$$3x = 4$$

$$x = \frac{4}{3} = 1.33\text{moles}$$

Q.25 (B) Given data pKa = 4.7,

$[CH_3COOH]$ = 0.01moldm^{-3}

$[CH_3COONa]$ = 0.1 moldm^{-3}

$$pH = pKa + \log\frac{[Salt]}{[Acid]}$$

$$pH = pKa + \log\frac{[CH_3COONa]}{[CH_3COOH]}$$

$$pH = pKa + \log\frac{[0.1]}{[0.01]}$$

$$pH = 4.7 + \log \frac{[0.1]}{[0.01]}$$

$$pH = 4.7 + 1 \quad = 5.7$$

Q.26 (C) **It is incorrect statement. In fact, when temperature is increased at equilibrium then reaction always moves towards endothermic side.**

Q.27 (D) **Statements I, II and III are correct as given in the question.**

Q.28 (C) **pH + pOH = 14**

pOH = 14 – pH

= 14 – 10

= 4

Q.29 (A) **Greater is the K_a value, stronger is the acid.**

Q.30 (C) **Na_2SO_4** is a **neutral salt** and it **cannot be** hydrolyzed. Such salt which are formed by strong acids and strong bases are not hydrolyzed because their conjugates are weak in nature.

Q.31 (D) **$FeCl_3$** is **acidic salt** because it is **formed by neutralization** of **strong acid HCl** and weak base **$Fe(OH)_3$.**

Q.32 (D) **PCl_3** is **Lewis base** because it acts as electron pair donor.

Q.33 (A) **The strength of anions as base can alternatively be expressed in terms of electronegativity of anion. More is the electronegativity of atom carrying negative charge, more will be its basic nature i.e. order of decreasing basic strength of halide ions is as follow:**

- **$F^- > Cl^- > Br^- > I^-$**
- **$NH_2^- > OH^- > SH^-$**

Q.34 (B) **In fact, $K_3[Fe(CN)_6]$** is used as an **external indicator** while **$KMnO_4$** is used as an **internal indicator.**

Q.35 (A) **Phenolphthalein** is used as **an indicator** in such acid base titration **in when strong** base is taken such as **NaOH, KOH etc.**

STEP

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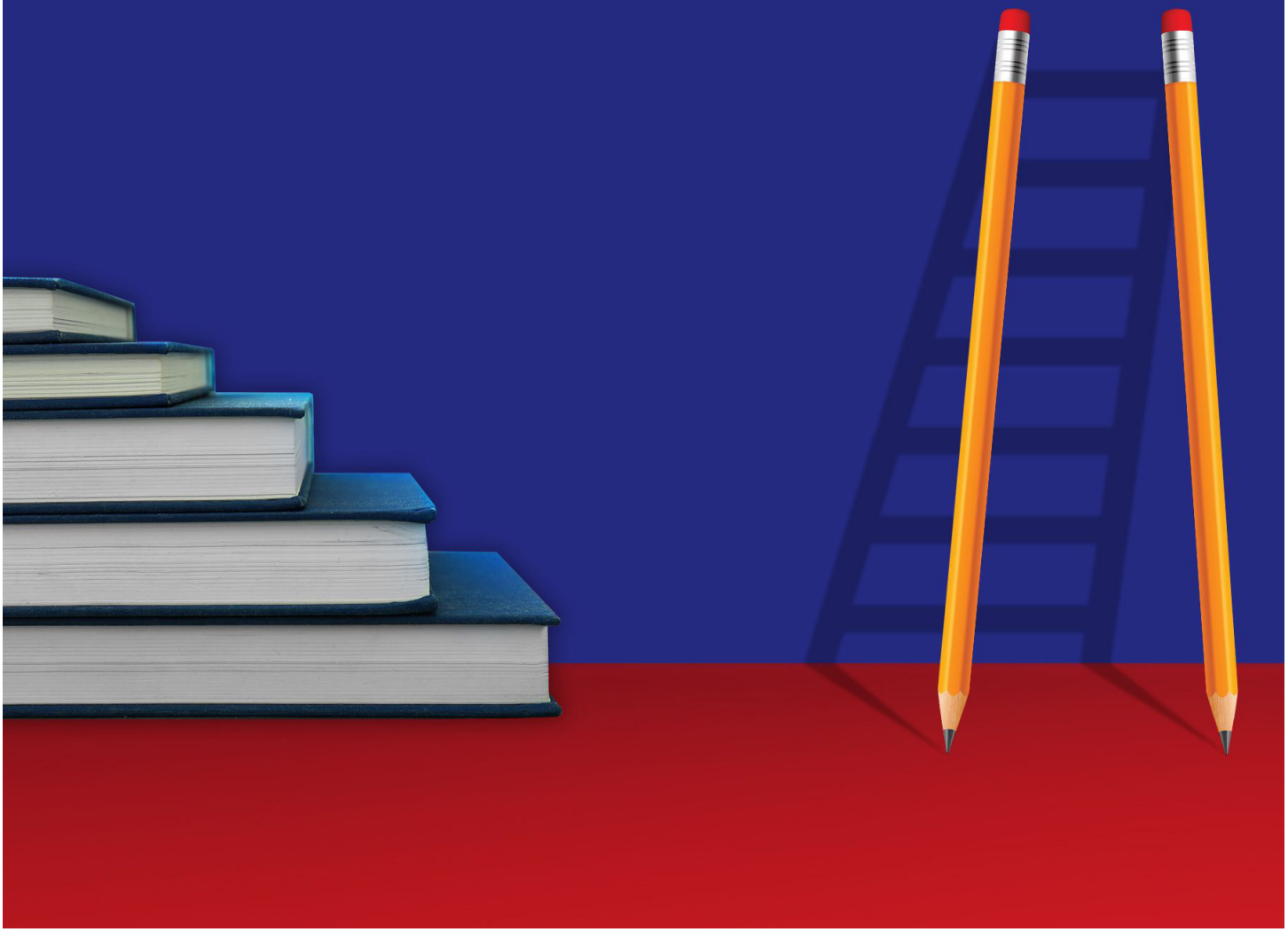

CHEMISTRY

WORKSHEET-18

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-18

(A. Physical Chemistry)

Reaction Kinetics

USE THIS SPACE FOR SCRATCH WORK

Q.1 **The change in concentration of reactants or products per unit time is called rate of reaction. The rate of reaction:**

A) Increases as the reaction proceeds

B) Decreases as the reaction proceeds

C) Remains the same as the reaction proceeds

D) May decrease or increase as the reaction proceeds

Q.2 **With the increase of 10°C temperature, the rate of reaction doubles. This increase in rate of reaction is due to:**

A) Decrease in activation energy of reaction

B) Decrease in the number of collision between molecules of reactants

C) Increase in activation energy of molecules of reactants

D) Increase in number of effective collision

Q.3 **The minimum amount of energy required for an effective collision is called activation energy. Which one of the following statements is incorrect about activation energy?**

Ea = Activation energy K = Specific rate constant

A) Ea of exothermic reaction in the forward reaction is less than that of backward reaction

B) Ea of endothermic reaction in the forward direction is greater than that of reverse reaction

C) Ea is directly proportional to k

D) Ea is independent of temperature

Q.4 **Order of reaction is the number of reacting molecules whose concentration alters as a result of chemical change. For which order of reaction, the unit of rate constant (k) is the same as that of rate of reaction?**

A) 1^{st} order reaction C) 2^{nd} order reaction

B) Zero order reaction D) 3^{rd} order reaction

Q.5 **Which of the following statements about order of reaction is incorrect?**

A) It determines mechanism of reaction

B) It is determined experimentally

C) It is associated with rate equation

D) It is always equal to molecularity

Q.6 **In which of the following order of reaction, the half-life is independent of initial concentration?**

A) Zero order C) 1st order

B) 2nd order D) 3rd order

Q.7 **All of the following factors affect rate of reaction EXCEPT:**

A) Concentration of reactants C) Catalyst

B) Molecularity D) Temperature

Q.8 **The addition of catalyst to a reaction can.**

A) Change the enthalpy

B) Change the entropy

C) Change the nature of products

D) Change the activation energy

Q.9 **The experimental relationship between rate of reaction and concentration of reactant is called:**

A) Rate Law C) Hess's Law

B) Law of mass action D) Le-Chateliar's principle

Q.10 **The specific rate constant is equal to rate of reaction when concentration of reactants are taken as unity. Which of the following factors affects specific rate constant?**

A) Concentration of reactants C) Temperature

B) Pressure D) Surface area

Q.11 **A reaction in which catalyst is used is called catalysis. Which of the following is an example of heterogeneous catalysis?**

A) $2SO_2 + O_2 \overset{V_2O_5}{\rightleftharpoons} 2SO_3$

B) $CH_3COOH + C_2H_5OH \overset{H^+}{\rightleftharpoons} CH_3COOC_2H_5 + H_2O$

C) $SO_2 + O_2 \overset{NO}{\rightleftharpoons} 2SO_3$

D) Both B and C

USE THIS SPACE FOR SCRATCH WORK

Q.12 **Half life cycle of an order of reaction is inversely proportional to initial concentration raised to the power one less than order of reaction. For which of the following half-life of an order of reaction is inversely proportional to the initial concentration of reactants?**

A) Zero order
C) 2^{nd} order
B) 1^{st} order
D) 3^{rd} order

Q.13 **If the reaction $P + Q \longrightarrow R + S$ is described as being of zero order w.r.t to P. It means that:**

A) P is a catalyst in this reaction
B) P molecules do not possess sufficient energy to react
C) The rate of reaction is independent of conc. of Q
D) The rate of reaction is independent of conc. of P

Q.14 **The hydrolysis of $(CH_3)_3CCl$ by OH^- ion proceed in two steps:**

$$R = (CH_3)_3C -$$

$$R - Cl \overset{\text{Slow}}{\rightleftharpoons} R^+ + Cl^-$$

$$R^+ + OH^- \overset{\text{Fast}}{\rightleftharpoons} R - OH$$

Which of the following rate equation is consistent with this mechanism of reaction?

A) rate = $k[RCl]^2$
C) rate = $k[RCl]\ [OH^{-1}]$
B) rate = $k\ [RCl]\ [OH^-]^2$
D) rate = $k\ [RCl]$

Q.15 **Which one of the following correctly represents the units of the rate constant k for a first order reaction?**

A) s^{-1}
C) mol $dm^{-3}s$
B) $mol.dm^{-3}s^{-1}$
D) $mol^{-1}dm^3s$

Q.16 **If rate of reaction decay of a radioactive isotope decreases from 200 counts per minutes to 25 counts per minute after 24 hours. What is half life?**

A) 3 hours
C) 4 hours
B) 6 hours
D) 8 hours

Q.17 **Consider the general reaction $nA \longrightarrow$ Product. The rate of equation for a reaction is given by rate of reaction = $k\ [A]^n$. If the value of n = 2. Then the unit of k for the 2^{nd} order of reaction is:**

A) mol $dm^{-3}s^{-1}$
C) $mol^{-1}dm^3s^{-1}$
B) $mol^{-2}dm^6s^{-1}$
D) $mol^{-1}s^{-1}$

USE THIS SPACE FOR SCRATCH WORK

Q.18 **For the gaseous reaction $2X + Y \rightarrow X$.**

$$\text{rate} = k[X]^2[Y]^0$$

If the pressure in the reaction vessel is doubled but temperature remains constant. By what factor does the rate of reaction increases?

A) 2 C) 3

B) 8 D) 4

Q.19 **A radioactive element has two isotopes, "G" and "H", with half lives of 5 min and 15 min respectively. An experiment starts with 4 times as many atoms of "G" as of "H". Radioactive decay is a first order reaction. How long will it be before the number of atoms of "G" left equal the number of atoms of "H" left?**

A) 5 min C) 15 min

B) 10 min D) 20 min

Q.20 **The half-life of any order of reaction is inversely proportional to the initial concentration. (a) raised to the power one less than the order of reaction:**

$$\left(t_{1/2}\right)_n \propto \frac{1}{a^{n-1}}$$

Which of the following mathematical expression is true for the half-life period of zero order reaction?

A) $\left(t_{1/2}\right)_0 \propto a^o$ C) $\left(t_{1/2}\right)_3 \propto \frac{1}{a^3}$

B) $\left(t_{1/2}\right)_2 \propto \frac{1}{a^1}$ D) $\left(t_{1/2}\right)_1 \propto \frac{1}{a^2}$

Q.21 **All of the following are characteristic features of catalyst EXCEPT:**

A) It speeds up a chemical reaction

B) It is used in smaller amount

C) It can initiate a chemical reaction

D) Enthalpy change of a catalyzed and uncatalyzed reaction is not same

Q.22 **In some of the reactions, a product formed acts as a catalyst, this phenomenon is called:**

A) Autocatalysis C) Negative catalysis

B) Enzyme Catalysis D) Poisoning of a catalyst

USE THIS SPACE FOR SCRATCH WORK

Q.23 Identify the incorrect statement about enzyme catalysis:

A) It is highly specific in action

B) Its activity is increased by the presence of activator

C) It shows maximum rate of reaction at minimum temperature

D) Its catalytic activity is inhibited by a poison

Q.24 A solution A of concentration 0.10 mol dm^{-3} undergoes first order reaction at an initial rate of 5.0 x 10^{-4} mol dm^{-3} s^{-1}. The value of rate constant for this reaction is:

A) 2 x 10^{-3} s^{-1} C) 4 x 10^{-3} s^{-1}

B) 3 x 10^{-3} s^{-1} D) 5x 10^{-3} s^{-1}

Q.25 Which of the following is an example of first order reaction?

A) $2N_2O_{5(g)} \longrightarrow 2N_2O_{4(g)} + O_{2(g)}$

B) $2FeCl_{3(aq)} + 6KI_{(aq)} \longrightarrow 2FeI_{2(aq)} + 6KCl_{(aq)}$

C) $NO_{(g)} + O_{3(g)} \longrightarrow NO_{2(g)} + O_{2(g)}$

D) $CHCl_{3(\ell)} + Cl_{2(g)} \longrightarrow CCl_{4(\ell)} + HCl_{(g)}$

Q.26 The reaction which takes place among the molecules when they have:

A) Activation energy

B) Properly oriented

C) Activation energy and proper orientation

D) Concentrated

Q.27 All of the following statements are correct for rate of reaction and specific rate constant EXCEPT:

Opt.	Rate of reaction	Specific rate constant
A)	Change in concentration of reactant or product per unit time is called rate of reaction	It is equal to rate of reaction when molar concentration of reactants are taken as unity
B)	Rate = $\frac{\Delta C}{\Delta t}$	k = proportionality constant
C)	Its unit is mol dm^{-3} s^{-2}	Its unit does not depend on order of reaction
D)	Its value changes with the passage of time	Its value remains constant under given conditions

USE THIS SPACE FOR SCRATCH WORK

USE THIS SPACE FOR SCRATCH WORK

Q.28 Mark the incorrect statement about molecularity and order of reaction:

Opt.	Molecularity	Order of reaction
A)	It is number of molecules involved in the balanced equation	It is sum of exponents of molar concentration of reactants as given in the rate equation
B)	It is theoretical value	It is experimental value
C)	Molecularity is ≥ 3	Order of reaction can be 1, 2 or 3
D)	It can have zero value	It cannot have small integral, half integral and zero value

Q.29 Choose the type of catalysis in the following reaction:

$$2SO_{2(g)} + O_{2(g)} \overset{NO_{(g)}}{\rightleftharpoons} 2SO_{3(g)}$$

A) Homogeneous catalysis C) Biological catalysis

B) Heterogeneous catalysis D) Gas catalysis

Q.30 Which of the following physical methods is used to determine rate of reaction when rate of reaction depends on the rate of change in the concentration of reacting ions or ions are formed during the reaction?

A) Electrical conductivity method

B) Dilatometeric method

C) Refractrometric method

D) Optical rotation method

ANSWER KEY (Worksheet-18)					
1	B	11	A	21	D
2	D	12	C	22	A
3	C	13	D	23	C
4	B	14	D	24	D
5	D	15	A	25	A
6	C	16	D	26	C
7	B	17	C	27	C
8	D	18	D	28	D
9	A	19	C	29	A
10	C	20	A	30	A

ANSWERS EXPLAINED

Q.1 (B) The frequency with which the molecules collide depends upon their concentrations of reactants. The more crowded the molecules are, the more likely they are to collide and react with one another. So as the reaction proceeds collision frequency of the molecules decreases, and thus the rate of reaction decreases.

Q.2 (D) **It can be explained by Collision Theory such as:** For a reaction to take place, the colliding particles must have energy equal to or greater than E_a. since there are more particles with energy greater than E_a with the increase of 10°C, the frequency of effective collisions with sufficient energy also increases. Hence, the rate of reaction doubles (Arrhenius equation $k = Ae^{-Ea/RT}$ proves it) with the increase of 10°C temperature.

Q.3 (C) In fact, Ea is inversely proportional to K.

- **Smaller is Ea value, greater is K value, faster is the rate of reaction.**

Q.4 (B) For general reaction nA $\longrightarrow$ Product $\therefore$ rate of reaction = $k\,[A]^n$. For zero order reaction [A] = 1, n = 0.

Rate of reaction = k $\therefore$ k = rate of reaction = $moldm^3s^{-1}$

Conclusion: For zero order reaction unit of k = rate of reaction= $moldm^3s^{-1}$

Q.5 (D) Order of reaction may or may **not equal** to **molecularity.**

Q.6 (C) $\left(t_{1/2}\right)_n \propto \frac{1}{a^{n-1}}$

$\Rightarrow$ **For 1st order reaction n = 1**

- $\left(t_{1/2}\right)1 \propto \frac{1}{a^{1-1}} \Rightarrow \left(t_{1/2}\right) \propto \frac{1}{a^o} \Rightarrow$

independent of initial concentration

Q.7 (B) Molecularity is associated with balanced equation but it has no concern with rate of reaction.

Q.8 (D) Addition of catalyst decreases Ea by changing mechanism of reaction.

Q.9 (A) The experimental relationship between rate of reaction and concentration of reactant is **called rate law.**

Q.10 (C) The only factor which affects the value of specific rate constant is **temperature.**

Q.11 (A) In **heterogeneous** catalysis reactant and catalyst are **not** in the **same phase** as shown in the reaction.

$$2SO_{2(g)} + O_{2(g)} \overset{V_2SO_{5(s)}}{\rightleftharpoons} 2SO_{3(g)}$$

Q.12 (C) $\left(t_{1/2}\right)_2 \propto \frac{1}{a^{2-1}} \Rightarrow \left(t_{1/2}\right)_2 \propto \frac{1}{a^1}$

$\therefore$ **Half-life of second order reaction is inversely proportional to initial concentration for second order reaction.**

Q.13 (D) **Zero order** with respect to a reactant **means** that the rate of reaction is **independent** of the concentration of the reactant **i.e.** a change in concentration of **P** has **no effect** on the rate of the reaction.

Q.14 (D) Since rate of reaction is always determined from the **slow step,** and in the given reaction only **one molecule RCl** takes part. It **means** that rate of

reaction **depends** on concentration of **RCl only.**

Q.15 (A) For general reaction nA $\longrightarrow$ Product A rate of reaction = k $[A]^1$. For 1st order reaction

n = 1, rate of reaction = kA

$$\therefore k = \frac{\text{rate of reaction}}{[A]}$$

$$= \frac{\text{moldm}^{-3}\text{s}^{-1}}{\text{moldm}^{-3}} = \text{s}^{-1}$$

$\therefore$ unit of k for first order reaction = s^{-1}

Q.16 (D) $200 \xrightarrow{t_{1/2}} 100 \xrightarrow{t_{1/2}} 50 \xrightarrow{t_{1/2}} 25$

Hence, $3 \times t_{1/2} = 24$

$t_{1/2} = 8$ hrs

Conclusion the half-life of decay of a radioactive isotope = 8 hrs

Q.17 (C) For general reaction nA $\longrightarrow$ Product $\therefore$ rate of reaction = k $[A]^n$. For 2nd order reaction

n = 2, k = $dm^3mol^{-1}s^{-1}$.

Q.18 (D) When the pressure is doubled **(e.g. by having the volume), [X] and [Y] are doubled.** Since the reaction is second order with respect to **X,** therefore, the rate increases by **4 times.**

Q.19 (C) Let the number of atoms in G and H be 4X and X respectively.

Solution:

$$G: 4X \xrightarrow{5\text{min}} 2X \xrightarrow{5\text{min}} X \xrightarrow{5\text{min}} \frac{1}{2}X$$

$$H: \text{X} \xrightarrow{15\text{min}} \frac{1}{2}X$$

Q.20 (A) Mathematical expression for the half-life period of zero order reaction is $\left(t_{1/2}\right)_0 \propto a$.

Q.21 (D) In fact, enthalpy change of a catalyzed and uncatalyzed reaction is same.

Q.22 (A) In some of the reactions, a product formed acts as a catalyst, this phenomenon is **called autocatalysis. e.g. the reaction of oxalic acid with acidified $KMnO_4$ is slow at the beginning, but after sometimes, $MnSO_4$ produced in the reaction makes it faster, so the product $MnSO_4$ act as a autocatalysis.**

Q.23 (C) It shows maximum rates of reaction at an **optimum** temperature.

Q.24 (D) Solution:

Given data:

Initial rate of reaction = 5×10^{-4} mol dm^{-3} s^{-1}

Concentration of A substance = 0.10 mol dm^{-3}

Initial rate = k[A] =

$$k = \frac{\text{Rate of reaction}}{A} = \frac{5 \times 10^{-4}}{0.10}$$

$$= 5 \times 10^{-3}\ \text{s}^{-1}$$

Q.25 (A) $2N_2O_{5(g)} \longrightarrow 2N_2O_{4(g)} + O_{2(g)}$ **is an example of first order reaction.**

Q.26 (C) The reaction takes place among the molecules of reactants when they have required activation energy and proper orientation.

Q.27 (C) It is incorrect statement. In fact, the correct statement is given in the tabular form:

C)	**Its unit is mol^1 dm^{-3} s^{-1}**	**Its unit depends on order of reaction**

Q.28 (D) It is incorrect statement. In fact, the correct statement is given in the tabular form:

Opt.	Molecularity	Order of reaction
D)	**It cannot have zero value**	**It cannot have integral fractional and zero value**

Q.29 (A) A type of reaction in which reactants and catalyst are in the same phase is called homogenous catalysis. The reaction below is an example of homogenous catalysis.

$$2SO_{2(g)} + O_{2(g)} \overset{NO_{(g)}}{\rightleftharpoons} 2SO_{3(g)}$$

Q.30 (A) **Electrical conductivity is a** physical method which is used to determine rate of reaction when rate of reaction depends on the rate of change in the concentration of reacting ions or ions are formed during the reaction.

STEP

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