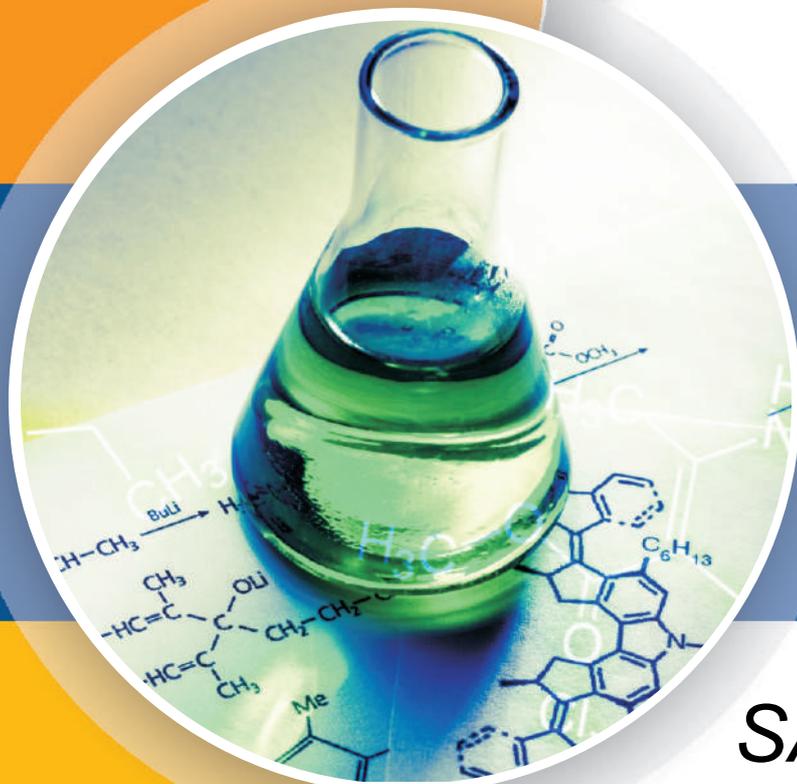




**MDS**  
**SR. SEC. SCHOOL**



# **SAMPLE PAPER CHEMISTRY**

*For Annual Exam  
Class - XI*

### SECTION A

1. What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?(molar mass of NaCl=58.5g/mol)

(a)  $0.1 \text{ mol L}^{-1}$     (b)  $10 \text{ mol L}^{-1}$     (c\*)  $0.2 \text{ mol L}^{-1}$     (d)  $1 \text{ mol L}^{-1}$

1. Molarity,  $M = \text{number of moles/volume of solution}$

$$M = n/v$$

Number of moles,  $n = \text{mass/molar mass}$

Molar mass of NaCl = 58.5 g/mol

Mass = 5.85g

$$n = 5.85/58.5 = 0.1 \text{ mol}$$

Volume,  $V = 500 \text{ mL} = 0.5 \text{ L}$

$$\therefore M = 0.1/0.5 = 0.2 \text{ mol/L}$$

Hence, option C is correct.

2. If the mass of a liquid substance is 31.2 g and it occupies 20 mL volume, then density of the substance is \_\_\_\_\_ (in  $\text{g mL}^{-1}$ )

(a) 1.75            (b)  $4680 \times 10^{-3}$     (c) 1.680            (d\*) 1.56

3. The magnetic quantum number specifies

(a) Size of orbitals            (b) Shape of orbitals            (c\*) Orientation of orbitals (d) Nuclear Stability

4. The total number of electrons that can be accommodated in all orbitals having principal quantum number 2 and azimuthal quantum number 1 is

(a) 2            (b) 4            (c\*) 6            (d) 8

5. Which one has minimum value of ionisation energy?

(a) Halogens    (b) Inert gases    (c) Alkaline earth metals    (d\*) Alkali metals

6. Which molecule is paramagnetic?

(a)  $\text{N}_2$             (b\*)  $\text{O}_2$             (c)  $\text{F}_2$             (d)  $\text{H}_2$

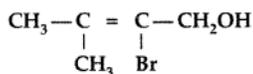
7. Which of the hybridization has highest percentage of s-character?

(a\*)  $sp$             (b)  $sp^2$             (c)  $sp^3$             (d) None of these

8. Which of the following is not a cyclic compound?

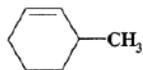
(a) Anthracene    (b) Pyrrole            (c) Phenol            (d\*) Neopentane

9. Give the IUPAC name of the following compound :



(a\*) 2-Bromo-3-methyl-but-2-ene-1-ol            (b) 3-Bromo-2-methyl-but-2-ene-4-ol  
(c) 3-Bromo-3-methyl-but-2-ene-1-ol            (d) 2-Bromo-2-methyl-but-2-ene-1-ol

10. The I.U.P.A.C. name of



(a\*) 3-Methyl cyclohexene            (b) 1-methyl cyclohex-2-ene.  
(c) 6-methyl cyclohexene            (d) 1-methyl cyclohex-5-ene.

11. 2-chloropropane and 1-chloropropane exhibit which isomerism.

a) chain            b\*) position            c) functional            d) metamerism

12.  $\text{ZnCO}_3(\text{s}) \rightleftharpoons \text{ZnO}(\text{s}) + \text{CO}_2(\text{g})$  Expression of the partial pressure of the above reaction, ( $K_p$ ) is

(a)  $K_p = [\text{ZnO}][\text{CO}_2] / [\text{ZnCO}_3]$  (b)  $K_p = [\text{ZnO}]p[\text{CO}_2] / p[\text{ZnCO}_3]$  (c)  $K_p = p^2(\text{ZnO}) p(\text{CO}_2)$             (d\*)  $K_p = p_{\text{CO}_2}$

13.

What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?

- (a)  $4 \text{ mol L}^{-1}$       (b)  $20 \text{ mol L}^{-1}$       (c)  $0.2 \text{ mol L}^{-1}$       (d)  $2 \text{ mol L}^{-1}$

**Ans. (c)** Since, molarity ( $M$ ) is calculated by following equation

$$\begin{aligned} \text{Molarity} &= \frac{\text{weight} \times 1000}{\text{molecular weight} \times \text{volume (mL)}} \\ &= \frac{5.85 \times 1000}{58.5 \times 500} = 0.2 \text{ mol L}^{-1} \end{aligned}$$

**Note** Molarity of solution depends upon temperature because volume of a solution is temperature dependent.

14.

Consider the isoelectronic species,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{F}^-$  and  $\text{O}^{2-}$ . The correct order of increasing length of their radii is

- (a)  $\text{F}^- < \text{O}^{2-} < \text{Mg}^{2+} < \text{Na}^+$       (b)  $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$   
(c)  $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$       (d)  $\text{O}^{2-} < \text{F}^- < \text{Mg}^{2+} < \text{Na}^+$

**Ans. (b)** In case of isoelectronic species ionic radii  $\propto \frac{1}{\text{atomic number}}$

The ionic radii increases as the positive charge decreases or the negative charge increases.

<b>Ion</b>	$\text{Mg}^{2+}$	$< \text{Na}^+$	$< \text{F}^-$	$< \text{O}^{2-}$
<b>Atomic number</b>	(12)	(11)	(9)	(8)

15.

Which of the following is not an actinoid?

- (a) Curium ( $Z = 96$ )      (b) Californium ( $Z = 98$ )  
(c) Uranium ( $Z = 92$ )      (d) Terbium ( $Z = 65$ )

**Ans. (d)** Elements with atomic number,  $Z = 90$  to  $103$  are called actinoids. Thus, terbium ( $Z = 65$ ) is not an actinoid. Terbium belong to lanthanoids.

16.

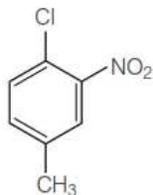
The IUPAC name for  $\text{CH}_3 - \overset{\text{C}}{\parallel} - \text{CH}_2 - \text{CH}_2 - \overset{\text{C}}{\parallel} - \text{OH}$  is

- (a) 1-hydroxypentane-1,4-dione  
(b) 1,4-dioxopentanol  
(c) 1-carboxybutan-3-one  
(d) 4-oxopentanoic acid

**Ans. (d)** When more than one functional group lie in the main chain, nomenclature is done according to that functional group which has higher priority.  
Carboxylic acid ( $-\text{COOH}$ ) has more priority than ketone ( $>\text{C} = \text{O}$ )

17.

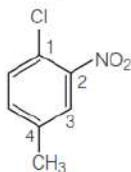
The IUPAC name for



- (a) 1-chloro-2-nitro-4-methylbenzene
- (b) 1-chloro-4-methyl-2-nitrobenzene
- (c) 2-chloro-1-nitro-5-methylbenzene
- (d) *m*-nitro-*p*-chlorotoluene

**Ans. (b)** For tri or higher substituted benzene derivatives, the compounds are named by identifying substituent, positions on the ring by following the lowest locant rule.

Substituent of the base compound is assigned number 1 and then the direction of numbering is chosen such that the next substituent gets the lowest number. The substituents appear in the name in alphabetical order.



18.

Choose the correct order of atomic radii of fluorine and neon (in pm) out of the options given below and justify your answer.

- (a) 72, 160
- (b) 160, 160
- (c) 72, 72
- (d) 160, 72

**Ans. (a)** Atomic radius of F is expressed in terms of covalent radius while, atomic radius of neon is usually expressed in terms of van der Waals' radius. van der Waals' radius of an element is always larger than its covalent radius.

Therefore, atomic radius of F is smaller than atomic radius of Ne (F = 72pm, Ne = 160pm).

19.

In  $\text{PO}_4^{3-}$  ion the formal charge on the oxygen atom of P—O bond is

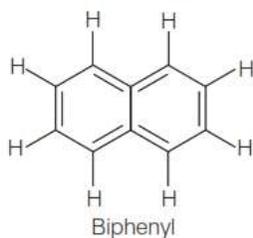
- (a) +1
- (b) -1
- (c) -0.75
- (d) +0.75

**Ans. (c)** In  $\text{PO}_4^{3-}$  ion, formal charge on each O-atom of P—O bond

$$= \frac{\text{total charge}}{\text{Number of O-atom}} = -\frac{3}{4} = -0.75$$

20.

Number of  $\pi$  bonds and  $\sigma$  bonds in the following structure is



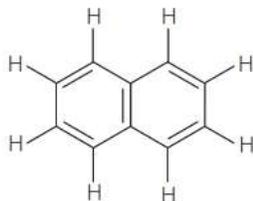
(a) 6, 19

(b) 4, 20

(c) 5, 19

(d) 5, 20

**Ans. (c)** The given compound will have the correct structure as



There are 5  $\pi$ -bonds and  $8\text{C}-\text{H} + 11\text{C}-\text{C}$   $\sigma$ -bonds, i.e., 19  $\sigma$ -bonds are present in the above molecule.

21.

Which of the following angle corresponds to  $sp^2$  hybridisation?

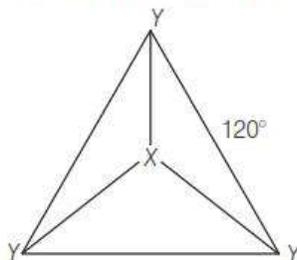
(a)  $90^\circ$

(b)  $120^\circ$

(c)  $180^\circ$

(d)  $109^\circ$

**Ans. (b)** For  $sp^2$  hybridisation, the geometry is generally triangular planar.



Thus, bond angle is  $120^\circ$ .

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion.

(c) Assertion is correct, reason is incorrect.

(d) Assertion is incorrect, reason is correct.

22. **Assertion :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.

**Reason :** The path of an electron in an atom is clearly defined.

**Ans. (c)**

23. **Assertion** : Smaller the size of an atom greater is the electronegativity.

**Reason** : Electronegativity refers to the tendency of atom to share electrons with other atom.

**Ans.** (c)

24. **Assertion** : The bond order of helium is always zero.

**Reason** : The number of electrons in bonding molecular orbital and antibonding molecular orbital is equal.

**Ans.** (a)

25. **Assertion** : The empirical mass of ethene is half of its molecular mass.

**Reason** : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

**Ans.** (a)

26.

**Assertion (A)** Black body is an ideal body that emits and absorbs radiations of all frequencies.

**Reason (R)** The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) Both A and R are false

**Ans. (c)** Assertion is true and reason is false.

A body which absorbs and emits all radiations falling on it is called perfect black body. With rise in temperature, frequency increases.

## SECTION B

27. State law of mass action for a chemical equilibrium.

**Sol.** The law of mass action states that the rate of a reaction is proportional to the product of the concentrations of each reactant.

28. Write correct order of first ionization enthalpy.

- (a) Na, Li, K, Cs, Rb
- (b) Mg, Be, Sr, Ba, Ca

**Sol.** (a)  $\text{Li} < \text{Na} < \text{K} < \text{Rb} < \text{Cs}$

(b)  $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr} < \text{Ba}$

29. Draw formulas for the first five members of each homologous series beginning with the following compounds, (a)  $\text{H}-\text{COOH}$  (b)  $\text{CH}_3\text{COCH}_3$

**Answer:** (a)  $\text{CH}_3-\text{COOH}$

$\text{CH}_3\text{CH}_2-\text{COOH}$   $\text{CH}_3\text{CH}_2\text{CH}_2-\text{COOH}$

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{COOH}$

(b)  $\text{CH}_3\text{COCH}_3$

CH<sub>3</sub>COCH<sub>2</sub>CH<sub>3</sub>  
CH<sub>3</sub>COCH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>  
CH<sub>3</sub>COCH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>  
CH<sub>3</sub>CO(CH<sub>3</sub>)<sub>4</sub>CH<sub>3</sub>

30. Consider the elements: Cs, Ne, I, F

- (a) Identify the element that exhibits -ve oxidation state.
- (b) Identify the element that exhibits +ve oxidation state.
- (c) Identify the element that exhibits both +ve and -ve oxidation states.
- (d) Identify the element which neither exhibits -ve nor +ve oxidation state.

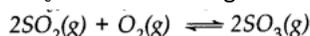
**Answer:** (a) F. Fluorine being the most electronegative element shows only a -ve oxidation state of -1.

(b) Cs. Alkali metals because of the presence of a single electron in the valence shell, exhibit an oxidation state of +1.

(c) I. Because of the presence of seven electrons in the valence shell, I shows an oxidation state of -1 (in compounds of I with more electropositive elements such as H, Na, K, Ca, etc.) or an oxidation state of +1 (in compounds of I with more electronegative elements, i.e., O, F, etc.) and because of the presence of d-orbitals it also exhibits +ve oxidation states of +3, +5 and +7.

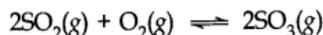
(d) Ne. It is an inert gas (with high ionization enthalpy and high positive electron gain enthalpy) and hence it neither exhibits -ve nor +ve oxidation states.

31. What is K<sub>c</sub> for the following reaction in state of equilibrium?



Given: [SO<sub>2</sub>] = 0.6 M; [O<sub>2</sub>] = 0.82 M; and [SO<sub>3</sub>] = 1.90 M

**Answer:**



$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} = \frac{(1.9 \text{ M}) \times (1.9 \text{ M})}{(0.6 \text{ M}) \times (0.6 \text{ M}) \times (0.82 \text{ M})}$$
$$= 12.229 \text{ M}^{-1} = \mathbf{12.229 \text{ L mol}^{-1}}$$

32.

How many significant figures should be present in the answer of the following calculations?

$$\frac{2.5 \times 1.25 \times 3.5}{2.01}$$

**Ans.** Least precise term 2.5 or 3.5 has two significant figures.

Hence, the answer should have two significant figures

$$\frac{2.5 \times 1.25 \times 3.5}{2.01} \approx 5.4415 = 5.4$$

33.

An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?

**Ans.** An atom having atomic mass number 13 and number of neutrons 7.

$$\begin{aligned} \text{i.e.,} & \quad A = 13, n = 7 \\ \text{As we know that,} & \quad A = n + p \\ \therefore & \quad p = A - n = 13 - 7 = 6 \\ \text{Hence,} & \quad Z = p = 6 \end{aligned}$$

34.

Explain why the electron gain enthalpy of fluorine is less negative than that of chlorine?

**Ans.** Electron gain enthalpy of F is less negative than that of Cl because when an electron is added to F, the added electron goes to the smaller  $n = 2$  quantum level and suffers repulsion from other electrons present in this level. In case of Cl, the added electron goes to the larger  $n = 3$  quantum level and suffers much less repulsion from other electrons.

35.

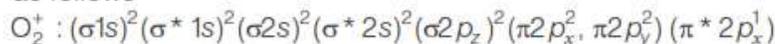
Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionisation enthalpy than nitrogen. Explain.

**Ans.** Electronic configuration of  ${}_{7}\text{N} = 1s^2, 2s^2, 2p_x^1, 2p_y^1, 2p_z^1$ . Nitrogen has stable configuration because  $p$ -orbital is half-filled. Therefore, addition of extra electron to any of the  $p$ -orbital requires energy. Electronic configuration of  ${}_{8}\text{O} = 1s^2, 2s^2, 2p_x^2, 2p_y^1, 2p_z^1$ . Oxygen has  $2p^4$  electrons, so process of adding an electron to the  $p$ -orbital is exothermic. Oxygen has lower ionisation enthalpy than nitrogen because by removing one electron from  $2p$ -orbital, oxygen acquires stable configuration, i.e.,  $2p^3$ . On the other hand, in case of nitrogen it is not easy to remove one of the three  $2p$ -electrons due to its stable configuration.

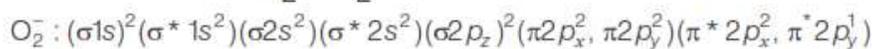
36.

Using molecular orbital theory, compare the bond energy and magnetic character of  $\text{O}_2^+$  and  $\text{O}_2^-$  species.

**Ans.** According to molecular orbital theory electronic configurations of  $\text{O}_2^+$  and  $\text{O}_2^-$  species are as follows



$$\text{Bond order of } \text{O}_2^+ = \frac{10 - 5}{2} = \frac{5}{2} = 2.5$$

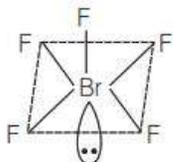


$$\text{Bond order of } \text{O}_2^- = \frac{10 - 7}{2} = \frac{3}{2} = 1.5$$

Higher bond order of  $\text{O}_2^+$  shows that it is more stable than  $\text{O}_2^-$ . Both the species have unpaired electrons. So, both are paramagnetic in nature.

37. Explain the shape of  $\text{BrF}_5$ .

**Ans.** The central atom Br has seven electrons in the valence shell. Five of these will form bonds with five fluorine atoms and the remaining two electrons are present as one lone pair.

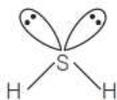


Hence, total pairs of electrons are six (5 bond pairs and 1 lone pair). To minimize repulsion between lone pairs and bond pairs, the shape becomes square pyramidal.

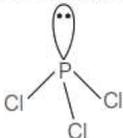
38.

Explain the non-linear shape of  $\text{H}_2\text{S}$  and non-planar shape of  $\text{PCl}_3$  using valence shell electron pair repulsion theory.

**Ans.** Central atom of  $\text{H}_2$  is S. There are 6 electrons in its valence shell ( $_{16}\text{S} = 2, 8, 6$ ). Two electrons are shared with two H-atoms and the remaining four electrons are present as two lone pairs.



Hence, total pairs of electrons are four (2 bond pairs and 2 lone pairs). Due to the presence of 2 lone pairs the shape becomes distorted tetrahedral or angular or bent (non-linear).



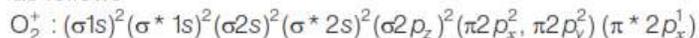
$\text{PCl}_3$ —Central atom is phosphorus. There are 5 electrons in its valence shell ( $_{15}\text{P} = 2, 8, 5$ ). Three electrons are shared with three Cl-atoms and the remaining two electrons are present as one lone pair.

Hence, total pairs of electrons are four (1 lone pair and 3 bond pairs). Due to the presence of one lone pair, the shape becomes pyramidal (non-planar).

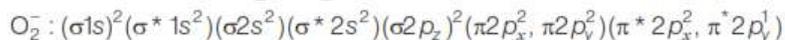
39.

Using molecular orbital theory, compare the bond energy and magnetic character of  $\text{O}_2^+$  and  $\text{O}_2^-$  species.

**Ans.** According to molecular orbital theory electronic configurations of  $\text{O}_2^+$  and  $\text{O}_2^-$  species are as follows



$$\text{Bond order of } \text{O}_2^+ = \frac{10 - 5}{2} = \frac{5}{2} = 2.5$$

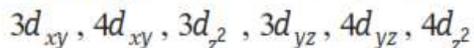


$$\text{Bond order of } \text{O}_2^- = \frac{10 - 7}{2} = \frac{3}{2} = 1.5$$

Higher bond order of  $\text{O}_2^+$  shows that it is more stable than  $\text{O}_2^-$ . Both the species have unpaired electrons. So, both are paramagnetic in nature.

40.

Which of the following orbitals are degenerate?



**Ans.** The orbitals which belong to same subshell and same shell are called degenerate orbitals. ( $3d_{xy}, 3d_{z^2}, 3d_{yz}$ ) and ( $4d_{xy}, 4d_{yz}, 4d_{z^2}$ ) are the two sets of degenerate orbitals.

41.

Which of the following will not show deflection from the path on passing through an electric field?

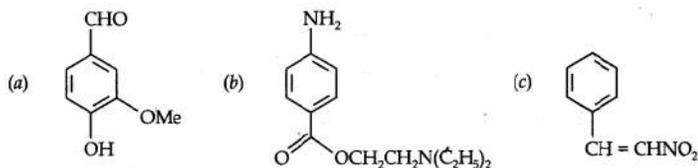
Proton, cathode rays, electron, neutron.

**Ans.** Neutron being neutral will not show deflection from the path on passing through an electric field.

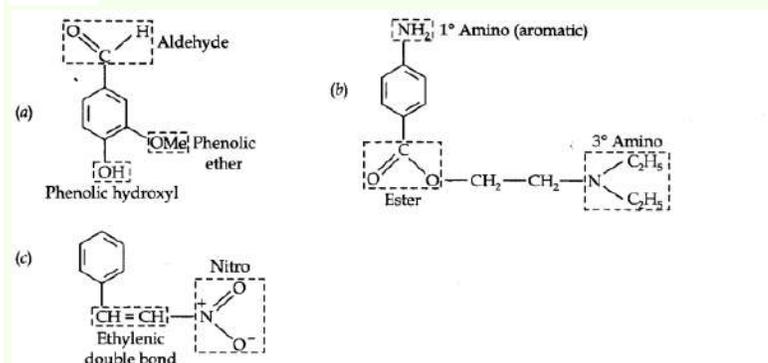
Proton, cathode rays and electron being the charged particle will show deflection from the path on passing through an electric field.

### SECTION C

42. Identify the functional groups in the following compounds:



**Answer:**



43. Write the IUPAC name of compounds :-

- (a)  $\text{CH}_3 - \text{CH}_2 - \text{CH}(\text{CH}_3) - \text{CH}_2 - \text{OH}$   
(b)  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{C}(\text{CH}_3)_2 - \text{COOH}$   
(c)  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_2 - \text{CH}_2 - \text{OH}$

**Ans.** (a) 2-methyl butane-1-ol  
(b) 2,2-dimethyl pentanoic acid  
(c) pent-3-yne-1-ol

44.

The equilibrium constant for the reaction is 10. Calculate the value of  $\Delta G^\ominus$ ; Given

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}; T = 300 \text{ K.}$$

(a)

(b) Discuss the shape of the following molecules using the VSEPR model:



**Answer: (a)**

$$\Delta G^\ominus = -RT \ln K = -2.303 RT \log K.$$

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}; T = 300 \text{ K}; K = 10$$

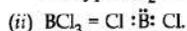
$$\Delta G^\ominus = -2.303 \times 8.314 \text{ JK}^{-1} \text{ mol}^{-1} \times (300 \text{ K}) \times \log 10$$

$$= -5527 \text{ J mol}^{-1} = -5.527 \text{ kJ mol}^{-1}.$$

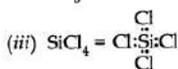
(b)



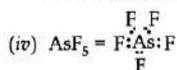
The central atom has only two bond pairs and there is no lone pair, i.e., it is of the type  $\text{AB}_2$ . Hence, shape is **linear**.



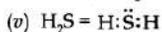
The central atom has only 3 bond pairs and no lone pair, i.e., it is of the type  $\text{AB}_3$ . Hence, shape is **triangular planar**.



Bond pairs = 4, lone pairs = 0, i.e., it is of the type  $\text{AB}_4$ . Hence, shape is **Tetrahedral**.



Bond pairs = 5, lone pairs = 0, i.e., it is of the type  $\text{AB}_5$ . Hence, shape is **Trigonal bipyramidal**.



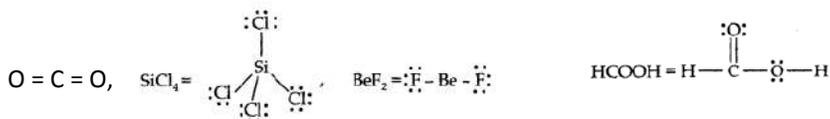
Bond pairs = 2, lone pairs = 2, i.e., it is of the type  $\text{AB}_2\text{L}_2$ . Hence, shape is **Bent/V-shaped**.

45. (i) Explain why cation are smaller and anions larger in radii than their parent atoms?

(ii) Draw the structures for the following molecules and ions:  $\text{CO}_2, \text{SiCl}_4, \text{BeF}_2, \text{HCOOH}$

**Answer: (a)** A cation is smaller than the parent atom because it has fewer electrons while its nuclear charge remains the same. The size of anion will be larger than that of parent atom because the addition of one or more electrons would result in increased repulsion among the electrons and a decrease in effective nuclear charge.

**(b)**



46. State Heisenberg's uncertainty principle. Write its mathematical equation.

**Ans.** Heisenberg's uncertainty principle- It states that the position and momentum of microscopic moving particles cannot be determined simultaneously with accuracy or certainty.

Mathematical expression-

$$\Delta x \times \Delta P > \text{or} = h/4\pi$$

$\Delta x$ = uncertainty in the position

$\Delta P$ = uncertainty in the momentum

$h$  = Planck's constant.

47. Yellow light emitted from a sodium lamp has a wavelength ( $\lambda$ ) of 580 nm. Calculate the frequency ( $\nu$ ) and wave number ( $\bar{\nu}$ ) of yellow light.

**Answer:**

**Step I.** Calculation of frequency of yellow light

We know that  $\nu = \frac{c}{\lambda}$   
 $c = 3 \times 10^8 \text{ m s}^{-1}; \lambda = 580 \text{ nm} = 580 \times 10^{-9} \text{ m}$

$\therefore \nu = \frac{(3 \times 10^8 \text{ ms}^{-1})}{(580 \times 10^{-9} \text{ m})} = 5.17 \times 10^{14} \text{ s}^{-1}$

**Step II.** Calculation of wave number of yellow light

Wave number ( $\bar{\nu}$ ) =  $\frac{1}{\lambda} = \frac{1}{(580 \times 10^{-9} \text{ m})} = 1.724 \times 10^6 \text{ m}^{-1}$ .

48. If 4 g of NaOH dissolves in 36 g of H<sub>2</sub>O, calculate the mole fraction of each component in the solution. Also, determine the molality of solution.

**Sol.** Mole fraction of H<sub>2</sub>O

$$= \frac{\text{No. of moles of H}_2\text{O}}{\text{Total No. of moles (H}_2\text{O} + \text{NaOH)}}$$

$$\text{No. of moles of H}_2\text{O} = \frac{36}{18} = 2 \text{ moles}$$

$$\text{No. of moles of NaOH} = \frac{4}{40} = 0.1 \text{ mol}$$

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Total number of moles = 2 + 0.1 = 2.1

$$\text{Mole fraction of H}_2\text{O} = \frac{2}{2.1} = 0.952$$

$$\text{Mole fraction of NaOH} = \frac{0.1}{2.1} = 0.048$$

Mass of solution

$$= \text{Mass of H}_2\text{O} + \text{Mass of NaOH} = 36 + 4 = 40 \text{ g}$$

49.

Explain why the electron gain enthalpy of fluorine is less negative than that of chlorine?

**Ans.** Electron gain enthalpy of F is less negative than that of Cl because when an electron is added to F, the added electron goes to the smaller  $n = 2$  quantum level and suffers repulsion from other electrons present in this level.

In case of Cl, the added electron goes to the larger  $n = 3$  quantum level and suffers much less repulsion from other electrons.

50.

All transition elements are  $d$ -block elements, but all  $d$ -block elements are not transition elements. Explain.

**Ans.** Elements in which the last electron enters in the  $d$ -orbitals, are called  $d$ -block elements or transition elements. These elements have the general outer electronic configuration  $(n-1)d^{1-10}ns^{0-2}$ . Zn, Cd and Hg having the electronic configuration  $(n-1)d^{10}ns^2$  do not show most of the properties of transition elements.

51.

Arrange the elements N, P, O and S in the order of

- (i) increasing first ionisation enthalpy.
- (ii) increasing non-metallic character.

Give reason for the arrangement assigned.

**Ans.** The placing of elements are as

Period	Group 15	Group 16
2nd period	N	O
3rd period	P	S

- (i) Ionisation enthalpy of nitrogen ( ${}_7\text{N} = 1s^2, 2s^2, 2p^3$ ) is greater than oxygen ( ${}_8\text{O} = 1s^2, 2s^2, 2p^4$ ) due to extra stable exactly half-filled  $2p$ -orbitals. Similarly, ionisation enthalpy of phosphorus ( ${}_{15}\text{P} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^3$ ) is greater than sulphur ( ${}_{16}\text{S} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4$ ).

On moving down the group, ionisation enthalpy decreases with increasing atomic size. So, the order is

$$S < P < O < N \rightarrow \text{First ionisation enthalpy increases.}$$

- (ii) Non-metallic character across a period (left to right) increases but on moving down the group it decreases. So, the order is

$$P < S < N < O \rightarrow \text{Non-metallic character increases.}$$

52.

The Balmer series in the hydrogen spectrum corresponds to the transition from  $n_1 = 2$  to  $n_2 = 3, 4, \dots$ . This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to  $n = 4$  orbit.

$$(R_H = 109677 \text{ cm}^{-1})$$

**Ans.** From Rydberg formula,

$$\text{Wave number, } \bar{\nu} = 109677 \left[ \frac{1}{n_i^2} - \frac{1}{n_f^2} \right] \text{ cm}^{-1}$$

Given,  $n_i = 2$  and  $n_f = 4$  (Transition in Balmer series)

$$\bar{\nu} = 109677 \left[ \frac{1}{2^2} - \frac{1}{4^2} \right] \text{ cm}^{-1}$$

$$\Rightarrow \bar{\nu} = 109677 \left[ \frac{1}{4} - \frac{1}{16} \right] \text{ cm}^{-1}$$

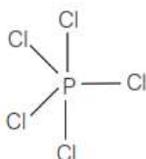
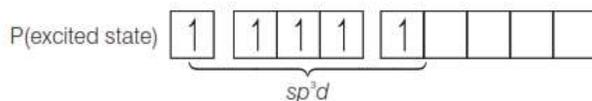
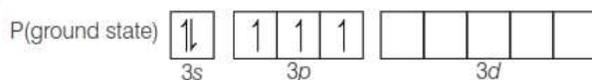
$$\Rightarrow \bar{\nu} = 109677 \times \left[ \frac{4-1}{16} \right] \text{ cm}^{-1}$$

$$\Rightarrow \bar{\nu} = 20564.44 \text{ cm}^{-1}$$

53.

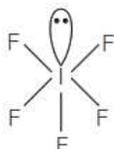
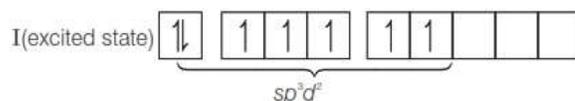
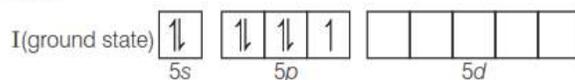
Explain why  $\text{PCl}_5$  is trigonal bipyramidal whereas  $\text{IF}_5$  is square pyramidal.

**Ans.**  $\text{PCl}_5$ —The ground state and the excited state outer electronic configurations of phosphorus ( $Z = 15$ ) are represented below



In  $\text{PCl}_5$ , P is  $sp^3d$  hybridised, therefore, its shape is trigonal bipyramidal.

$\text{IF}_5$ —The ground state and the excited state outer electronic configurations of iodine ( $Z = 53$ ) are represented below.



In  $\text{IF}_5$ , I is  $sp^3d^2$  hybridised, therefore, shape of  $\text{IF}_5$  is square pyramidal.

#### SECTION D

##### 54. Case Study/Passage Based Questions:

The particle nature of light posed a dilemma for scientists. The only way to resolve the dilemma was to accept the idea that light possesses both particle and wave-like properties, i.e., light has dual behaviour. Depending on the experiment, we find that light behaves either as a wave or as a stream of particles. Whenever radiation interacts with matter, it displays particle-like properties in contrast to the wave-like properties (interference and diffraction), which it exhibits when it propagates. This concept was totally alien to the way the scientists thought about matter and radiation and it took them a long time to become convinced of its validity. The study of emission or absorption spectra is referred to as spectroscopy. The emission spectra of atoms in the gas phase, on the other hand, do not show a continuous spread of wavelength from red to violet, rather they emit light only at specific wavelengths with dark spaces between them. Such spectra are called line spectra or atomic spectra. The Swedish spectroscopist, Johannes

Rydberg, noted that all series of lines in the hydrogen spectrum could be described by the following

$$\bar{\nu} = 109,677 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ cm}^{-1}$$

expression :

The value  $109,677 \text{ cm}^{-1}$  is called the Rydberg constant for hydrogen. The first five series of lines that correspond to  $n_1 = 1, 2, 3, 4, 5$  are known as Lyman, Balmer, Paschen, Brackett and Pfund series, respectively. Neils Bohr (1913) was the first to explain quantitatively the general features of the structure of hydrogen atom and its spectrum. He used Planck's concept of quantisation of energy. Though the theory is not the modern quantum mechanics, it can still be used to rationalize many points in the atomic structure and spectra.

- (i) Write the Planck's equation ?
- (ii) What is nature of light ?
- (iii) Define Black body and black body radiation.
- (iv) Electrically neutral particles having a mass slightly greater than that of protons, these particles termed as .....

**Sol.**

- (i)  $E = h\nu$
- (ii) Wave and Particle nature
- (iii) An ideal body, which emits and absorbs radiations of all frequencies uniformly, is called a black body and the radiation emitted by such a body is called black body radiation.
- (iv) Neutron

#### 55. Case Study/Passage Based Questions:

The existing large number of organic compounds and their ever-increasing numbers has made it necessary to classify them on the basis of their structures. Organic compounds are broadly classified as open-chain compounds which are also called aliphatic compounds. Aliphatic compounds further classified as homocyclic and heterocyclic compounds. Aromatic compounds are special types of compounds. Alicyclic compounds, aromatic compounds may also have heteroatom in the ring. Such compounds are called heterocyclic aromatic compounds. Organic compounds can also be classified on the basis of functional groups, into families or homologous series. The members of a homologous series can be represented by general molecular formula and the successive members differ from each other in molecular formula by a  $-\text{CH}_2-$  unit.

- (i) Write one example of homologous series.
- (ii) Define homocyclic and heterocyclic compound.
- (iii) Write one example of homocyclic and heterocyclic compound.
- (iv) What is an aromatic compound.

**Sol.** (i) **Alkane series – methane , ethane... or any other successive continuous functional group series – alcohol, aldehyde, ketone etc.**

(ii) Homocyclic compounds are composed of rings made of atoms of the same element whereas heterocyclic compounds are composed of rings made of atoms of different elements. The different elements can be nitrogen, oxygen and Sulphur.

(iii) Homocyclic compounds- Cyclohexane , **Benzene etc.** Heterocyclic compounds- furane, pyridine etc.

(iii) Aromatic compounds are chemical compounds that consist of conjugated planar ring systems accompanied by delocalized pi-electron clouds in place of individual alternating double and single bonds.

### SECTION E

56. (a) State Le Chatelier's principle. Explain effects of change in concentration and pressure on following equilibrium reaction –  $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$   
(b) What is the relationship between  $K_p$  and  $K_c$ ?  
(c) Write the expressions of  $K_p$  and  $K_c$  for  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ .

**Sol.**

(a) Le Chatelier's principle can be stated as follows: A change in one of the variables that describe a system at equilibrium produces a shift in the position of the equilibrium that counteracts the effect of this change.

$$(b) \quad K_p = K_c (RT)^{\Delta n}$$
$$K_c = \frac{K_p}{(RT)^{\Delta n}}$$

$$(c) \quad K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

57. (a) What is the difference between molality and molarity?  
(b) An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?  
(c) Explain photoelectric effect.

**Sol.**

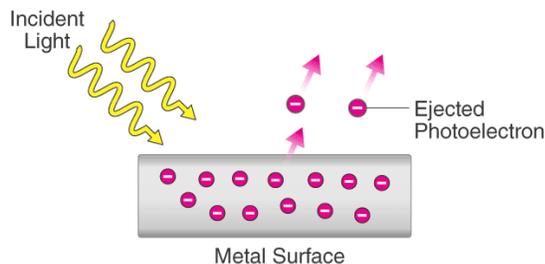
(a) The molality of a solution is equal to the moles of solute divided by the mass of solvent in kilograms, while the molarity of a solution is equal to the moles of solute divided by the volume of solution in liters.

(b) Atomic Number = Mass Number – Number of neutrons

$$\text{Atomic Number} = 13 - 7 = 6.$$

Hence, the atomic number will be 6.

(c) The **photoelectric effect** is a phenomenon in which electrons are ejected from the surface of a metal when light is incident on it. These ejected electrons are called **photoelectrons**. It is important to note that the emission of photoelectrons and the kinetic energy of the ejected photoelectrons is dependent on the frequency of the light that is incident on the metal's surface. The process through which photoelectrons are ejected from the surface of the metal due to the action of light is commonly referred to as **photoemission**.



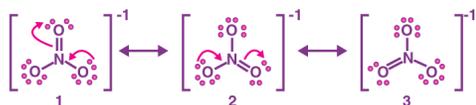
58. (a) Draw the resonating structure of: (a) Ozone molecule (b) Nitrate ion  
 (b) What is the hybridisation of each carbon in  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ ?  
 (c) Calculate the radius of orbit and velocity of electron in first Bohr orbit of  $\text{He}^+$  ion.

**Answer. (a)**

(i) Ozone molecule



(ii) Nitrate ion



(b) In  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ , the terminal carbons are  $sp^2$  hybridised as they form three sigma bonds and one pi bond, while the centre carbon is  $sp$  hybridised

(c)  $r_n = a_0 \frac{n^2}{Z}$  where  $a_0 = 0.529 \text{ \AA}$

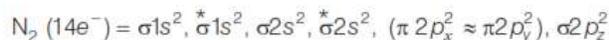
$$v_n = 2.18 \times 10^6 \frac{Z}{n} \text{ m/s}$$

59.

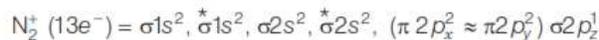
What is the effect of the following processes on the bond order in  $\text{N}_2$  and  $\text{O}_2$ ?



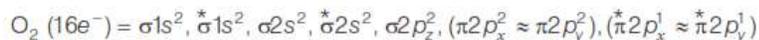
**Ans.** According to molecular orbital theory, electronic configurations and bond order of  $\text{N}_2$ ,  $\text{N}_2^+$ ,  $\text{O}_2$  and  $\text{O}_2^+$  species are as follows



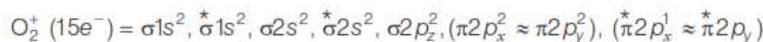
$$\text{Bond order} = \frac{1}{2} [N_b - N_a] = \frac{1}{2} (10 - 4) = 3$$



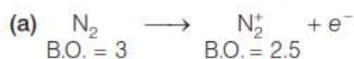
$$\text{Bond order} = \frac{1}{2} [N_b - N_a] = \frac{1}{2} (9 - 4) = 2.5$$



$$\text{Bond order} = \frac{1}{2} [N_b - N_a] = \frac{1}{2} (10 - 6) = 2$$



$$\text{Bond order} = \frac{1}{2} [N_b - N_a] = \frac{1}{2} (10 - 5) = 2.5$$



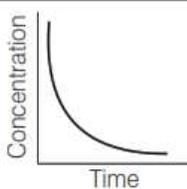
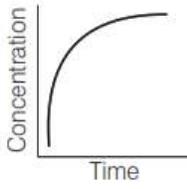
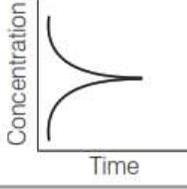
Thus, bond order decreases.



Thus, bond order increases.

60.

Match the following graphical variation with their description.

<b>A</b>		<b>B</b>
A.		1. Variation in product concentration with time
B.		2. Reaction at equilibrium
C.		3. Variation in reactant concentration with time

ANS.

**A.** → (3)    **B.** → (1)    **C.** → (2)

A. Graph (A) represents variation of reactant concentration with time.

B. Graph (B) represents variation of product concentration with time.

C. Graph (C) represents reaction at equilibrium.