

# CHEMISTRY

## SECTION - A

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer :**

1. Which of the following ions has spin only magnetic moment of 4.9 BM?

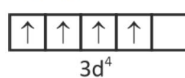
- (1)  $Mn^{2+}$  (2)  $Cr^{2+}$   
 (3)  $Fe^{3+}$  (4)  $Co^{2+}$

**Answer (2)**

**Sol.**  $\mu_{spin\ only} = \sqrt{n(n+2)}$  BM

$n$  = number of unpaired electrons

$Cr^{2+} = 3d^4 4s^0$



$n = 4$

$\mu_{spin\ only} = \sqrt{4(4+2)}$  BM

=  $\sqrt{24}$  BM

= 4.9 BM

$Cr^{2+}$  has spin only magnetic moment = 4.9 BM

2. Which among the following element has highest atomic number.

- (1) Po (2) Pt  
 (3) Pr (4) Pb

**Answer (1)**

**Sol.** Po → Polonium (Z = 84)

Pt → Platinum (Z = 78)

Pr → Praseodymium (Z = 59)

Pb → Lead (Z = 82)

∴ Of the given metals Po has the highest atomic number

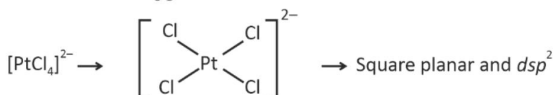
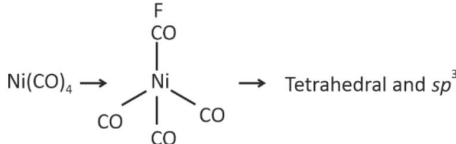
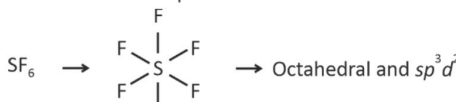
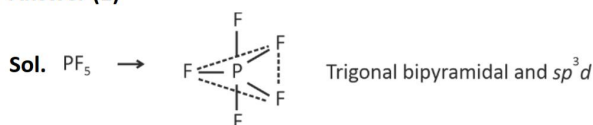
3. Match the following List-I with List-II and choose the correct option.

|     | List-I (Compounds) |       | List-II (Shape and Hybridisation) |
|-----|--------------------|-------|-----------------------------------|
| (A) | $PF_5$             | (I)   | Tetrahedral and $sp^3$            |
| (B) | $SF_6$             | (II)  | Square planar and $dsp^2$         |
| (C) | $Ni(CO)_4$         | (III) | Octahedral and $sp^3d^2$          |
| (D) | $[PtCl_4]^{2-}$    | (IV)  | Trigonal bipyramidal and $sp^3d$  |

(1) A-IV, B-III, C-I, D-II (2) A-III, B-IV, C-I, D-II

(3) A-III, B-IV, C-II, D-I (4) A-IV, B-III, C-II, D-I

**Answer (1)**



4. 2 moles each of ethylene glycol and glucose are mixed with 500 g of water. Find the boiling point of solution. ( $K_b = 0.52$  K kg/mol)

- (1) 377.16 K (2) 368.84 K  
 (3) 376.16 K (4) 369.84 K

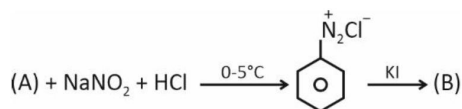
**Answer (1)**

**Sol.**  $\Delta T_b = i \times K_b \times m$

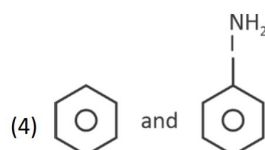
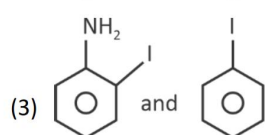
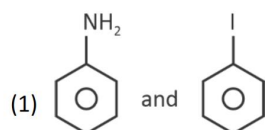
$$= 0.52 \times \left[ (2+2) \times \frac{1000}{500} \right] = 4.16 \text{ K}$$

∴ Boiling point of solution = 377.16 K

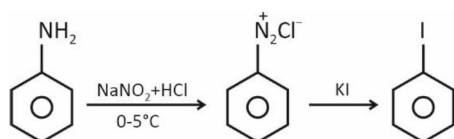
5. Observe the following reaction sequence.



Which of the following options has correct structure of (A) and (B) respectively.



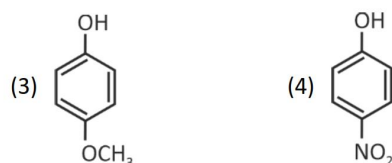
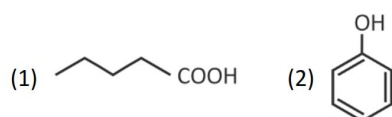
**Answer (1)**



**Sol.** (A)

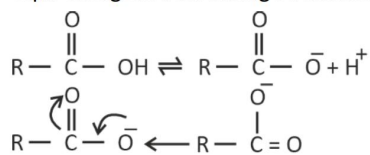
(B)

6. Which one of the following compounds is most acidic?

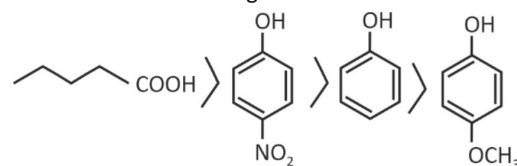


**Answer (1)**

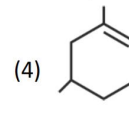
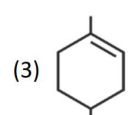
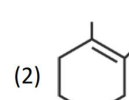
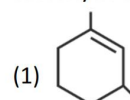
**Sol.** Carboxylic acid is more acidic than phenol and the given phenol derivatives because carboxylate anion has two equi-energetic resonating structures



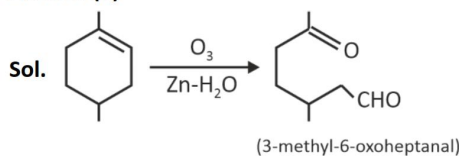
The correct acidic strength order is



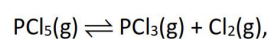
7. 3-methyl-6-oxoheptanal, will be formed after ozonolysis of



**Answer (3)**



8. The following reaction is at equilibrium starting with only  $\text{PCl}_5$



when Xe gas is added to the above system at constant pressure, then which of the following is correct?

- (1) Concentration of  $\text{PCl}_3$  will become more than  $\text{Cl}_2$
- (2)  $\text{PCl}_3$  and  $\text{Cl}_2$  will have same concentration at new equilibrium.
- (3) Concentration of  $\text{Cl}_2$  will be more than  $\text{PCl}_3$
- (4)  $\text{PCl}_3$  will be 30% and  $\text{Cl}_2$  will be 70% at new equilibrium

**Answer (2)**

**Sol.** Addition of inert gas at constant pressure will result in increase in volume, which will increase gaseous moles and hence equilibrium will shift in forward direction.

Same amount of  $\text{PCl}_3(\text{g})$  and  $\text{Cl}_2(\text{g})$  will be formed.

9. Consider the following statements

**Statement I:** N-N has less bond strength than P-P

**Statement II:** All group-15 elements in +3 oxidation state undergo disproportionation.

In the light of above statements, choose the correct option.

- (1) Statement I and statement II both are correct
- (2) Statement I and statement II both are incorrect
- (3) Statement I is correct, statement II is incorrect
- (4) Statement I is incorrect, statement II is correct

**Answer (3)**

**Sol.** Due to small size of nitrogen interelectronic repulsion takes place and N-N bond strength is less than P-P bond strength. Statement I is correct.

Not all group-15 elements undergo disproportionation in +3 oxidation state. Statement II is incorrect.

10. Which of the following property shows irregular trend in group 16?

- (1) Electronegativity
- (2) Atomic radius
- (3) Electron affinity
- (4) Ionisation enthalpy

**Answer (3)**

**Sol.** Down the group electron affinity decreases, but O has the lowest value due to  $e^- - e^-$  repulsion.

Electron gain enthalpy

|      |      |      |      |      |   |
|------|------|------|------|------|---|
| O    | S    | Se   | Te   | Po   |   |
| -141 | -200 | -195 | -190 | -174 | $\left( \frac{\text{kJ}}{\text{mol}} \right)$ |

11. Which of the following statement(s) is/are incorrect?

- I.  $\text{NO}_2$  dimerises easily
  - II.  $\text{NF}_5$  does not exist but  $\text{PF}_5$  exists
  - III. The oxides  $\text{N}_2\text{O}_3$  and  $\text{P}_2\text{O}_3$  are purely acidic but  $\text{As}_2\text{O}_3$  and  $\text{Sb}_2\text{O}_3$  are basic
  - IV. Nitrogen cannot form  $d\pi-p\pi$  bond as the heavier elements can
- (1) Only I, II and IV      (2) Only III  
(3) Only III and IV      (4) Only I and II

**Answer (2)**

**Sol.**  $\text{N}_2\text{O}_3$  and  $\text{P}_2\text{O}_3 \Rightarrow$  Purely acidic

$\text{As}_2\text{O}_3$  and  $\text{Sb}_2\text{O}_3 \Rightarrow$  Amphoteric

$\text{Bi}_2\text{O}_5 \rightarrow$  Basic

All other statements are correct.

12. Consider the following complex ions

- (a)  $[\text{Co}(\text{NH}_3)_6]^{3+}$       (b)  $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{3+}$   
(c)  $[\text{Co}(\text{NH}_3)_5\text{H}_2\text{O}]^{3+}$       (d)  $[\text{Co}(\text{CN})_6]^{3-}$

Choose the correct order of wavelength absorbed by complex ions

- (1)  $a > b > c > d$       (2)  $b > c > a > d$   
(3)  $b > a > c > d$       (4)  $d > c > b > a$

**Answer (2)**

**Sol.** More the crystal field splitting energy ( $\Delta_o$ ) more will be energy absorbed by complex.

$\Delta_o \propto$  ligand field strength

Order of ligand field strength

$\text{CN}^- > \text{NH}_3 > \text{H}_2\text{O} > \text{Cl}^-$

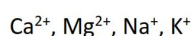
Order of  $\Delta_o$  for complex ions

$d > a > c > b$

Order of wavelength absorbed

$b > c > a > d$

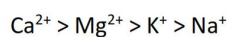
13. Arrange the following metal ions in the decreasing order of their molar conductivity in aqueous solution.



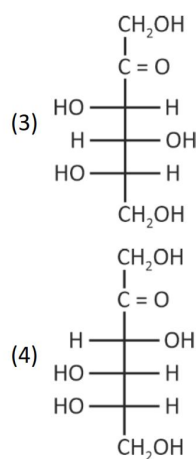
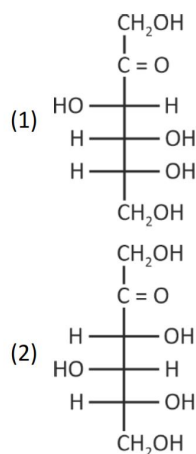
- (1)  $\text{Na}^+ > \text{K}^+ > \text{Ca}^{2+} > \text{Mg}^{2+}$   
 (2)  $\text{Mg}^{2+} > \text{Ca}^{2+} > \text{Na}^+ > \text{K}^+$   
 (3)  $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ > \text{Na}^+$   
 (4)  $\text{Mg}^{2+} > \text{Ca}^{2+} > \text{K}^+ > \text{Na}^+$

**Answer (3)**

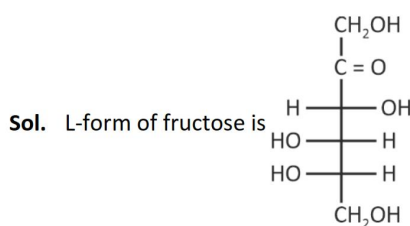
**Sol.** Molar conductivity of a metal ion in aqueous solution is directly proportional to charge on the ion and inversely proportional to the size of hydrated ion. Molar conductivity of  $\text{M}^{2+}$  is expected to be higher than that of  $\text{M}^+$ . The extent of hydration of  $\text{Mg}^{2+}$  will be higher than that of  $\text{Ca}^{2+}$ , so its mobility will be slower and hence molar conductivity of  $\text{Mg}^{2+}(\text{aq})$  will be lower than that of  $\text{Ca}^{2+}(\text{aq})$ . Similarly, molar conductivity of  $\text{K}^+(\text{aq})$  will be higher than that of  $\text{Na}^+(\text{aq})$ . The correct order of molar conductivity of the given metal ions in aqueous solution is



14. Which of the following represents the L-form of fructose?



**Answer (4)**



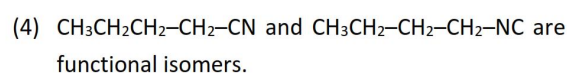
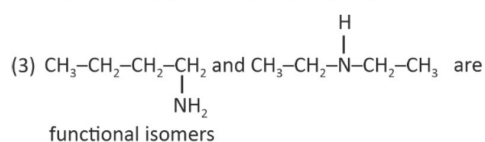
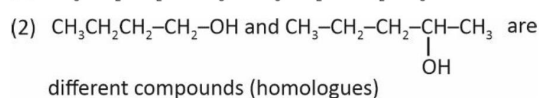
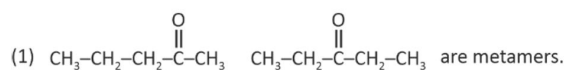
15. Which of the following is/are correct?

- (a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{-COCH}_3$  and  $\text{CH}_3\text{-CH}_2\text{-COCH}_2\text{CH}_3$  metamers  
 (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{-CH(OH)-CH}_3$  position isomers  
 (c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$  and  $\text{CH}_3\text{-CH}_2\text{NH-CH}_2\text{CH}_3$  homologues  
 (d)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CN}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NC}$  functional isomers
- (1) (a) and (d)  
 (2) (a) and (c)  
 (3) (b) and (c)  
 (4) (b) and (d)

**Answer (1)**



Sol.



16. Correct set of four quantum numbers for last electron of  $\text{Cr}^{3+}$  ion is

(1)  $n = 4, l = 1, m = 0, s = +\frac{1}{2}$

(2)  $n = 4, l = 2, m = 0, s = +\frac{1}{2}$

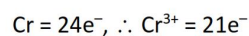
(3)  $n = 3, l = 2, m = 0, s = +\frac{1}{2}$

(4)  $n = 3, l = 2, m = -1, s = 0$

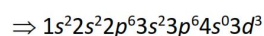
Answer (3)

Sol. Chromium = Atomic number 24.

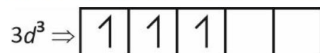
$\therefore$  It has 24 protons and 24 electrons.



$\text{Cr}^{3+} \Rightarrow$  electronic configuration



Four Quantum numbers decided on the basis of



$n = 3$

$l = 2$

$m = 0$

$S = +\frac{1}{2}$

17. Given below are two statements about X-ray spectra of elements:

**Statement (I)** : A plot of  $\sqrt{\nu}$  ( $\nu$  = frequency of X-rays emitted) vs atomic mass is a straight line

**Statement (II)** : A plot of  $\nu$  ( $\nu$  = frequency of X-rays emitted) vs atomic number is a straight line.

In the light of the above statements, choose the correct answer from the options given below.

(1) **Statement I** is true but **Statement II** is false

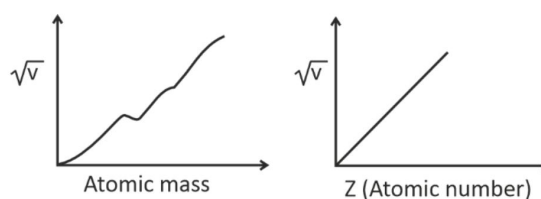
(2) **Statement I** is false but **Statement II** is true

(3) Both **Statement I** and **Statement II** are false

(4) Both **Statement I** and **Statement II** are true

Answer (3)

Sol.



[Graphs plotted by Henry Moseley]

18.

19.

20.

#### SECTION - B

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. 0.5 g of an organic compound gives 1.46 g  $\text{CO}_2$  and 0.9 g  $\text{H}_2\text{O}$ . What is the % of carbon in organic sample?

**Answer (80)**

**Sol.**  $n_{\text{CO}_2} = \frac{1.46}{44} = n_{\text{C}} = 0.033 \text{ mol}$

Mass of carbon =  $0.033 \times 12 = 0.398 \text{ g}$

% of carbon =  $\frac{0.398}{0.5} \times 100$

= 79.6 %

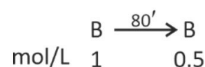
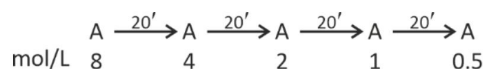
≈ 80%

22. In two first order reactions initial concentration of  $[A]_0 = 8[B]_0$ . Find the time after which concentration of A and B become equal. Given that  $(t_{1/2})_A = 20 \text{ min}$  and  $(t_{1/2})_B = 80 \text{ min}$ .

**Answer (80)**

**Sol.** Let initial concentration of  $[B] = 1 \text{ mol/L}$

∴ Initial concentration of  $[A] = 8 \text{ mol/L}$



∴ After 80 min, both (A) and (B) will have same concentrations.

23. How many of the following statements are correct?
- First ionisation energy of Boron is more than that of Beryllium.
  - Lithium is strongest reducing agent.
  - Electronegativity of carbon is 2.5 (approx.) in  $\text{CCl}_4$ .
  - Removal of electron from isolated gaseous atom is endothermic and addition of electron to isolated gaseous atom is generally exothermic.

**Answer (3)**

**Sol.**  $\text{IE}_1$  of Be > B

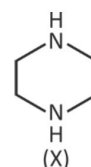
Li is strongest reducing agent.

Electronegativity of 'C' in  $\text{CCl}_4$  is 2.5.

Removal of electron is endothermic and addition of electron is generally exothermic.

Statements (b), (c) and (d) are correct.

24. 0.42 g of the following compound (X) is subjected to analysis for estimation of volume of  $\text{N}_2$  gas by Duma's method



What is the volume of  $\text{N}_2$  gas evolved in mL at STP (1 atm pressure and 273 K temperature) to the nearest integer

**Answer (109)**

**Sol.** Mass of (X) = 0.42 g

No of moles of (X)  $\frac{0.42}{86}$

Volume of  $\text{N}_2$  gas at STP

=  $\frac{0.42}{86} \times 22.400 \text{ mL}$

= 109.4

≈ 109 mL

25.