**SECTION 1 (Maximum marks: 24)**

- This section contains **EIGHT (08)** questions.
- The answer to each question is a **SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
  *Full Marks* : +3 If **ONLY** the correct integer is entered;
  *Zero Marks* : 0 If the question is unanswered;
  *Negative Marks* : −1 In all other cases.

Q.1 Concentration of $H_2SO_4$ and $Na_2SO_4$ in a solution is 1 M and $1.8 \times 10^{-2}$ M, respectively. Molar solubility of $PbSO_4$ in the same solution is $X \times 10^{-Y}$ M (expressed in scientific notation). The value of Y is **6**.

[Given: Solubility product of $PbSO_4$ ($K_{sp}$) = $1.6 \times 10^{-8}$. For $H_2SO_4$, $K_{a1}$ is very large and $K_{a2} = 1.2 \times 10^{-2}$]

Q.2 An aqueous solution is prepared by dissolving 0.1 mol of an ionic salt in 1.8 kg of water at 35 ºC. The salt remains 90% dissociated in the solution. The vapour pressure of the solution is 59.724 mm of Hg. Vapor pressure of water at 35 ºC is 60.000 mm of Hg. The number of ions present per formula unit of the ionic salt is **5**.

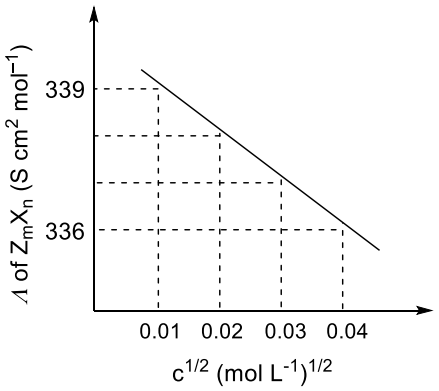
Q.3 Consider the strong electrolytes $Z_mX_n$, $U_mY_p$ and $V_mX_n$. Limiting molar conductivity ($\Lambda^0$) of $U_mY_p$ and $V_mX_n$ are 250 and 440 S cm$^2$ mol$^{-1}$, respectively. The value of (m + n + p) is **7**.

Given:

| Ion | $Z^{n+}$ | $U^{p+}$ | $V^{n+}$ | $X^{m-}$ | $Y^{m-}$ |
|---|---|---|---|---|---|
| $\lambda^0$ (S cm$^2$ mol$^{-1}$) | 50.0 | 25.0 | 100.0 | 80.0 | 100.0 |

$\lambda^0$ is the limiting molar conductivity of ions

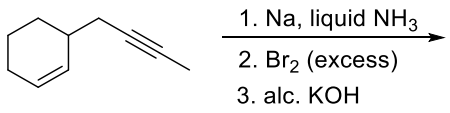
The plot of molar conductivity ($\Lambda$) of $Z_mX_n$ *vs* $c^{1/2}$ is given below.



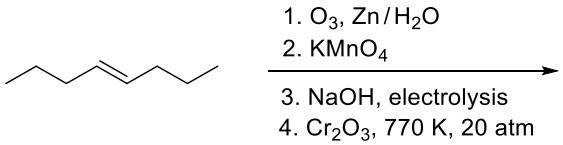

Q.4 The reaction of Xe and $O_2F_2$ gives a Xe compound **P**. The number of moles of HF produced by the complete hydrolysis of 1 mol of **P** is **4**.

Q.5 Thermal decomposition of $AgNO_3$ produces two paramagnetic gases. The total number of electrons present in the antibonding molecular orbitals of the gas that has the higher number of unpaired electrons is **6**.

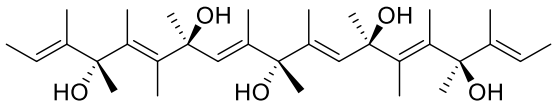
Q.6 The number of isomeric tetraenes (**NOT** containing *sp*-hybridized carbon atoms) that can be formed from the following reaction sequence is **2**.




Q.7 The number of -$CH_2$- (methylene) groups in the product formed from the following reaction sequence is **0**.




Q.8 The total number of chiral molecules formed from one molecule of **P** on complete ozonolysis ($O_3$, $Zn/H_2O$) is **2**.




**P**

**SECTION 2 (Maximum marks: 24)**

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : $+4$ **ONLY** if (all) the correct option(s) is(are) chosen;
*Partial Marks* : $+3$ If all the four options are correct but **ONLY** three options are chosen;
*Partial Marks* : $+2$ If three or more options are correct but **ONLY** two options are chosen, both of which are correct;
*Partial Marks* : $+1$ If two or more options are correct but **ONLY** one option is chosen and it is a correct option;
*Zero Marks* : $0$ If unanswered;
*Negative Marks :* $-2$ In all other cases.

Q.9 To check the principle of multiple proportions, a series of pure binary compounds ($P_mQ_n$) were analyzed and their composition is tabulated below. The correct option(s) is(are)

| Compound | Weight % of P | Weight % of Q |
|---|---|---|
| **1** | 50 | 50 |
| **2** | 44.4 | 55.6 |
| **3** | 40 | 60 |

(A) If empirical formula of compound **3** is $P_3Q_4$, then the empirical formula of compound **2** is $P_3Q_5$.
(B) If empirical formula of compound **3** is $P_3Q_2$ and atomic weight of element P is 20, then the atomic weight of Q is 45.
(C) If empirical formula of compound **2** is PQ, then the empirical formula of the compound **1** is $P_5Q_4$.
(D) If atomic weight of P and Q are 70 and 35, respectively, then the empirical formula of compound **1** is $P_2Q$.

**Answer: B, C**

Q.10 The correct option(s) about entropy (S) is(are)
[R = gas constant, F = Faraday constant, T = Temperature]

(A) For the reaction, $M(s) + 2H^+(aq) \rightarrow H_2(g) + M^{2+}(aq)$, if $\frac{dE_{cell}}{dT} = \frac{R}{F}$, then the entropy change of the reaction is R (assume that entropy and internal energy changes are temperature independent).

(B) The cell reaction, $Pt(s) \mid H_2(g, 1bar) \mid H^+(aq, 0.01M) \parallel H^+(aq, 0.1M) \mid H_2(g, 1bar) \mid Pt(s)$, is an entropy driven process.

(C) For racemization of an optically active compound, $\Delta S > 0$.

(D) $\Delta S > 0$, for $[Ni(H_2O)_6]^{2+} + 3\ en \rightarrow [Ni(en)_3]^{2+} + 6H_2O$ (where en = ethylenediamine).

**Answer: B, C, D**

Q.11 The compound(s) which react(s) with $NH_3$ to give boron nitride (BN) is(are)

(A) B (B) $B_2H_6$ (C) $B_2O_3$ (D) $HBF_4$

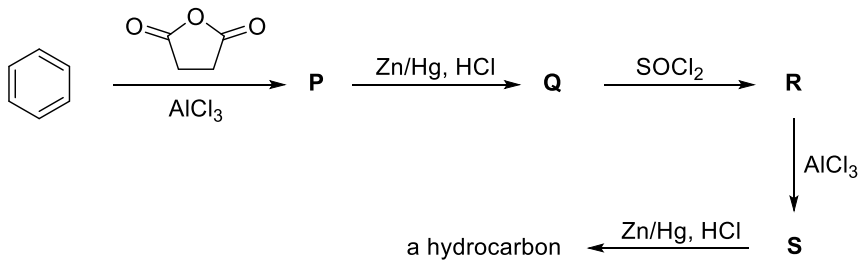
**Answer: [B, C] or [A, B, C]**

Q.12 The correct option(s) related to the extraction of iron from its ore in the blast furnace operating in the temperature range $900 - 1500$ K is(are)

(A) Limestone is used to remove silicate impurity.
(B) Pig iron obtained from blast furnace contains about 4% carbon.
(C) Coke (C) converts $CO_2$ to CO.
(D) Exhaust gases consist of $NO_2$ and CO.

**Answer: A, B, C**

Q.13 Considering the following reaction sequence, the correct statement(s) is(are)




(A) Compounds **P** and **Q** are carboxylic acids.
(B) Compound **S** decolorizes bromine water.
(C) Compounds **P** and **S** react with hydroxylamine to give the corresponding oximes.
(D) Compound **R** reacts with dialkylcadmium to give the corresponding tertiary alcohol.

**Answer: A, C**

Q.14 Among the following, the correct statement(s) about polymers is(are)

(A) The polymerization of chloroprene gives natural rubber.
(B) Teflon is prepared from tetrafluoroethene by heating it with persulphate catalyst at high pressures.
(C) PVC are thermoplastic polymers.
(D) Ethene at 350-570 K temperature and 1000-2000 atm pressure in the presence of a peroxide initiator yields high density polythene.

**Answer: B, C**

**SECTION 3 (Maximum marks: 12)**

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

*Full Marks* : +3 If **ONLY** the correct option is chosen;
*Zero Marks* : 0 If none of the options is chosen (i.e. the question is unanswered);
*Negative Marks* : −1 In all other cases.

Q.15 Atom X occupies the fcc lattice sites as well as alternate tetrahedral voids of the same lattice. The packing efficiency (in %) of the resultant solid is closest to

(A) 25 (B) 35 (C) 55 (D) 75

**Answer: B**

Q.16 The reaction of $HClO_3$ with HCl gives a paramagnetic gas, which upon reaction with $O_3$ produces

(A) $Cl_2O$ (B) $ClO_2$ (C) $Cl_2O_6$ (D) $Cl_2O_7$

**Answer: C**

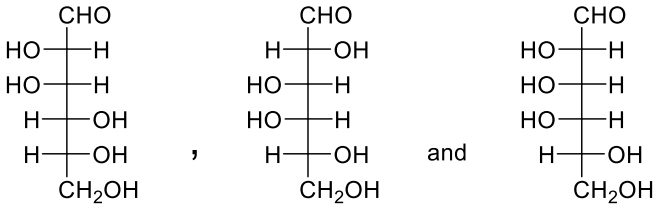
Q.17 The reaction of $Pb(NO_3)_2$ and NaCl in water produces a precipitate that dissolves upon the addition of HCl of appropriate concentration. The dissolution of the precipitate is due to the formation of

(A) $PbCl_2$ (B) $PbCl_4$ (C) $[PbCl_4]^{2-}$ (D) $[PbCl_6]^{2-}$

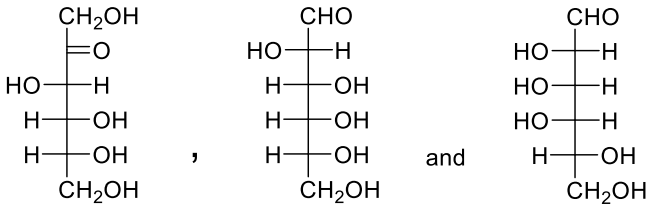
**Answer: C**

Q.18 Treatment of D-glucose with aqueous NaOH results in a mixture of monosaccharides, which are

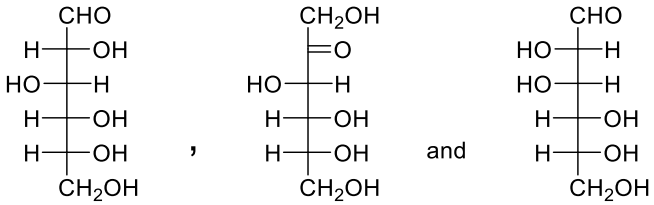
(A)



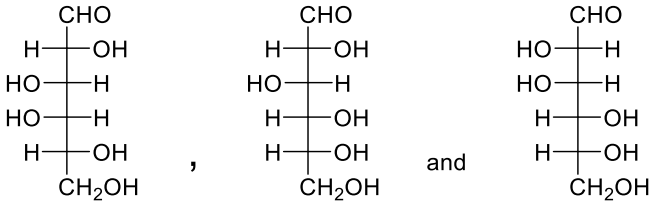
(B)



(C)



(D)



**Answer: C**

## END OF THE QUESTION PAPER