

### Paper Specific Instructions

1. The examination is of 3 hours duration. There are a total of 60 questions carrying 100 marks. The entire paper is divided into three sections, **A**, **B** and **C**. All sections are compulsory. Questions in each section are of different types.
2. **Section – A** contains a total of 30 **Multiple Choice Questions (MCQ)**. Each MCQ type question has four choices out of which only **one** choice is the correct answer. Questions Q.1 – Q.30 belong to this section and carry a total of 50 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.30 carry 2 marks each.
3. **Section – B** contains a total of 10 **Multiple Select Questions (MSQ)**. Each MSQ type question is similar to MCQ but with a difference that there may be **one or more than one** choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct answers only and no wrong answers. Questions Q.31 – Q.40 belong to this section and carry 2 marks each with a total of 20 marks.
4. **Section – C** contains a total of 20 **Numerical Answer Type (NAT)** questions. For these NAT type questions, the answer is a real number which needs to be entered using the virtual keyboard on the monitor. No choices will be shown for these type of questions. Questions Q.41 – Q.60 belong to this section and carry a total of 30 marks. Q.41 – Q.50 carry 1 mark each and Questions Q.51 – Q.60 carry 2 marks each.
5. In all sections, questions not attempted will result in zero mark. In **Section – A (MCQ)**, wrong answer will result in **NEGATIVE** marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In **Section – B (MSQ)**, there is **NO NEGATIVE** and **NO PARTIAL** marking provisions. There is **NO NEGATIVE** marking in **Section – C (NAT)** as well.
6. Only Virtual Scientific Calculator is allowed. Charts, graph sheets, tables, cellular phone or other electronic gadgets are **NOT** allowed in the examination hall.
7. The Scribble Pad will be provided for rough work.

## SECTION – A

## MULTIPLE CHOICE QUESTIONS (MCQ)

**Q. 1 – Q.10 carry one mark each.**

Q.1 On hydrolysis, aluminium carbide produces

- (A) CH<sub>4</sub>                      (B) C<sub>2</sub>H<sub>6</sub>                      (C) C<sub>2</sub>H<sub>4</sub>                      (D) C<sub>2</sub>H<sub>2</sub>

Q.2 Carbonic anhydrase is an example of

- (A) Hydrolysis enzyme                      (B) Redox enzyme  
(C) O<sub>2</sub> transport protein                      (D) Heme protein

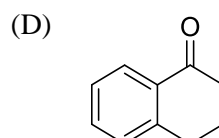
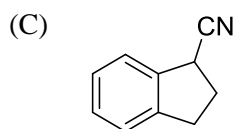
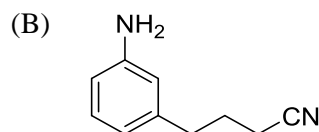
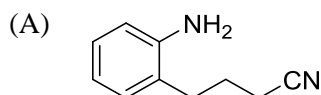
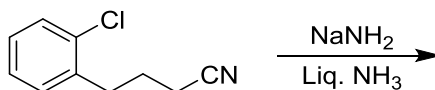
Q.3 The **CORRECT** order of melting points of group 15 trifluorides is

- (A) PF<sub>3</sub> < AsF<sub>3</sub> < SbF<sub>3</sub> < BiF<sub>3</sub>                      (B) BiF<sub>3</sub> < SbF<sub>3</sub> < PF<sub>3</sub> < AsF<sub>3</sub>  
(C) PF<sub>3</sub> < SbF<sub>3</sub> < AsF<sub>3</sub> < BiF<sub>3</sub>                      (D) BiF<sub>3</sub> < AsF<sub>3</sub> < SbF<sub>3</sub> < PF<sub>3</sub>

Q.4 NaF, KF, MgO and CaO are crystalline solids. They have NaCl structure. Their lattice energies vary in the order

- (A) NaF < KF < MgO < CaO  
(B) KF < NaF < CaO < MgO  
(C) MgO < CaO < NaF < KF  
(D) CaO < MgO < KF < NaF

Q.5 The major product formed in the following reaction is



Q.6 The compound that contains the most acidic hydrogen is

- (A)  $\text{H}_2\text{C}=\text{CH}_2$  (B)  $\text{HC}\equiv\text{CH}$  (C)  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$  (D)  $\text{H}_3\text{C}-\text{CH}_3$

Q.7 The C-2 epimer of D-glucose is

- (A) D-Mannose (B) D-Fructose (C) D-Galactose (D) D-Gulose

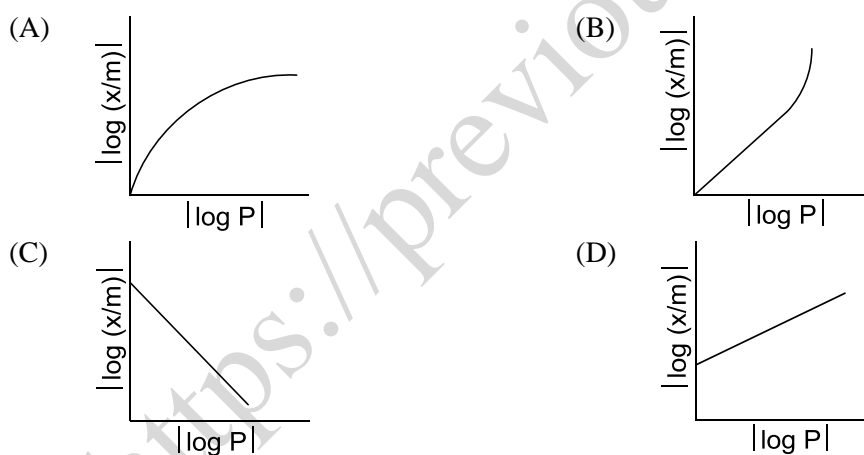
Q.8 The value of integral  $\int_{-2}^{+2} x e^{-2x^2} dx$  is

- (A) 0 (B)  $\frac{1}{2}$  (C) 1 (D) 2

Q.9 The number of crystal systems and the number of Bravais lattices are, respectively,

- (A) 14 and 7 (B) 7 and 32 (C) 32 and 14 (D) 7 and 14

Q.10 For adsorption of a gas on a solid surface, the plot that represents Freundlich isotherm is (x = mass of gas, m = mass of adsorbent, P = pressure)

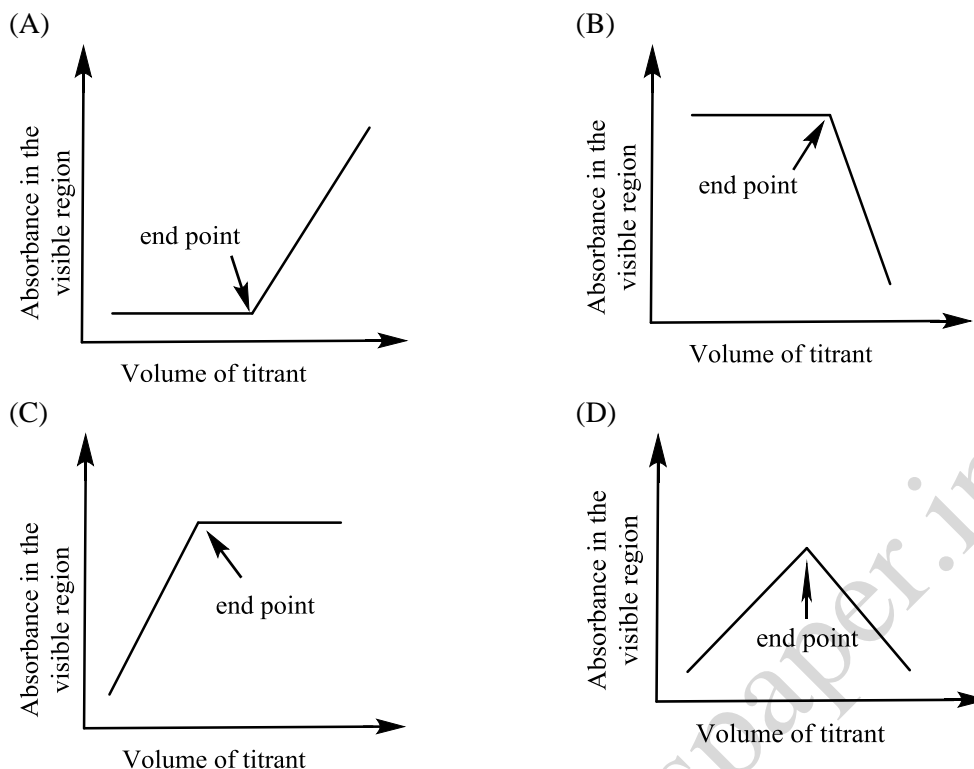


**Q. 11 – Q. 30 carry two marks each.**

Q.11 With respect to periodic properties, the **CORRECT** statement is

- (A) Electron affinity order is  $\text{F} > \text{O} > \text{Cl}$   
 (B) First ionisation energy order is  $\text{Al} > \text{Mg} > \text{K}$   
 (C) Atomic radius order is  $\text{N} > \text{P} > \text{As}$   
 (D) Ionic radius order is  $\text{K}^+ > \text{Ca}^{2+} > \text{Mg}^{2+}$

Q.12 Which plot represents a spectrophotometric titration, where the titrant alone absorbs light in the visible region?



Q.13 Among the following metal carbonyl species, the one with the highest metal-carbon back bonding is

- (A)  $[\text{Ti}(\text{CO})_6]^{2-}$       (B)  $[\text{V}(\text{CO})_6]$       (C)  $\text{Cr}(\text{CO})_6$       (D)  $[\text{Mn}(\text{CO})_6]^+$

Q.14 The **CORRECT** order of  $\Delta_o$  (the octahedral crystal field splitting of d orbitals) values for the following anionic metal complexes is

- (A)  $[\text{Ir}(\text{CN})_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{CoI}_6]^{3-}$   
 (B)  $[\text{CoI}_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{Ir}(\text{CN})_6]^{3-}$   
 (C)  $[\text{CoI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-} < [\text{Ir}(\text{CN})_6]^{3-}$   
 (D)  $[\text{Ir}(\text{CN})_6]^{3-} < [\text{CoI}_6]^{3-} < [\text{Rh}(\text{CN})_6]^{3-} < [\text{RhI}_6]^{3-}$

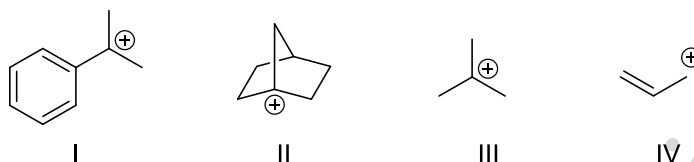
Q.15 The decay modes of  $^{14}\text{C}$  and  $^{14}\text{O}$  are

- (A)  $\beta$  decay  
 (B) positron emission  
 (C)  $\beta$  decay and positron emission, respectively  
 (D) positron emission and  $\beta$  decay, respectively

Q.16 Consider the following four xenon compounds:  $\text{XeF}_2$ ,  $\text{XeF}_4$ ,  $\text{XeF}_6$  and  $\text{XeO}_3$ . The pair of xenon compounds expected to have non-zero dipole moment is

- (A)  $\text{XeF}_4$  and  $\text{XeF}_6$  (B)  $\text{XeF}_2$  and  $\text{XeF}_4$   
 (C)  $\text{XeF}_2$  and  $\text{XeO}_3$  (D)  $\text{XeF}_6$  and  $\text{XeO}_3$

Q.17 The **CORRECT** order of stability for the following carbocations is

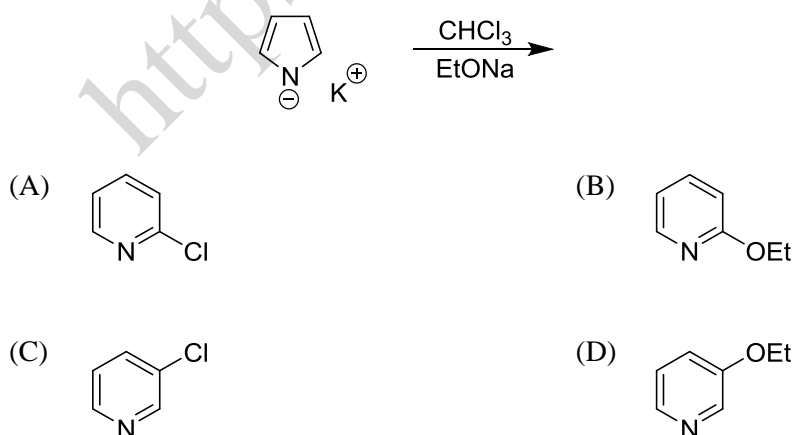


- (A) I < III < IV < II (B) III < II < IV < I  
 (C) II < IV < III < I (D) IV < III < I < II

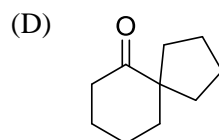
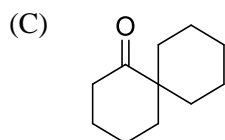
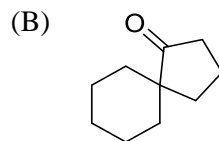
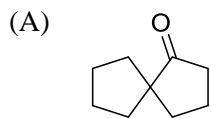
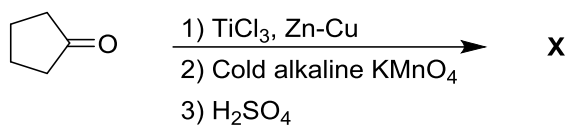
Q.18 Among the dimethylcyclohexanes, which one can be obtained in enantiopure form?



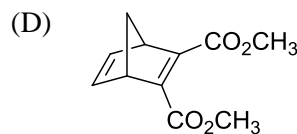
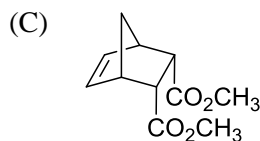
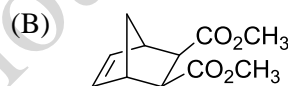
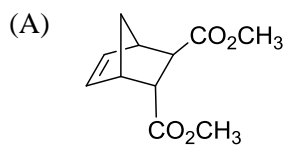
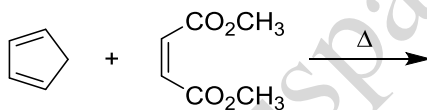
Q.19 The major product formed in the following reaction is



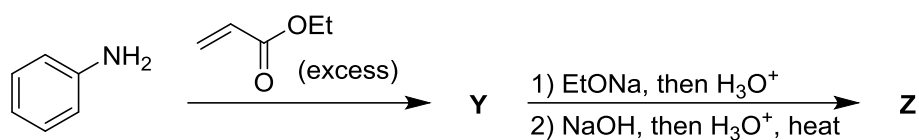
Q.20 The product **X** in the following reaction sequence is

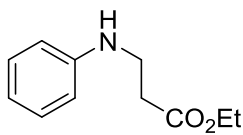
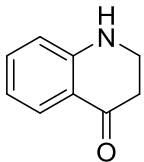
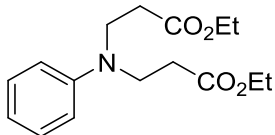
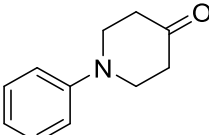
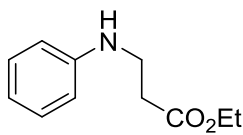
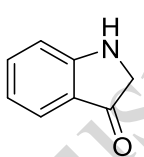
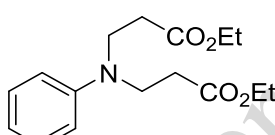
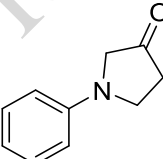


Q.21 The major product formed in the following reaction is

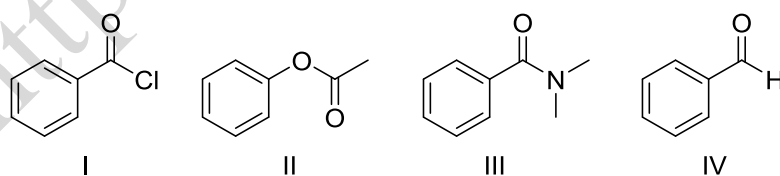


Q.22 The major products **Y** and **Z** in the following reaction sequence are



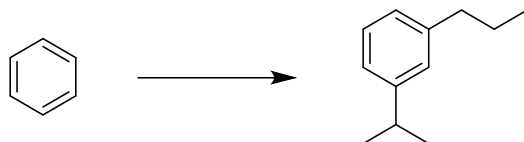
- (A) **Y** =  **Z** = 
- (B) **Y** =  **Z** = 
- (C) **Y** =  **Z** = 
- (D) **Y** =  **Z** = 

Q.23 The **CORRECT** order of carbonyl stretching frequencies for the following compounds is



- (A) II < I < III < IV                      (B) I < III < II < IV
- (C) IV < II < III < I                        (D) III < IV < II < I

Q.24 The sequence of three steps involved in the following conversion is

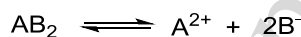


- (A) (i) Friedel-Crafts alkylation; (ii) Reduction; (iii) Friedel-Crafts acylation  
 (B) (i) Friedel-Crafts acylation; (ii) Friedel-Crafts alkylation; (iii) Reduction  
 (C) (i) Friedel-Crafts acylation; (ii) Reduction; (iii) Friedel-Crafts alkylation  
 (D) (i) Friedel-Crafts alkylation; (ii) Friedel-Crafts acylation; (iii) Reduction

Q.25 The **CORRECT** expression that corresponds to reversible and adiabatic expansion of an ideal gas is

- (A)  $\Delta U = 0$                       (B)  $\Delta H = 0$                       (C)  $\Delta S = 0$                       (D)  $\Delta G = 0$

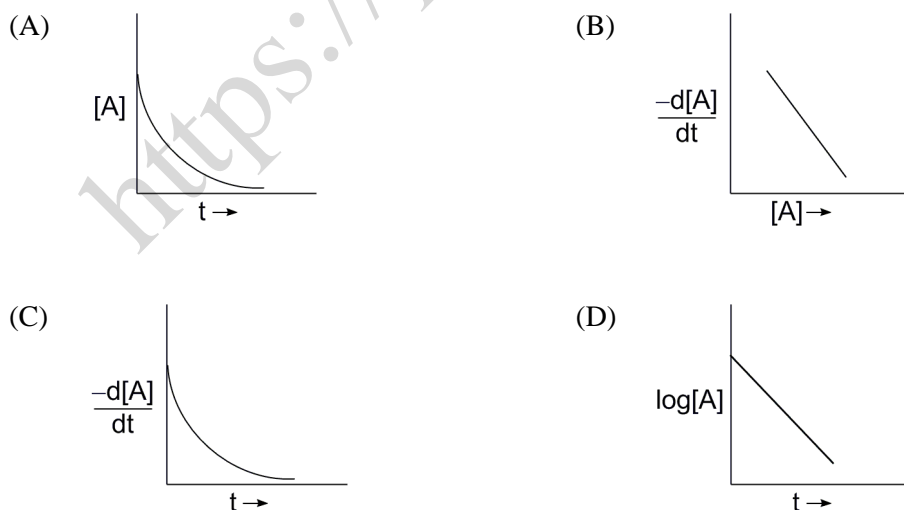
Q.26 The electrolyte  $AB_2$  ionises in water as



The mean ionic activity coefficient ( $\gamma_{\pm}$ ) is

- (A)  $\gamma_{A^{2+}}^{\frac{1}{2}} \gamma_{B^{-}}$                       (B)  $\gamma_{A^{2+}}^{\frac{1}{2}} \gamma_{B^{-}}^{\frac{2}{3}}$                       (C)  $\gamma_{A^{2+}}^{\frac{2}{3}} \gamma_{B^{-}}^{\frac{1}{3}}$                       (D)  $(\gamma_{A^{2+}} + 2\gamma_{B^{-}})^{\frac{1}{2}}$

Q.27 The reaction,  $A \longrightarrow \text{Products}$ , follows first-order kinetics. If  $[A]$  represents the concentration of reactant at time  $t$ , the **INCORRECT** variation is shown in





- Q.28 The behavior of  $\text{Cl}_2$  is closest to ideal gas behavior at
- (A)  $100^\circ\text{C}$  and  $10.0\text{ atm}$   
(B)  $0^\circ\text{C}$  and  $0.50\text{ atm}$   
(C)  $200^\circ\text{C}$  and  $0.50\text{ atm}$   
(D)  $-100^\circ\text{C}$  and  $10.0\text{ atm}$
- Q.29 A vector  $\vec{A} = \vec{i} + x\vec{j} + 3\vec{k}$  is rotated through an angle and is also doubled in magnitude resulting in  $\vec{B} = 4\vec{i} + (4x - 2)\vec{j} + 2\vec{k}$ . An acceptable value of  $x$  is
- (A) 1 (B) 2 (C) 3 (D)  $\frac{4}{3}$
- Q.30 With reference to the variation of molar conductivity ( $\Lambda_m$ ) with concentration for a strong electrolyte in an aqueous solution, the **CORRECT** statement is
- (A) The asymmetry effect contributes to decrease  $\Lambda_m$  whereas the electrophoretic effect contributes to increase  $\Lambda_m$   
(B) The asymmetry effect contributes to increase  $\Lambda_m$  whereas the electrophoretic effect contributes to decrease  $\Lambda_m$   
(C) Both asymmetry effect and electrophoretic effect contribute to decrease  $\Lambda_m$   
(D) Both asymmetry effect and electrophoretic effect contribute to increase  $\Lambda_m$

## SECTION - B

### MULTIPLE SELECT QUESTIONS (MSQ)

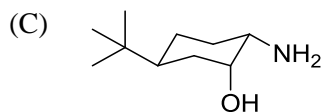
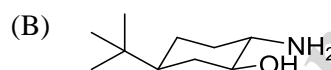
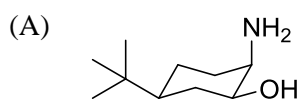
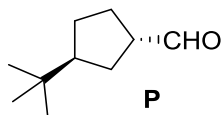
**Q. 31 – Q. 40 carry two marks each.**

- Q.31 Which of the following metal(s) is(are) extracted from its(their) sulfide ore(s) by self-reduction/air reduction method?
- (A) Cu (B) Al (C) Au (D) Pb
- Q.32 In a saturated calomel electrode, the saturation is with respect to
- (A) KCl (B)  $\text{Hg}_2\text{Cl}_2$  (C)  $\text{HgCl}_2$  (D) AgCl
- Q.33 Consider the following six solid binary oxides: CaO,  $\text{Al}_2\text{O}_3$ , PbO,  $\text{Cs}_2\text{O}$ ,  $\text{SiO}_2$  and  $\text{Sb}_2\text{O}_3$ . The pair(s) of ionic oxides is(are)
- (A) CaO and  $\text{Al}_2\text{O}_3$  (B) CaO and PbO (C)  $\text{Cs}_2\text{O}$  and  $\text{Al}_2\text{O}_3$  (D)  $\text{SiO}_2$  and  $\text{Sb}_2\text{O}_3$

Q.34 Choose the **CORRECT** answer(s) with respect to the magnesium-EDTA titration carried out in the pH range 7 – 10.5, using Solochrome black as indicator

- (A) Magnesium–indicator complex is more stable than the magnesium–EDTA complex
- (B) At the end point, the colour changes from red to blue
- (C) After the end point, the colour of the solution is due to the indicator
- (D) pH range of 7 – 10.5 is necessary for observing the specific colour change

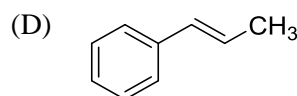
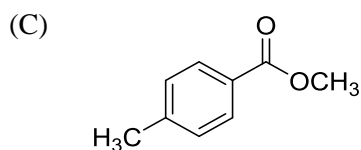
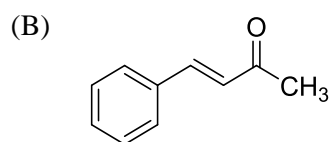
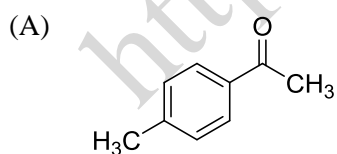
Q.35 On reaction with  $\text{NaNO}_2$  and  $\text{HCl}$ , which of the following amino alcohol(s) will yield compound **P**?



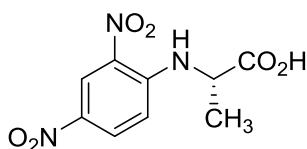
Q.36 The **CORRECT** statement(s) about carbene is(are)

- (A) Carbene is a neutral species
- (B) Carbene is an intermediate in the Curtius rearrangement
- (C) Carbene can insert into both  $\sigma$  and  $\pi$ -bonds
- (D) Carbene is generated from amines on reaction with nitrous acid

Q.37 The compound(s) that shows(show) positive haloform test is(are)



- Q.38 Tetrapeptide(s) that gives(give) the following product on reaction with Sanger's reagent followed by hydrolysis is(are)



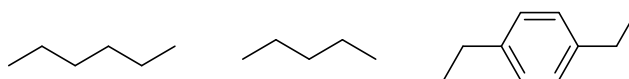
- (A) Ala-Gly-Leu-Phe (B) Asp-Phe-Leu-Pro  
(C) Asp-Gly-Tyr-Phe (D) Ala-Phe-Tyr-Pro
- Q.39 Which of the following set(s) of quantum numbers is(are) **NOT** allowed?
- (A)  $n = 3, l = 2, m_l = -1$  (B)  $n = 4, l = 0, m_l = -1$   
(C)  $n = 3, l = 3, m_l = -3$  (D)  $n = 5, l = 3, m_l = +2$
- Q.40 The **CORRECT** expression(s) for isothermal expansion of 1 mol of an ideal gas is(are)
- (A)  $\Delta A = RT \ln \frac{V_{initial}}{V_{final}}$  (B)  $\Delta G = RT \ln \frac{V_{initial}}{V_{final}}$   
(C)  $\Delta H = RT \ln \frac{V_{final}}{V_{initial}}$  (D)  $\Delta S = R \ln \frac{V_{final}}{V_{initial}}$

### SECTION – C

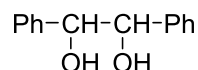
#### NUMERICAL ANSWER TYPE (NAT)

**Q. 41 – Q. 50 carry one mark each.**

- Q.41 The number of possible isomers for  $[\text{Pt}(\text{py})(\text{NH}_3)\text{BrCl}]$  is \_\_\_\_\_. (py is pyridine)
- Q.42 The volume of 0.3 M ferrous ammonium sulphate solution required for the completion of redox titration with 20 mL of 0.1 M potassium dichromate solution is \_\_\_\_\_ mL.
- Q.43 Among the following hydrocarbon(s), how many of them would give rise to three groups of proton NMR peaks with 2:2:3 integration ratio?



Q.44 The number of stereoisomers possible for the following compound is \_\_\_\_\_.



Q.45 The number of hydrogen bond(s) present in a guanine-cytosine base pair is \_\_\_\_\_.

Q.46 The time for 50% completion of a zero order reaction is 30 min. Time for 80% completion of this reaction is \_\_\_\_\_ min.

Q.47 Consider the reaction  $\text{CO}(g) + \frac{1}{2} \text{O}_2(g) \longrightarrow \text{CO}_2(g)$ .

The value of  $\Delta U$  for the reaction at 300 K is  $-281.8 \text{ kJ mol}^{-1}$ . The value of  $\Delta H$  at same temperature is \_\_\_\_\_  $\text{kJ mol}^{-1}$  (rounded up to the first decimal place).  
[ $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

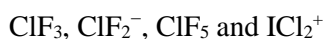
Q.48 The nuclear spin quantum number ( $I$ ) of a nucleus is  $\frac{3}{2}$ . When placed in an external magnetic field, the number of possible spin energy states it can occupy is \_\_\_\_\_.

Q.49 The value of  $C_v$  for 1 mol of  $\text{N}_2$  gas predicted from the principle of equipartition of energy, ignoring vibrational contribution, is \_\_\_\_\_  $\text{J K}^{-1} \text{ mol}^{-1}$  (rounded up to two decimal places).  
[ $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

Q.50 Assuming ideal gas behavior, the density of  $\text{O}_2$  gas at 300 K and 1.0 atm is \_\_\_\_\_  $\text{g L}^{-1}$  (rounded up to two decimal places).  
[ $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$ , molar mass of  $\text{O}_2 = 32$ ]

**Q. 51 – Q. 60 carry two marks each.**

Q.51 How many of the following interhalogen species have 2 lone pairs of electrons on the central atom?

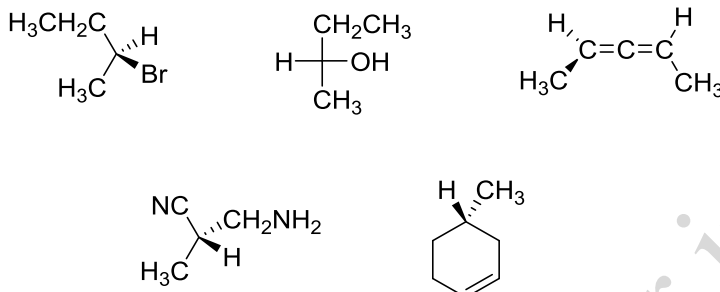


Q.52  $^{24}\text{Na}$  decays to one-fourth of its initial amount in 29.8 hours. Its decay constant is \_\_\_\_\_  $\text{hour}^{-1}$  (rounded up to four decimal places).

Q.53 The magnitude of crystal field stabilization energy (CFSE) of octahedral  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  complex is  $7680 \text{ cm}^{-1}$ . The wavelength at the maximum absorption ( $\lambda_{\text{max}}$ ) of this complex is \_\_\_\_\_ nm (rounded up to the nearest integer).

Q.54 Elemental analysis of an organic compound containing C, H and O gives percentage composition: C: 39.9 % and H: 6.7 %. If the molecular weight of the compound is 180, the number of carbon atoms present in the molecule is \_\_\_\_\_.

Q.55 The number of compounds having *S*-configuration among the following is \_\_\_\_\_.



Q.56 The *emf* of a standard cadmium cell is 1.02 V at 300 K. The temperature coefficient of the cell is  $-5.0 \times 10^{-5} \text{ V K}^{-1}$ . The value of  $\Delta H^\circ$  for the cell is \_\_\_\_\_  $\text{kJ mol}^{-1}$  (rounded up to two decimal places).  
[1 F = 96500 C mol<sup>-1</sup>]

Q.57 For the reaction  $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{l})$ , the following information is given

$$T = 300 \text{ K}$$

$$\Delta \bar{H}^\circ = -285 \text{ kJ mol}^{-1}$$

$$\bar{S}_{\text{H}_2\text{O}}^\circ(\text{l}) = 70 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\bar{S}_{\text{O}_2}^\circ(\text{g}) = 204 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\bar{S}_{\text{H}_2}^\circ(\text{g}) = 130 \text{ J K}^{-1} \text{ mol}^{-1}$$

$\Delta \bar{S}_{\text{universe}}^\circ$  for the reaction is \_\_\_\_\_  $\text{J K}^{-1} \text{ mol}^{-1}$ .

Q.58 For  $\text{H}_2$  molecule, the fundamental vibrational frequency ( $\bar{\nu}_e$ ) can be taken as  $4400 \text{ cm}^{-1}$ . The zero-point energy of the molecule is \_\_\_\_\_  $\text{kJ mol}^{-1}$  (rounded up to two decimal places).  
[ $h = 6.6 \times 10^{-34} \text{ J s}$ ,  $c = 3 \times 10^8 \text{ m s}^{-1}$ ,  $N_A = 6 \times 10^{23} \text{ mol}^{-1}$ ]

Q.59 The solubility of  $\text{PbI}_2$  in 0.10 M  $\text{KI}(\text{aq})$  is \_\_\_\_\_  $\times 10^{-7} \text{ M}$  (rounded up to two decimal places).  
[The solubility product,  $K_{\text{sp}} = 7.1 \times 10^{-9}$ ]

Q.60 The electron of a hydrogen atom is in its  $n^{\text{th}}$  Bohr orbit having de Broglie wavelength of  $13.4 \text{ \AA}$ . The value of  $n$  is \_\_\_\_\_ (rounded up to the nearest integer).  
[Radius of  $n^{\text{th}}$  Bohr orbit =  $0.53n^2 \text{ \AA}$ ,  $\pi = 3.14$ ]

**END OF THE QUESTION PAPER**

<b>Paper Code : CY</b>			
<b>Q. No.</b>	<b>Question Type (QT)</b>	<b>Section</b>	<b>Key/Range (KY)</b>
1	MCQ	A	A
2	MCQ	A	A
3	MCQ	A	A
4	MCQ	A	B
5	MCQ	A	C
6	MCQ	A	B
7	MCQ	A	A
8	MCQ	A	A
9	MCQ	A	D
10	MCQ	A	D
11	MCQ	A	D
12	MCQ	A	A
13	MCQ	A	A
14	MCQ	A	B
15	MCQ	A	C
16	MCQ	A	D
17	MCQ	A	C
18	MCQ	A	A
19	MCQ	A	C
20	MCQ	A	D
21	MCQ	A	C
22	MCQ	A	B
23	MCQ	A	D

<b>Paper Code : CY</b>			
<b>Q. No.</b>	<b>Question Type (QT)</b>	<b>Section</b>	<b>Key/Range (KY)</b>
24	MCQ	A	B
25	MCQ	A	C
26	MCQ	A	Marks To All (MTA)
27	MCQ	A	B
28	MCQ	A	C
29	MCQ	A	B
30	MCQ	A	C
31	MSQ	B	A,D
32	MSQ	B	A,B
33	MSQ	B	A,C
34	MSQ	B	B,C,D
35	MSQ	B	B,C
36	MSQ	B	A,C
37	MSQ	B	A,B
38	MSQ	B	A,D
39	MSQ	B	B,C
40	MSQ	B	A,B,D
41	NAT	C	3 to 3
42	NAT	C	40 to 40
43	NAT	C	2 to 2
44	NAT	C	3 to 3
45	NAT	C	3 to 3
46	NAT	C	48 to 48

<b>Paper Code : CY</b>			
<b>Q. No.</b>	<b>Question Type (QT)</b>	<b>Section</b>	<b>Key/Range (KY)</b>
47	NAT	C	-286.0 to -282.0
48	NAT	C	4 to 4
49	NAT	C	20.00 to 21.00
50	NAT	C	1.29 to 1.31
51	NAT	C	2 to 2
52	NAT	C	0.0460 to 0.0470
53	NAT	C	520 to 521
54	NAT	C	6 to 6
55	NAT	C	4 to 4
56	NAT	C	-201.00 to -198.00
57	NAT	C	786 to 790
58	NAT	C	25.80 to 26.40
59	NAT	C	7.0 to 7.2
60	NAT	C	4 to 4