

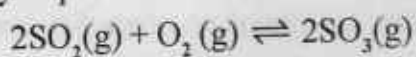
2024

CHEMISTRY
(Theory)**Full Marks : 70****Pass Marks : 21****Time : Three hours***All the Questions are compulsory.**The figures in the right margin indicate full marks for the questions.***Question Nos. 1–10 are Very short Answer (VSA) types of 1 mark each.**

1. What are isobars? 1
2. According to Bohr's theory, the energy of an electron in a stable stationary state is expressed as, $E_n = -R_H \left(\frac{1}{n} \right)$. Why is the energy considered to be negative? 1
3. What will be the IUPAC name of the hypothetical element having atomic number 120? 1
4. Assign formal charge to the oxygen atom in the cyanate ion, 1
 $[\text{:}\ddot{\text{O}}-\text{C}\equiv\text{N}]^-$
5. 1.0 dm³ of an ideal gas at 5 atmospheric pressure undergoes free expansion isothermally to a final volume of 5.0 dm³. How much heat is absorbed by the system during the process? 1

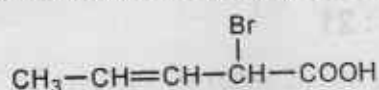
P.T.O.

6. A key step in acid rain formation is the oxidation of sulphur dioxide,



The equilibrium constant for the forward reaction is found to be 261. What will be the equilibrium constant for the backward reaction? 1

7. Write the conjugate base of H_2S . 1
8. Assign oxidation number of Mn in KMnO_4 . 1
9. Write the IUPAC name of the following compound. 1



10. Why does 2,2-dimethylpropane have lower boiling point than its isomer n-pentane? 1

Question Nos. 11-17 are Multiple choice questions (MCQ) carrying 1 mark each. Choose and rewrite the best answer out of the given alternatives.

11. The number of significant figures in the scientific notation 1.23×10^5 is— 1

- (A) One
(B) Three
(C) Five
(D) Eight

12. Cathode rays consist of— 1

- (A) neutrons
(B) positrons
(C) electrons
(D) α -particles

13. Which of the following is an element whose existence was predicted by Mendeleev and discovered later? 1
- (A) Silicon
(B) Aluminium
(C) Gallium
(D) Cesium
14. In which of the following compounds the central atom does not obey the octet rule of bonding? 1
- (A) CH_3Cl
(B) BH_3
(C) NH_3
(D) H_2O
15. Melting of KCl crystal is associated with an enthalpy change of 7.25 J mol^{-1} and entropy change of 0.007 J mol^{-1} . The melting point of the crystal is – 1
- (A) 762.7°C
(B) 752.0°C
(C) 1111.0°C
(D) 1035.7°C
16. Which of the following compounds has the most electronegative carbon atom? 1
- (A) CH_4
(B) CH_3-CH_3
(C) $\text{CH}_2=\text{CH}_2$
(D) $\text{CH}_3-\text{C}\equiv\text{CH}$

17. But-2-yne on reduction with sodium metal in liquid ammonia gives – 1
- (A) n-Butane
 - (B) trans-But-2-ene
 - (C) cis-But-2-ene
 - (D) Isobutane

Question Nos. 18 - 26 are Short Answer (SA - II) types of 2 marks each.

18. A compound of nitrogen and oxygen weighing 1.587 g on analysis, is found to contain 0.483 g N and 1.104 g O. Calculate the empirical formula of the compound. 2
19. State Heisenberg uncertainty principle and write its equation. 2
20. How does the ΔH_{rxn} change when 2
- (i) the reaction is reversed?
 - (ii) the stoichiometric equation of the reaction is multiplied by 2?
21. The heat of vaporization, ΔH_{vap} , of carbon tetrachloride, CCl_4 , at 25°C is 39.4 kJ/mol . $\text{CCl}_4(l) \rightarrow \text{CCl}_4(g)$
- If 1 mol of liquid carbon tetrachloride at 25°C has an entropy of 216 J/K , calculate the entropy of 1 mol of the vapour in equilibrium with the liquid at this temperature. 2
22. Explain why aqueous ammonium chloride solution is acidic. 2
23. For the reaction, $\text{PCl}_3(g) + \text{Cl}_2(g) \rightleftharpoons \text{PCl}_5(g)$ $\Delta H^\circ = -111 \text{ kJ}$, predict the
- (i) Change in equilibrium when temperature is decreased.
 - (ii) Change in $[\text{PCl}_3]$ when some Cl_2 is removed. 2
24. Identify the oxidant and reductant in the following redox reaction. 2
- $$\text{Fe}_2\text{O}_3(s) + 3 \text{CO}(g) \rightarrow 2 \text{Fe}(s) + 3 \text{CO}_2(g)$$
25. Explain resonance effect using a suitable example. 2

26. Write the bond line structure of the alicyclic and heterocyclic constitutional isomers of C_3H_7N . 2

27. Explain why the ethylenic bond is a good site for attack by electrophilic reagents. 2

Question Nos. 28-33 are Short Answer (SA - I) types of 3 marks each.

28. *Either*

(a) State whether each of the following sets of quantum numbers is permissible for an electron in an atom. If a set is not permissible, explain why. 3

(i) $n=3, l=1, m_l=-2, s=-\frac{1}{2}$

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

(iii) $n=2, l=1, m_l=0, s=1$

Or

(b) Illustrate Hund's rule of maximum spin multiplicity in the case of oxygen atom.

29. *Either*

(a) State modern periodic law. How does the atomic radii vary in a period and in a group. 3

Or

(b) Write the general valence shell electronic configuration of s-, p- and d-Block elements.

30.

Either

- (a) Derive the relationship between C_p and C_v for one mole of an ideal gas. 3

Or

- (b) Show that the work done in isothermal reversible expansion of an ideal gas.

$$W_{\text{rev}} = -2.303nRT \log \frac{V_f}{V_i}$$

31.

Either

- (a) A buffer solution is prepared by adding acetic acid to an aqueous solution of sodium acetate. Is the buffer solution acidic or basic? Derive the Handerson-Hasselbalch equation for the buffer system. 3

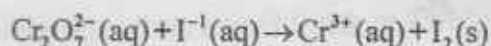
Or

- (b) For a general gaseous reaction in equilibrium, $aA + bB \rightleftharpoons cC + dD$, show that $K_p = K_c(RT)^{\Delta n}$

32.

Either

- (a) Balance the following redox reaction by ion electron method



3

Or

- (b) When red copper metal powder is added to a colourless aqueous silver nitrate solution, the solution turns bluish. Justify that the change involves a redox reaction.

33.

Either

- (a) 1.0 g of an organic acid on combustion gives 0.7 g CO_2 and 0.6 g H_2O . Calculate the mass percentage of carbon, hydrogen and oxygen present in the acid. 3

Or

- (b) A sample of rubbing alcohol is found to contain propan-2-ol (boiling point 83°C) and ethanol (boiling point 78°C). Describe how can the two alcohols be separated from the mixture?

Question Nos. 34-36 are Essay (E) types of 5 marks each.

34.

Either

- (a) In an industrial process, hydrogen chloride is prepared by burning 10 g hydrogen gas in an atmosphere of 5 g chlorine gas. Write the chemical equation for the reaction and identify the limiting reagent. How much hydrogen chloride will be produced in the process?

- (b) Illustrate the Law of Multiple Proportion using a suitable example.

3+2=5

Or

- (a) An aqueous solution has 0.150 mole fraction glucose, $\text{C}_6\text{H}_{12}\text{O}_6$. Calculate the molality of the solution.

- (b) Illustrate with a suitable example the law of definite proportions.

3+2=5

35.

Either

- (a) Draw the molecular orbital energy level diagram Li_2 . Write its molecular electronic configuration and state the bond order also?

- (b) Define hybridization.

4+1=5

Or

- (a) Write the postulates of the VSEPR theory.

- (b) Define hydrogen bond.

4+1=5

36.

Either

(a) Hydrocarbon n-butane on treatment with a limited amount of bromine undergoes monobromination only to produce compound "X". Compound "X" on treatment with alcoholic potash gives a new compound "Y" which can show geometrical isomerism. Identify the compound "X" and the two geometrical isomers of "Y".

(b) Write the mechanism involved in the conversion of benzene to chlorobenzene. 3+2=5

Or

(a) An alkyne "A" with molar mass 26, on passing through red hot iron tube at 600°C is converted to another hydrocarbon "B". Treatment with acetyl chloride in the presence of ferric chloride introduces a functional group in "B" to give compound "C". Identify the compounds "A", "B" and "C".

(b) Write the mechanism involved in the conversion of 2-methylpropene to 2-bromo-2-methylpropane. 3+2=5