2023

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. Write the mathematical representation of Heisenberg's uncertainty principle. 1

2. Consider NH_3 and NF_3. Which one has higher dipole moment ? 1

3. Predict the bond order of He_2^+ ion. 1

4. Water decomposes by absorbing 286.2 kJ of electrical energy per mole. When H_2 and O_2 combine to form one mole of H_2O, 286.2 kJ of heat is produced. What statement of the law follows from it ? 1

5. Why is standard hydrogen electrode called a reversible electrode ? 1

6. M, an alkali metal reacts with nitrogen in the following reaction. Identify M.

$$6M\,(s) + N_2\,(g) \xrightarrow{\Delta} 2M_3\,N(s)$$ 1

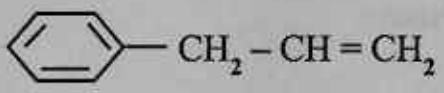
7. A mixture of dilute NaOH and aluminium pieces is used to open clogged drain. Give reason. 1

8. If the starting material for the manufacture of silicones is $RSiCl_3$, draw the structure of the product. 1

9. Write the bond line formula for : 1

   4-Chloro - 2, 3, 5 - trimethyl hexanal

10. Give the IUPAC name of the compound : 1



Question Nos. 11 – 14 are Objective types (MCQ) carrying 1 mark each. Choose and rewrite the best answer out of the given alternatives.

11. A molecule of O_2 and that of SO_2 travel with the same velocity. The ratio of their wavelengths is 1

   (A) 1

   (B) 2

   (C) 2.5

   (D) 3

12. Which of the following is strongest conjugate base ? 1

   (A) I^-

   (B) Br^-

   (C) Cl^-

   (D) F^-

13. Which of the following element does $\overline{\text{NOT}}$ form hydride by direct heating with dihydrogen? 1

(A) Beryllium

(B) Magnesium

(C) Strontium

(D) Barium

14. Hyperconjugation is most useful for stabilising – 1

(A) neo-pentyl carbocation

(B) tert- butyl carbocation

(C) isopropyl carbocation

(D) ethyl carbocation

Question Nos. 15 – 24 are Short Answer (SA-II) types of 2 marks each.

15. Define the term 'molarity'. What is the effect of temperature on molarity of a solution? 2

16. Calculate the empirical formula of an oxide of metal 'A' which has 69.9% A and 30.1 % dioxygen by mass. [Atomic mass of 'A' = 55.85 amu 'O' = 16.00 amu] 2

17. What is the basic difference in approach between Mendeleev's Periodic Law and Modern Periodic Law? 2

18. Assign the position of the element having outer electronic configuration, $(n-2)\,f^7\,(n-1)\,d^1ns^2$ for $n = 6$ in the periodic table and justify the answers. 2

19. The size of the weather balloon becomes larger and larger as it ascends up into higher altitude. Give reason. 2

20. Pressure of 1g of an ideal gas 'A' at 27°C is found to be 2 bar. When 2g of another ideal gas 'B' is introduced in the same flask at the same temperature, the pressure becomes 3 bar. Find a relationship between their molecular masses. 2

21. A buffer solution of acetic acid and sodium acetate is diluted 10 times. What is the effect on its pH ? Justify the answers. 2

22. Explain the following observations :

    (a) Alkali metals do not occur in free state.

    (b) Alkali and alkaline earth metals cannot be obtained by chemical reduction method. 2

23. Discuss the homolytic and heterolytic cleavage of convalent bond. Give one example each. 2

24. Write the preparation of the following compounds :

    (i) n-Butane by Wurtz reaction

    (ii) Benzene from ethyne 2

Question Nos. ***25 –31*** *are Short Answer (SA-I) types of* ***3*** *marks.*

25. Write down all the four quantum numbers for : 3

    19^{th} electron of $_{24}Cr$

26. An atom 'X' having seven valence electrons form covalent compound with five fluorine atoms. Predict the shape of the molecule according to VSEPR theory. Represent the structure. 3

27. What are homogeneous and heterogenous equilibria. Give one example each. 3

28. Fluorine reacts with ice and results in the change : 3

$H_2O(s) + F_2(g) \rightarrow HF(g) + HOF(g)$

Justify that the reaction is a redox reaction.

29. (a) What is meant by demineralized water ?

(b) Give the chemical reactions to justify the amphoteric nature of water. 3

30. Write the structural formulae of the possible isomers of the organic compound having the molecular formula C_3H_6O and assign the type of isomerism. 3

31. What are green house gases ? What would have happened if the green house gases were totally missing in the earth's atmosphere ? 3

Questions from 32 – 34 are Essay (E) types carrying 5 marks each.

32. (a) State Hess's Law.

(b) Calculate the standard enthalpy of formation of CH_3OH (l) from the following data :

$CH_3OH(l) + \frac{3}{2} O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; $\Delta_r H^{\ominus} = -726\ kJmol^{-1}$

$C\ (graphite) + O_2(g) \rightarrow CO_2(g)$; $\Delta_c H^{\ominus} = -393\ kJmol^{-1}$

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$; $\Delta_f H^{\ominus} = -286\ kJmol^{-1}$

(c) In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in the internal energy for the process?

1+3+1=5

OR

(d) Define specific heat capacity.

(e) A swimming pool contains 1×10^6 L of water. How much energy in joules is required to raise the temperature of water from 20°C to 30°C ? The specific heat capacity of water is 4.184 $J°C^{-1} g^{-1}$ [density of water = 1 gc^{-3}]

(f) At 298 K, Kp for the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 0.98. Predict whether the reaction is spontaneous or not. 1+3+1=5

33. (a) What are group 13 elements ?

(b) Write the preparation of Borazine and Lithium borohydride from diborane.

(c) Write a brief account on the reactivity of BF_3 with a suitable reaction.

1+2+2=5

OR

(d) What are group 14 elements ?

(e) Write the laboratory preparations of CO and CO_2.

(f) Write a brief account on Fullerenes. 1+2+2=5

34. (a) Addition of HBr to propene to yield α-Bromopropene is an ionic electrophilic addition reaction. Justify.

(b) Convert 1,2 - Dibromoethane into ethane.

(c) What effect does branching of an alkane chain has in its boiling point ?

2+2+1=5

OR

(d) Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitution with difficulty ?

(e) Convert benzene into ρ-Nitrotoluene.

(f) Hex-2-ene molecule exist in two 'cis' and 'trans' isomers. Which isomer will have higher boiling point ? 2+2+1=5