

2023

CHEMISTRY**(Theory)**

Full Marks : 70

Time : 3 hours

General Instructions :

- (i) All questions are compulsory.
- (ii) Question No. **1** to **5** are multiple choice questions carrying 1 mark each.
- (iii) Question No. **6** to **10** are very short answer questions carrying 1 mark each.
- (iv) Question No. **11** to **17** are short answer questions carrying 2 marks each.
- (v) Question No. **18** to **26** are long answer questions carrying 3 marks each.
- (vi) Question No. **27** is a value based answer question carrying 4 marks.
- (vii) Question No. **28 to 30** are very long answer questions carrying 5 marks each.
- (viii) If necessary simple calculator and log table can be used.

Choose the correct answer:

1 × 5 = 5

- 1. Considering the elements *B*, *Al*, *Mg* and *K* the correct order of their metallic character is : 1
 - (a) $B > Al > Mg > K$
 - (b) $Al > Mg > B > K$
 - (c) $Mg > Al > K > B$
 - (d) $K > Mg > Al > B$
- 2. The % by mass of carbon in methane is: 1
 - (a) 25%
 - (b) 50%
 - (c) 75%
 - (d) 100%
- 3. Which of the following has the highest dipole moment? 1
 - (a) NH_3
 - (b) NF_3
 - (c) BF_3
 - (d) $BeCl_2$

(3)

4. An electrophilic reagent is: 1
- (a) Electron deficient species
- (b) Electron rich species
- (c) Negatively charged species
- (d) A Lewis base

5. The empirical formula and molecular mass of a compound are CH_2O and 180g respectively. What will be the molecular formula of the compound? 1
- (a) $\text{C}_9\text{H}_{18}\text{O}_9$
- (b) CH_2O
- (c) $\text{C}_6\text{H}_{12}\text{O}_6$
- (d) $\text{C}_2\text{H}_4\text{O}_2$

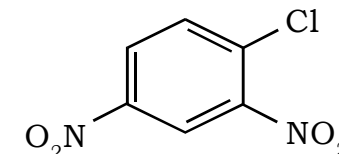
PART — II

6. How do you express the bond length in terms of bond order? 1
7. Define molarity of a solution. 1
8. Write down the electronic configuration of Cr (Atomic no.24). 1

(4)

9. What type of a chemical reaction attain a state of equilibrium when carried out in a closed vessel? 1

10. Give the IUPAC name of 1



PART — III

11. Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% oxygen by mass. 2
12. Derive de-Broglie equation. 2
13. Define (i) Entropy and (ii) Gibb's free energy 2

14. *Either*

- (a) Define and explain the law of multiple proportion with suitable example. 2

Or

- (b) How many moles of nitrogen will be needed to produce 8.2 moles of ammonia by reaction with hydrogen. 2

(5)

15. (a) Why does BF_3 behave as Lewis acid? 1
(b) Define Octet rule. 1
16. Derive the relation : $\Delta H = \Delta U - p\Delta V$ 2
17. *Either*
- (a) Explain the shapes of the following on the basis of VSEPR theory. 2
(i) BeCl_2 (ii) PCl_5
Or
- (b) Define Intermolecular and Intramolecular hydrogen bonding with examples. 2

PART — IV

18. (a) Give the relationship between standard free energy change and equilibrium constant. 1
(b) State First Law of Thermodynamics and derive its mathematical expression. 2
19. (a) An atomic orbital has $n=3$. What are the possible values of l and m_l ? 1
(b) How many protons, electrons and neutrons are there in $^{25}_{12}\text{Mg}$? 2

(6)

20. (a) Find out the oxidation number of the underlined elements in each of the following species. 1
(i) $\text{K}\underline{\text{C}}\text{IO}_3$ (ii) $[\underline{\text{F}}\text{e}(\text{CN})_6]^{4-}$
- (b) Write the expression for the equilibrium constant, K_c of the following reaction. 1
$$2\text{NOCl(g)} \rightleftharpoons 2\text{NO(g)} + \text{Cl}_2\text{(g)}$$
- (c) What is common ion effect? 1
21. *Either*
- (a) Ionization enthalpy of Nitrogen is more than that of oxygen. Give reason. 2
- (b) Why electrons are first filled up in the 4s orbital and then the 3d orbital in writing electronic configuration of atoms? 1
- Or*
- (c) Among the elements B, Al, C and Si which has the most negative electron gain enthalpy? 1
- (d) How do atomic radius vary in a period and in a group? How do you explain the variation? 2

(7)

- 22.** *Either*
- (a) Permanganate ion reacts with iodide ion in acidic medium to give Manganese ion and iodine. Write a balanced chemical equation for the reaction by oxidation number method/ion electron method. 3

Or

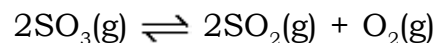
- (b) Define Oxidation and Reduction in terms of electronic concept with suitable example. 3
- 23.** (a) What will be the wavelength of a ball of mass 0.1kg moving with a velocity of 10ms^{-1} . 1
- (b) What are Isotopes and Isobars? 2

- 24.** (a) The equilibrium constant expression for a gas reaction is 1

$$K_c = \frac{[\text{NH}_3]^4 [\text{O}_2]^5}{[\text{NO}]^4 [\text{H}_2\text{O}]^6}$$

Write the balanced chemical equation corresponding to this expression.

- (b) Calculate K_c for the reaction: 2



for which $K_p = 3.5 \times 10^{-23}$ atm at 27°C

Given $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$.

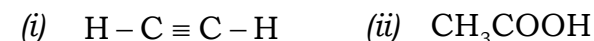
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- 25.** *Either*
- (a) Write Lewis dot symbols for the following atom and ion. 1
- (i) S^{2-} (ii) Al

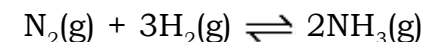
- (b) What is a Buffer solution? Give examples. 2

Or

- (c) What is the total number of σ and π bonds in the following molecules? 1



- (d) What is the effect of increasing pressure on the equilibrium? 2



- 26.** (a) Explain Isoelectronic species with examples. 2

- (b) State Hess's Law of Constant Heat Summation. 1

PART – V

- 27.** $-\text{NO}_2$ group attached to benzene ring is meta directing whereas $-\text{OH}$ group is ortho and para directing. Why? 4

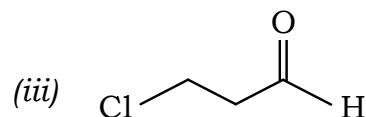
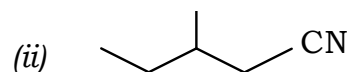
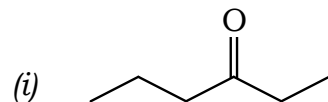
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28.

Either

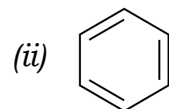
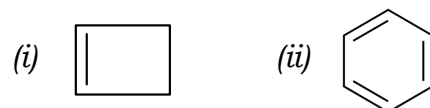
- (a) Give a complete structural formula of the following compounds.

3



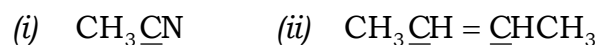
- (b) Which of the following compounds are aromatic according to Huckel rule?

1



- (c) Give the hybridisation state of the underlined Carbon atom in the following molecules.

1



Or

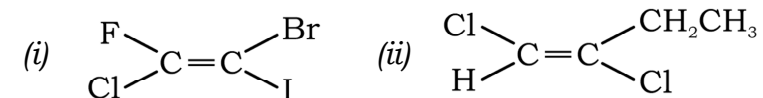
- (d) Explain Inductive effect and Electromeric effect with suitable examples.

3

(10)

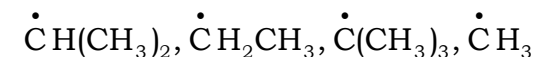
- (e) Assign E-Z system to the following compounds

1



- (f) Give the correct order of stability of the following alkyl free radicals.

1



29.

Either

- (a) Define Rearrangement reaction and Isomerisation reaction with examples.

3

- (b) What is α - elimination reaction?

1

- (c) What are carbenes?

1

Or

- (d) What are Carbocations and Carbanions?

3

- (e) Write down the Resonance structure of Aniline.

1

- (f) Write bond line formula of Isopropyl alcohol.

1

30. (a) What happens when benzene is treated with chlorine in the presence of anhydrous AlCl_3 ?
(Give equation only) 1
- (b) Complete the reaction: 1
- (i) $\text{CaC}_2 + 2\text{H}_2\text{O} \rightarrow$
- (ii) $\text{CH}_3 - \text{CH} = \text{CH}_2 + \text{HBr} \xrightarrow{\text{Peroxide}}$ 1
- (c) Explain Geometrical Isomerism with suitable examples. 2

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