FYUG Odd Semester Exam., 2024

CHEMISTRY

(3rd Semester)

Course No. : CHMDSM–201T

(Fundamentals of Chemistry—II)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

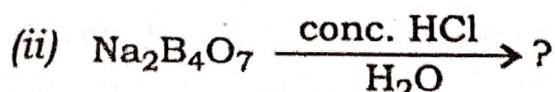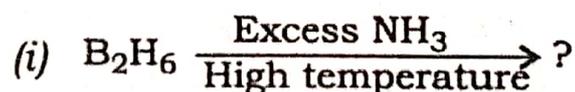*The figures in the margin indicate full marks for the questions*

UNIT—I

1. Answer any *two* of the following questions :

$2 \times 2 = 4$

(a) "$B(OH)_3$ is an acid but $Al(OH)_3$ is amphoteric." Explain. 2

(b) Complete the following reactions and draw the structures of the products formed : $1+1=2$

(i) $B_2H_6 \xrightarrow[\text{High temperature}]{\text{Excess } NH_3}$?

(ii) $Na_2B_4O_7 \xrightarrow[\text{H}_2O]{\text{conc. HCl}}$?

(c) What are allotropes? Give two examples of allotropes of carbon. 2

(Turn Over)

Scanned with OKEN Scanner

2. Answer any *one* of the following questions :   10

  (a)   *(i)* Predict the products of the following reactions : $1 \times 3 = 3$

     1. $BCl_3 + H_2O \longrightarrow ?$

     2. $2CaO.3B_2O_3 + 2Na_2CO_3 \longrightarrow ?$

     3. $B_2H_6 + Cl_2 \xrightarrow{298 \text{ K}} ?$
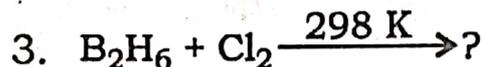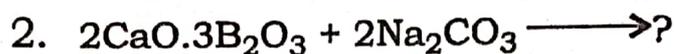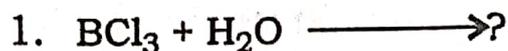
   (ii) "Orthoboric acid is a very weak acid but in the presence of glycerol or ethylene glycol, it acts as a strong acid." Explain.   2

   (iii) Why is concentrated HNO_3 suitable for transportation in aluminium containers, whereas concentrated HCl is not? Explain.   2

   (iv) Discuss in detail the structure of diborane.   3

  (b)   *(i)* What is catenation? Why is carbon particularly well-suited for this property compared to other elements of group-14? Explain. $1 + 2 = 3$

   (ii) Write short notes on the following : $2 \times 2 = 4$
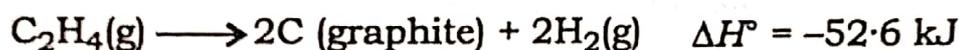
     1. Silicones

     2. Zeolites

   (iii) Explain why diamond is a good electrical insulator, while graphite is a good conductor of electricity. Explain the role of graphite in the production of fullerenes. $2 + 1 = 3$

UNIT—II

3. Answer any *two* of the following questions :

$2 \times 2 = 4$

(a) Define extensive and intensive properties with one example of each. 2

(b) Define the terms 'bond energy' and 'resonance energy'. 2

(c) What is integral enthalpy of solution? 2

4. Answer any *one* of the following questions : 10

(a) (i) State the first law of thermo-dynamics. Give the mathematical formulation of the first law of thermodynamics. $1+2=3$

(ii) The enthalpy of combustion of $C_6H_{12}O_6(s)$ is $-2816 \text{ kJ mol}^{-1}$ at $25\,°C$. Calculate the standard enthalpy of formation (ΔH_f°) of $C_6H_{12}O_6(s)$. The ΔH_f° values for $CO_2(g)$ and $H_2O(l)$ are $-393{\cdot}5 \text{ kJ mol}^{-1}$ and $-285{\cdot}9 \text{ kJ mol}^{-1}$ respectively. 2

(iii) For one mole of an ideal gas, deduce the relationship between heat capacity at constant pressure (C_P) and heat capacity at constant volume (C_V). 3

(iv) "Enthalpies of formation of $H_2O(g)$ and $H_2O(l)$ are not same." Justify the statement with proper reasonings. 2

(b) *(i)* What is standard enthalpy of formation? Discuss in detail the variation of enthalpy of a reaction with temperature. 1+3=4

(ii) Calculate the C=C bond enthalpy from the following data :

$C_2H_4(g) \longrightarrow 2C$ (graphite) $+ 2H_2(g)$ $\Delta H° = -52.6$ kJ

$C(graphite) \longrightarrow C(g)$ $\Delta H° = 716.7$ kJ

$H_2(g) \longrightarrow 2H(g)$ $\Delta H° = 435.9$ kJ

and enthalpy of C—H bond is 413 kJ. 3

(iii) What is inversion temperature? Why is Joule-Thomson coefficient of an ideal gas always zero? 1+2=3

Unit—III

5. Answer any *two* of the following questions : 2×2=4

(a) What do you mean by ideal and non-ideal solutions? Explain. 2

(b) What is azeotropic mixture? Give one example of it. 2

(c) Write the mathematical expression of Gibbs' phase rule and explain the various terms involved in it. 2

**6.** Answer any *one* of the following questions :   10

(a) (i) State the Raoult's law for a solution of volatile liquids. Show that the relative lowering of vapour pressure for a solution is equal to the mole fraction of the solute when solvent alone is volatile.   1+2=3

(ii) Give the labelled phase diagram of water system and discuss the importance of various points, lines and areas.   1+3=4

(iii) The vapour pressures of pure components *A* and *B* are 120 mmHg and 96 mmHg respectively. What will be the partial pressures of the components and the total pressure, when the solution contains 1 mole of component *A* and 4 moles of component *B* and the solution is ideal?   3

(b) (i) Draw the labelled phase diagram of sulphur system and discuss its salient features.   1+3=4

(ii) Determine the number of components, phases and degrees of freedom in the following equilibrium system :   2
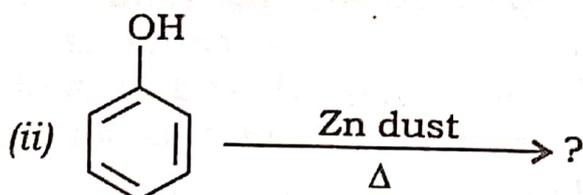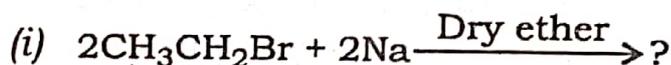
$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

(Turn Over)
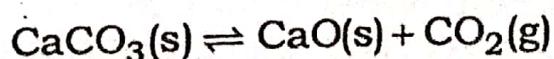
(iii) Explain why KCl–NaCl–H$_2$O system is regarded as a 3-component system, whereas KCl–NaBr–H$_2$O system is regarded as a 4-component system. **2**

(iv) Draw and discuss the vapour pressure composition diagram for ideal solutions. **2**

UNIT—IV

7. Answer any *two* of the following questions : 2×2=4

(a) Predict the products of the following reactions : 1+1=2

  (i) 2CH$_3$CH$_2$Br + 2Na $\xrightarrow{\text{Dry ether}}$?

  (ii)

  OH

  (benzene ring with OH) $\xrightarrow[\Delta]{\text{Zn dust}}$?

(b) What happens when—

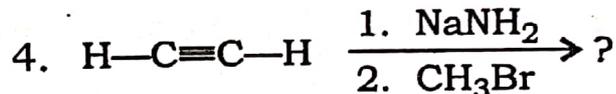 (i) propene is treated with H$_2$ in the presence of Raney Ni as catalyst;

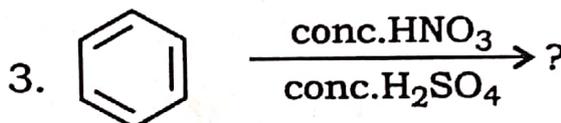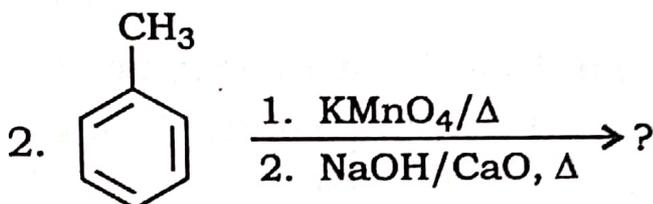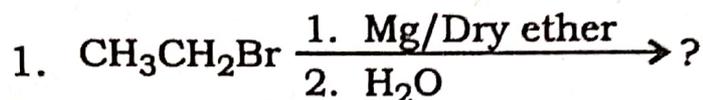 (ii) cyclohexene is treated with dilute alkaline KMnO$_4$? 1+1=2

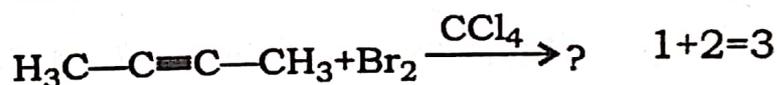(c) How will you prepare carbonyl compounds from alkenes? Explain with appropriate chemical reaction. **2**

8. Answer any *one* of the following questions : 10

(a) (i) Complete the following reactions :

$1 \times 4 = 4$

1. $CH_3CH_2Br \xrightarrow[\text{2. } H_2O]{\text{1. Mg/Dry ether}} ?$

2. (benzene with CH_3 group) $\xrightarrow[\text{2. NaOH/CaO, } \Delta]{\text{1. KMnO}_4/\Delta} ?$

3. (benzene) $\xrightarrow[\text{conc.H}_2SO_4]{\text{conc.HNO}_3} ?$
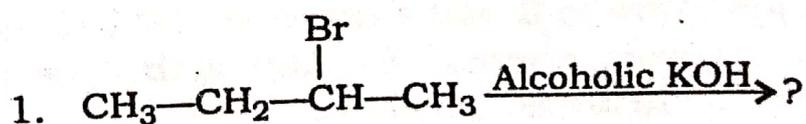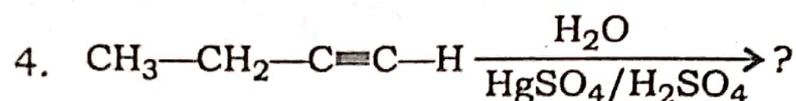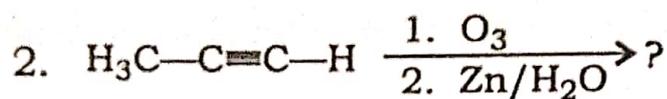
4. $H—C\equiv C—H \xrightarrow[\text{2. CH}_3Br]{\text{1. NaNH}_2} ?$

(ii) Predict the product of the following reaction with plausible mechanism :

$H_3C—C\equiv C—CH_3 + Br_2 \xrightarrow{CCl_4} ?$ $1+2=3$

(iii) Discuss with mechanism the Friedel-Crafts alkylation reaction of benzene.   3

(b) (i) Predict the products of the following reactions : $1 \times 4 = 4$

1. $CH_3—CH_2—\overset{\overset{\displaystyle Br}{|}}{CH}—CH_3 \xrightarrow{\text{Alcoholic KOH}} ?$

(*Turn Over*)

Scanned with OKEN Scanner

2. $H_3C-C \equiv C-H \xrightarrow[\text{2. } Zn/H_2O]{\text{1. } O_3} ?$

3. $CH_3-CH=CH_2 \xrightarrow[H_2O_2]{HBr} ?$

4. $CH_3-CH_2-C \equiv C-H \xrightarrow[HgSO_4/H_2SO_4]{H_2O} ?$
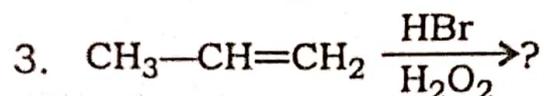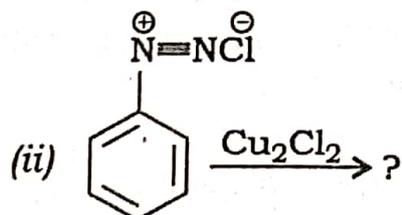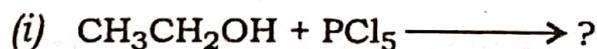
(ii) Discuss with mechanism—

1. sulphonation reaction of benzene;

2. halogenation reaction of benzene. 3+3=6

UNIT—V

9. Answer any *two* of the following questions :

2×2=4

(a) "Aryl halides, unlike alkyl halides do not undergo nucleophilic substitution reaction easily." Justify the statement with proper reasons. 2
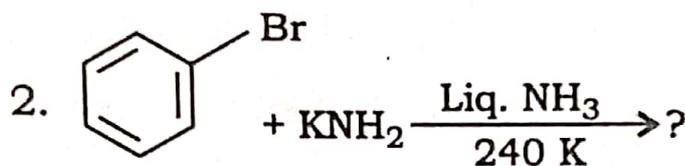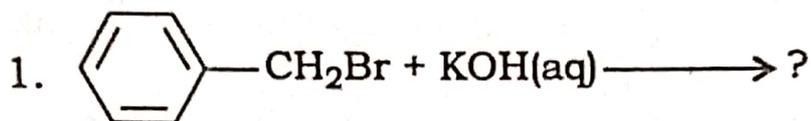
(b) Complete the following reactions : 1+1=2

(i) $CH_3CH_2OH + PCl_5 \longrightarrow ?$

(ii) $\overset{\overset{\displaystyle \overset{\oplus}{N} \equiv \overset{\ominus}{N}Cl}{|}}{\bigcirc} \xrightarrow{Cu_2Cl_2} ?$

(c) How will you synthesize ethoxybenzene from phenol? Explain with appropriate chemical reaction. 2

10. Answer any *one* of the following questions : 10

(a) (i) Predict the products of the following reactions with plausible mechanisms : 3+3=6

1. $C_6H_5-CH_2Br + KOH(aq) \longrightarrow ?$

2. (benzene with Br) $+ KNH_2 \xrightarrow[240\ K]{\text{Liq. } NH_3} ?$

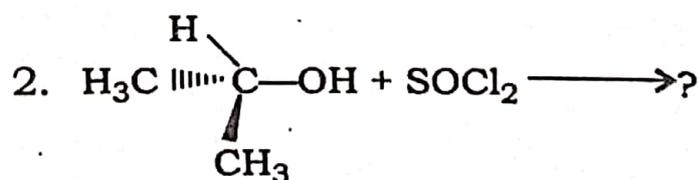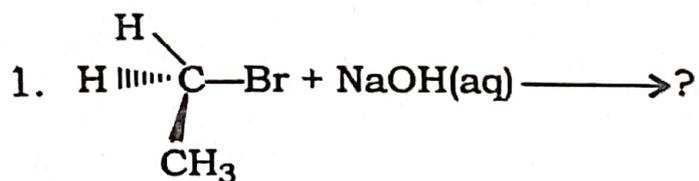(ii) Carry out the following conversions : 2

Iodobenzene from Aniline

(iii) What happens when ethyl bromide is treated with—

1. KCN;

2. AgCN?

(Write only the reactions.) 1+1=2

(b) (i) Complete the following reactions with appropriate mechanisms : 3+3=6

1. $H\cdots C(-H)(-CH_3)-Br + NaOH(aq) \longrightarrow ?$

2. $H_3C\cdots C(-H)(-CH_3)-OH + SOCl_2 \longrightarrow ?$

(ii) What happens when methyl bromide is treated with—

1. $AgNO_2$;

2. KNO_2?

(Write only the reactions.)   1+1=2

(iii) Outline the synthesis of—

1. 2-bromopropane from propene;

2. *p*-nitrophenol from *p*-nitro-chlorobenzene.   1+1=2

★ ★ ★