FYUG Even Semester Exam., 2025

CHEMISTRY

(4th Semester)

Course No. : CHMDSM-252

(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* questions from the following : 2×2=4

(a) What is inorganic benzene? Write its structure.

(b) Write two structural differences between diamond and graphite.

(c) Discuss briefly the catenation property of carbon.

2. Answer any *one* question [*either (a) or (b)*] from the following : 10

(a) What happens, when—

(i) diborane is hydrolyzed (write reaction);

(ii) diborane is treated with NH_3 under different conditions;

(iii) calcium carbide is treated with water (write reaction also);

(iv) excess CO_2 is passed through a solution of $Ca(OH)_2$;

(v) BF_3 is treated with sodium borohydride in diglyme? 2×5=10

(b) *(i)* Write dimeric structure of Al_2Cl_6. 2

(ii) Discuss the bonding in B_2H_6. 3

(iii) What are silicates? Discuss the classification of silicates. 2+3=5

UNIT—II

3. Answer any *two* questions from the following : 2×2=4

(a) What are open system and closed system?

(b) Distinguish between reversible and irreversible processes.

(c) State the first law of thermodynamics. Write its mathematical form.

4. Answer any *one* question [*either (a) or (b)*] from the following : 10

(a) (i) What are enthalpy of formation and standard enthalpy of formation? 2

(ii) What is bond enthalpy? 1

(iii) Calculate the bond energy of C—H bond, given the heat of combustion of methane (CH_4), graphite and hydrogen are 891 kJ, 394 kJ and 286 kJ respectively, while the heat of sublimation of graphite is 717 kJ and the heat of dissociation of hydrogen molecule is 436 kJ. 4

(iv) Calculate the enthalpy of formation of methane from the following data : 3

$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$; $\Delta H = -393{\cdot}5$ kJ

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$; $\Delta H = -571{\cdot}8$ kJ

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; $\Delta H = -890{\cdot}3$ kJ

(b) (i) Explain the concept of standard state. Derive thermodynamically Kirchhoff's equation giving the variation of heat of reaction with temperature. 2+4=6

(ii) Calculate the heat of formation of HCl at 348 K from the following data :

$$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g);$$

$$\Delta H^{\circ}_{298} = -92{\cdot}300 \text{ J}$$

The mean heat capacities over this temperature range are

$H_2(g)$; $C_p = 28{\cdot}53 \text{ JK}^{-1} \text{ mol}^{-1}$

$Cl_2(g)$; $C_p = 32{\cdot}26 \text{ JK}^{-1} \text{ mol}^{-1}$

$HCl(g)$; $C_p = 28{\cdot}49 \text{ JK}^{-1} \text{ mol}^{-1}$ 4

UNIT—III

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

(a) Distinguish between ideal and non-ideal solutions.

(b) What are azeotropes? Give one example.

(c) Define Gibbs' phase rule. Explain the terms involved in it.

6. Answer any *one* question [*either (a) or (b)*] from the following : 10

(a) *(i)* Define Raoult's law for two-component system. Write the vapour pressure and mole fraction relationship. 2

(ii) Draw the diagram of vapour pressure composition (two-component system) for ideal solution, non-ideal solution showing positive deviation and non-ideal solution showing negative deviation. 2+2+2=6

(iii) What are minimum and maximum boiling azeotropes? 2

(b) *(i)* Draw the phase diagram of water system. Discuss the different points, curves and lines on the diagram in the light of physical states. 1+5=6

(ii) Discuss different criteria of phase equilibrium. 4

UNIT—IV

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

(a) What happens when ethyl bromide is treated with metallic sodium in presence of diethyl ether? (Write chemical reactions also)

(b) What happens when propene is treated with HBr in presence and absence of peroxide? (Write chemical reactions also)

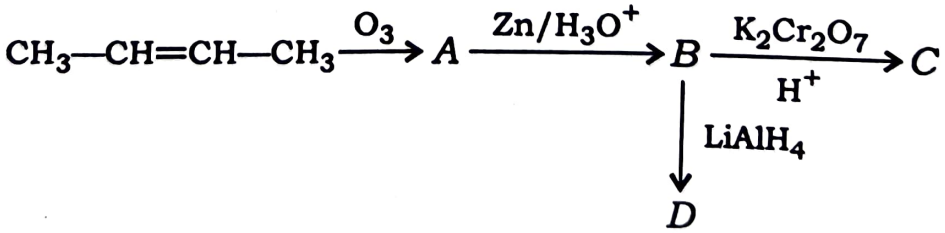
(c) What happens when benzoic acid is heated in presence of soda lime? (Write chemical reactions also)

8. Answer any *one* question [*either (a) or (b)*] from the following : 10

(a) (i) Discuss the mechanism of chlorination of methane in diffused sunlight. 3

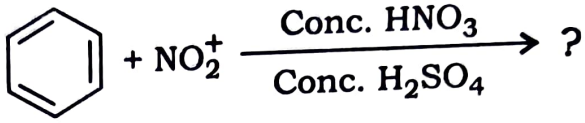
(ii) What happens when 2-bromobutane is treated with alcoholic KOH? Write the reaction and mechanism. Name the reaction. 2+1=3

(iii) Identify *A*, *B*, *C* and *D* from the following reaction : 4



(b) (i) Benzene contains 3-pairs of π-e^- still it prefers electrophilic substitution reactions rather than nucleophilic substitution reactions. Explain with suitable reasons. 2

(ii) Find the product and write the mechanism of the following reaction : 2



(iii) Discuss briefly the Friedel-Crafts alkylation and acylation. Write the reaction and mechanism using suitable reaction conditions for product formation. 3+3=6

UNIT—V

9. Answer any *two* questions from the following : 2×2=4

(a) Why does CH_3X favour S_N2 reaction with aq. KOH solution?

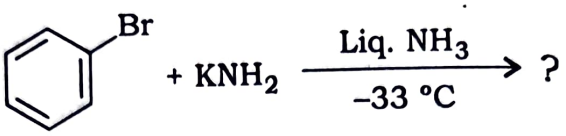
(b) How can you synthesize diethyl ether from alcohol by Williamson's ether synthesis? Write the mechanism of the reaction involved.

(c) How can you prepare chlorobenzene from phenol? Write the mechanism also.

10. Answer any *one* question [*either (a) or (b)*] from the following : 10

(a) (i) Taking suitable example, discuss S_N1 mechanism. Why does S_N1 lead to formation of racemic mixture? Draw the energy profile diagram for S_N1 mechanism. 2+2+2=6

(ii) Write the product and mechanism of the following reaction :



Name the reactive intermediate formed in the above reaction.

1+2+1=4

(b) (i) Treatment of 2-bromobutane with hot alcoholic KOH gives a mixture of three isomeric butenes *A*, *B* and *C*. On ozonolysis of *A* (minor product), gives formaldehyde and another aldehyde in equimolar amounts. Both *B* and *C* give the same single product *D* on ozonolysis. What are the structural formulas of *A*, *B*, *C* and *D*? Give reactions for all the products.

(½×4)+4=6

(ii) Taking suitable examples, discuss briefly that S_N1 reactions are accompanied by *E*1 and S_N2 reactions are accompanied by *E*2.

2+2=4

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