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3 (Sem-3 /CBCS) CHE HC 3

2021

(Held in 2022)

CHEMISTRY

(Honours)

Paper : CHE-HC-3036

(Physical Chemistry III)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed : $1 \times 7 = 7$

(i) A triple point is —

(a) trivariant

(b) bivariant

(c) univariant

(d) invariant

(Choose the correct option)

Contd.

- (ii) A compound with a congruent melting point melts into a liquid of _____ composition as the solid.

(Fill in the blanks with suitable word)

- (iii) The minimum number of independent variables required to characterize the composition of each phase in a system is called degrees of freedom.

(State True or False)

- (iv) Write the differential rate law for a zeroth order reaction.

- (v) Give one example of a consecutive reaction.

- (vi) Give one example of homogeneous catalysis.

- (vii) What are adsorption isotherms ?

2. Answer the following questions : $2 \times 4 = 8$

- (a) State and explain the phase rule for a non-reactive system.

- (b) Distinguish between order and molecularity of a reaction.

- (c) For the reaction $A + B \rightarrow C$, when the concentration of A is doubled, the rate of the reaction is doubled. But doubling the concentration of B does not change the rate of the reaction. Calculate the order of the reaction.

- (d) In a reaction catalysed by metal, fine division of the metal increases the catalytic action. Explain.

3. Answer **any three** questions from the following : $5 \times 3 = 15$

- (a) Discuss the application of phase rule to the water system. 5

- (b) (i) Explain what is meant by azeotropic mixture. 2

- (ii) Explain the principle of steam distillation. 3

- (c) (i) Derive an expression for rate constant of a zero-order reaction. 3

- (ii) Give the characteristics of zero-order reaction. 2

(d) (i) Show that in a first order reaction the time required for completion of 99.9% of the reaction is ten times its half-life period. 3

(ii) Explain activation energy of a reaction. 2

(e) (i) What is catalysis ? 1

(ii) Depending on the role and nature of the catalyst used in a reaction, classify catalysts and give suitable examples for each of them. 4

4. Answer **any three** questions from the following : $10 \times 3 = 30$

(a) (i) Discuss the application of phase rule to the sulphur system. 5

(ii) Explain the term 'component'. How many components are present in the following systems ? $2 + 3 = 5$

1. $\text{Water} \rightleftharpoons \text{water vapour}$

2. $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$

3. $\text{NH}_4\text{Cl}(s) \rightleftharpoons \text{NH}_3(g) + \text{HCl}(g)$

(b) (i) Define the terms congruent and incongruent melting points. 2

(ii) At 373.6 K and 372.6 K the vapour pressures of water are 1.018 atm and 0.982 atm respectively. Calculate the enthalpy of vapouration of water. 3

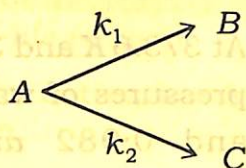
(iii) Define critical solution temperature (CST). Sketch and explain the curves showing upper CST and lower CST. Give suitable examples. 5

(c) (i) Derive the integrated rate law for the 2nd order reaction $A + B \rightarrow \text{products}$.

Consider the initial concentrations of A and B be a and $b \text{ mol L}^{-1}$ respectively. 4

(ii) Define activation energy. Give the significance of activation energy. Explain an experimental method to determine activation energy of a reaction. $1 + 2 + 3 = 6$

- (d) (i) Find the integrated rate law for the reaction



5

- (ii) Explain the Lindemann mechanism of unimolecular gaseous decomposition reaction and find an expression for the rate of the reaction.

5

5. (a) Give the criteria of a catalyst. 4

- (b) Give *one* example of heterogeneous catalysis. Describe the mechanism of the heterogeneous catalysis.

1+5=6

6. (a) Distinguish between physisorption and chemisorption. Give *one* example of each of the physisorption and the chemisorption.

3+2=5

- (b) What is adsorption isotherm? Write the Freundlich adsorption isotherm indicating different terms involved in it. How can the Freundlich isotherm be tested?

1+2+2=5