## 3 SEM TDC CHMH (CBCS) C 7

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( Held in January/February, 2022 )

## CHEMISTRY

( Core )

Paper : C–7

### ( Physical Chemistry )

*Full Marks* : 53
*Pass Marks* : 21

*Time* : 3 hours

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

1. Choose the correct answer :      1×5=5

   *(a)* When benzoic acid distributes between benzene and water, it dimerizes in benzene layer. The exact expression for Nernst's distribution law is

   *(i)* $\sqrt{\dfrac{C_{org}}{C_{aq}}}$        *(ii)* $\dfrac{C_{org}^2}{C_{aq}}$

   *(iii)* $\dfrac{\sqrt{C_{org}}}{C_{aq}}$        *(iv)* $\dfrac{C_{org}}{\sqrt{C_{aq}}}$

       *( Turn Over )*

(b) For a chemical reaction

$$T_{1/2} \propto \frac{1}{a^2}$$

where $a$ is the initial concentration of the reactant. The order of the reaction is

(i) 3

(ii) 2

(iii) 1

(iv) 0

(c) Which of the following is not a characteristic of enzyme catalysis?

(i) Enzyme catalysts are highly efficient

(ii) One enzyme can catalyse more than one reaction

(iii) The effectiveness of catalyst is maximum at its optimum temperature

(iv) Enzyme catalysis is dependent upon the pH of the solution

(d) Sulphur can exist as sulphur rhombic(s), sulphur monoclinic(s), liquid sulphur(l) and sulphur vapour(g). Maximum number of phases which can coexist in equilibrium can be

   (i) 3

   (ii) 4

   (iii) 1

   (iv) 2

(e) The absorbent used for humidity and moisture control in many utility items is

   (i) activated charcoal

   (ii) silica gel

   (iii) metal nanoparticles

   (iv) finely divided nickel

2. Answer the following questions :     2×5=10

(a) Water and sulphur both are one-component system. Water system has one triple point but, sulphur system has more than one triple point in the phase diagram. Explain.     2

(b) What is critical solution temperature (CST)? Give one example each of solution with lower and upper CST.

$1+1=2$

(c) Describe the Ostwald isolation method for determination of order of a reaction. 2

(d) Explain the effect of particle size in heterogeneous catalysis. 2

(e) When the adsorbate is adsorbed onto a surface of adsorbent, then both the enthalpy and entropy changes become negative. Explain. 2

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

$6 \times 2 = 12$

(a) (i) Derive Gibbs phase rule thermodynamically for reactive and non-reactive systems. 4

(ii) What are condensed systems? Write phase rule equation for such systems.

$1+1=2$

(b) (i) Melting point of pure Pb is 327 °C and of pure Ag is 961 °C and eutectic point is observed at 303 °C with 97·4% of Pb and 2·6% of Ag. Draw a labelled phase diagram of Pb-Ag system. 2

*( Continued )*

*(ii)* What do you mean by peritectic change? Discuss the phase diagram of $Na_2SO_4$-$H_2O$ system.                1+3=4

*(c)*  *(i)* Derive Duhem-Margules equation for a binary solution.                3

*(ii)* State Nernst distribution law. State the principle of solvent extraction on the basis of Nernst distribution law.                1+2=3

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

$$6 \times 2 = 12$$

*(a)*  *(i)* Derive an expression of rate constant for the following second-order reaction :

$$A + B \rightarrow \text{products}$$
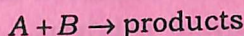
Prove that when either $A$ or $B$ is taken in excess, then this second-order reaction shows first-order kinetics.                3+1=4

*(ii)* The values of rate constants for a chemical reaction at $427\,°C$ and $527\,°C$ are $2.0\,s^{-1}$ and $20\,s^{-1}$ respectively. Evaluate energy of activation for the reaction.                2

*(b)*  *(i)* Give one example of reversible reaction. Discuss the kinetics of first-order reversible reaction

$$A \rightleftharpoons B \qquad\qquad 1+3=4$$

(ii) Write different steps involved in the mechanism of chain reactions. 2

(c) (i) Discuss Lindemann's mechanism of a unimolecular gas phase reaction. Show that according to this mechanism a gaseous unimolecular reaction becomes first order at high pressure and second order at low pressure. 4

(ii) Discuss the drawbacks of collision theory of reaction rate. 2

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

$4\frac{1}{2} \times 2 = 9$

(a) Derive Michaelis-Menten equation for enzyme catalysis. $4\frac{1}{2}$

(b) Discuss different steps of adsorption theory for heterogeneous catalysis. $4\frac{1}{2}$

(c) What is acid-base catalysis? Discuss different mechanisms of acid-base catalysis. $1 + 3\frac{1}{2} = 4\frac{1}{2}$

6. Answer any *one* of the following questions : 5

(a) Derive Langmuir adsorption equation. Show that under low pressure condition the Langmuir adsorption equation becomes equal to Freundlich adsorption equation. $4 + 1 = 5$

*( Continued )*

*(b)*  *(i)* Show five main categories of adsorption isotherms diagrammatically.   2½

*(ii)* Write basic differences between chemisorption and physisorption. Why is heat of adsorption greater for chemisorption than physisorption?   1½+1=2½

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