2023

CHEMISTRY

Paper : CHMHC3076

(Physical Chemistry—III)

Full Marks : 60
Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following (any *five*) : 1×5=5

(a) The maximum number of phases that can be simultaneously in equilibrium for one-component system is

(i) 1

(ii) 2

(iii) 3

(iv) 4

(b) The reduced phase rule for a condensed system is

(i) $F = C - P + 2$

(ii) $F = C - P + 1$

(iii) $F = C - P$

(iv) $F = C - P + 3$

(c) The rate constant of zero-order reactions has the unit

(i) S^{-1}

(ii) mol $L^{-1}S^{-1}$

(iii) L^2 mol^{-2} S^{-1}

(iv) L mol^{-1} S^{-1}

(d) The molecularity of a reaction

(i) is same as its order

(ii) is different from order

(iii) may be same or different as compared to order

(iv) is always zero

(e) In an enzyme-catalyzed reaction, when the concentration of substrate is very small, the order of the reaction with respect to substrate is

(i) zero

(ii) 1st

(iii) 2nd

(iv) 3rd

(f) Which of the following is an example of sorption?

(i) Sponge in water

(ii) Cotton dipped in ink

(iii) Water on silica gel

(iv) Oxygen on metal surface

(g) What is the point at which all the three phases of a system exist?

(i) Triple point

(ii) Sublimation point

(iii) Vapour point

(iv) Eutectic point

(h) For water system, the number of phases at the triple point is

(i) 0

(ii) 1

(iii) 2

(iv) 3

(i) A straight line is drawn when $\log(a-x)$ is plotted against time t, this shows that the reaction is of order

(i) zero

(ii) 1st

(iii) 2nd

(iv) 3rd

(j) Which of the following is not the characteristic of physisorption?

(i) It arises due to van der Waals forces

(ii) It is not specific in nature

(iii) Enthalpy of adsorption is high

(iv) It results into multi-molecular layers or adsorbent surface under high pressure

2. Answer any *five* the following questions : 2×5=10

(a) Write two characteristics of 1st-order reaction.

(b) Write four factors that affect the rate of a chemical reaction.

(c) Show that the time required for 99·9% completion of reaction is 10 times the time required for 50% completion of reaction.

(d) Draw a labelled phase diagram for water system.

(e) What is an azeotrope? What are the different types of it?

(f) Define critical solution temperature. Write one liquid pair having upper critical solution temperature.

(g) Write the general characteristics of catalytic reactions.

3. Answer any *five* of the following questions : 5×5=25

(a) Define component and degrees of freedom. Determine the number of components, the number of phases and the degrees of freedom in the following equilibria : 2+3=5

(i) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

(ii) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

(b) Draw and explain the phase diagram of a system having a compound with congruent melting point. 5

(c) For the consecutive reaction

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

derive the expression for concentration of B. 5

(d) Derive an expression for the rate constant of a 1st-order reaction. Give two examples of 1st-order reaction. 3+2=5

(e) Write the Arrhenius equation. In Arrhenius equation for a certain reaction, the values of A and E_a are 4×10^{13} s^{-1} and 98·6 kJ mol^{-1} respectively. If the reaction is of 1st order, at what temperature will its half life period be 10 minutes? 1+4=5

(f) Write one characteristic of enzyme catalysis. Derive Michaelis-Menten equation for enzyme catalysis. 1+4=5

(g) What is adsorption isotherm? Derive an expression for Langmuir's adsorption isotherm. 1+4=5

(h) Derive an expression for the rate constant of 2nd-order reaction $2A \rightarrow P$. 5

(i) Explain the thermodynamic treatment of activated complex theory. 5

(Continued)

4. Answer any *two* of the following questions : 10×2=20

(a) (i) Define adsorbate and adsorbent. Give examples of each type. Write the differences between physi-sorption and chemisorption. 2+1+2=5

(ii) What is steam distillation? What conditions should be fulfilled by the liquids for carrying out steam distillation? 1+2=3

(iii) State lever rule. 2

(b) (i) Write two limitations of collision theory. Discuss the Lindemann's theory of unimolecular reactions. 2+5=7

(ii) Give one example of each of the following : 3

Opposing reaction

Parallel reaction

Consecutive reaction

(c) (i) Derive Gibbs-Duhem-Margules equation. 5

(ii) State Nernst distribution law. Derive this law thermodynamically. 1+4=5

(Turn Over)

(d) (i) Write the factors on which adsorption depends. Explain Freundlich adsorption iostherm. 2+2=4

(ii) What are catalysts? What are the different types of it? Give one example of each. 2+2=4

(iii) Write two differences between order and molecularity of a reaction. 2

* * *