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3 SEM TDC CHMH (CBCS) C 7

2022

(Nov/Dec)

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 from the following : 1×5=5

(a) At a particular concentration, the $t_{½}$ of a reaction is 100 min. When the concentration of reactant becomes double half-life period becomes 25 min. The order of the reaction is

(i) 1

(ii) 2

(iii) 0

(iv) 3

(b) Number of components, number of phases and degrees of freedom of the system

$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g), \quad P_{NH_3} \neq P_{HCl}$

are

(i) 2, 2, 2

(ii) 2, 1, 1

(iii) 2, 1, 0

(iv) 1, 1, 1

(c) If two liquids *A* and *B* form minimum boiling azeotrope at some specific composition, then

(i) *A–B* interactions are stronger than those between *A–A* or *B–B*

(ii) vapour pressure of solution increases because more number of molecules of liquids *A* and *B* can escape from the solution

(iii) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution

(iv) *A–B* interactions are weaker than those between *A–A* or *B–B*

(Continued)

(d) The condition which is not a favourable condition of physical adsorption is

(i) high pressure

(ii) negative ΔH

(iii) high critical temperature of adsorbate

(iv) high temperature

(e) A first-order reaction has a specific reaction rate of 10^{-2} s^{-1}. How much time will it take for 20 g of the reactant to reduce to 5 g?

(i) 238·6 seconds

(ii) 138·6 seconds

(iii) 346·5 seconds

(iv) 693·0 seconds

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

(a) The possibility of 4-phase equilibria in the sulphur system is ruled out. Explain.

(b) Describe the half-life method for determining the order of a reaction.

(c) "Azeotropes are mixtures." Comment on the statement with proper explanation.

(d) For the reaction $A(g)+3B(g) \rightarrow 2C(g)$, the rate of the reaction $\left\{\frac{-d[A]}{dt}\right\}$ is 3×10^{-3} mol L^{-1} min^{-1}. What is the value of $\frac{-d[B]}{dt}$ in mol L^{-1} min^{-1}?

(e) Explain any two factors upon which adsorption depends.

(f) What is shape-selective catalysis? Give one example of it.

3. Answer any *two* questions from the following : $6\times2=12$

(a) (i) Explain the effect of pressure on the transition temperature of rhombic sulphur and on the melting point of monoclinic sulphur with the help of Clapeyron equation. $2+2=4$

(ii) What is the maximum number of phases that can coexist for a two-component system? Give reason. 2

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(b) (i) Draw and explain the phase diagram of water system. 4

(ii) Explain why the fusion curve of ice has a negative slope whereas the sublimation curve has a positive slope in the phase diagram of water. 2

(c) (i) State Nernst distribution law. How is the law helpful in ascertaining the molecular complexity of the dissolved solute? 1+2=3

(ii) Prove that multi-step extraction is more economical than the single-step extraction. 3

4. Answer any *two* questions from the following : 6×2=12

(a) (i) Show that for a first-order reaction, the time required for 99·9% completion of the reaction is 10 times that required for 50% completion. 2

(ii) What are pseudounimolecular reaction? Give one example of this type of reaction. 2

(iii) Explain the effect of temperature on the rate of a chemical reaction. 2

(b) The following mechanism has been suggested for the decomposition of O_3 :

$$O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$$

$$O_3 + O \xrightarrow{k_2} 2O_2$$

Assuming $k_{-1}[O_2] \geq k_2[O_3]$, show that the rate of the overall reaction is

$$\frac{-d[O_3]}{dt} = \frac{k[O_3]^2}{[O_2]}$$

What could be concluded from the appearance of $\frac{1}{[O_2]}$ in the rate equation? 5+1=6

(c) (i) For the reaction between gaseous chlorine and nitric oxide

$$2NO + Cl_2 \rightarrow 2NOCl$$

it is found that doubling the concentration of both reactants increases the rate 8 times but doubling the chlorine concentration alone doubles the rate. What is the order of the reaction with respect to nitric oxide and chlorine? Write the rate law of the reaction. 3+1=4

(ii) Show that for a second-order reaction, half-life period is inversely proportional to the initial concentration of the reactant. 2

(Continued)

5. Answer any *two* questions from the following : $4\frac{1}{2}\times2=9$

(a) What are enzyme-catalyzed reactions? Discuss the effects of concentration, temperature and pH on the rate of enzyme-catalyzed reaction. $1+3\frac{1}{2}=4\frac{1}{2}$

(b) *(i)* Discuss any one mechanism of heterogeneous catalysis. $2\frac{1}{2}$

(ii) What is autocatalysis? Give one example. 2

(c) *(i)* Discuss the use of nanoparticles as catalyst giving three examples. 3

(ii) What are catalytic poisons? Give one example. $1+\frac{1}{2}=1\frac{1}{2}$

6. Answer any *one* question from the following : 5

(a) What are adsorption isotherms? Derive Langmuir adsorption isotherm and show that Freundlich isotherm is a special case of this isotherm. $1+3+1=5$

(b) *(i)* Mention any four differences between physical adsorption and chemical adsorption. 2

(ii) Give reason why a finely divided substance is more effective as an adsorbent. 2

(iii) Write two important applications of adsorption in industry. 1

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