Unit Practice Test

for Board Examination

Time Allowed : 2 Hrs. Maximum Marks : 35

1. Define activation energy of a reaction. (1)
2. 75% of a radioactive substance disintegrates in 50 s. What is its half-life period? (1)
3. For a chemical reaction $A \longrightarrow B$, the rate increases by a factor of 2.25 when the concentration of A is increased by 1.5. What is the order of the reaction? (1)
4. Can order of a reaction be fractional? Explain. (1)
5. What is the order of a reaction whose rate constant has same units as the rate of the reaction? (1)
6. The decomposition of ammonia on platinum surface is zero order reaction. What are the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4}$ mol $L^{-1}s^{-1}$? (2)
7. Show that half life period of a first order reaction does not depend upon the initial concentration of reactants. (2)
8. A first order reaction is 15% complete in 20 minutes. How long will it take to complete 60%? (2)
9. Give differences between rate constant and rate of a reaction. (2)
10. A reaction is of second order with respect to a reactant. How is the rate of reaction affected if the concentration of the reactant is reduced to half? What is the unit of rate constant for such a reaction? (2)
11. The rate of a particular reaction quadruples when the temperature changes from 293 K to 313 K. Calculate the energy of activation for such a reaction. (3)
12. A first order reaction has a rate constant of 0.0051 min^{-1}. If we begin with 0.10 M concentration of the reactant, what concentration of the reactant will be left after 3 hours ? (3)
13. Explain the following: (3)

    (*i*) pseudo first order reactions

    (*ii*) graphical method for measuring rate of a reaction.
14. Discuss the effect of temperature on the rate of a reaction. How can this temperature effect on rate constant be represented quantitatively ? (3)
15. During nuclear explosion one of the products is ^{90}Sr with half-life of 28.1 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby instead of calcium, how much of it will remain after 10 years and 60 years if it is not lost metabolically? (3)
16. (*a*) What is meant by order and molecularity of a reaction? How do these differ?

    (*b*) Derive an expression for the rate constant of a zero order reaction.

    (*c*) A reaction rate is first order in A and second order in B. How is its rate affected on increasing concentrations of A and B two and three times respectively? (5)

► To check your performance, see HINTS AND SOLUTIONS TO SOME QUESTIONS at the end of Part I of the book.

UNIT 4 : CHEMICAL KINETICS

1. Activation energy is the minimum energy that the reactants must possess for the conversion into the products during their collision. It is equal to difference between the threshold energy needed for the reaction and the average kinetic energy of the reactant molecules.
2. 25 s
3. 1.5
4. Order can be fractional.
5. Zero order.

6.
$$\text{Rate} = -\frac{1}{2}\frac{d[NH_3]}{dt}$$
$$= \frac{d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt} = k = 2.5 \times 10^{-4}\ \text{Ms}^{-1}$$

Rate of production of N_2, $\frac{d[N_2]}{dt} = 2.5 \times 10^{-4}\ \text{Ms}^{-1}$

Now $\frac{1}{3}\frac{d[H_2]}{dt} = 2.5 \times 10^{-4}\ \text{Ms}^{-1}$

$\therefore$ Rate of production of H_2, $\frac{d[H_2]}{dt} = 3 \times 2.5 \times 10^{-4} = 7.5 \times 10^{-4}\ \text{Ms}^{-1}$

8. Let $[A]_0 = a,\ [A] = a - \frac{15}{100}a = 0.85a$

$$k = \frac{2.303}{20}\log\frac{a}{0.85a} = 8.12 \times 10^{-3}\ \text{min}^{-1}$$

For 60% completion, $[A] = a - \frac{60}{100}a = 0.40a$

$$t = \frac{2.303}{8.12\times10^{-3}}\log\frac{a}{0.40a} = 112.86\ \text{min}$$

10. When conc. of the reactant is reduced to half, the rate becomes $\frac{1}{4}$ times.
    Units of rate constant : L mol^{-1} s^{-1}.

11.
$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$
$$\frac{k_2}{k_1} = 4$$
$$R = 8.314\ \text{JK}^{-1}\text{mol}^{-1},\ T_1 = 293\ \text{K},\ T_2 = 313\ \text{K}$$
$$\log 4 = \frac{E_a}{2.303\times8.314}\left[\frac{1}{293} - \frac{1}{313}\right]$$
$$0.6021 = \frac{E_a}{2.303\times8.314}\left[\frac{313-293}{293\times313}\right]$$

$\therefore$
$$E_a = \frac{2.303\times8.314\times0.6021\times293\times313}{20}$$

or
$$= 52863.3\ \text{J mol}^{-1} = 52.86\ \text{kJ mol}^{-1}.$$

15.
$$k = \frac{0.693}{t_{1/2}}$$
$$t_{1/2} = 28.1\ \text{years}$$
$$k = \frac{0.693}{28.1} = 0.0247\ \text{years}^{-1}$$
$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$$

Initial concentration of ^{90}Sr = 1μg

Let concentration of ^{90}Sr after 10 years = x

$$0.0247 = \frac{2.303}{10 \text{ years}} \log \frac{1\mu g}{x\mu g}$$

$$\log\frac{1}{x} = \frac{0.0247 \times 10}{2.303} = 0.1072$$

$$\frac{1}{x} = 1.280 \quad \text{or} \quad x = 0.782\ \mu g$$

Concentration of ^{90}Sr after 10 years = 0.782

Let concentration of ^{90}Sr after 60 years = y

$$0.0247 = \frac{2.303}{60} \log \frac{1\mu g}{y\mu g}$$

$$\log\frac{1}{y} = \frac{0.0247 \times 60}{2.303} = 0.6435$$

$$\frac{1}{y} = 4.40 \quad \text{or} \quad y = 0.228\ \mu g$$

Concentration of ^{90}Sr after 60 years = **0.228 μg.**

16. (*c*) 16 times.