Chemistry Worksheets Class 12 on Chapter 4 Chemical Kinetics with Answers - Set 4

Q-1: The increase in the rate of the reaction with every 10° rise in the temperature is:

a.) Twice the initial rate
b.) Half of the initial rate
c.) Thrice of the initial rate
d.) ten times of the initial rate

Answer: (a.)

Explanation: The increase in the rate of the reaction with every 10° rise in the temperature is twice the initial rate of the reaction.

Q-2: The rate of the reaction A + B + C → Products is :

$$-d[A] / dt = k[A]^{1/2}[B]^{1/3}[C]^{1/4}$$

The order of the reaction is _____.

a.) 1/2
b.) 2
c.) 13/12
d.) 1

Answer: (c.)

Explanation: The order of a reaction can be determined by the addition of powers of the concentration terms given in the rate law. Hence, the order of the reaction is:
Order = ½ + ⅓ + ¼ = 13 / 12

Q-3: DDT decomposes when it comes in contact with water. The half-life period of DDT is 10 years. Calculate the time required for its 99% decomposition.

Answer: From the half-life equation we have:

$$t_{1/2} = 0.693 / k$$

$$\therefore k = 0.693 / t_{1/2} = 0.693 / 10 \text{ year}^{-1}$$

$$k = \frac{2.303}{t_{99\%}} log \frac{a}{a - 0.99a}$$
$$\frac{0.693}{10}\ years^{-1} = \frac{2.303}{t_{99\%}} log(10)^2$$
$$t_{99\%} = \frac{10}{0.693} \times 2.303 \times 2$$
$$t_{99\%} = 66.5\ years$$

Hence, the time required for its 99% decomposition of DDT is 66.5 years.

Q-4: In the rate expression, the term -dx/dt refers to ____.

a.) the instantaneous rate of the reaction
b.) the concentration of the reactants
c.) the increase in concentration of the reactants
d.) the average rate of the reaction

Answer: (a.)

Explanation: -dx/dt refers to the instantaneous rate of the reaction.

Q-5: Give reason for the following:
Coal does not burn itself in air. However, once the burning is initiated by a flame, the coal keeps burning.

Answer: In order to burn, coal must have sufficient activation energy in the presence of air (oxygen). However, since the value of required activation energy is too high and is not readily available at room temperature. Hence, flame is brought in contact with the coal and air in order to bring a reaction between the two (combustion reaction). On burning of coal, a high amount of energy keeps liberating and this energy provides the activation energy for further combustion to continue.

Q-6: According to the Collision theory:

a.) all collisions are sufficiently violent for the reaction
b.) all collisions are effective
c.) all collisions result in product formation
d.) only a few collisions which have the sufficient energy are effective and result in product formation

Answer: (d.)

Explanation: Only a few collisions that have sufficient energy lead to product formation.

Q-7: Why does the equilibrium constant remain unchanged even when a catalyst is used for the reaction?

Answer: This is because the catalyst increases the speed of the forward and the backward reactions simultaneously. Hence, as a result, the equilibrium constant is not disturbed and remains unchanged.

Q-8: Differentiate between the order and the molecularity of a reaction.

Answer: The differences between the two are:

S.no.	Order	Molecularity
1.	Order is the sum of the powers of the concentrations of the reactants present in the rate law expression.	Molecularity is the number of atoms/molecules/ions that must collide simultaneously in order to bring about an effective collision.
2.	Its value can be either zero, fractional or a whole number.	Its value can only be a whole number.
3.	The order of a reaction can only be determined experimentally.	Molecularity can be determined by the sum of the number of reacting species present in the reaction's slow step.
4.	Order is applicable to an elementary as well as a complex reaction.	Molecularity is applicable only to the elementary reactions. Since, the molecularity of the overall complex reaction has no significance, molecularity of only the slowest step is considered for the whole reaction.

Q-9: The rate of a reaction depends on

a.) the active mass of the reactant
b.) the molecular mass of the reactant
c.) the atomic mass of the reactant
d.) the equivalent mass of the reactant

Answer: (a.)

Explanation: The rate of the reaction depends on the number of moles of the reactants colliding together in a reaction.

Q-10: Give an example of a first order reaction.

Answer: The example of a first order reaction is given below:

$$N_2O_5 \rightarrow N_2O_4 + \frac{1}{2} O_2$$

Q-11: A reactant with initial concentration 'a' undergoes a zero order reaction. How much time will the reaction take for completion?

Answer: For a zero order reaction,
k = dx / dt
dx = k.dt
∴ x = kt + I
Now, for t = 0, x = 0, the value of I also becomes 0.
Hence, x = kt
⇒ t = x / k
When the reaction is complete, x = a
∴ t = a / k
So, the time taken by the reaction for its completion is a/k.

Q-12: Which is the rate determining step of a chemical reaction?

Answer: The slowest step is the rate determining step.

Q-13: Give reason for the following observation:
1 gram of pulverised wood burns faster than a piece of wood weighing 1 gram.

Answer: This is because the particles in 1gram pulverised wood have greater surface area than a piece of 1 gram wood. The surface area of the reactant is proportional to the rate. The more the surface area, the higher the rate of the reaction. As a result, 1 gram of pulverised wood burns faster (undergoes a combustion reaction rapidly) than the 1 gram wooden piece.

Q-14: At 27 °C, the activation energy of a reaction reduces by 2 kcal due to the presence of a catalyst. Calculate the increase in the rate of the reaction. (Given R = 2 x 10^{-3} kcal K^{-1} mol^{-1})

Answer: Let us assume the rate constant in the absence of the catalyst = k
Hence, from the Arrhenius equation:

$$\log k = \log A - \frac{E_a}{2.303RT} \qquad \text{(i)}$$

Now, let us assume, rate constant = k' in the presence of the catalyst
Activation energy in presence of the catalyst = E_a - 2 (assuming E_a to be in kcal mol^{-1})
∴ in the presence of catalyst:

$$\log k' = \log A - \frac{E_a - 2}{2.303RT} = \log A - \frac{E_a}{2.303RT} + \frac{2}{2.303RT} \qquad \text{(ii)}$$

On subtracting equation (i) from equation (ii) we get:

$$\log k' - \log k = \frac{2\ kcal\ mol^{-1}}{2.303RT}$$
$$\log\frac{k'}{k} = \frac{2\ kcal\ mol^{-1}}{2.303 \times 300\ K \times 2 \times 10^{-3}\ kcal\ K^{-1}\ mol^{-1}}$$
$$\log\frac{k'}{k} = 1.4474$$
$$\frac{k'}{k} = Antilog\ 1.4474 = 28$$

∴ k' = 28 k

This implies that the rate of the reaction in the presence of a catalyst will increase by 28 times.

Q-15: The catalyst

a.) decreases the activation energy of the reaction
b.) increases the collision frequency
c.) increases the activation energy of the reaction
d.) increases the average kinetic energy of reactants

Answer: (a.)

<u>Explanation</u>: The catalyst decreases the activation energy of the reaction.

Q-16: The concentration of A takes 10 minutes to change from 0.5 mol L^{-1} to 0.4 mol L^{-1} in the given reaction: 2A → Products. What must be the rate of the reaction during this interval?

Answer: For the given reaction,

Rate = -½ (d[A] / dt)

∴ Average rate = -½ (Δ[A] / Δt)
Where Δ[A] = change in concentration of A = $[A] - [A]_0$ = (0.4 - 0.5) mol L^{-1} = -0.1 mol L^{-1}
Δt = change in time = 10 minutes
Hence, Average rate = -½(-0.1 mol L^{-1} / 10 min) = 5 x 10^{-3} mol L^{-1} min^{-1}
Hence, the rate is 5 x 10^{-3} M min^{-1}.

Q-17: Match the following.
Note:- More than 1 option of column I can have the same answer in Column II.

	Column I		**Column II**
a.	Rate of reaction	(i)	s^{-1}
b.	First order rate constant	(ii)	mol L^{-1} s^{-1}

c.	Second order rate constant	(iii)	mol L^{-1}
d.	Zero order rate constant	(iv)	L mol^{-1} s^{-1}

Answer: (a.)-(ii), (b.)-(i), (c.)-(iv), (d.)-(ii)

Explanation: The unit of rate of reaction and that of the rate constant of zero order reaction are same.

Q-18: Determine the order of the reactions and the dimensions of the rate constants for the given rate expressions of the following reactions:
(a.) H_2O_2 (aq) + $3I^-$ (aq) + $2H^+ \rightarrow 2H_2O$ (l) + I_3^-; Rate = k[H_2O_2][I^-]
(b.) 3NO (g) $\rightarrow$ N_2O (g) + NO_2 (g); Rate = k$[NO]^2$

Answer: Thorder of reaction and the units of rate constants are determined hereunder.
(a.) Order from rate law = 1+ 1 = 2
For dimensions of k: k = Rate / k[H_2O_2][I^-]
The dimension of rate for a second order reaction is mol L^{-1} s^{-1}.
∴ k = mol L^{-1} s^{-1} / (mol L^{-1})(mol L^{-1}) = L mol^{-1} s^{-1}
Hence, the dimension of the rate constant for the given reaction is L mol^{-1} s^{-1}.

(b.) Order from rate law = 2
For dimensions of k: k = Rate / k$[NO]^2$
The dimension of rate for a second order reaction is mol L^{-1} s^{-1}.
∴ k = mol L^{-1} s^{-1} / $(\text{mol } L^{-1})^2$ = L mol^{-1} s^{-1}
Hence, the dimension of the rate constant for the given reaction is L mol^{-1} s^{-1}.

Q-19: What is the effect of temperature on the rate constant of a reaction?

Answer: The rate constant gets doubled by an increase of 10° in temperature. The temperature dependence of the rate constant is explained by the Arrhenius equation as:

$$k = A.e^{-Ea/RT}$$

Q-20: The rate constant of a first order reaction is 1.15 x 10^{-3} s^{-1}. Calculate the time taken by the reactant to reduce from 5 g to 3 g.

Answer: Given $[A]_0$ = initial concentration = 5 g
[A] = concentration after time 't' = 3 g
Rate constant = 1.15 x 10^{-3} s^{-1}
Now from the first order reaction:

$$t = \frac{2.303}{k} log \frac{[A]_0}{[A]} = \frac{2.303}{1.15 \times 10^{-3} s^{-1}} log \frac{5 g}{3 g}$$
$$t = 2.00 \times 10^3 (log\, 1.667)\ s$$
$$t = 2 \times 10^3 \times 0.2219\ s = 443.8\ s$$

So, the time taken by the reactant to reduce from 5 g to 3 g is 443.8 s.