QUESTIONS (CHEMICAL KINETICS)

RATES OF A REACTION

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| **Example 1  :**  The following reaction was carried out in water : Cl2 + 2I- → I2 + 2Cl-  The initial concentration of I- was 0.25 mol L-1 and the concentration after 10 minutes 0.23 mol L-1. Calculate the rate of disappearance of I- and appearance of I2.  **Solution  :**  ?[I-]  =  [I-]final - [I-]initial = 0.23 - 0.25 = -0.02 mol L-1  ?t = 10 - 0 = 10 min  -?[I- ]/?t = -((-0.02))/10 = 0.002  mol L-1 min-1  Rate of appearance of I2  = 1/2 ?[I- ]/?t = 0.002/2  = 0.001 mol L-1 min-1  = 1 × 10-3 mol L-1 min-1    **Example 2  :**  The reaction between Cr2O72- and HNO2 in an acidic medium is Cr2O72- + 15H+ + 3HNO2 → 2Cr3+ + 3NO3- + 4H2O  The rate of disappearance of  is found to be 2.4 × 10-4 mol L-1 s-1 during a measured time interval. Find the rate of disappearance of HNO2 and the rate of appearance of Cr3+ during thus time interval.  **Solution  :**  The equality in this case is  -?[Cr2O72-]/?t = 1/3 ?[HNO2 ]/?t = 1/2(?[Cr3+])/?t  It is given that  -?[Cr2O72- ]/?t = 2.4×10-4   mol L-1 s-1  So -?[HNO2]/?t = 3×2.4×10-4 = 7.2×10-4   mol L-1 s-1  and ?[Cr3+]/?t 2×2.4×10-4 = 4.8×10-4   mol L-1 s-1 |



**Question 1:** As the chemical reaction proceeds, the concentration of

a. reactants increases

b. prducts increases

c. reactant remains constant

d. products decreases

**Question 2:** Rate of reaction is rate of change of concentration with

a. pressure

b. temperature

c. volume

d. time

**Question 3:** Which of the following expressions is correct for rate of reaction  HNO2 → 2Cr3+ + 3NO3- + 4H2O

a. d[HNO2]/dt

b. d[2Cr3+]/dt

c. -d[4H2O]/dt

d. -d[3NO3-]/dt

**Question 4:**It is defined as the time taken by a reaction to proceed to 98% of completion is known as

a. half life of reaction

b. rate of reaction

c. reaction life time

d. reaction coefficient

MOLECULARITY

**Question 1:**Which of the following reaction is bimolecular one?

a**. PCl5  →  PCl3 + Cl2**

b. H2O2 → H2O +  1/2O2

c. N2O5 → N2O4 +  O2

d. N2O + H2 →  N2 + H2O

**Question 2:** Which of the following statements about molecularity of any reaction is correct?

a. It is experimentally determined

b. It is meant for the reaction and not for its individual steps

c. It may or may not be whole number.

d. It can never me zero

**Question 3:** Rate of a reaction depends on

a. slow step

b. fast step

c. overall reaction

d. both slow and fast step

**Question 4:**

Molecularity of the reaction 2HI → H2 + I2is?

a.1

b. 2

c.1/2

d.3/2

**Methods for Determination of Order of a Reaction**

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| **Solved Example** |
| **Question:**  From the following data show that the decomposition of hydrogen peroxide in aqueous solution is a first - order reaction. What is the value of the rate constant?   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Time in minutes | 0 | 10 | 20 | 30 | 40 | | Volume V in ml | 25.0 | 20.0 | 15.7 | 12.5 | 9.6 |   where V is the number of ml of potassium permanganate required to decompose a definite volume of hydrogen peroxide solution.  **Solution:**  The equation for a first order reaction is  The volume of KMnO4 used, evidently corresponds to the undecomposed hydrogen peroxide.  Hence the volume of KMnO4 used, at zero time corresponds to the initial concentration a and the volume used after time t, corresponds to (a - x) at that time. Inserting these values in the above equation, we get  when t = 10 min. k1 = 2.23/10 log (25/20) = 0.022318 min-1 = 0.000372 s-1  when t = 20 min. k1 = 2.23/20 log (25/12) = 0.023265 min-1 = 0.0003871 s-1  when t = 30 min. k1 = 2.23/30 log (25/12.5) = 0.02311 min-1 = 0.000385 s-1  when t = 40 min. k1 = 2.23/40 log (25/19.6) = 0.023932 min-1 = 0.0003983 s-1  The constancy of k, shows that the decomposition of H2O2 in aqueous solution is a **first order** reaction.  The average value of the rate constant is **0.0003879 s-1**. |

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**Question 1:**

In which of the following methods initial rate of reaction is determined by varying the concentration of one of the reactants while others are kept constant

a. Graphical method

b. Initial rate method

c. Half life method

d. Van’t hoff method

**Question 2:**

If the plot of 1/[A]2is a straight line , the reaction follows

a. zero order

b. first order

c. second order

d. third order

**Question 3:**

log t(1/2) =

a. log k’ - (1-n)a

b. log k’ + (1-n)a

c. -log k’ + (1-n)a

d. log k’ / (1-n)a

**Question 4:**

Which of the following methods is used only when the rate law involved by only one concentration term?

a. Graphical method

b. Initial rate method

c. Half life method

d. Van’t hoff method

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| **Example :**The rate of a reaction triples when temperature changes from 20oC to 50oC. Calculate energy of activation for the reaction (R = 8.314 JK-1 mol-1).  **Solution:**  The Arrhenius equation is  log10k2/k1 = Ea/(R×2.303) [(T2-T1)/(T1 T2 )]  Given:  k2/k1 = 3; R=8.314 JK-1 mol–1; T1 = 20 + 273 = 293 K  and   T2 = 50 + 273 = 323 K  Subtracting the given values in the Arrhenius equation,   log10 3 = Ea/(8.314×2.303) [(323-293)/(323×293)]   Ea = (2.303 × 8.314×323 × 293×0.477)/30  = 28811.8 J mol-1  = 28.8118 kJ mol-1  **Example :**  In Arrhenius equation for a certain reaction, the value of A and Ea(activation energy) are 5×1013 sec-1 and 98.6 kJ mol-1 respectively. At what temperature, the reaction will have specific rate constant 1.1 × 10-3 sec-1 ?  **Solution :**  According to Arrhenius equation  k =  Ae-Ea/RT  or    loge k = loge A - Ea/RT loge e  or    2.303 log10 k = 2.303 log10 A - Ea/RT  or    2.303 log (1.1×10-3)  = 2.303 log(4×1013)-(98.6×103)/(8.314×T)  T = (98.6×103)/(8.314×2.303×16.56) K  = 310.96 K  **Example :**  The rate constant is given by Arrhenius equation  k = Ae-Ea/RT  Calculate the ratio of the catalyst and uncatalysed rate constants at 25oC if the energy of activation of a catalysed reaction is 162 kJ and for the uncatalysed reaction the value is 350 kJ.  **Solution :**  Let kca and kun be the rate constants for catalysed and uncatalysed reactions.  2.303 log10 kca = 2.303 log10 A -  (162×103)/RT     .... (i)  and   2.303 log10 kun = 2.303 log10 A - (350 × 103)/RT    .... (ii)  Subtracting Eq. (ii) from Eq. (i)  log10kca/kun = 103/(2.303 RT) (350-162)  = (188× 103)/(2.303×8..314×298) = 32.95  kca/kun = 8.88 × 1032 |

**FACTORS AFFECTING RATE OF A REACTION**

**Question 1:**

Which of the following factors does not affect rate of a reaction ?

a. Temperature

b. Catalyst

c. Concentration of reactants

d. Nature of Product

**Question 2:**

Among the solids, rate increases with decrease in particle size.

a. pressure

b. particle size

c. concentration

d. mass of particle

**Question 3:**

A negative catalyst increases

a. rate of reaction

b. activation energy

c. amount of product formed

d. rate of backward reaction

**Question 4:**

The slope of plot  log10 k vs  [1/T] gives activation energy and intercept gives frequency factor

a.frequency factor

b. rate constant

c.rate f reaction

d.temperature coefficient

ZERO ORDER REACTIONS

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**Question 1:**

Rate of zero order reaction.

a. depends on concentration of reactants.

b. depends on concentration of products.

c. depends on concentration of both reactant and product.

d. does not depend on concentrations.

**Question 2:**

Unit of rate constant for a zero order reaction is

a. mol L-1 time-2.

b. mol2 L-1 time-1.

c. mol L-1 time-1.

d. mol-1 L-1 time-1.

**Question 3:**

If we plot [A] against t, we get a straight line with slope =

a. rate constant

b. arrhenius constant

c. temperature coefficient

d. equilibrium constant

**Question 4:**

For zero order reaction d[A] =

a. -kdt

b.  -k[A]0

c.-k[A]0dt

d. -k[A]0

FIRST ORDER REACTIONS

**Question 1:**

Rate of first order reaction.

a. depends on concentration of reactants.

b. depends on concentration of products.

c. depends on concentration of both reactant and product.

d. does not depend on concentrations.

**Question 2:**

Unit of rate constant for first order reaction is

b. mol2 L-1 time-1.

c. mol L-1 time-1.

d. time-1.

**Question 3:**

If we plot ln [A]o/[A] vs t, we get a straight line with slope =

a. rate constant

b. arrhenius constant

c. temperature coefficient

d. equilibrium constant

**Question 4:**

For zero order reaction d[A] =

a. -kdt

b.  -k[A]0

c.-k[A]0dt

d. -k[A]0

PARALLEL AND SEQUENTIAL REACTIONS

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**Question 1:**

Parallel  reactions take place in

a. more than one way

b. more than one step

c. in one way but more than one step

d. in one step but more than one way

**Question 2:**

Sequential reactions have

a. more than one way to proceed toward product

b. more than one step

c. no intermediate

d. catalyst

**Question 3:**

Which one of the following statements is correct?

a. parallel reactions are also known as consecutive reactions

b. Competingreactions  have more than one step

c. Sequential reactions are also called consecutive reactions

d. Consecutive reactions do not have intermediates.

**Question 4:**

Decomposition of ethylene oxide is

a. parallel reaction

b. competing reaction

c.both parallel as well as competing reaction

d. sequential reaction