Sub : chemistry

Grade : 11

Unit – 4 (CHEMICAL KINETICS)

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By: Esmael Abdlkadr (in collabration with ethio university)

Ethio university

Part one

4.1 rate of reaction

Rate of reaction(rxn) :- is change in concentration (conc) of reactant & product over agiven period of time.

- During rxn conc of reactants dec rease while conc of prouct increase.

Rate of rxn(r) = - Δ[reactants]/ Δtime = Δ[product]/Δtime

- The negative sign indicates final concentration of reactant is less than the intial concentration.

NB unit of rate of rxn is $MOL^{-}L^{-}S$

Given hypothetical rxn represented by balanced equation :

Aa+ bB→ Cc + dD

Rate of rxn= -Δ[A]/ a^{-}Δt= - Δ[B]/ bΔt= Δ[C]/ cΔt= Δ[D]/ d Δt

Worked example 1:- express the rate of the ff rxn interms of reactant & product ?

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Solution rate = -Δ $[CH_4]/\Delta t$ = $-\Delta[O_2]/2\Delta t = \Delta[CO_2]/\Delta t = \Delta[H_2O]/\Delta t$

Worked example :- 2 write the valid rxn rate for the given rxn?

$2NO_2(g) \rightarrow 2NO(g) + O_2(g)$

Rate = $-\Delta[NO_2]/2\Delta t = \Delta[NO]/2\Delta t = \Delta[O_2]/\Delta t$

Factors affecting rate of reactants

1 cocntration of reactants

- As conctration of reactants increase rate of rxn also increase
- For gaseous reactants increasingpressure will increase rate of rxn

2 nature of reactants

- The more reactive the reactant the fster the rate of rxn

3 surface area of reactants

- As surface area of solid increase rate of rxn increase

Homogeneous rxn:- rxn occur b/n the same phase .

Hetrogeneous rxn :- rxn b//n two d/t phase

4 Temperature of reactants

- Increasing temp icrease average kinetic energy
- Increasing temp increase the rate of rxn

5 catalyst

- Catalyst is subs that speed up a given chemical rxn by lowering its activation energy (EA).
- Catalyst speed up a rxn rate with out consuming in the rxn
- They doesn't alter position of equlibruim

NB positive catalyst, speed up(increase) rate of rxn by lowering acrivation energy.

Negative catalyst slow down(decrease) rate f rxn by increasing activation energy.

Questions from entrance exam from this topic 1 & 2

1 In a rxn A + B →product , the rate law is doubled when the concn of B Is dobled & the rate increased by factor of 8 when the conc of both reactants A&B are doubled, the rate for the rxn can be written as:- (2006 E.C)

A) K[A][B]
B) K[A][B]2
C) K$[A]_2$[B]
D) K$[A]_2$[B],2

2 consider rxn below in w\h the ff will the effect of conc & temp simultaneous cause an increase in the rate at w/h product are formed ?(2007 E.C)

$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CO_{2(g)} + CaCl_{2(aq)} + H_2O_{(l)}$ + heat

A) Decrease [HCl] & decrease temp
B) Increase [HCl] & increase temp
c) increase [HCl] & decrease temp
D) grind up the $CaCO_3$ &decrease tem

3 if we increase the conc of reactants, what hppen to collision b/n particles?(2008 E.C)

A) There are more collision
B) There are fewer collision
C) there are same number of collision, but they have less energy
D) there are same number of collision , but they have more energy.

4 the rate law of the over all rxn A + B→C is rate = k$[A]_2$ then w/h of the ff will not increase rate of rxn? (2008 E.C)

A) Increase conc of A
B) Increase conc of B
C) increase temp of rxn
D) adding catalyst

5 rate of rxn increase with increasing conct 0f reactants this is b/c… (2009 E.C)

A) Avg kinetic energy of molecule increase
B) Frequency of molecular collision increase
C) Order of rxn increase
D) Activation energy increase

6 w/h of the ff increase the rate of rxn at which solid dissolve in liquid ? (2010 EC)

A) Supersaturating the solution
B) Grinding solution in to smaller piece
C) Lowering temp
D) Placing solution in opaque material

7 …… ΔH corresponds to …… process (2010 E.C)

A) Positive , endothermic
B) Positive , exothermic
C) negative , endothermic
D) Zero, exothermic

8 the minimum energy required for effective collision is called …… (2011 E.C)

A) Potential energy
B) Kinetic energy
C) free energy
D) activation energy

9 what does it mean by ΔH= negative for the gven process ? (2011 E.C)

A) The process is endothetmic
B) The pricess is adiabatic
C) The process is exothermic
D) The process is eqithermic

4.2 theories of reaction rate

States that " for a rxn to occur collision of particle must occur".

- The rate of rxn is directly proportional to number of collision per second.
- According to collision theory , the more the collision the faster the rate of rxn , however not all collsions b/n recting species result in reaction .

Collision can be classified in to two based on formation of product :-

- ✓ Ineffective collision :- doesn't result in formation of desired product.
- ✓ Effective collision:- results in formation of desired prodct

- Postulates of collision theory states that for a reaction to occur:-

- ➔ The particles must collide
- ➔ The perticles of reacting species must have proper orientation
- ➔ The particles must collide with energy greather than or equal to activation energy

What is activation energy (EA)?

Is the minimum energy required for areaction to occur during collision of reacting species .

- Increasing concentration of reacting species results in higher number of collision per unit time, and rate of rxn increase .

Transition state(activated compex) theory

According to this theory, collision b/n reacting species results in a short lived, high energy state species in the formation of activated complex.

Activated complex:- is short lived high energy state species that is temporary formed by collision of reactants before formation of product.

- According to transition state theory, the rate of rxn depend on the rate at whuch the reactants can climb top of barrier & form activated complex.

The difference b/n endothermic & exothermic rxn

Endothermic rxn	**exothermic r**
1 Absorb heat	release heat
2 ΔH>0	Δ H<0
3 Products have higher energy than reactans	products have lower energy than reactants

4.3 rate of equations(law)

Rate law(equations) :- is an equation w/h link rxn rate with cocentrtion or pressure with certain parameter .

Consider this hypothetical rxn

Aa +bB→Cc + Dd

Rate = **$k[A]^x [b]_y$**

[A] = conctrtion of reactant A

[B] = concentration of reactant B

X = order of rxn for reactant A

Y= order of rxn for reactant B

- **order of rxn can be zero , positive or negative.**
- **Order of rxn is not the sam as stiochiometric coefficient for balanced equation .**

Worked Example :- **determine the order of rxn with resoect to each reactant & product from the give rate law ?**

$2NO + O_2 \rightarrow 2NO_2$

Solution

Steps 1 :- first we write rate l law by the formula given above

Rate = $K [NO]_2 [O_2]$

Step 2:- the order of rxn with respect to [NO2] is = 2

The order of rxn with respect to [O2] = 1

Step 3:- the over all order is the sum of the two orders so 2 + 1= 3

So the over all order is 3

Determination of rate law

For the given rxn A +bB→ Cc + dD

Intial rate law = $k[A]_x^o + [B]_y^o$

- X is determined by varying conc of A while keeping constamt conc of B
- Y is determined by varying conc of B while keeping constant conc of A

Example:- the intial rate of & conc are measured for the given rxn

$2NO(g) + 2H_2(g) \rightarrow N_{2(g)} + 2H_2O(g)$

[NO] , M	[H_2] , M	Intial rate mol/L/S
0.0005	0.0005	0.000025
0.0005	0.0010	0.000050
0.0010	0.0010	0.00020

What is rate equation for the rxn?

Soln :- rate = $k[NO]_x[H_2]_y$

x is determined by 2^{nd} & 3^{rd} data while y is determined by 1^{st} & 2^{nd} dat

Rate 2/ rate 3 = $k[NO]_x\ [H_2]_y/K[NO]_{x3}\ [H_2]$ =

$0.000050/0.00020 = k(0.0005)_x(0.0010)/k\ (0.0010)_x\ (0.0010)_y$ = $1/4 = (1/2)_x = (1/2)_2$ >> x= 2

Rate 1/ rate 2 = $k[NO]_1\ [H_2]_1/[NO]_2\ [H_2]_2$ =

$0.000025/ 0.000050 = (0.0005)_x\ (0.005)_y/\ (0.0005)_x\ (0.0010)_y$ = 1/2 = $(1/2)_y$ y= 1

So the rate of rxn is rate = $k[NO]_2[H_2]$

Questions from entrance exam from this topic

1 kinetic data below are for the rxn : A + B →C from this data the order of rxn with respect to A & B? (2006 E.C)

[A]	[B]	Intial rate
0.1	0.1	1x 10^-5
0.1	0.2	4x 10^-5
0.2	0.1	1x 10^-5

A) order of A = 1 & order B =0
B) order of A = 0 & order of B = 2
C) order of A = 0 & order of B = 4
D) Order of A = 1 & order of B = 2

2 given rxn 2NOCl (g) → 2NO(g) + Cl_2 the ff data obtained

[NOCl]	Intial rate
3x 10^ 16	5.98 x 10^4
2 x10^ 16	2.66 x 10^4
1 x10^16	6.64 x 10^ 3
4x 10^ 16	1.06 x 10^ 5

Then what is the rate law for the above decomposition? (2008 E.C)

A) K[NOCl]
B) K[NOCl]
C) K[NOCl][NO]
D) K[NOCl][Cl]

3 given the ff rxn

$NH_4 + NO_2 \rightarrow N_2 + 2H_2O$

Experimwnt	[NH4] (M)	[NO2] (M)	Rate (M/S)
1	0.01	0.02	0.02
2	0..15	0.02	0.03
3	0.010	0.01	0.005

What will be the rate law for the given rxn? (2009 E.C)

A) K[NH4] [NO2]
B) K[NH4]^2 [NO2]
C) K[NH4^2] [NO2]^2
D) K [NH4] [NO2]^2

4 for the rxn $N_2 + 3H_2 \rightarrow 2NH_3$, the rate of disaperance of H2 is 0.01mol/min. what is the rate appearance of NH3? (2011 E.C)

A) 0.01 Mmol/min
B) 0.02 mol/ min
C) 0.002 mol/ min
D) 0.007 mol/ min