Pakistan School
Kingdom of Bahrain

Grade :10th

Subject: Chemistry

Welcome to
E-Learning

بسم الله الرحمن الرحيم
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ImaanBoosters

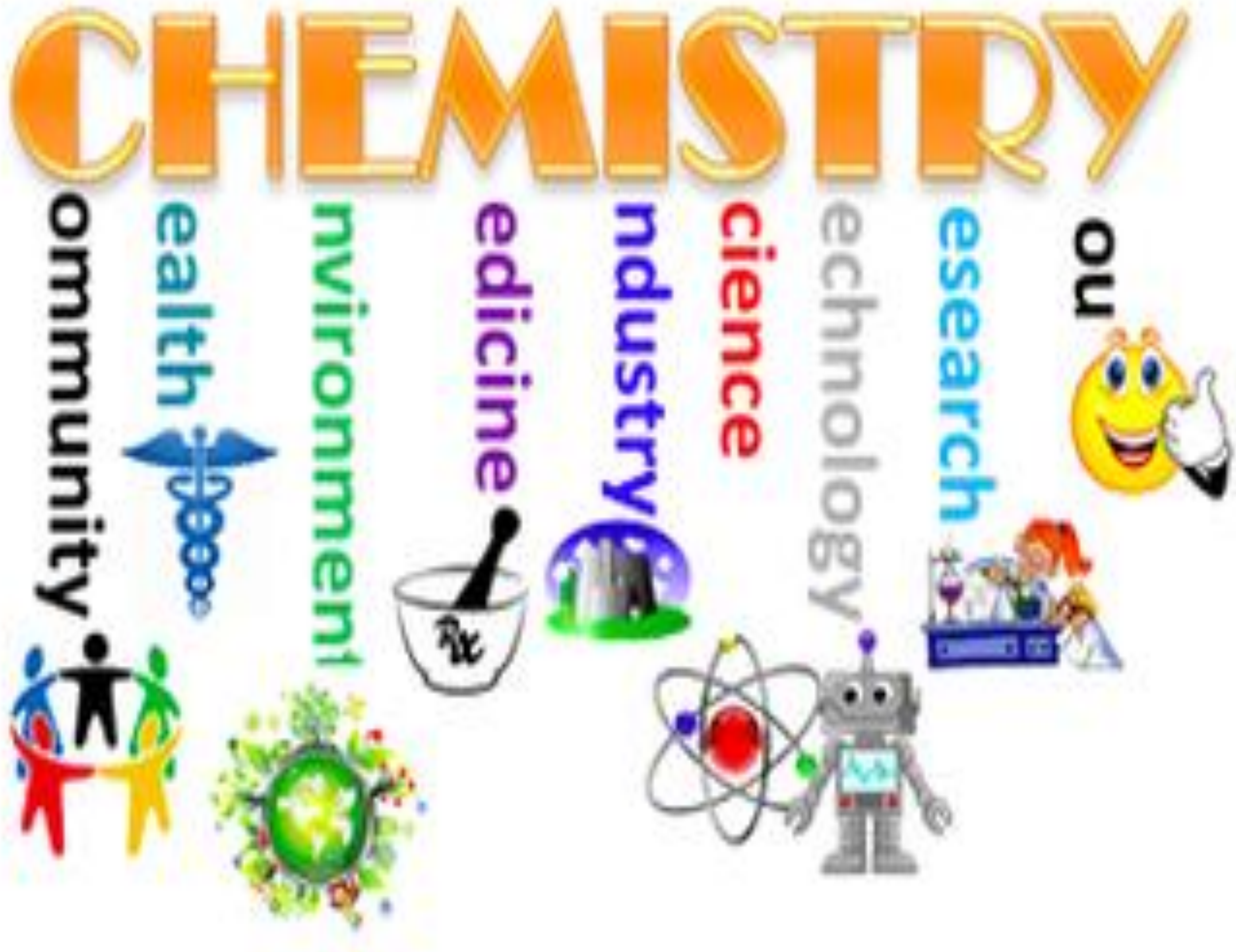
رَبِّ زِدْنِي عِلْمًا

Rabbi zidnī ‘ilmā

O my Lord! Advance me in Knowledge

[Qur'an, 20:114]

#seekingknowledge


CHEMISTRY
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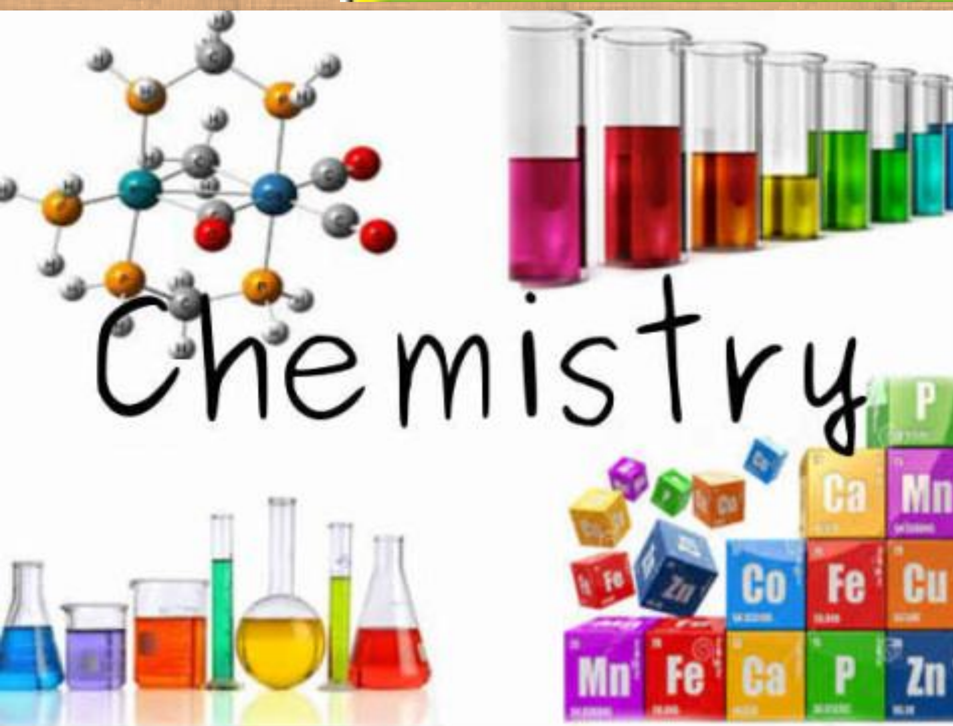
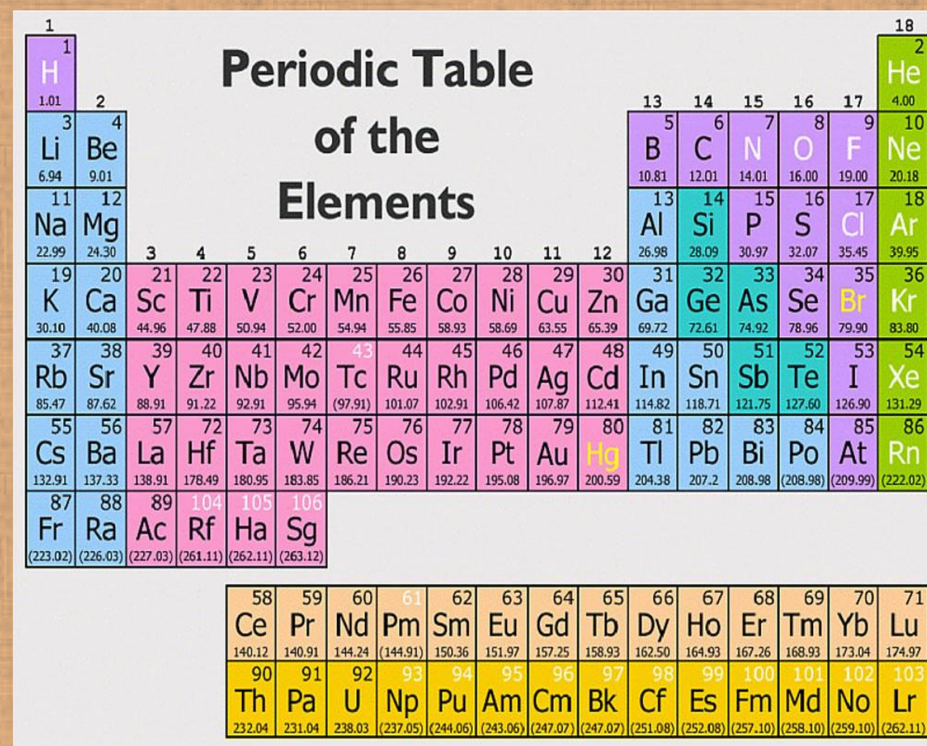
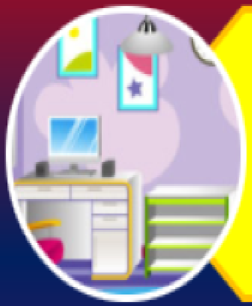
Welcome!


Chemistry


Periodic Table
of the
Elements

Virtual Classroom Rules



Select a quiet place to study.

Be on time.

Come to class prepared in every way to learn and participate.

Virtual Classroom Rules

Be respectful.

Listen to & follow directions.

Turn off your video before joining the class.

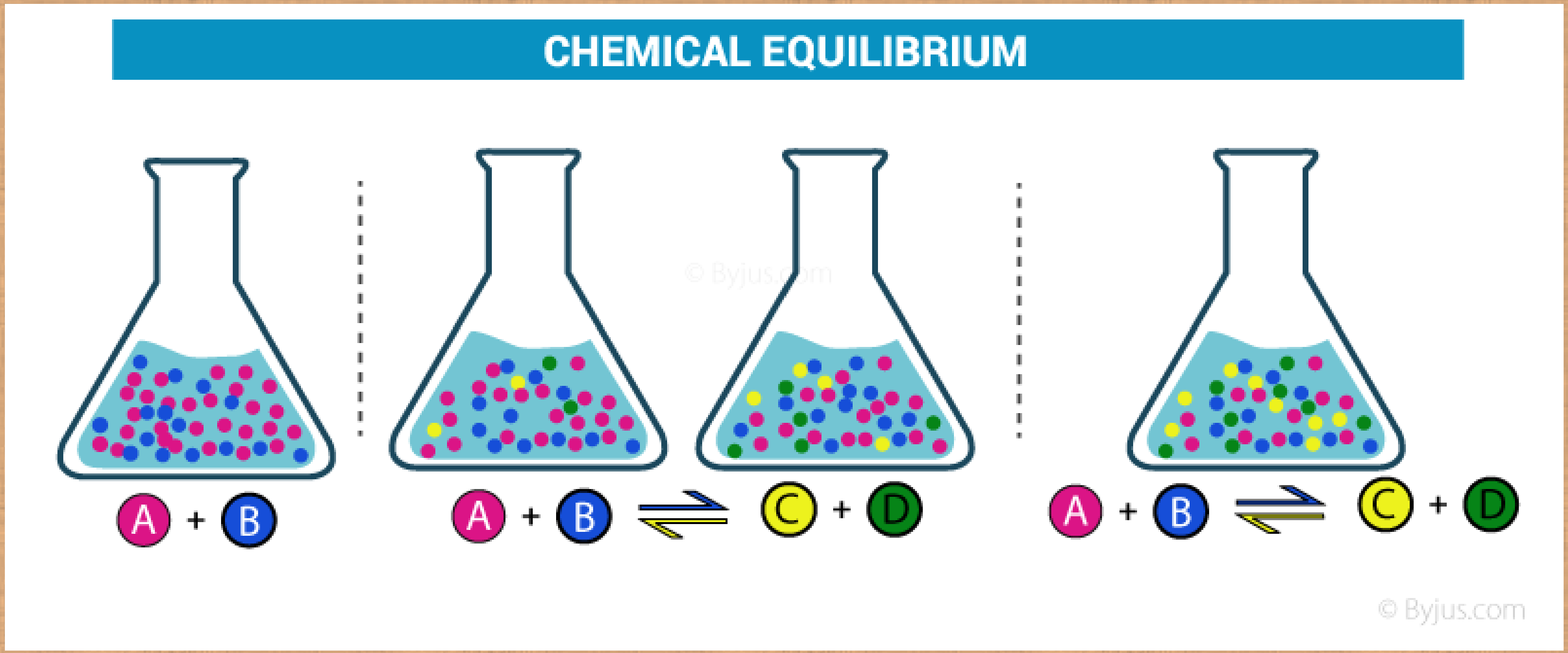
I hope you will follow all the above mentioned rules to make your dear teacher happy.

ENGAGING STARTER


Are these reversible changes?
TTYP: Why not?
en we can't easily change the substan
the end back into the substance at th


Burning wood
Reversible / Irreversible
Melted butter
Reversible / Irreversible
Breaking an egg
Reversible / Irreversible
Chopping a tomato
Reversible / Irreversible

Chemical Equilibrium



Lesson Objectives:

- By the end of this lesson, students

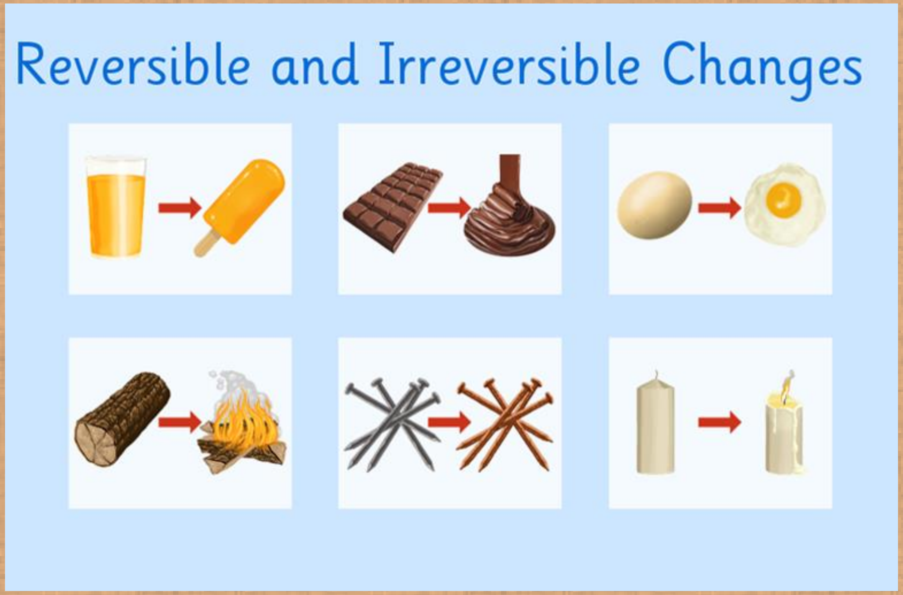
will be able to:

- Write both the forward & reverse reactions.
- Write the equilibrium constant expression of a reaction.
- Determine the units for equilibrium constant .

General Chemical Reaction

COMPLETE /IRREVERSIBLE REACTION :

A complete reaction is one in which all reactants have been converted to products.



(a) $H_2 + I_2 \longrightarrow 2HI$

(b) $H_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4 + 2H_2O$

(c) $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$

(d) $Fe + S \longrightarrow FeS$

Characteristics of irreversible reaction:

- Proceed in one direction(unidirectional) from left to right.
- Represented by single arrow($\longrightarrow$)
- These reactions are complete reactions. Or they go to completion.
- There is not equilibrium phenomenon.
- They are generally fast reactions.

REVERSIBLE REACTION :

$$H_2 + I_2 \rightleftharpoons 2HI$$

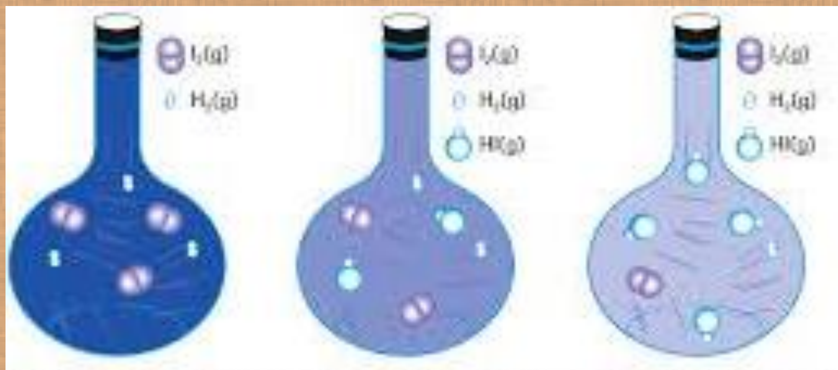
- A reaction in which the products can react together to re-form the original reactants is called reversible reaction.

Characteristics of Reversible reaction:

- Reversible reactions never go to completion .All reversible changes (physical and chemical)
- Occur simultaneously in both the directions.
  - Left to right=Forward
  - Right to left=Reverse
- Notation of reversible reaction:
- The double arrow ($\leftrightharpoons$) in the chemical equation shows that the reaction is reversible

Examples:

$$H_2 + I_2 \rightleftharpoons 2HI$$



Forward

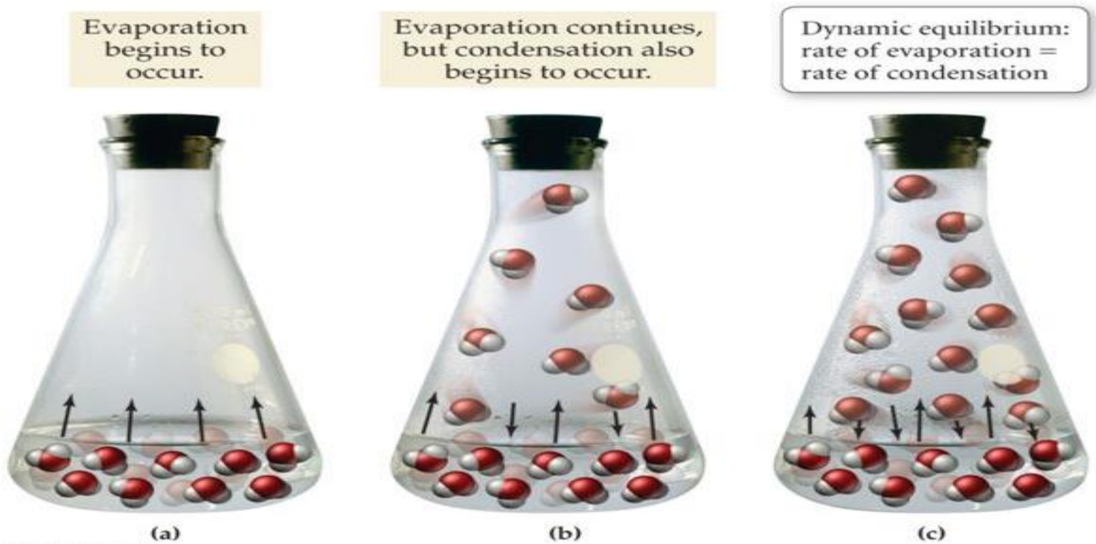
$$H_2 + I_2 \longrightarrow 2HI$$

Reverse

$$2HI \longrightarrow H_2 + I_2$$

Vapor Pressure and Dynamic Equilibrium

- Vapor Pressure of a liquid is the partial pressure of its vapor in dynamic equilibrium with its liquid.

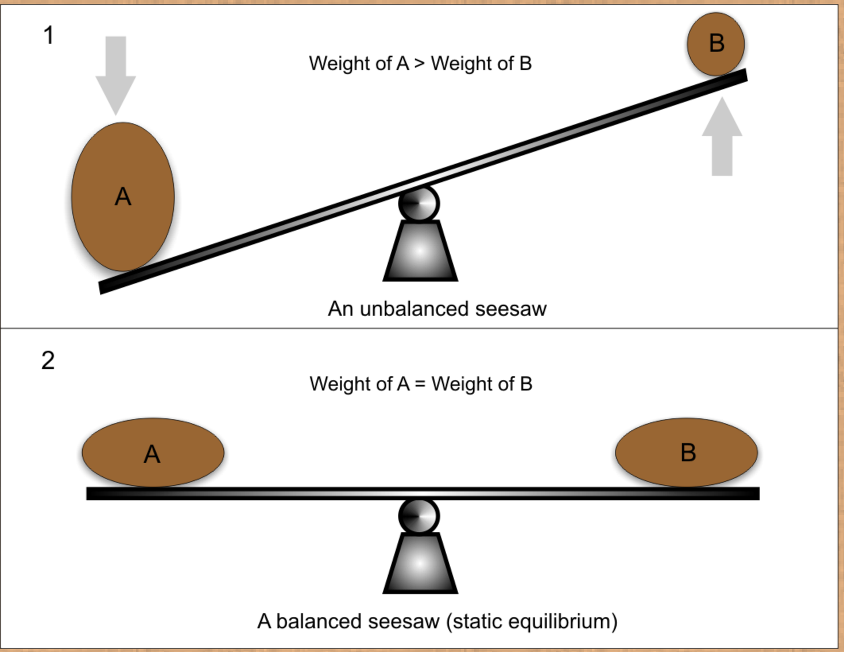


Chemical Equilibrium

A state of a chemical reaction in which forward and reverse reactions take place at the same rate is called "chemical equilibrium".

Chemical Equilibrium

- **Dynamic equilibrium**
- **Static equilibrium**



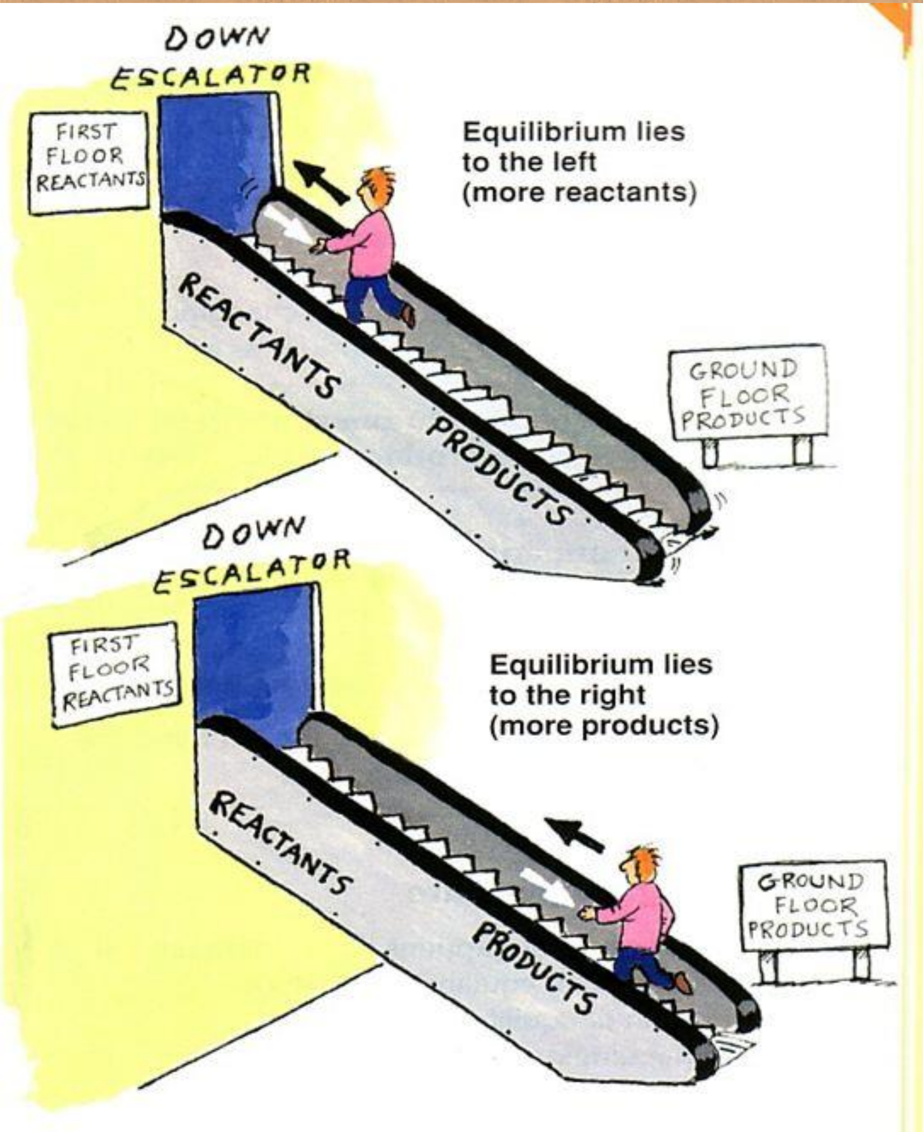
- The equilibrium sign (⇌) is used to show that both sides of the equation are present.
  - When all of the reactant particles remain as reactants and all of the products remain as products, it is known as **static equilibrium**
  - When there is a constant exchange from reactants to products (and visa versa), it is known as **dynamic equilibrium**

Dynamic & static equilibrium

- examples

Dynamic Equilibrium:
is the steady state of a reversible reaction where the rate of the forward reaction is the same as the reaction rate in the backward direction.

Static Equilibrium:
Static equilibrium, also known as mechanical equilibrium, means the reaction has stopped. In other words, the system is at rest.

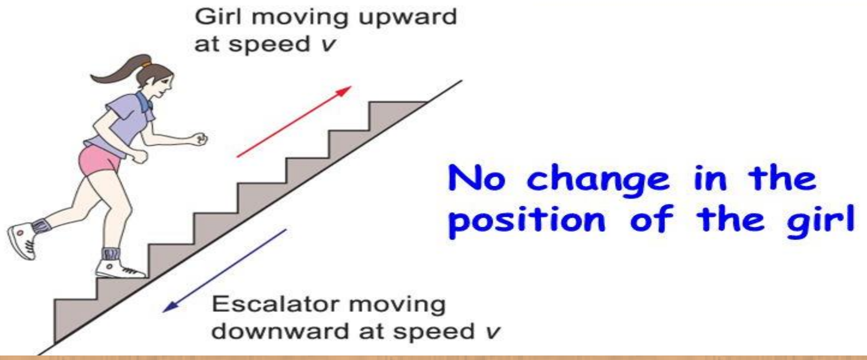


The man running up the 'down-escalator' can appear to be still on any part of the staircase

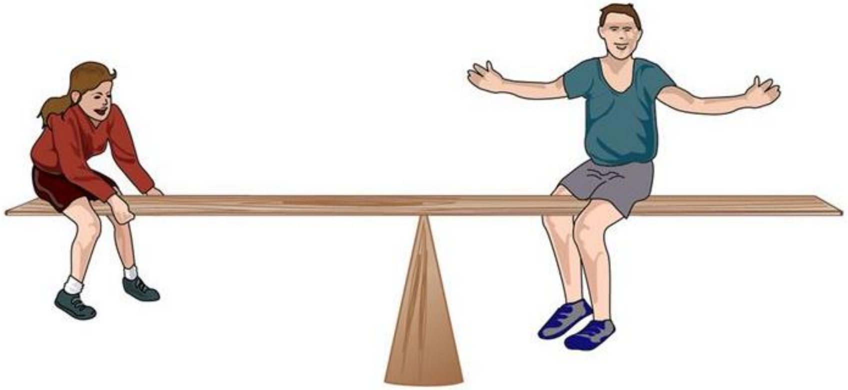
- Dynamic Equilibrium:
  - Child ascending escalator at the same rate the escalator descends.
  - At the balance point (the equilibrium position), the child and escalator are moving at the same rate in opposite directions.

- Static Equilibrium:
  - Children on see-saw.
  - At the balance point (the equilibrium position), there is no movement of the children or the see-saw (the opposing processes) .

Dynamic Equilibrium



Examples of static equilibrium



Macroscopic characteristics of Dynamic Equilibrium

- 1. **Macroscopic properties** (e.g. colour, pressure, concentration, pH) are constant
  - I.e. It appears as if nothing is changing
- 2. Can only be reached in a **closed system**
- 3. **Forward rate = Reverse rate**
- 4. Can be established from **either direction**

$$H_2 + I_2 \rightleftharpoons 2HI$$

At equilibrium, the concentrations of all reactants and products will remain constant

Writing Forward and Reverse Reactions:

(i) $2NO_2 \rightleftharpoons N_2O_4$

Forward Reaction:

- $2NO_2 \rightarrow N_2O_4$

Reverse Reaction:

- $N_2O_4 \rightarrow 2NO_2$

(ii) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Forward Reaction:

- $N_2 + 3H_2 \rightarrow 2NH_3$

Reverse Reaction:

- $2NH_3 \rightarrow N_2 + 3H_2$

(iii) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

Forward Reaction:

- $2SO_2 + O_2 \rightarrow 2SO_3$

Reverse Reaction:

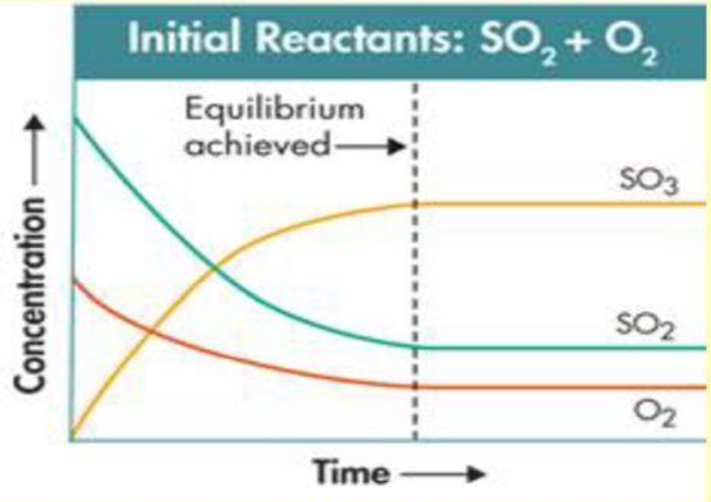
- $2SO_3 \rightarrow 2SO_2 + O_2$

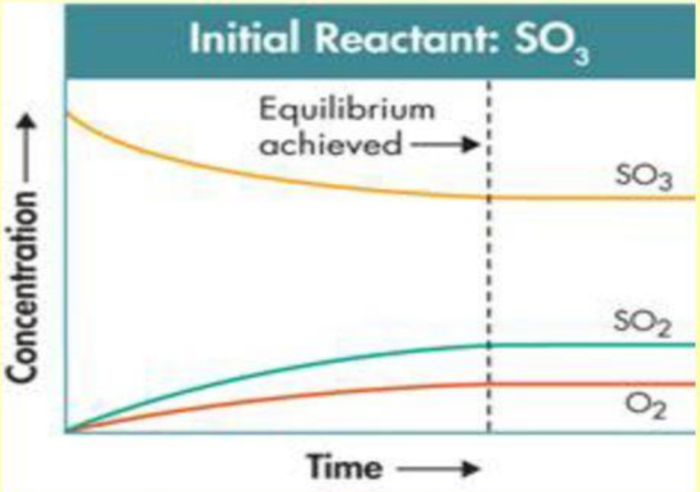
Explanation with Graph:

When the rates of the forward and reverse reactions are equal, the reaction has reached a state of balance called chemical equilibrium.

Reaction starting SO_2 & O_2, but no SO_3.

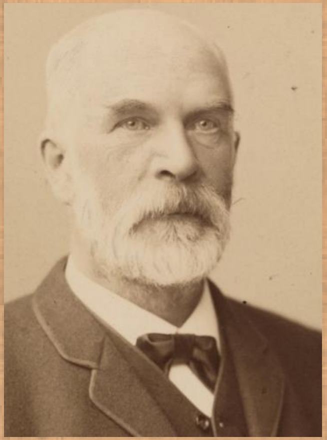
Reaction starting with SO_3, but no SO_2 and O_2.





Eventually, the concentrations remain constant.

Law of Mass Action:



- **Introduction:**

  Two chemists C.M Gulberg and P. Waage in 1864 proposed the law of mass action to describe the equilibrium state.

- **Statement:**

  "It states that the rate at which a substance reacts is directly proportional to its active mass and the rate at which the reaction proceeds is directly proportional to the product of the active masses of the reactants."

- **Active Mass:**

  The term "Active Mass " represents the concentration of reactants and products in moles.dm^{-3} for a dilute solution, and is expressed in terms of square brackets [ ].

Equilibrium Constant Expression

In the reaction:

$$aA + bB \rightleftharpoons cC + dD$$

$$K_c = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b}$$

[A] = concentration of A in $moldm^{-3}$

a = number of moles of A

Writing Equilibrium Constant Expressions

- for the reaction $aA_{(aq)} + bB_{(aq)} \Leftrightarrow cC_{(aq)} + dD_{(aq)}$ the equilibrium constant expression is

$$K = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$$

- so for the reaction $2\,N_2O_5 \Leftrightarrow 4\,NO_2 + O_2$ the equilibrium constant expression is:

$$K = \frac{[NO_2]^4 \times [O_2]}{[N_2O_5]^2}$$

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

Examples:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

$$2N_2 + O_2 \rightleftharpoons 2NO_2$$

$$K_c = \frac{[SO3]2}{[SO2]2\ [O2]}$$

$$K_c = \frac{[NH3]2}{[N2]\ [H2]3}$$

$$K_c = \frac{[NO2]2}{[N2]2\ [O2]}$$

Equilibrium Constant & its units

i) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

$$K_c = \frac{[SO3]2}{[SO2]2\,[O2]}$$

$$K_c = \frac{[\,mol.dm-3]2}{[mol.dm-3\ \ ]2\,[mol.dm-3\,]}$$

$Kc = mol^{-1}.dm^{3}$

i) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

<u>Solution:-</u>

$$K_c = \frac{\text{Concentration of Products}}{\text{Concentration of Reactants}}$$

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$

Concentrarion in mol dm^{-3}

$$K_c = \frac{[mol.dm^{-3}][mol.dm^{-3}]}{[mol.dm^{-3}][mol.dm^{-3}][mol.dm^{-3}]}$$

$$K_c = \frac{1}{mol \cdot dm^{-3}} = mol^{-1}.dm^{3}$$

$$\boxed{K_c = mol^{-1}.dm^{3}}$$

ii) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$K_c = \frac{[NH3\ ]2}{[N2]\ [H2]3}$$

$$K_c = \frac{[\,mol.dm-3]2}{[mol.dm-3\ ]\ [mol.dm-3\ ]3}$$

$$Kc = mol^{-2}.dm^{6}$$

ii) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Solution:-

$$Kc = \frac{\text{Concentration of Products}}{\text{Concentration of Reactants}}$$

$$Kc = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$Kc = \frac{[mol.dm^{-3}][mol.dm^{-3}]}{[mol.dm^{-3}][mol.dm^{-3}][mol.dm^{-3}][mol.dm^{-3}]}$$

$$Kc = \frac{1}{[mol.dm^{-3}][mol.dm^{-3}]}$$

$$Kc = \frac{1}{mol^{2}.dm^{-6}}$$

$$\boxed{Kc = mol^{-2}.dm^{6}}$$

iii) $2N_2 + O_2 \rightleftharpoons 2NO_2$

iii) $2N_2 + O_2 \rightleftharpoons 2NO_2$

Solution:-

$$K_c = \frac{\text{Concentration of Products}}{\text{Concentration of Reactants}}$$

$$K_c = \frac{[NO_2]^2}{[N_2]^2\,[O_2]}$$

$$K_c = \frac{[\cancel{mol.dm^{-3}}]\,[\cancel{mol.dm^{-3}}]}{[\cancel{mol.dm^{-3}}]\,[\cancel{mol.dm^{-3}}]\,[mol.dm^{-3}]}$$

$$K_c = \frac{1}{[mol.dm^{-3}]}$$

$$\boxed{K_c = mol^{-1}.dm^{3}}$$

$$K_c = \frac{[NO2\,]2}{[N2]2\,[O2]}$$

$$K_c = \frac{[\,mol.dm-3]2}{[mol.dm-3\ \ ]2\,[mol.dm-3\,]}$$

$K_c = mol^{-1}.dm^{3}$

Q:Bromine chloride (BrCl)decomposes to form chlorine and Bromine.For this reaction write:
(i) Chemical equation
(ii) K_c expression
iii) Units of K_c

* (i) Chemical Equation:-

$$2BrCl \rightleftharpoons Br_2 + Cl_2$$

* (ii) K_c expression:-

$$K_c = \frac{\text{Concentration of Products}}{\text{Concentration of Reactants.}}$$

$$K_c = \frac{[Br_2][Cl_2]}{[BrCl]^2}$$

* (iii) Unit of K_c :-

$$K_c = \frac{[mol\text{-}dm^{-3}][mol\text{-}dm^{-3}]}{[mol\text{-}dm^{-3}][mol\text{-}dm^{-3}]}$$

K_c = No-unit

Plenary

Q: What happens when H_2 and I_2 gases are mixed in a sealed container?

Q: i) In an irreversible reaction equilibrium is:
A) Established quickly B) Established slowly C) Never Established
D) Established when reaction stops

Q: Choose reactant and product for this reaction.

$2\ N_2O_5 \Leftrightarrow 4\ NO_2 + O_2$ the equilibrium constant expression is:

$$K = \frac{[NO_2]^4 \times [O_2]}{[N_2O_5]^2}$$

Q:What will be K_c units for this reaction?

Home Work

SOLVE:

- Self Assessment Exercise.9.2
- Self Assessment Exercise.9.3
- Review Questions:3,4,5,6


Let's Stop COVID-19
Stay
Home
Stay Safe
WORK
FROM HOME


.Allah Hafiz.
خدا حافظ


في أمان الله
May Allah protect you
(ARABIC PHRASE USED BY
WAY OF SAYING GOODBYE)
@TRUSTING_TRUTHS