Outcome 1 - Chemical Equilibrium

Part 1: Defining Equilibrium and Writing Equilibrium Equations

Equilibrium - a state of balance

Static equilibrium - Nothing is moving or changing to create the balance

A textbook sitting on a level desktop - It stays motionless because two equal and opposite forces act on it simultaneously

Dynamic equilibrium - an balance in which there is still movement, but no net (overall) movement

A juggler's act is a *dynamic equilibrium*,with some balls moving upward and some moving downward at any given moment. There is no net change because the rates of upward movement and downward movement are equal at any given moment.

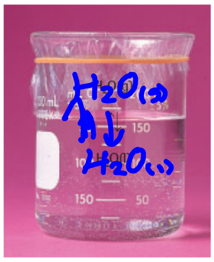
Chemical systems at equilibrium have constant observable properties.

Nothing appears to be happening because the internal movement involves entities that are too small to see.

http://ed.ted.com/lessons/if-molecules-were-people-george-zaidan-and-charles-morton

Chemical Equilibrium - pgs 676-678

- We assume that any closed chemical system with constant macroscopic properties (no observable change occurring) is in a state of equilibrium



- There are 3 types of chemical equilibrium:

  a. Phase equilibrium - involves a single chemical substance existing in more than one phase in a closed system

  b. Solubility equilibrium - involves a single chemical solute interacting with a solvent substance, where excess solute is in contact with the saturated solution

  c. chemical reaction equilibrium - involves several substances: the reactants and products of a chemical reaction

- The terms ***forward*** and ***reverse*** are used to identify which process is being referred to, and are specific to a written equilibrium equation

- When any equation is written with arrows to show that the change occurs both ways,

    - the left-to-right change is called the forward reaction

    - the right-to-left change is called the reverse reaction

how fast

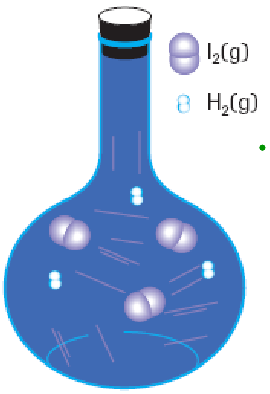
- When a chemical system is in a state of dynamic equilibrium, the rate of the forward reaction equals the rate of the reverse reaction

Chemical Reaction Equilibrium - pgs 678-680

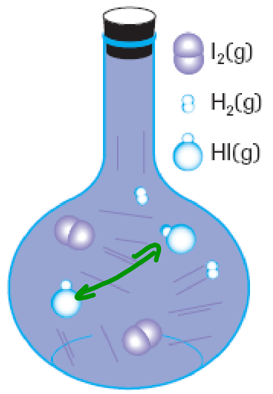
Chemical reaction equilibria are more complex than phase or solubility equilibria, due to the variety of possible chemical reactions and the greater number of substances involved

To explain chemical equilibrium systems, we need to combine ideas from

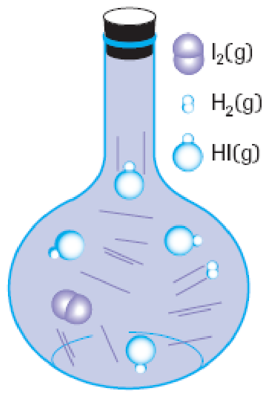
- kinetic molecular theory
- collision–reaction theory
- the concepts of reversibility
- the concept of dynamic equilibrium



Initially, hydrogen (in excess) and iodine are added to the flask. The colour of the iodine vapour is the only easily observable property.

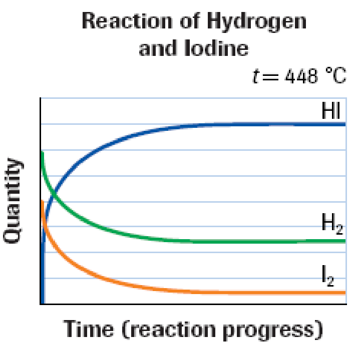


Early in the reaction, hydrogen and iodine form hydrogen iodide faster than hydrogen iodide forms hydrogen and iodine. Overall, the amount of iodine decreases, so the colour of the flask contents appears to lighten. Both hydrogen and hydrogen iodide are colourless.



At equilibrium, analysis shows that the flask contains all three substances. The purple colour shows that some iodine remains. The constancy of the colour is evidence that equilibrium exists. Forward and reverse reactions are occurring at equal rates.

$$H_2(g) + I_2(g) \rightleftarrows 2\,HI(g),$$



http://www.kentchemistry.com/links/Kinetics/Equilibrium/equilibrium.swf

Percent Yield and Position of Equilibrium - pg 680

- **percent yield** is defined as the yield of product measured at equilibrium compared with the maximum possible yield of product

- The **maximum possible yield** of product is calculated using the method of stoichiometry, assuming a quantitative forward reaction with no reverse reaction

$$\underline{1}\ H_2(g) + I_2(g) \rightleftharpoons \underline{2}\ HI(g),$$

1.0 mol   excess   max: 2.0 mol   % yield: 75%

act: 1.5 mol

% yield = (actual yield / max. possible yield) x 100

Percent yield	Description of equilibrium	Position of equilibrium
negligible	nonspontaneous (no apparent reaction)	
< 50%	reactants favoured	< 50% ⇌
> 50%	products favoured	> 50% ⇌
> 99.9%	quantitative	→

http://ed.ted.com/lessons/the-chemical-reaction-that-feeds-the-world-daniel-d-dulek#review