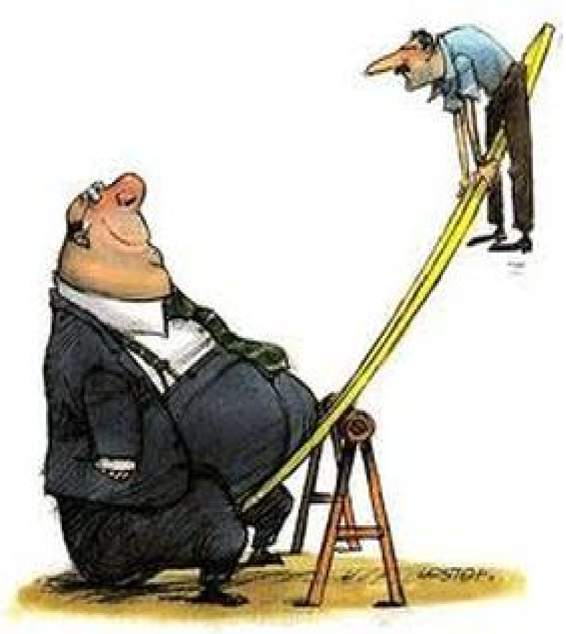

Dynamic Chemical Equilibrium

basic education
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Cover Pics: http://mrlawsonscience.weebly.com/unit-2---equilibrium.html
http://www.chem4kids.com/files/react_equilib.html

TOOLBOX-What you need to know before doing chemical equilibrium

- Chemical formulae
- Oxidation states
- Concentrations
- The mole concept
- Excess and limiting reagents
- Reversible and irreversible reactions
- FUN

This lesson should ideally be presented as a game. Learners are able to visualise the reactions understand how graphs come into being. Enjoy!

A. Common misconceptions 10

1. Students often do not discriminate between reactions that go to completion and reversible reactions;

   - may believe that the forward reaction goes to completion before the reverse reaction commences;
   - may fail to distinguish between rate (how fast) and extent (how far);
   - often think that the rate of the forward reaction increases with time from the mixing of reactants until the equilibrium is established (Driscoll, 1960; Wheeler & Kass, 1978; Hackling & Garnett, 1985; Banerjee, 1991):

2. Students often fail to understand the dynamic nature of a system in a state of chemical equilibrium. Instead, many of them hold a static conception, for they believe that nothing happens in that state (Godoretsky & Gussarsky, 1986; Thomas & Schwenz, 1998).

3. Students often conceptualise equilibrium as oscillating like a pendulum (Bergquist & Heilkkinen, 1990; Van Driel et al., 1998).

4. Students may have a compartmentalised view of equilibrium (Johnstone, MacDonald & Webb,1977; Furió & Ortiz; 1983; Cachapuz & Maskill, 1989; Stavridou & Solomonidou, 2000).

5. Students may believe that mass and concentration mean the same thing for substances in equilibrium systems (Wheeler & Kass, 1978; Quílez & Solaz, 1995; Quílez, 2004).

6. Students may believe that the concentrations of the reactants at equilibrium equal the concentrations of the products (Hackling & Garnett, 1985; Huddle & Pillay, 1996).

7. Students may find difficulties in understanding and using many of the terms (*e.g.* equilibrium,displacement, shift, stress, balanced, reversible, etc) used in chemical equilibrium lessons (Évrard,Huynen & De Bueger-Vander Broght, 1998; Pedrosa & Dias, 2000; Quílez, 2004).

Analogies

8. Studies on the pedagogical effectiveness of the use of analogies are numerous. The majority of these works conclude that analogies promote an unequivocal help in assimilating and understanding the phenomena (HALPERN, HANSAN and REIFER, 1998),

9. Reducing the incidence of misconceptions (HARRISON and TREAGUST, 1994)

10. Help to explain fundamentally important science concepts (GLYNN, YEANY and BRITTON, 1991).

11. Some studies (for instance, HIDEO, 1997) emphasise that the use of analogies can be effective in facilitating conceptual exchange.

Real Life context: 2

EQUILIBRIUM AND HEALTH

Discussions of chemical equilibrium tend to be rather abstract, despite the challenges involved in addressing the subject of equilibrium; the results of chemical equilibrium can be seen in processes involving human health, industrial and many other contexts.

Haemoglobin and oxygen in human blood.

HAEMOGLOBIN AND OXYGEN.

Haemoglobin, a protein containing iron, is the material in red blood cells responsible for transporting oxygen to the cells. Each haemoglobin molecule attaches to four oxygen atoms, and the equilibrium conditions of the haemoglobin-oxygen interaction can be expressed thus: Hb *(aq)* + $4O_2$ *(g)* ⇋ $Hb(O_2)_4$ *(aq)* , where "Hb" stands for haemoglobin. As long as there is sufficient oxygen in the air, a healthy equilibrium is maintained; but at high altitudes, considerable changes occur.

At significant elevations above sea level, the air pressure is lowered, and thus it is more difficult to obtain the oxygen one needs. The result, in accordance with Le Châtelier's principle, is a shift in equilibrium to the left, away from the oxygenated haemoglobin. Without adequate oxygen fed to the body's cells and tissues, a person tends to feel light-headed.

When someone not physically prepared for the change is exposed to high altitudes, it may be necessary to introduce pressurized oxygen from an oxygen tank. This shifts the equilibrium to the right. For people born and raised at high altitudes, however, the body's chemistry performs the equilibrium shift—by producing more haemoglobin, which also shifts equilibrium to the right.

HEMOGLOBIN AND CARBON MONOXIDE.

When someone is exposed to carbon monoxide gas, a frightening variation on the normal haemoglobin-oxygen interaction occurs. Carbon monoxide "fools" haemoglobin into mistaking it for oxygen because it also bonds to haemoglobin in groups of four, and the equilibrium expression thus becomes:

Hb *(aq)* + 4CO *(g)* ⇋ $Hb(CO)_4$ *(aq).*

Instead of haemoglobin, what has been produced is called carboxyhemoglobin, which is even redder than haemoglobin. Therefore, one sign of carbon monoxide poisoning is a flushed face.

The bonds between carbon monoxide and haemoglobin are about 300 times as strong as those between haemoglobin and oxygen, and this means a shift in equilibrium toward the right side of the equation—the carboxyhemoglobin side. It also means that *K* for the haemoglobin-carbon monoxide reaction is much higher than for the haemoglobin-oxygen reaction. Due to the affinity of haemoglobin for carbon monoxide, the haemoglobin puts a priority on carbon monoxide bonds, and haemoglobin that has bonded with carbon monoxide is no longer available to carry oxygen.

Carbon monoxide in small quantities can cause headaches and dizziness, but larger concentrations can be fatal. To reverse the effects of the carbon monoxide, pure oxygen must be introduced to the body. It will react with the carboxyhemoglobin to produce properly oxygenated haemoglobin, along with carbon monoxide:

$Hb(CO)_4\,(aq) + 4O_2\,(g) \leftrightharpoons Hb(O_2)_4\,(aq) + 4CO\,(g).$

The gaseous carbon monoxide thus produced is dissipated when the person exhales.

Read more: http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-2/Chemical-Equilibrium-Real-life-applications.html#ixzz269Lfpy7Q

Get more real life examples **FROM GROUPS:**

1.

2.

3.

4.

5.

Concrete models 1 hour

CHEMICAL EQUILIBRIUM

The following game requires four people; the rest of the team members will help.

The **first** person represents the forward reaction while the **second** person represents the reverse reaction, the **third** is the time monitor who stops the reaction to take the time and count the entities formed in the reaction and the **fourth** is responsible for plotting of the graph

How to play: Dynamic Chemical equilibrium©

1. Draw a large circle on a piece of paper, preferably A3, this represents your closed reaction vessel
2. The following reaction is being observed:

   $H_2 + I_2 \rightleftarrows 2HI$
3. Player 1:
   - Choose two colours of sweet or play dough to represent H and I respectively
   - Make the molecule representing H_2 and I_2 respectively, make sure all your molecules are in pairs to represent the molecules
   - Let every molecule that you make represent a mole of molecules of that substance and the circle on the A3 represent I dm^3

   Player 3

   - Indicate the time as 0 and check the number of molecules of H_2, I_2 and HI respectively, and record these on a table

   Player 4

   Plot these on a graph paper provided; Y-axis as number of moles, while the x-axis is time in seconds or minutes (You decide)

4. Let the games begin:
   - Player one reacts the two molecules H_2 and I_2 to form HI, while at the same time player 2 separates the molecule HI back into H_2 and I_2
   - At intervals decided by the players, the third player stops the game and takes the readings: The number of entities for all; H_2, I_2 and HI
   - The fourth player plots these on the graph
   - This game continues for 20 minutes and then everybody stops
5. All four plot the graphs, using different colours for curves of different reactions, the forward and the reverse. Find the perfect fit and then calculate Kc

6. Continue with the game but his time reduce or increase the number of one of the species H_2, I_2 or HI
7. Continue with the game as from step 4 above up to step 5.
8. Repeat step four but this time use the following equation

   $$H_2 + N_2 \rightleftarrows NH_3$$

9. Plot the graph and discuss.

Game Over

Now think about this

10. Effect of Temperature, Pressure (volume). Investigate the effect of temperature and pressure on life processes, enzymes, bacteria, viruses and sickness.
11. What are you going to do with the science you are learning?
12. Solve the following problems on chemical equilibrium

    Solve the following problems:

    1. *At 444°C, 15g mole of hydrogen is mixed with 5.2g mole of I_2 vapour. When equilibrium was established, 10g mole of HI was formed. Calculate the equilibrium constant for the reaction.*
    2. *When 3.06g of solid NH_4HS is introduced into a 2 litre evacuated flask at 27°C, 30% of the solid decomposed into gaseous ammonia and hydrogen sulphide.*
       (i) Calculate K_c for reaction at 27°C.
       (ii) What would happen to the equilibrium when more solid NH_4HS is introduced into the flask?