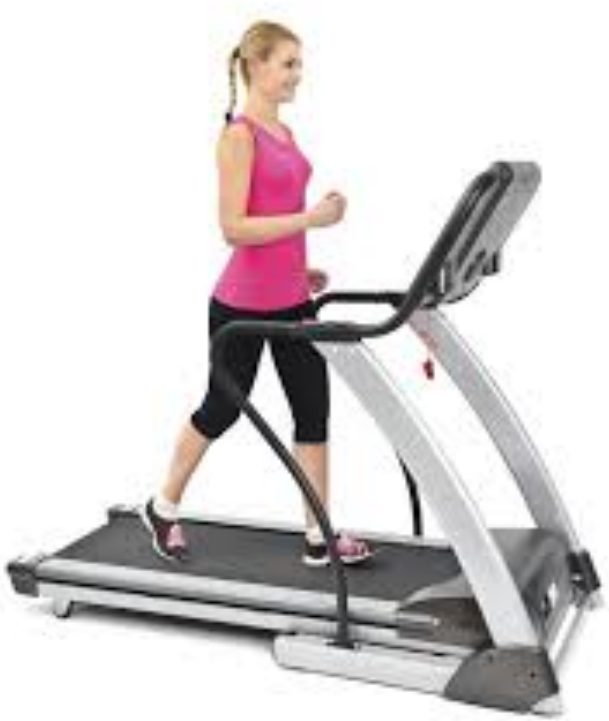
Chemical Equilibrium
Check out TED ED

If molecules were people... - George Zaidan and Charles Morton

- Equilibrium – 'state of balance'
- Static equilibrium - entire system is not moving - meter stick balanced
- Dynamic equilibrium - two opposing motions balance each other- going backwards on an escalator



Chemical equilibrium

- Some chemical reactions have a forward and back reaction.
- The reaction goes to completion when the concentration of reactants and products are the same. This is known as dynamic equilibrium.
- Chemical equilibrium is a state of dynamic balance where the rate of the forward reaction equals the rate of the reverse reaction.

Le Chatelier's principle

- If a stress is applied to a system at equilibrium, the system readjusts to relieve the stress applied.
- A change in stress could be a change in the conditions of the reaction, e.g.
- concentration of reactants or products,
- temperature,
- pressure if in gaseous state

How does a change in temperature change the state of equilibrium of a reaction?

- Exothermic reactions: increased temperature favours the reactants
- Endothermic reactions: increased temperature favours the products.
- How does a change in pressure alter the state of equilibrium of a reaction?
- Le Chatelier's principle states that in a gaseous reaction an increase in pressure will favour the direction of the reaction that has the least number of moles.
- If there are the same number of moles of both sides of an equation, a change in pressure will not effect the state of equilibrium.
- A catalyst does not change the yield of product, it simply speeds up the rate at which equilibrium is reached.

Manufacture of Ammonia by the Haber Process using Le Chatelier's Principle

- Approximately 80% of Ammonia is used in making fertilizers
- Ammonia made by reacting N_2 and H_2 .
- Iron is used as a catalyst to speed up the rate at which equilibrium is reached.
- $N_2 + 3H_2 \rightleftharpoons 2NH_3$
- Yield of NH_3 produced depends on:
- Temperature
- The reaction is exothermic therefore the reaction is driven to RHS if temperature is lowered.
- Pressure-only applies to gaseous system
- 3 moles of reactants on LHS and 2 moles of product on RHS
- High pressure will drive reaction to RHS as a result.
- High –pressure plant is expensive.
- Overall, the best conditions for a high yield of NH_3 are **high pressure** and **low temperature**.

Manufacture of Sulphuric acid by the Contact process

- Sulphur burned in air to form Sulphur Dioxide
- Sulphur Dioxide burned in more air to form Sulphur Trioxide(in presence of a catalyst, vanadium pentoxide)
- Sulphur Trioxide is then reacted with water to form Sulphuric acid.

- $2SO_2 + O_2 \rightleftharpoons 2SO_3$

- Yield of SO_3 produced depends on: Temperature and Pressure
- 3 moles of reactants on LHS and 2 moles of product on RHS
- High pressure will drive reaction to RHS as a result.
- High –pressure plant is expensive.
- The reaction is exothermic therefore the reaction is driven to RHS if temperature is lowered.
- Overall, the best conditions for a high yield of SO_3 are high pressure and low temperature. A low
- temperature would slow down the rate of the reaction so a compromise temperature is chosen.

The equilibrium constant

- Kc gives us an indication of how far the reaction has gone forwards.
- The bigger the Kc the reaction lies to the RHS.

The smaller the Kc the reaction the reaction lies to the LHS.

The temperature is always stated for a particular Kc.

For the Leaving Cert. Units don't matter.

The equilibrium constant

- $N_2 + 3H_2 \rightleftharpoons 2NH_3$

- $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]}$

Square brackets essential

This question comes up regularily in Q4 OL

2010 Exam Craft Mock

$$H_2 + I_2 \rightarrow 2HI$$

Kc= 50. If 1 mole of hydrogen and 1 mole of iodine were added to a flask and allowed to come to equilibrium. Calculate the amount of each substance in the flask at equilibrium.

Exam questions to be done for Easter holidays

- 2014 Q.9
- 2013 Q.9
- 2012 Q.11 (b)
- 2011 Q.9 (b) not on syllabus anymore
- 2010 Q.7
- 2009 Q.11(a)
- 2008 Q.7
- 2007 Q.10(a)
- 2006 Q.11 (b) not on syllabus anymore
- 2005 Q.9
- 2004 Q.9
- 2003 Q.10 (c)