TYPES OF CATALYSIS

1. a) A homogeneous catalyst is one which is in the same phase as the reaction it is catalysing. For example, everything present, including the catalyst might be in solution.

   A heterogeneous catalyst is in a different phase from the reaction it is catalysing. Commonly, this involves a solid catalyst with the reaction in the gas or liquid phase.

   b) Different physical states could be a solid or a liquid or a gas. Different phases might also be a solid or a liquid or a gas, but could consist of, for example, two immiscible liquids which float on top of each other. A phase is any part of a system which is physically separate from another part.

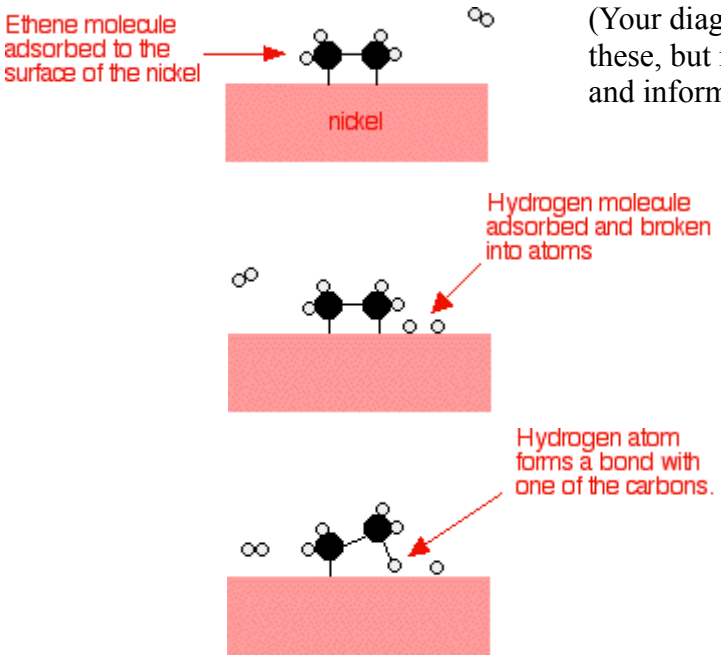
2. a) Adsorption happens when something (a molecule from a gas or liquid, for example) becomes stuck to the surface of a solid. Absorption happens when one substance is taken taken up inside another one - for example, when you wet a filter paper, the water is absorbed into the structure of the paper.

   b) Solid catalysts often work by first adsorbing something on their surface. A reaction then takes place, and the products are desorbed from the surface (break away into the gas or liquid again). That frees up the surface for the next lot of reactants to become adsorbed.

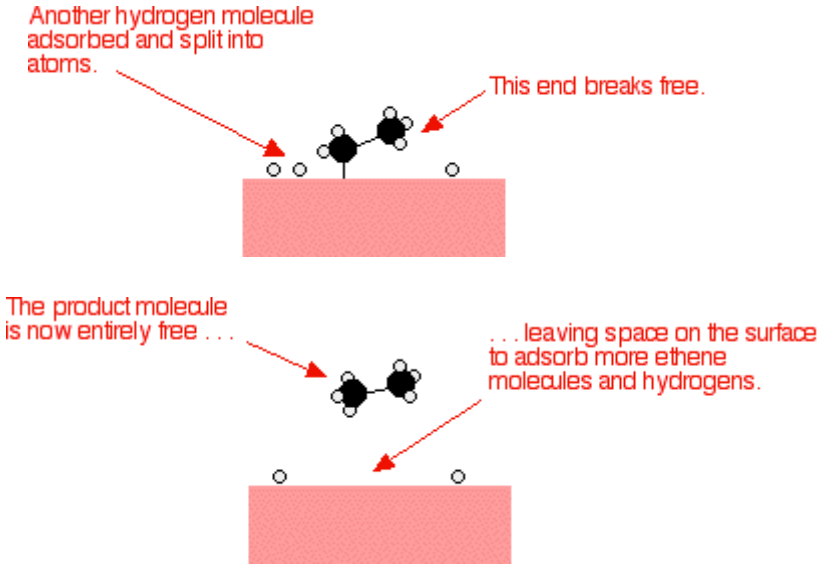
   Silver isn't a very good catalyst because it isn't very good at adsorbing things on its surface - it doesn't form strong enough attachments. Tungsten isn't a very good catalyst because it adsorbs things too strongly, and so doesn't release the products of a reaction and so free up the surface again.

   Platinum and nickel adsorb to just the right extent - strongly enough to activate the reactant molecules, but not so strongly that the products aren't released after the reaction is complete.

3. a)



(Your diagrams don't have to look exactly like these, but must include all the essential stages and information.)



b) $SO_2 + V_2O_5 \longrightarrow SO_3 + V_2O_4$

$V_2O_4 + \frac{1}{2}O_2 \longrightarrow V_2O_5$

If you have chosen to double up these equations to avoid using the ½, that's fine.

4. a) The honeycomb structure maximises the surface area. Coating the expensive metals as a thin layer onto ceramic reduces cost. All that matters is the surface of the metal - having thick pieces of metal is a complete waste of money, because no gas molecules can possibly get at the inside of the catalyst.

b) $2CO + 2NO \xrightarrow{Pt/Pd/Rh} 2CO_2 + N_2$

c) Lead poisons the catalyst (stops it working) irreversibly.

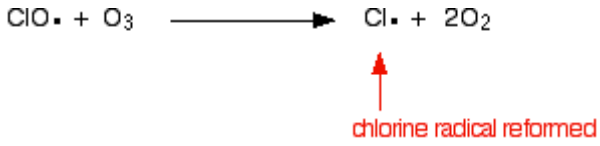
5. a) Reactions involving oxygen and ozone in the high atmosphere absorb extremely harmful UV light which would otherwise reach the ground.

b) The dangerous free radicals are free chlorine atoms (containing an unpaired electrons) which are formed during the break-down of CFCs in the atmosphere.

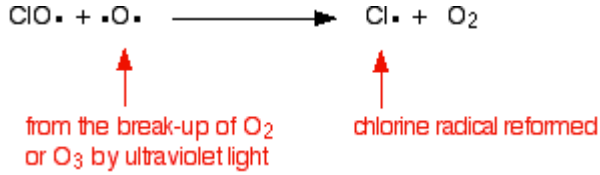
These react with ozone to give another free radical and an oxygen molecule:

$Cl\cdot + O_3 \longrightarrow ClO\cdot + O_2$

The new radical can react with a second ozone molecule to turn it into ordinary oxygen and regenerate a chlorine radical.



(Note: There is an alternative reaction which can regenerate the chlorine radical:

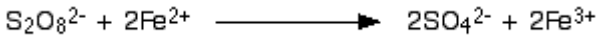


If you have used that one, that's fine. But whichever you have used, it makes sense to use the one expected by your examiners.)

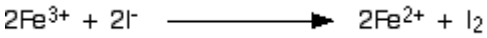
6. a) Homogeneous

b) The reaction would need a collision between two negative ions, which would repel each other.

c) The persulphate ions oxidise the iron(II) ions to iron(III) ions, and are themselves reduced to sulphate ions.

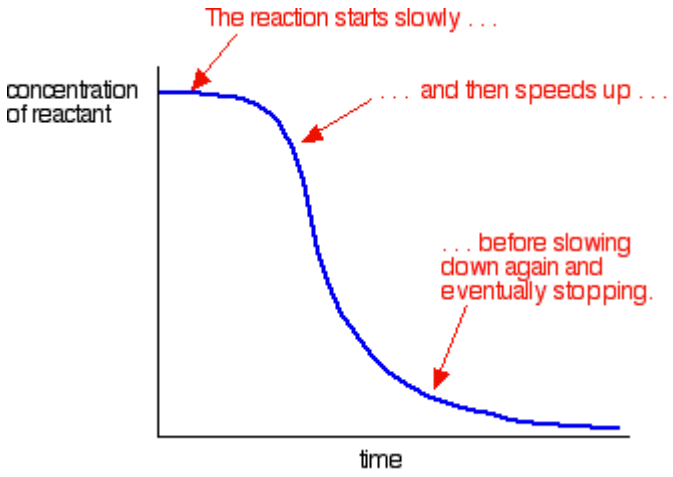


The iron(III) ions oxidise the iodide ions to iodine, and are themselves reduced back to iron(II) ions, regenerating the catalyst.



7. a) Autocatalysis is where one of the products of the reaction acts as a catalyst for the reaction. In this case, the reaction is catalysed by the manganese(II) ions which are produced during the reaction.

b)



c) Either: The reaction is strongly exothermic, and you aren't controlling the temperature properly. The reaction mixture would heat up and the rate would increase because of that.

Or: This can happen if you are reacting a solid with a liquid, where the solid has some sort of coating which has to be removed before the expected reaction can take place. (A simple example of this is the reaction between aluminium and dilute hydrochloric acid. The acid has to react with the aluminium oxide layer on the surface before any hydrogen would be produced by reaction with the aluminium underneath. The oxide reaction is very slow in the cold.)