The electrolysis of molten ionic compounds

- Compounds must be melted to release their ions.
- Positive ions move towards the cathode where they gain electrons (are reduced), and negative ions move towards the anode where they lose electrons (are oxidised).
- e.g. lead(II) bromide: cathode: $Pb^{2+} + 2e^- \rightarrow Pb$
  anode: $2Br \rightarrow Br_2 + 2e^-$
  Pb^{2+} ions are reduced because they gain electrons, and Br^- ions are oxidised because they lose electrons.

The industrial extraction of aluminium using electrolysis

- Alumina (aluminium oxide) dissolves in molten cryolite at a temperature much lower than its melting point, therefore saving energy.
- cathode: $Al^{3+} + 3e^- \rightarrow Al$
  anode: $2O^{2-} \rightarrow O_2 + 4e^-$
- The oxygen formed reacts with the carbon anodes, forming carbon dioxide gas and requiring these to be replaced frequently.

The electrolysis of water

- Hydrogen gas is collected at the cathode while oxygen gas is collected at the anode.
- The volume of hydrogen formed is twice that of oxygen because there are twice as many hydrogen atoms that oxygen atoms in a water molecule.
- cathode: $2H^+ + 2e^- \rightarrow H_2$
  anode: $2OH^- \rightarrow O_2 + 2H^+ + 4e^-$

The electrolysis of aqueous solutions

- There are H^+ and OH^- ions present in an aqueous solution as well as the ions from the dissolved salt.
- Metals lower than hydrogen in the reactivity series are formed at the cathode.
- e.g. When copper(II) chloride is electrolysed, the products are copper metal (as copper is lower than hydrogen in the reactivity series) and chlorine gas.
  cathode: $Cu^{2+} + 2e^+ \rightarrow Cu$
  anode: $2Cl^- \rightarrow Cl_2 + 2e^-$
- e.g. When sodium chloride is electrolysed, the products are hydrogen gas (as sodium is above hydrogen in the reactivity series) and chlorine gas.
  cathode: $2H^+ + 2e^+ \rightarrow H_2$
  anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

The global economic and political importance and social and environmental impact of the oil industry

- Burning fuels causes global warming and acid rain, which of course don't only affect the countries using the energy.
- Rapidly growing economies in China and India will consume greater amounts of energy year on year and supplying that energy using crude oil is not sustainable in the long term.
- Growing demand drives prices upwards, affecting individuals' heating and travel costs but also indirectly causing inflation (such as in food prices).
- Many important products (such as plastics and medicines) are made using components of crude oil and that people will eventually have to decide between burning the remaining reserves of oil and using it for other purposes.

The combustion of hydrocarbons and other fuels

- requires oxygen (from the air)
- produces carbon dioxide and water
- exothermic

The determination of the amount of energy released by a fuel

- burning four different alcohols and comparing the amount of energy they give off
- alcohol + oxygen → carbon dioxide + water
- energy released from alcohol per gram (J) $= \frac{\text{mass of water (g)} \times \text{temperature increase (°C)} \times 4.2}{\text{mass of alcohol}}$

The combustion of hydrogen

- forms water only

Hydrogen as an energy source

- used in rocket fuel
- used in hydrogen fuel cells to power cars
- renewable, as it is produced from water
- does not contribute towards global warming or acid rain, as water is the only product
- requires large amounts of electricity to produce hydrogen from electrolysis
- storage requires bulky and heavy pressurised containers
- potentially hazardous, as it forms an explosive mixture with air

Ethanol as a solvent

- dissolves many substances, including some that are insoluble in water

Biofuel (ethanol as a fuel)

- produced from plants (such as sugar cane, in some countries)
+ renewable
+ carbon-neutral
– decreases the amount of land available to grow food crops
– dependent on climate for sugar growth

Alcohols

- $C_nH_{2n+1}OH$

The microbial oxidation of ethanol to ethanoic acid

- occurs slowly
- leads to beer and wine 'going off' once exposed to air for a few days

Ethanoic acid

- CH_3COOH
- belongs to a homologous series called carboxylic acids

Infrared spectroscopy

- used to identify the presence of certain bonds in organic molecules, thereby indicating whether they may be alkanes, alkenes, alcohols or carboxylic acids

Concentrated sulfuric acid as a dehydrating agent in its reaction with sugar

- glucose $\xrightarrow{\text{concentrated sulfuric acid}}$ carbon
- $C_6H_{12}O_6 \xrightarrow{\text{concentrated sulfuric acid}} C$
- removes the 'elements of water' from sugar

Concentrated sulfuric acid as a dehydrating agent in its reaction with hydrous blue copper(II) sulfate

- (blue) copper(II) sulfate $\xrightarrow{\text{concentrated sulfuric acid}}$ (white) copper(II) sulfate
- $CuSO_4\ (5H_2O) \xrightarrow{\text{concentrated sulfuric acid}} C$
- removes the 'elements of water' from sugar

Fertilisers

- made by neutralising sulfuric/nitric acid with alkaline ammonia
- ammonia + sulfuric acid → ammonium sulfate
- ammonium hydroxide + sulfuric acid → ammonium sulfate + water
- ammonia + nitric acid → ammonium nitrate
- ammonium hydroxide + nitric acid → ammonium nitrate + water

The identification of NH_4^+ by the addition of aqueous OH^-

- Ammonium ions can be identified by adding sodium hydroxide solution and warming gently to release ammonia gas (which turns damp red litmus paper turns blue).

Nitrogenous fertilisers for crop growth

- used by farmers on their land because healthy plant growth requires nitrogen to make protein

\+ increases crop yields

\+ make plants healthier

– relatively cheap

– could enter water supply, leading to blue baby syndrome

Eutrophication

- nutrients load up
- plants flourish
- algae blooms, oxygen is depleted
- decomposition further depletes oxygen
- death of the ecosystem