- Renewable
- Lots of energy
- Common element

- Disadvantages
  - Expensive
  - High pressure
  - Explosive/flammable
  - Hydrogen is manufactured using fossil fuels

**Topic 6- Groups in the periodic table**

Elements in the periodic table are split into groups depending on the column (period) they are in. Elements are arranged by number of electrons in the outer shell.

**Group 1- Alkali metals**

- Properties
  - Soft
  - Low melting points
  - Dull

- Reactions with water
  - Lithium
    - Small fizzing
    - Disappears
  - Sodium
    - Fizzes rapidly
    - Moves around surface
    - May burn with orange flame
  - Potassium
    - Moves around surface rapidly
    - Lilac flame
    - May explode
    - Hydrogen ignites immediately

- Order of reactivity: alkali metals

<table>
<thead>
<tr>
<th>Physical state</th>
<th>Yellow-green</th>
<th>Red-brown</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chlorine</strong></td>
<td>Gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bromine</strong></td>
<td>Liquid</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Iodine</strong></td>
<td>Solid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Further down the table, the higher the melting point
  - Gases to solids
- Further down the table, the darker the element

Chemical test: Chlorine
- Sharp, choking smell
- Damp blue litmus turns red then bleaches white
- Damp starch-iodine paper turns blue black

Halogen reactions:
- Halogens and metals
  - Forms salts called metal halides
  - $\text{sodium} + \text{chlorine} \rightarrow \text{sodium chloride}$
- Hydrogen halides
  - One part halogen, one part hydrogen
  - Dissolve in water to become acidic solutions
- Halogens in aqueous solution
  - The most reactive halogen displaces and becomes part of the solution
  - Solution turns colour of displaced solid
- Displacement reactions
  - Same as above
  - Redox because halogens gain electrons, halides lose electrons
  - $\text{I}^{-} + \text{Br}_2 \rightarrow \text{I}_2 + 2\text{Br}^-$
  - Bromine gains electrons- reduced iodide loses electrons- oxidised

Becomes less reactive as it goes down table
- Each additional shell shields electrons from attraction of the nucleus
- Needs to gain 1 electron and has less force of attraction as it goes down the table

Group 0- Noble gases
- Chemically inert
  - Has a full outer shell
- Uses
  - Lightbulb
    - Inertness
    - Non-flammable
  - Balloons

- Each additional shell shields electrons from attraction of the nucleus
- Less strength of bond

**Group 7- Halogens**

<table>
<thead>
<tr>
<th>Colour</th>
<th>Chlorine</th>
<th>Bromine</th>
<th>Iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gas</td>
<td>Liquid</td>
<td>Solid</td>
</tr>
</tbody>
</table>

- Yellow-green
- Red-brown
- Purple

- Further down the table, the higher the melting point
  - Gases to solids
- Further down the table, the darker the element
Topic 7 - Rates of reaction and energy changes

Physical properties
- Low density
- Non-flammable

Marble chips and hydrochloric acid
- Put a small pile of marble chips in the bottom of a conical flask
- Drip hydrochloric acid onto it
- Gas travels down tube, into upside down test tube in water trough
- CO₂ collects in the top

2HCl + CaCO₃ → CaCl₂ + H₂O + CO₂

Sodium thiosulphate and hydrochloric acid
- Put a small amount of sodium thiosulphate in a conical flask
- Put the flask on a piece of paper with a cross on it
- Add hydrochloric acid
- Wait for sulphur to be formed and turn the liquid cloudy, so the cross appears to disappear

Na₂S₂O₃ + 2HCl → 2NaCl + S + SO₂ + H₂O

Rate of reaction
- Measure mass before and after
  - Reactant
  - Product

Rate of reaction = change in mass/time taken

Reactions
- Occur when particles collide
- Increase with increase in:
  - Frequency of collisions
  - Energy of collisions
- Catalyst: substance that speeds up rate of reaction without altering products, without changing chemically or in mass
- Catalyst lowers activation energy
- Creates alternate pathway
- Enzymes are biological catalysts
  - Used to produce alcoholic drinks

Heat changes in chemical reactions

Changes in energy
- Exothermic
  - Give out energy to surroundings
  - Neutralisation
  - Respiration
  - Combustion
  - Making of bonds
- Endothermic
  - Take in energy from surroundings
  - Electrolysis
  - Thermal decomposition
  - Photosynthesis
  - Breaking of bonds

Energy change = total (bond breaking)/Total (bond making)

Fractional distillation:
- Separates all parts of crude oil
- Industrial fractional distillation:
  - The higher the tower, the cooler the temperature
- When condensed, liquid is siphoned off separately

Heat changes in chemical reactions

Topic 8 - Fuels and Earth science

Hydrocarbons: only hydrogen and carbon

Crude oil:
- Complex mixture of hydrocarbons
- Contains molecules where carbon atoms are in chains or rings
- Important source of useful substances
  - Fuels
  - Feedstock for petrochemical
- Finite