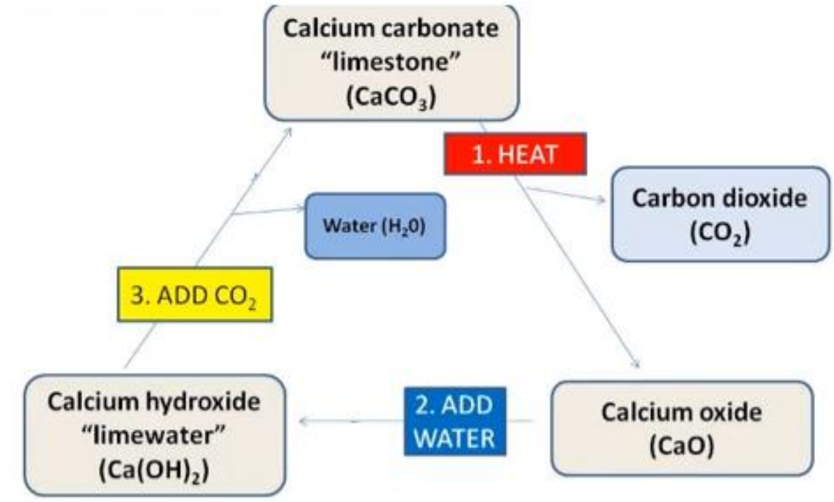
Topic 2 – Materials from the Earth

- **ROCKS AND THEIR FORMATION**
- **Igneous rocks e.g granite:**
- Igneous rocks are formed by molten rock (called 'magma' underground…called 'lava' when it erupts above the surface) cooling and then solidifying
- Igneous rocks are hard and are characterised by interlocking crystals
- The size of the crystals depends on the rate at which the lava/magma cools…:
    - If magma/lava cools quickly→small crystals
    - If magma/lava cools slowly→large crystals
- **Sedimentary rocks e.g chalk, limestone:**
- Rocks are broken up by chemical reactions with water or air…this process is called erosion
- Erosion happens as rocks are transported e.g along a river bed towards the sea
- Layers of these small pieces of rock ('sediment') build up on the sea bed
- Over a long time, these layers of sediment are compacted (squashed together), forming sedimentary rocks
- Sedimentary rocks:
    - Mostly form from pieces of other rocks. E.g chalk and limestone are made mostly from calcium carbonate
    - Can contain fossil remains of dead plants or animals, and/or imprints such as footmarks
- **Metamorphic rocks e.g marble:**
- The action of heat and/or pressure can change rocks, causing new crystals to form
- These changed rocks are called metamorphic rocks
- E.g the action of heat and pressure causes chalk or limestone to form marble; an example of a metamorphic rock
- Properties of metamorphic versus sedimentary rocks:
    - Marble: new crystals of calcium carbonate are formed that interlock tightly →marble is hard
    - Chalk and limestone: weakly joined grains with gaps between them→are crumbly
    - This explains why sedimentary rocks are more susceptible to erosion than igneous and metamorphic rocks
- **LIMESTONE AND ITS USES**
- **Quarrying limestone:**
- Limestone is removed from the ground at a quarry
- Explosions are used to break the limestone into pieces. These pieces are then cut into useful sizes and transported to customers
- Benefits of quarrying limestone:
    - It is used in the construction of buildings
    - It can be crushed into smaller lumps to make a base for railway lines and roads
    - It is a raw material for the manufacture of cement, concrete and glass
    - It is valuable and is exported to other countries, helping the UK's economy
    - Provides jobs to locals
- Drawbacks of quarrying limestone:
    - Dusty and noisy→may affect the quality of life of the locals

- Destroy the original landscape→damages the tourist industry (especially as the quarries are often in attractive places in the countryside)
  - Heavy lorries around the site cause extra traffic and pollution
  - Destroys habitats of animals and birds
- **CHEMICAL REACTIONS**
- **Word equations:**
- Word equations show what's happening in a chemical reaction…:
  - E.g zinc carbonate→zinc oxide + carbon dioxide
- Substances on the left of the arrow are called reactants (zinc carbonate in the above example)
- Substances on the right of the arrow are called products (zinc oxide and carbon dioxide in the above example)
- **Atoms and chemical reactions:**
- Substances are made of atoms
- An atom is the smallest part of an element that can take part in a chemical reaction
- A compound consists of the atoms of two or more different elements chemically joined together
- The chemical formula of a compound shows the symbols of the elements it contains and the ratios in which their atoms are present
- E.g with calcium carbonate:
  - Its chemical formula is $CaCO_3$
  - It's a compound
  - It contains 3 elements: calcium, carbon and oxygen
  - It contains 1 calcium atom, 1 carbon atom and 3 oxygen atoms
- **Balancing equations:**
- This involves first writing the word equation into chemical form
- To balance the equation there must be the same numbers of atoms of each element on both sides of the arrow…
- E.g (*don't worry about the science here, it's just showing how to balance equations*):
  - Word equation: sodium oxide + water→sodium hydroxide
  - Chemical equation: $Na_2O_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)}$
  - Balanced chemical equation: $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$
- Note that state symbols are added to each substance:
  - s – solid
  - g – gas
  - l – pure liquid (e.g water)
  - aq – aqueous solution…formed when substances dissolve in water (e.g sodium hydroxide)
- **Mass is conserved in chemical reactions:**
- Atoms are **NOT** made or destroyed in a chemical reaction. They are only **<u>rearranged</u>** to form new products
- →total mass before and after a reaction is the same
- This rearrangement of atoms means products and reactants have different physical and chemical properties
- **Precipitation reactions:**
- This is when two soluble (→given $_{(aq)}$ state symbol) substances react together to form an insoluble (→given $_{(s)}$ state symbol) product, called the precipitate
- E.g:

- Silver nitrate + potassium bromide → potassium nitrate + silver bromide
- $AgNO_3$ (aq) + KBr (aq) → KNO_3 (aq) + AgBr (s)
- AgBr is the solid precipitate formed in this example
- Remember that even though a solid is formed, the total mass before and after the reaction is still the same!

- **REACTIONS OF CALCIUM COMPOUNDS**



- **Step 1 - Thermal decomposition of calcium carbonate ($CaCO_3$)**
- When heated strongly, calcium carbonate breaks down to form calcium oxide and carbon dioxide
- This type of reaction (i.e breakdown using heat) is called thermal decomposition
- Word equation: calcium carbonate→calcium oxide + carbon dioxide
- Chemical equation: $CaCO_3$→CaO + CO_2
- Note: zinc carbonate and copper carbonate thermally decompose much more easily than calcium carbonate
- **Step 2 - Calcium oxide + water:**
- Word equation: Calcium oxide + water → calcium hydroxide
- Chemical equation: CaO (s) + H_2O (l) → $Ca(OH)_2$ (s)
- In this reaction calcium oxide dissolves in water to form calcium hydroxide – a crumbly, white solid...
  - Heat is given off
  - Fizzing
  - Steam is produced
- When more water is added, calcium hydroxide dissolves to form a colourless calcium hydroxide solution called limewater (see below)
- Note: $Ca(OH)_2$ means that each unit of calcium hydroxide contains 2 hydroxide units. →a unit of calcium hydroxide contains 1 calcium atom, 2 oxygen atoms and 2 hydrogen atoms
- **Step 3 - Calcium hydroxide solution (limewater) + carbon dioxide:**
- When carbon dioxide is bubbled through limewater (originally a colourless solution), the limewater turns cloudy
- This happens because carbon dioxide and limewater (calcium hydroxide solution) react to form a solid precipitate called calcium carbonate…:
  - Word equation: calcium hydroxide + carbon dioxide → calcium carbonate + water
  - Chemical equation $Ca(OH)_2$ (aq) + CO_2 (g) → $CaCO_3$ (s) + H_2O (l)

- **Calcium compounds can be used to neutralise soil acidity:**
- Acids can be neutralised by alkalis. This is called a neutralisation reaction
- Some crops don't grow well if the soil is too acidic
- →to reduce acidity of the soil, farmers can spray alkalis such as calcium carbonate, calcium oxide or calcium oxide over their fields
- **Calcium carbonate can be used to remove harmful emissions from coal-fired power stations:**
- Many power stations use coal, which contains sulphur impurities…:
    - When the coal burns, the sulphur reacts with oxygen to form sulphur dioxide
    - Nitrogen oxides are also formed
- Both sulphur dioxide and nitrogen oxides are harmful gases that produce acid rain if they escape into the atmosphere
- To stop this, calcium carbonate is sprayed through the acidic gases (i.e sulphur dioxide and nitrogen oxides), neutralising them
- →in this way, limestone (calcium carbonate) reduces harmful emissions and helps to reduce acid rain