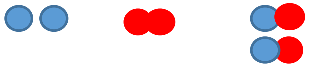
Word equations to symbol equations:

- replace names of each substance symbols or formula
- use numbers to balance the equation

Example:

copper + oxygen → copper oxide

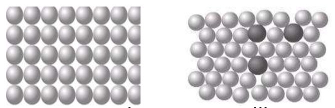
2Cu + O_2 → 2CuO



Two copper atoms (2Cu) react with **one oxygen molecule (O_2)** to produce **two units of copper oxide (2CuO)**

Typical properties of metals	
Appearance	Shiny
State at room temperature	Solid (except mercury, a liquid)
Density	High
Strength	Strong
Malleable or brittle	Malleable
Conduct heat?	Good
Conduct electricity?	Good
Magnetic material	**Only** iron, cobalt & nickel
Sound when hit	Make a ringing sound (**sonorous**)

Pure metals Vs Alloy



The rows of atoms in a pure metal can slide over each other easily.
In an alloy, the different sized atoms disrupt the layers so the atoms can't slide.
This makes alloys more useful than pure metals.

Bases v alkalis

A **base** is a substance that can react with acids and **neutralise** them. Many bases are insoluble in water. If a base does dissolve in water it is called an **alkali**

Bases are usually:

- **metal oxides**, such as copper oxide
- **metal hydroxides**, such as sodium hydroxide, or
- **metal carbonates**, such as calcium carbonate

General word equations for neutralisation reactions:

Metal oxide + acid → salt + water
Metal hydroxide + acid → salt + water
Metal carbonate + acid → salt + carbon dioxide + water

The lab test for carbon dioxide
Bubble the gas through lime water and watch for it turn from colourless to a cloudy milky colour.

Acids and metals

Acids react with most metals to produce a salt and hydrogen. This is the general word equation :

metal + acid → salt + hydrogen

The lab test for hydrogen
Place **lighted splint** put in the test tube and listen for the gas to burn with a squeaky pop

Naming salts

Hydro**chlor**ic acid → metal **chlorides**
Sulfuric acid → metal **sulfates**
Nitric acid → metal **nitrates**

Calculating relative formula mass

Formula mass is calculated by adding together the mass number of each atom in a compound's chemical formula.

E.g. $MgCl_2$ **A_r Mg = 24** **A_r Cl = 35.5**

Formula mass = 24 + (2 x 35.5) = 95

There are 2 chlorines in the chemical formula

Reactivity Series

The **reactivity series** is a list of elements in order of their reactivity:

Most reactive

Potassium
Sodium
Calcium
Magnesium
Aluminium
Carbon
Zinc
Iron
Tin
Lead
Hydrogen
Copper
Silver
Gold
Platinum

Least reactive

If a metal loses its outer electrons more easily, it will be more reactive.

Reactivity

Extracting copper from copper oxide

Copper is so unreactive, it does not react with cold or hot water, so it is used for water pipes

To extract copper:

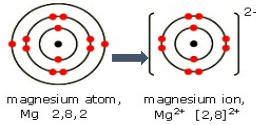
- mix **copper oxide** powder with **carbon powder**;
- heat the mixture strongly in a **crucible**;
- keep the lid on the crucible, to stop carbon reacting with oxygen in the air;
- the **carbon dioxide** formed in the reaction escapes into the air;
- let the crucible cool down, you tip the mixture into cold water.
- brown copper sinks to the bottom, leaving unreacted powder suspended in the water.

These equations represent the reaction:
copper oxide + carbon → copper + carbon dioxide
2CuO + C → 2Cu + CO_2

Why do metals react?

Metals react because they want to gain a full outer shell and become stable. They do this by <u>losing their outer electron(s)</u> to become <u>positively charged ions</u>

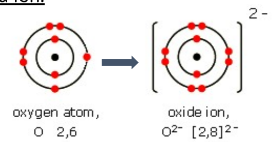
For example:
Magnesium loses its 2 outer electrons to become a +2 ion



Why do non-metals react?

Non-metals react because they want to gain a full outer shell and become stable. They do this by <u>gaining electrons</u> into their outer shell to become <u>negatively charged ion.</u>

For example:
Oxygen gains 2 electrons into its outer shell to become a -2 ion



Displacement Reactions:

This is when a more reactive metal **displaces** a less reactive metal from its compound.

For example:

magnesium + copper sulfate → magnesium sulfate + copper

If the more reactive metal is already in the metal compound, nothing happens. For example:

magnesium sulfate + copper → no reaction

Carbon and metal extraction

Some metals can be extracted from their metal oxides using carbon **if the metal is less reactive than carbon.**

The metal is reduced – it has lost its oxygen

metal oxide + carbon → metal + carbon dioxide

The carbon is oxidised – it has gained oxygen

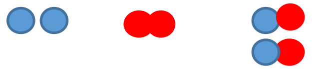
This works for **zinc**, **iron**, **tin**, **lead** and **copper** because they <u>all less reactive</u> than carbon.

Word equations to symbol equations:

1. Use the number of particles to balance the symbol equation

copper + oxygen → copper oxide

__Cu + O_2 → __CuO



Typical properties of metals	
Appearance	
State at room temperature	
Density	
Strength	
Malleable or brittle	
Conduct heat?	
Conduct electricity?	
Magnetic material	
Sound when hit	

Pure metals Vs Alloy

1. Draw the particle diagrams of a pure metal and alloy

pure metal

allloy

2. Describe the particle arrangement of a pure metal

3. Explain why alloys do not have layers

Bases v alkalis

1. What is a base?

2. Write down the 3 types of bases

3. Write down the general word equations using all the bases in question 2

4. Describe the test for carbon dioxide gas

Acids and metals

1. Write the general word equation for metals and acid reaction

2. Describe the test for hydrogen gas

Naming salts

Hydro**chloric** acid → metal _________

Sulfuric acid → metal _________

Nitric acid → metal _________

Calculating relative formula mass

1. Calculate the relative formula mass of **$MgCl_2$**. Show all your working out

Reactivity Series

1. what is the reactivity series?

2. explain why some metals are more reactive than others?

Reactivity

Extracting copper from copper oxide

1. Explain why copper is used for water pipes?

2. Describe the process of extracting copper from copper oxide

Why do metals react?

1. What must metals do in order to react?

2. what charge do metals form when they react?

Why do non-metals react?

1. What must non-metals do in order to react?

2. what charge do non-metals form when they react?

Displacement Reactions:

1. What is a displacement reaction?

2. magnesium + copper sulfate → magnesium sulfate + copper

Look at the reaction above. Explain why magnesium displaces copper from copper sulfate

Carbon and metal extraction

1. Explain why some metals can be extracted using carbon

2. Name all the metals that can be extracted using carbon

3. When carrying out extraction of metals using carbon, which element is oxidised, and which is being reduced?

9CE Energetics and rates

Rate of reaction

Reacting particles must **collide** with a minimum amount of energy **(activation energy)** for a chemical reaction to happen.

How quickly a reaction happens is called the **rate of reaction,** and always involves a **time measurement.**

We can **increase reaction rate** by:

1) **Increasing the concentration of liquid reactants** as it **increases the frequency of collisions**
2) **Increasing the surface area of solid reactants** as it **increases the frequency of collisions**
3) Using a **catalyst** as it **decreases the energy that particles need to collide with for a successful reaction**

Some ways to measure the rate of a reaction

- Time taken for a reactant to disappear
- Time taken for the reaction mixture to change colour
- Measure the number of bubbles produced in a certain time
- Measure the volume of gas produced in a certain time.
- Measure the change in mass in a certain time

Exothermic and Endothermic reactions

- **Exothermic** reaction - **releases** energy to the surroundings.
- Causes a **rise** in temperature (**positive** temperature change)

- **Endothermic** reaction - **take in** energy from the surroundings.
- Causes a **drop** in temperature (**negative** temperature change)

Catalysts

- Speed up reactions
- Are not used up during reactions
- Are chemically unchanged after the reaction completes
- Work by reducing the energy needed to start a reaction (**activation energy**).

In industry, using catalysts often results in **lower temperature** being used in industry, **saving money** and **cutting** the **use of fossil fuels** and their subsequent **emissions**

Car exhausts have **catalytic converters**.

- They reduce amount of toxic gases released
- They contain platinum and rhodium as catalysts.

Oxidation

In oxidation reactions, a substance **gains oxygen**. Metals and non-metals can take part in oxidation reactions (be **oxidised**).

Examples:

- Magnesium reacts with oxygen to produce magnesium oxide

magnesium + oxygen → magnesium oxide

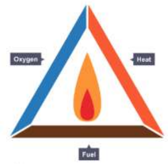
$2Mg + O_2 \rightarrow 2MgO$

- Carbon reacts with oxygen to form carbon dioxide:

carbon + oxygen → carbon dioxide

$C + O_2 \rightarrow CO_2$

Combustion



- **Combustion** is another name for burning fuels.
- It is an **exothermic** reaction
- It is an example of an **oxidation** reaction.

Complete combustion

- **Fuels** contain **hydrocarbons** which react with oxygen when they **burn**
- With enough oxygen, **complete combustion** happens:
  - the hydrogen atoms combine with oxygen to make water vapour, H_2O
  - the carbon atoms combine with oxygen to make carbon dioxide, CO_2
  - the **maximum amount of energy** is released.

The equations for the complete combustion of **methane.**

methane + oxygen → water + carbon dioxide

$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$

Incomplete combustion

- **H**appens when there is **not enough oxygen.**
- Water vapour and carbon dioxide are still produced;
- Two other products are also produced:
  - **carbon monoxide**, CO; colourless toxic gas.
  - particles of **carbon** (soot/smoke); causes breathing problems.
- the **maximum amount of energy** is **NOT released.**

Thermal Decomposition

This is the **breaking down of a substance using heat**, to form two or more products.

Many **metal carbonates** take part in thermal decomposition reactions.

For example, copper carbonate:

- copper carbonate is green; copper oxide is black.

copper carbonate → copper oxide + carbon dioxide

$CuCO_3 \rightarrow CuO + CO_2$

Other metal carbonates decompose in the same way. When they do, they follow this equation:

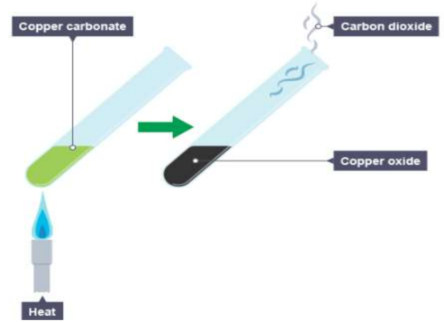
metal carbonate → metal oxide + carbon dioxide

For example, calcium carbonate:

calcium carbonate → calcium oxide + carbon dioxide

$CaCO_3 \rightarrow CaO + CO_2$

Thermal decomposition is an example of an **endothermic** reaction. Energy must be supplied **constantly** for the reaction to keep going.



Identification tests

Lime water – colour change from colourless to **cloudy when carbon dioxide**
Glowing splint – will relight when placed in **oxygen.**
Blue cobalt chloride paper– colour change from blue to pink with **water**
Cobalt chloride paper – colour change from blue to pink with **water**

Conservation of mass

Atoms are not destroyed nor created during chemical reactions, so in any reaction:

Total mass of reactants = total mass of products

9CE Energetics and rates

Rate of reaction
1. What must particles do to start a chemical reaction?

2. What does term 'rate' mean in terms of a chemical reaction?

3. Describe and explain 3 ways of increasing the rate of a reaction?

3. Describe 3 ways of measuring the rate of a reaction

Exothermic and Endothermic reactions
1. what is an exothermic reaction

2. what happens to the surrounding temperature in an exothermic reaction?

3. what is an endothermic reaction?

4. what happens to the surrounding temperature in an endothermic reaction?

Catalysts
1 . What is a catalyst?

2. How does it speed up a reaction?

3. Describe the advantages of using a catalyst in chars and industries

Oxidation
1. what is an oxidation reaction?

2. magnesium + oxygen → magnesium oxide
For the above reaction, which element has become oxidised?

3. **carbon + oxygen →** ________ ________

Combustion
1. what is combustion?

2. what type of reaction is a combustion reaction?

3. what do all fuels contain?

4. write down the products of complete combustion reaction

4. write down the products of incomplete combustion

5. Describe how complete combustion is different to incomplete combustion

Thermal Decomposition
1. what is thermal decomposition?

2. Name a type of substance that will undergo thermal decomposition

3. write down the general word equation for thermal decomposition of metal carbonates

4. complete the following word equation:
copper carbonate → ___________ **+** ____________

5. complete the following word equation:
calcium carbonate → ____________ **+** __________

6. explain why thermal decomposition is an exothermic reaction?

Identification tests
1. Describe the test for carbon dioxide gas

2. Describe the test for water

Conservation of mass
1. what is meant by the term 'conservation of mass?'

Hooke's Law

Hooke's Law says that **the extension of an elastic object is directly proportional to the force applied**. In other words:

- the extension doubles, if the force is doubled;
- there is no extension, if no force is applied.

You can investigate Hooke's Law using a spring:

- hang the spring from a stand and clamp;
- measure its length with a ruler;
- hang a mass from the spring and measure the new length of the spring;
- Work out: **extension = new length – original length**;
- keep adding more masses, measuring the new length each time;
- Work out extension for each mass.

You can then plot a force-extension graph:

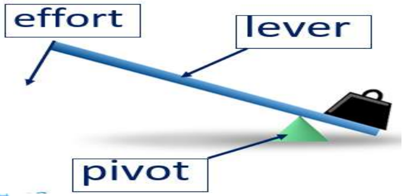
- plot force on the vertical (y) axis
- plot extension on the horizontal (x) axis

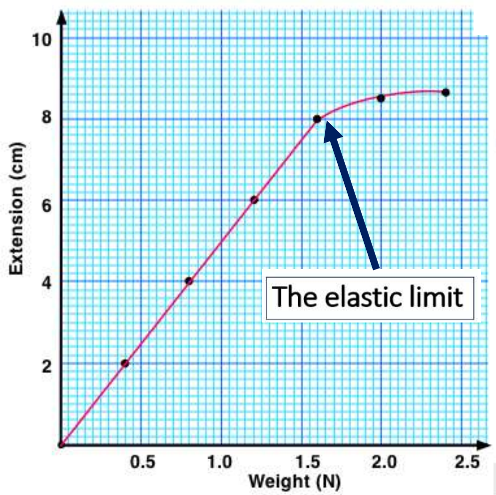
Force Applied (N) = spring constant (N/m) x extension (m)

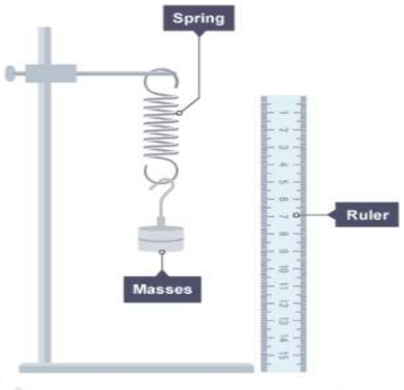
Using Hooke's Law

In a force-extension graph:

- the steeper the line, the stiffer the spring
- the area under the line is the **work done** (energy needed) to stretch the spring.







An experiment to investigate Hooke's Law

Moments

- A **moment** is a turning effect of a force.
- Forces can make objects turn if there is a **pivot**.
- When the turning forces are **balanced** - the moments are **equal and opposite.**

Forces in action

Calculating moments

To calculate a moment, you need to know:

- the distance of the force from the pivot;
- the size of the force.

Moment	=	Force	x	Perpendicular distance
(Nm)		(N)		(m)
(Ncm)				(cm)

Force multipliers

- Increasing the distance will increase the moment for the same force;
- This is why a longer spanner will loosen a tight nut;
- And a crowbar or long lever can be used lift heavy objects.

÷100	÷1000
centimetres – metres	**metres – kilometres**
x100	x1000

Work Done (J) = Force (N) x Distance (m)

Deformation

Elastic materials:

- **change shape** when a force is exerted on them;
- **return to their original shape/size** when the force is removed.

Deformation is a change in shape. There are two types of deformation:

- **Stretching** is when the object/material is pulled;
- **Compression** is when the object/material is squashed.

The greater the force exerted, the greater the amount of deformation.

If the force is large enough, the object/material may no longer return to its original size. Until you reach this point, a special case called **Hooke's Law** applies.

Simple machines

Example of simple machines are **see-saws, wheelbarrows** and **forceps**. **Simple machines give a bigger force but with a smaller movement**

See –saw

A force is exerted in one place, causing movement and a force at another place in the see-saw. A see saw will **balance** when:

Clockwise moment = Anticlockwise moment

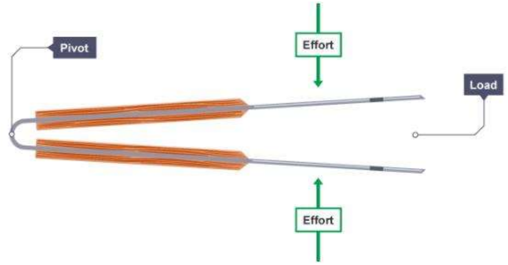
Force (N) x distance (cm) = Force (N) x distance (cm)

Wheelbarrows

Wheelbarrows is a simple machine with the load near the pivot (the wheel) and the effort on the handles far from the pivot.

Forceps

With forceps, fingers provide the effort force, and this is nearer to the pivot than the load (the object you are picking up):



- Some machines give a smaller force but with a bigger movement;

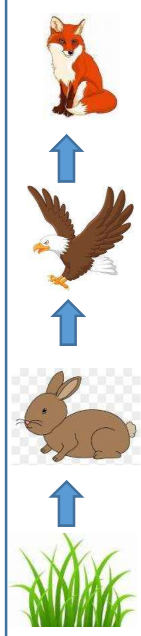
This is the opposite to the see-saw and wheelbarrow, but again if you multiply the force by the distance travelled, you get the same value for the effort and for the load.

A **food chain** shows the different **species** of an organism in an **ecosystem**, and what eats what.

A food chain always starts with a **producer.**

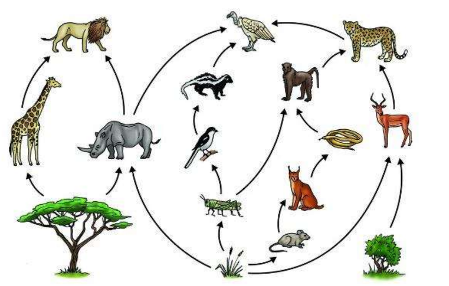
A food chain ends with a **consumer.**

Here is an example of a simple food chain:



Consumer Tertiary consumer Carnivore	
Consumer Secondary consumer carnivore	
Consumer Primary consumer herbivore	
Producer	

When all the food chains in an ecosystem are joined up together, they form a **food web**.



Food webs are just several food chains joined together. Some of the food chains in this food web are:
Tree → giraffe → lion
Tree → rhino → lion
Grass → rhino → eagle
Grass → grass hopper → small bird → racoon → eagle

Ecological relationships and classification

When dead plant and animal materials are broken down by **decomposers**, it is called **decay.**

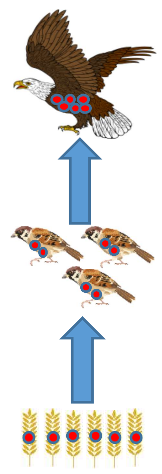
Decay releases the nutrients locked up in the dead material, back into the ground, so that it can be used for new plant growth.

This is important because there is only a finite amount of nutrients on our planet. Decay means that the nutrients can be constantly recycled.

The ideal conditions for decay are:

1) Plenty of oxygen, so that decomposers can respire.
2) Warm temperatures so that decomposers are more active.
3) Some moisture as this allows important chemical reactions to take place.

Bioaccumulation is the build up of toxic material through a food chain, often with devastating effects for the top carnivore.



= toxic particle

Adaptations are features that help organisms compete better and survive in their environment. For example:

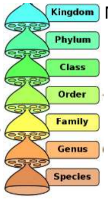
 Polar bear	White coat → camouflage Big feet → spread weight to reduce pressure on snow/ice Thick layer of fat → insulation & food store Greasy fur → water runs off easily after swimming
 Camel	Hump that stores fat → reduce heat loss over rest of the body Sandy colour → camouflage Big feet → spread weigh to reduce pressure on sand

Natural selection

- Individuals in a species show a wide range of **genetic variation** due to mutations.
- Individuals who are best adapted to the environment are **more likely to survive** and **reproduce.**
- The **genes** that allow these individuals to be successful are **inherited** by their offspring.
- Over many generations these small differences add up to the new evolution of species.

Classification is the sorting out of organisms into groups based on their similarities.

Today's classification system is designed by Carl Linnaeus
Organisms were divided into kingdoms. Each kingdom was then sub-divided into smaller groups (phylum) and these into even smaller groups (class), so on and so forth.
Species are the smallest group.



Many organisms with few similar characteristics

One type of organism, with many similar characteristics

Extinction
Changes in the environment may leave individuals less well adapted to compete for resources (eg food, water and mates). If an entire species is unable to compete successfully and reproduce it will lead to extinction.

Here are some of the changes in the environment that can cause a species to become extinct:

- a new disease;
- a new predator;
- a change in the physical environment (eg climate change);
- competition (from another species that is better adapted, including competition from humans).

Factors that can affect the population of individual organisms
Temperature (land/water)
Seasonal changes
Rainfall
Increased predation/hunting
Deforestation
pH of soil/water
Use of chemicals in farming
Disease
Pollution
New predators

Might lead to:
- a shortage of food
- loss of habitat
- lack of partners to reproduce with
- Less water

Estimating populations
Method:
Count the numbers of a species within a small section of the area being sampled by:

1. Using a **quadrat** to make multiple random small samples.

2. A mean is then calculated and multiplied up to the whole area.

Biodiversity
It is important to conserve the variety of living organisms on Earth because:

- moral and cultural reasons;
- In the future, plant species might be identified for medicines;
- keeps damage to food chains and food webs to a minimum;
- protects our future food supply.

Seeds are carefully stored in **seed banks** so that new plants may be grown in the future.
Seed banks are an example of a **gene bank**. Gene banks are used to preserve genetic animals and plant material for the future.