KNOWLEDGE ORGANISER

Seahaven Academy
The best in everyone™
Part of United Learning

YEAR 9:

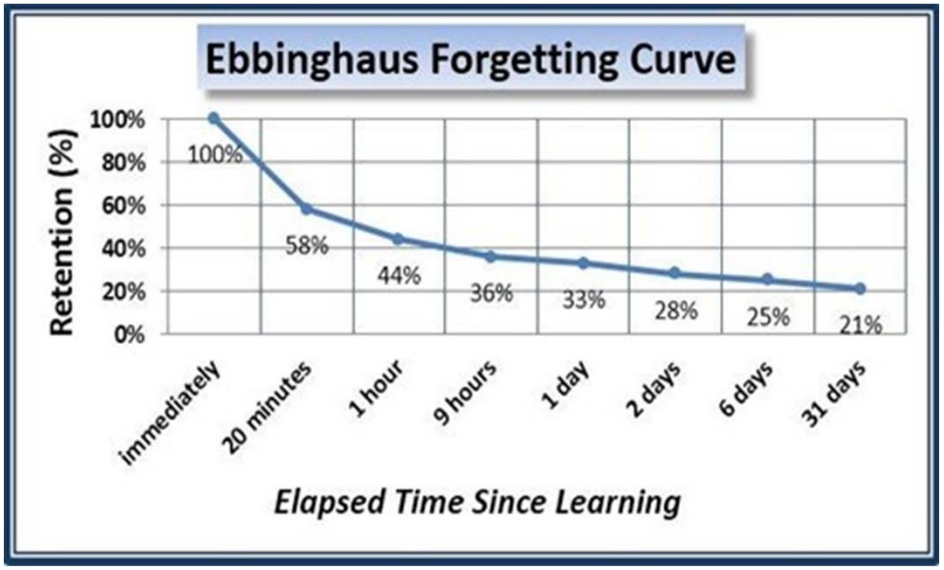
Terms 3 and 4

2023 - 2024

Core Subjects

Name: _____ Tutor Group: _____

Knowledge Organisers and The Forgetting Curve



Why are knowledge organisers important?

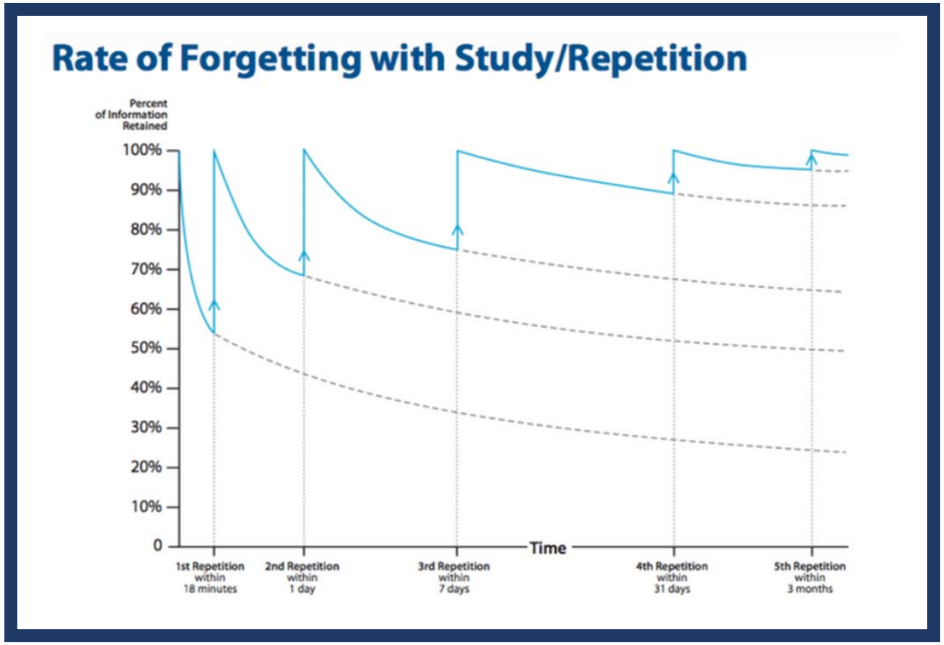
- Almost as soon as we have learnt something we begin to forget it
- In fact, it is surprising how quickly we begin to forget and within a few hours we usually only remember a fraction of what we have learnt ,the graph (left) is an example of how this happens

What can knowledge organisers be used for?

- The speed and amount of forgetting can be reduced by using knowledge organisers to practice recalling what you know
- By retrieving something back into our working memory we slow the rate of forgetting (see the second graph, below)

How will we be using our knowledge organisers?

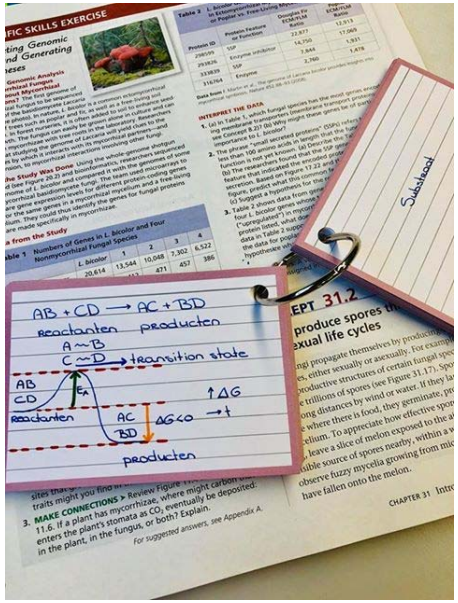
- You need to bring these to school each day in your bag, they may be used in lessons
- You will be set homework activities that use them
- You should use them to practice recall – there are tips on ways to do this in the next few pages
- You will use them to prepare for end of unit tests, including the 'Haven Hundred', set in drop-down tutor time during the penultimate week of each term



How To Use Your Knowledge Organiser

Make Flashcards

- A flashcard is a piece of card that has a cue or hint on the front side, and the answer on the back side.
- The cue can be a question, an image, or just one word that prompts or triggers a response
- Flashcards are one of the best ways to remember new information because they involve you in active learning, repetition, and reflection of your answers
- Use them to play memory test, pairing games, self quizzing or others quizzing you.
- They are very effective when used with the Leitner technique (see below)



Leitner Technique

When you've written the flashcards, they're sorted into three different boxes: 1, 2 and 3.

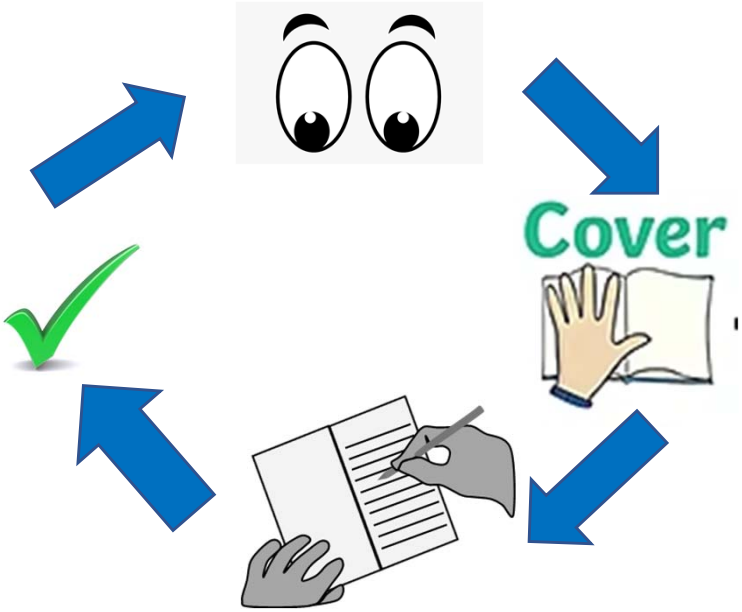
You start with all the cards in Box 1.
You learn these every day

You know a card from Box 1? Then it goes to Box 2.
You learn these every three days

You know are card from Box 2? Then it goes to Box 3
You learn these 3 every five days

If you get a card wrong, it goes back to Box 1

How To Use Your Knowledge Organiser



Read – Cover – Write – Check – Repeat

Read – a small section of your knowledge organiser
Cover – Cover the information so you are unable to read it
Write – out what you have remembered
Check – the knowledge organiser to see if you are right and add in any missing points in a different colour pen
Repeat this process the next day then a few days later

Help From Others
Parents/Carers /Siblings/ Friends

Where possible involve others in your review and recall practice. They can:

- Use your Knowledge Organiser to ask you questions or set you a quiz
- Play memory games with your flashcards – pairs or snap (with diagrams and specialist terms, specialist terms and definitions)
- Check your notes with you after read – cover – write
- Watch the videos and read the attached articles with you

Useful Links

Flashcards and Leitner Method

Read
https://study-stuff.com/how-to-study-flashcards-with-the-leitner-method/
https://e-student.org/leitner-system/

Watch
https://www.youtube.com/watch?v=d9u3KxGCio8
https://www.youtube.com/watch?v=C20EvKtdJwQ

Different Methods of Revision – Created by Staff at Seahaven
https://www.seahavenacademy.org.uk/parents/key-stage-information-evening/key-stage-4-information

Homework Sites We Use That Assist with Recall
https://senecalearning.com/en-GB/
https://hegartymaths.com/
https://www.languagenut.com/en-gb/

KPI 9.01 Decimals Manipulation

1) Multiplying decimals	1) Remove the decimal points. 2) Multiply. 3) Insert the same number of decimal points in the answer as in the question. 0.5 x 0.3 5 x 3 = 15 0.5 x 0.3 = 0.15	**2) Dividing a decimal by an integer**	0.72÷6 $6\overline{)0.72}$ = 0.12 0.972÷8 $8\overline{)0.9720}$ = 0.1215
		3) Dividing an integer by a decimal	1) Write as a fraction. 2) Form an equivalent fraction. 3) Divide.

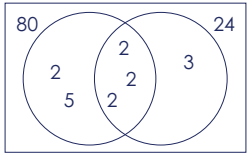
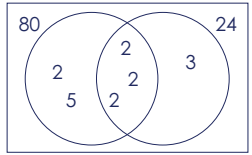
KPI 9.02 Estimation and Limits of Accuracy

1) ≈	"approximately equal to"	**2) Truncation**	Ignoring all decimal places past a certain point without rounding.
3) Significant figures	The total number of digits in a number, not counting the zeros at the beginning of a number or at the end of a decimal number. 345 000 has 6 significant figures. 0.3047 has 4 significant figures.	**4) Estimate**	Find approximate answer by calculating with numbers rounded to one significant figure.
5) Error Intervals	The range of values (between the upper and lower bounds) in which the precise value could be. **least possible value ≤ x < greatest possible value**		

KPI 9.03 Related Calculations

19 x 18 = 342	108 ÷ 9 = 12
19 x 180 = 3420	1080 ÷ 9 = 120
190 x 18 = 3420	108 ÷ 90 = 1.2
190 x 180 = 34200	108 ÷ 0.9 = 120
1900 x 180 = 342000	108 ÷ 0.09 = 1200

KPI 9.04 HCF and LCM of Large Numbers

1) Prime numbers	A prime number has two distinct factors; 1 and itself. 2 is the only even prime number. 1 is not a prime number. The first ten prime numbers are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29		
2) Factor	Any whole number that divides exactly into another number leaving no remainder. Factors of 20 are: 1, 2, 4, 5, 10, 20	**3) Multiple**	The result of multiplying a number with a whole number. (times tables!) The multiples of 7: 7, 14, 21, 28, 35, 42, 49, 56, 63, 70 ...
4) HCF–Venn diagram	 HCF of 80 and 24 = 2 x 2 x 2 = 8	**5) LCM–Venn diagram**	 LCM of 80 and 24 = 2 x 2 x 2 x 2 x 3 x 5 = 240

KPI 9.05 Fraction Calculations

1) Writing one number as a fraction of another	Write £15 as a fraction of £25. $\frac{15}{25} = \frac{3}{5}$	**2) Reciprocal**	*Reciprocal of* $7 \rightarrow \frac{1}{7}$ *Reciprocal of* $\frac{2}{3} \rightarrow \frac{3}{2}$
3) Fractions of an amount	Divide the amount by the denominator and then multiply the result by the numerator.		
4) Add/Subtract fractions	Make the denominators the same (find the LCM). Use equivalent fractions to change each fraction to the common denominator. Add/subtract the numerators only.		$\frac{2}{7} + \frac{2}{5} = \frac{10}{35} + \frac{14}{35} = \frac{24}{35}$
5) Multiplying fractions	Multiply the numerators. Multiply the denominators. Simplify where possible.		$\frac{4}{5} \times \frac{3}{8} = \frac{12}{40} = \frac{3}{10}$
6) Dividing fractions	Keep the first fraction the same. Change the second to its reciprocal. Multiply the fractions. Simplify/convert to mixed number where possible.		$\frac{4}{5} \div \frac{3}{8} = \frac{4}{5} \times \frac{8}{3} = \frac{32}{15} = 2\frac{2}{15}$

KPI 9.06 Algebraic Manipulation

1) 2a	2 x a	**2) ab**	a x b
3) a^2	a x a	**4) $3a^2$**	3 x a x a
5) a subtracted from b	b - a	**6) a less than b**	b - a
7) a divided by b	$\frac{a}{b}$	**8) b divided by a**	$\frac{b}{a}$
9) 4 times smaller than a	$\frac{a}{4}$ or $a \div 4$	**10) 4 times larger than a**	4 x a → 4a
11) 5th power of a	a^5	**12) Variable**	A letter used to represent any number.
13) Coefficient	The number to the left of the variable. This is the value that we multiply the variable by. $4x$ → The coefficient of x is 4. x → The coefficient of x is 1.	**14) Term**	A single number, variable or numbers and variables multiplied together.
15) Simplifying	An expression can be simplified by grouping like terms. E.g. $2a + b^2 - 4b + 7a = 9a+b^2 - 4b$	**16) Identity**	An identity is an equation which is always true no matter what value of the unknown is substituted. E.g. $3x - 15 = 3(x - 5)$

KPI 9.07 Index Laws

1) Multiplication law	$a^m \times a^n = a^{m+n}$ Same base numbers, ADD the powers.	**2) Division law**	$a^m \div a^n = a^{m-n}$ Same base numbers, SUBTRACT the powers.
3) Power to a power	$(a^m)^n = a^{m \times n}$ MULTIPLY the powers.	**4) Raising a fraction by a power**	$(ab)^n = a^n \times b^n$ Raise each number or variable to the same power.
5) Power of 0	$a^0 = 1.$ Any number or variable to the power of zero equals 1.	**6) Negative powers (integers)**	$a^{-1} = \frac{1}{a}$ $a^{-2} = \frac{1}{a^2}$ $a^{-n} = \frac{1}{a^n}$ A negative power represents the reciprocal.
7) Positive unit fractions	$a^{\frac{1}{2}} = \sqrt{a}$ $a^{\frac{1}{3}} = \sqrt[3]{a}$ $a^{\frac{1}{n}} = \sqrt[n]{a}$	**8) Negative unit fractions**	$a^{-\frac{1}{2}} = \frac{1}{\sqrt{a}}$ $a^{-\frac{1}{3}} = \frac{1}{\sqrt[3]{a}}$ $a^{-\frac{1}{n}} = \frac{1}{\sqrt[n]{a}}$
9) Positive non-unit fractions	$a^{\frac{m}{n}} = (\sqrt[n]{a})^m$	**10) Negative non-unit factions**	$(a)^{-\frac{m}{n}} = \left(\frac{1}{a}\right)^{\frac{m}{n}} = \left(\sqrt[n]{\frac{1}{a}}\right)^m$

9.08 Standard Form

1) Rule	Numbers written in standard form are always written in the form $a \times 10^n$, where $0<a<10$	**2) Powers of 10**	$10^1 = 10$ $10^2 = 100$ $10^3 = 1000$ $10^3 = 10\,000$ $10^4 = 100\,000$ etc.	$10^{-1} = \frac{1}{10} = 0.1$ $10^{-2} = \frac{1}{100} = 0.01$ $10^{-3} = \frac{1}{1000} = 0.001$ $10^{-4} = \frac{1}{10000} = 0.0001$ etc
3) Ordinary to Standard Form	$340000 = 3.4 \times 10^5$ $0.00903 = 9.03 \times 10^{-3}$	**4) Standard Form to Ordinary**	$1.09 \times 10^3 = 1090$ $8.77 \times 10^{-6} = 0.00000877$	

KPI 9.09 Expanding and Factorising 2

1) Expand	Multiply out the bracket(s) in the expression. E.g. $3(5x + 7) = 15x + 21$	**2) Factorise**	Identify the HCF and rewrite the expression with brackets. E.g. $6x^2 + 9x = 3x(2x+3)$.
3) Expanding double brackets	Writing two brackets next to each other means the brackets need to be multiplied together. $(x + 1)(x + 2) = (x + 1) \times (x + 2) = x^2 + 3x + 2$ Note: $(x + a)^2 = (x + a)(x + a)$		
4) Factorising quadratics	To factorise a quadratic, put it back into a pair of brackets. To find the terms that go in each bracket, look for a pair of numbers which multiply to give the constant and add together to give the coefficient of x		
5) Difference of two squares (DOTS)	$a^2 - b^2 = (a+b)(a-b)$	E.g. $x^2 - 16 = (x + 4)(x - 4)$	

x	x	+1
x	x^2	$+x$
+2	$+2x$	+2

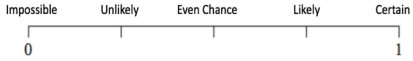
KPI 9.10 Forming Expressions and Substitution

1) Substitution	Replace a variable with a given value.	**2) Function machine**	Shows the relationship between two variables, the input and the output.
3) Formula	A mathematical relationship or rule expressed in symbols.		
4) Expression	A mathematical statement which contains one or more terms combined with addition and/or subtraction signs.		

KPI 9.11 Direct and inverse proportion

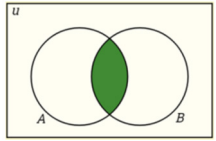
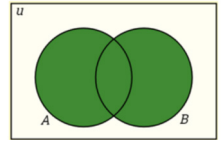
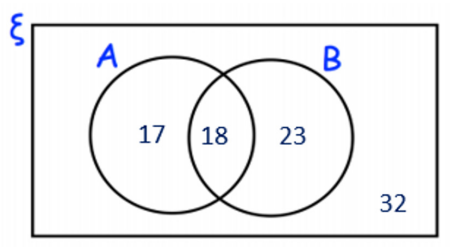
1) Direct proportion	A relationship between two variables where, as one increases, the other also increases.	**3) Unitary method**	To find the value of one unit first.
2) Inverse Proportion	A relationship between two variables where, as one increases, the other decreases.	**4) Exchange rate**	Tells us how much of one currency you can exchange for another currency e.g. £1 = $1.39

KPI 9.12 Probability 1

1) Probability	How likely something is going to happen. All probabilities must be given as a fraction, decimal or a percentage (NOT a ratio).	**2) Probability scale words**	Impossible, Unlikely, Even chance, Likely, Certain
3) Probability scale	All probabilities exist between 0 and 1. Impossible = 0, Even chance = ½ and certain = 1 	**4) Systematic listing**	The outcomes for an event can be listed in an organised or systematic way to make sure that none of the possible outcomes are missed out.
5) Single event probability	The sum of the probabilities of a set of outcomes must equal one.	**6) Probability notation**	In probability we use the notation P(___) to represent the probability of something happening.
7) Probability of an event happening	$P(of\ an\ outcome\ happening) = \frac{number\ of\ the\ desired\ outcome}{total\ number\ of\ outcomes\ of\ the\ event}$	**8) Mutually exclusive**	Are events that cannot happen at the same time.
9) Expected outcomes	You need to multiply the probability by the total number of trials.	**10) Frequency trees**	Is used to record and organise information given as frequencies. This can then be used to calculate probabilities.
11) Sample space	Listing all of the possible outcomes from two events in a table. E.g. Displaying all of the scores for the sum of two spinners. Spinner A (1,2,3,4) and Spinner B (2,3,4)	**12) Relative frequency**	Relative frequency is used when probability is being estimated using the outcomes of an experiment or trial, when theoretical probability cannot be used. Relative frequency or experimental probability is calculated from the number of times an event happens, divided by the total number of trials in an actual experiment. $Relative\ Frequency = \frac{No.\ of\ Successful\ Outcomes}{No.\ of\ Trials}$

+		Spinner A			
		1	2	3	4
Spinner B	2	3	4	5	6
	3	4	5	6	7
	4	5	6	7	8

KPI 9.12 Probability 1

13) Venn Diagrams	A Venn diagram shows the relationship between groups of different outcomes.	**14) Element**	A list of numbers, objects or outcomes.
15) Universal set	Contains all of the elements for our question	**16) Set Notation**	**A** – all elements in A **A'** – all elements NOT in A **B** – all elements in B **B'** – all elements NOT in B
17) Intersection	**A∩B** – all the elements in both A and B 	**18) Union**	**A∪B** – all the elements in A or B or both 
19) Finding probabilities from a Venn diagram	Venn diagrams can be useful for organising information about frequencies and probabilities. We can then use them to solve conditional probability problems. E.g. The following Venn diagram shows information about the number of members of a local sport club who take part in the Archery and Badminton classes. A person is chosen at random. Find P(B only) $= \frac{18 + 23}{17 + 18 + 23 + 32} = \frac{41}{90}$		

KPI 9.13 Solving Equations 2

1) Solve	Use inverse operations to find the solution of an equation.	**2) Linear equation**	Contains an equals sign (=) and has one unknown. E.g. $5x - 2 = 2x + 7$
3) Equation	An equation is a statement with an equal sign, starting that two expressions are equal in value.		

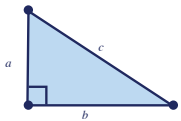
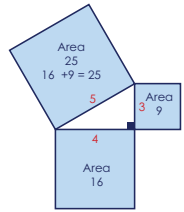
KPI 9.14 Inequalities 1

1) Representing an inequality on a number line– closed circle	A closed circle is used to show greater than or equal to (or less than or equal to) the number. $x \geq 3$ 	**2) Representing an inequality on a number line – open circle**	An open circle is used to show greater than (or less than) the number. $x > 3$ 
3) Reversing the Inequality	Multiplying or dividing both sides by a negative number reverses the inequality	E.g. $-3x < 6$ $x > -2$	

KPI 9.15 Sequences

1) Sequence	A pattern of numbers which fit a certain rule.	**2) Term**	A number in a sequence.
3) Term to term rule	The rule for how to get from one number to the next number in the sequence.	**4) Position**	Where a term is in a sequence.
5) Position to term rule	The rule for how to work out a number in a sequence if you know its position.	**6) Nth term**	Used to find a term in a sequence given its position e.g. 5n + 3
7) Linear sequence	The terms increase or decrease by the same amount each time. Also known as an arithmetic sequence. Nth term is written in the form, an + b.	**9) Geometric sequence**	A geometric sequence goes from one term to the next by always multiplying or dividing by the same value.
10) Fibonacci sequence	The Fibonacci sequence is unique because the next term is found by adding up the two previous terms. 1, 1, 2, 3, 5, 8, 13, 21…		

KPI 9.16 Pythagoras

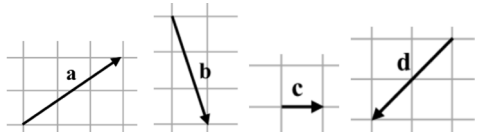
1) Right-angled triangle	A triangle that contains a right-angle (90 degrees).	**2) Hypotenuse**	The longest side – opposite the right-angle.
3) Pythagoras' Theorem	For any right-angled triangle, the area of the square of the longer length (the hypotenuse) is equal to the area of the squares of the shorter lengths added together.  $c^2 = a^2 + b^2$ $a^2 = c^2 - b^2$ $b^2 = c^2 - a^2$		

KPI 9.17 Interior and Exterior Angles			
1) Polygon	A polygon is a two-dimensional shape with 3 or more straight sides. A polygon is either regular or irregular: Regular – side lengths are equal, and all angles are equal. Irregular – side lengths are unequal, and angles are unequal.		
2) 3 sides	Triangle	**3) 4 sides**	Quadrilateral
4) 5 sides	Pentagon	**5) 6 sides**	Hexagon
6) 7 sides	Heptagon	**7) 8 sides**	Octagon
8) 9 sides	Nonagon	**9) 10 sides**	Decagon
10) 11 sides	Hendecagon	**11) 12 sides**	Dodecagon
12) Exterior Angles	Exterior angles of polygons sum to 360°. An exterior angle of a regular polygon is found by calculating $\frac{360}{n}$ n is the number of sides.	**13) Interior Angles**	In a regular polygon. Interior Angle + Exterior Angle = 180°
14) Tessellation	A pattern created with identical shapes that fit together with no gaps.		

KPI 9.18 Vectors 1

1) Vector

Vectors represent movement of a certain size in a certain direction, they are represented on a diagram with an arrow.



2) Magnitude

Magnitude is defined as the length of a vector.

3) Scalar

A scalar is the number we multiply a vector by.

4) Column vector

$\begin{pmatrix} a \\ b \end{pmatrix}$

a: movement along the x-axis (left/right)
b: movement along the y-axis (up/down)

5) Adding and subtracting column vectors

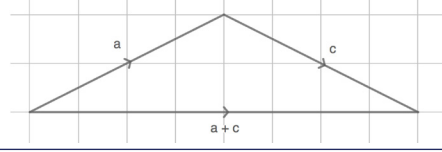
$$\begin{pmatrix} a \\ b \end{pmatrix} + \begin{pmatrix} c \\ d \end{pmatrix} = \begin{pmatrix} a+c \\ b+d \end{pmatrix}$$

6) Multiplying vectors

To multiply a column vector by a number, we multiply both values in the vector by that number.

7) Resultant vectors

The resultant vector is the vector that results from adding two or more vectors together.

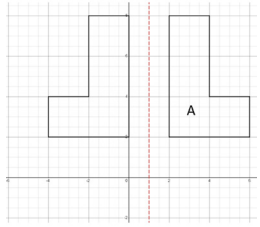
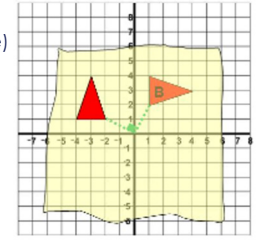
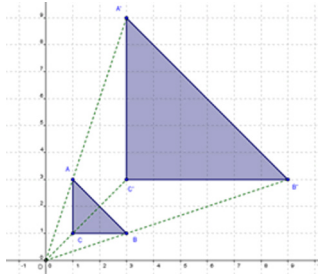
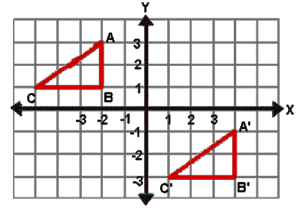


8) Parallel vectors

Travel in the same or opposite direction.
Can be of varying lengths.
Must be scalar multiples of one another.

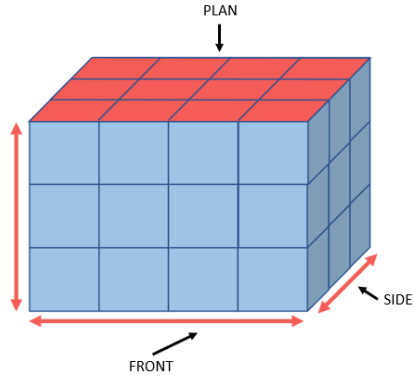
The vectors $\begin{pmatrix} 8 \\ 12 \end{pmatrix}$ and $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$ are parallel because $\begin{pmatrix} 8 \\ 12 \end{pmatrix} = 4\begin{pmatrix} 2 \\ 3 \end{pmatrix}$

KPI 9.19 Transformations 1

1) Transformations	There are four types of transformations: Reflection Rotation Enlargement Translation	**2) Object**	This is the original shape used to perform the transformation on
3) Image	This is the new shape created as the result of the transformation.	**4) Congruent**	Two (or more) shapes that are the same size and the same shape.
5) Reflection	A shape is reflected in a line of symmetry. When a shape is reflected the image is always congruent to the object. The line of symmetry used must be given or found using an equation. An object and its image are always the same perpendicular distance from the line of symmetry. E.g. Reflect shape A in the line x=1 	**6) Rotation**	When rotating a shape we must have 3 pieces of information. Centre of rotation given as a coordinate (x,y) Angle of rotation (usually 90°,180°,270°) Direction (clockwise or anticlockwise) 
7) Enlargement	When enlarging a shape we must have two pieces of information. Centre of enlargement given as a coordinate (x,y) Scale factor 	**8) Translation**	A translation is a movement of an object When a shape in translated the image is congruent to the object. Translations are described using column vectors (a ¦ b) a: movement along the x-axis (left or right) b: movement along the y-axis (up or down) E.g. Translate the original triangle ABC by the vector (6 ¦ (– 4)) 

KPI 9.20 Plans and Elevations

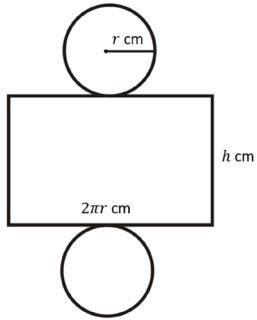
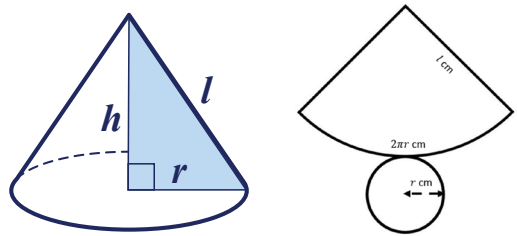
1) Plan	View looking vertically downwards.
2) Side elevation	View looking horizontally from the side.
3) Front elevation	View looking horizontally from the front.



KPI 9.21 Arcs and Sectors

1) Circumference	The perimeter of the circle. $C = \pi d$	**5) Area of a circle**	$A = \pi r^2$
2) Perimeter of a semi-circle	$P = \frac{\pi d}{2} + d$	**6) Area of a semi-circle**	$A = \frac{\pi r^2}{2}$
3) Perimeter of a quarter–circle	$P = \frac{\pi d}{4} + 2r$	**7) Area of a quarter-circle**	$A = \frac{\pi r^2}{4}$
4) Perimeter of a three-quarter circle	$P = \frac{3}{4}\pi d + 2r$	**8) Area of a three-quarter circle**	$A = \frac{3\pi r^2}{4}$

KPI 9.22 Surface Area

1) Surface Area	The total area of the surface of a three-dimensional object. For example, the surface area of a cube is the area of all 6 faces added together. It is measured in square units. E.g. square centimetres (cm^2), square metres (m^2).		
2) Cylinder	Surface Area = $2\pi r^2 + 2\pi rh$ 	**3) Cone**	Surface Area = $\pi r^2 + \pi rl$ 
4) Sphere	Surface Area = $4\pi r^2$	**5) Hemi-sphere**	Surface Area of a Hemi-sphere = $3\pi r^2$

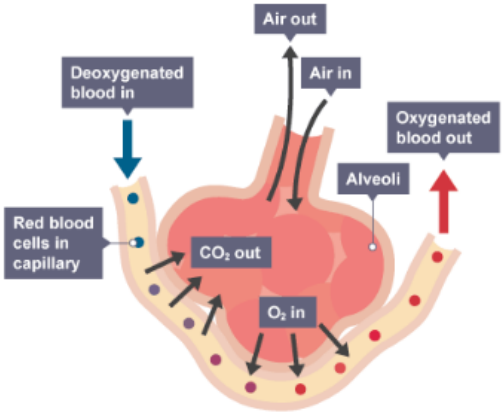
The human gas exchange system

- Oxygen is needed for respiration;
- Carbon dioxide produced in respiration needs to be removed;

Gas exchange is moving oxygen from the air into the blood, and removing waste carbon dioxide from the blood into the air.

The respiratory system contains the organs that allow us to get the oxygen we need and to remove the waste carbon dioxide we do not need:

- Air passes from the mouth into the **trachea** (windpipe);
- The trachea divides into two **bronchi** - one for each lung.
- Each bronchus divides into smaller tubes called **bronchioles**.
- At the end of each bronchiole, there are air sacs (**alveoli**)
- The alveoli increase the **surface** of the lungs.

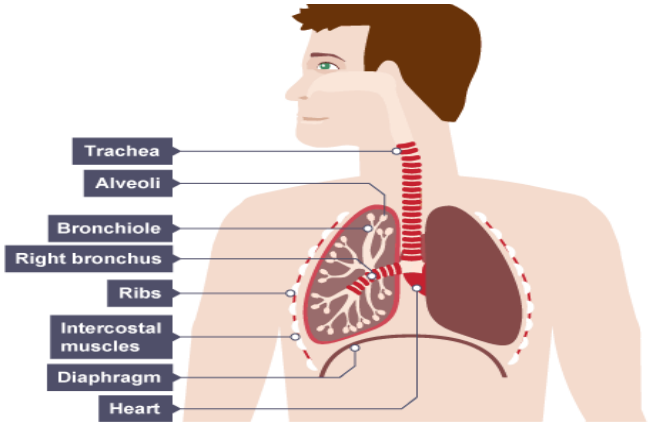


Features of the alveoli

- Increase surface area of lungs;
- Moist, thin walls (just one cell thick);
- A lot of tiny blood vessels called **capillaries**

The gases move by **diffusion** (from a **high concentration to a low concentration**):

- oxygen diffuses from the air into the blood;
- carbon dioxide diffuses from the blood into the air.



Aerobic respiration

Energy is needed for:

- growth and repair
- movement
- control of body temperature in mammals/birds

The equation for aerobic respiration is:

glucose + oxygen → carbon dioxide + water

- Glucose and oxygen react to produce carbon dioxide and water and release energy;
- It is **aerobic** respiration because oxygen is used;
- Respiration happens in all living cells, including plant and animal cells;
- Takes place in the **mitochondria** of the cell;
- Energy is released from glucose;
- **Do not** confuse respiration with breathing (which is called **ventilation**).

Science 9BB
Biological systems and processes

Ventilation

- Ventilation is another word for breathing;
- It involves movements of the **ribs**, **intercostal muscles** and **diaphragm** to move air in and out of the lungs:
- **inhale** – breathing in; **exhale** – breathing out;

	Inhaling	Exhaling
Diaphragm	Contracts and moves downwards	Relaxes and moves upwards
Intercostal muscles	Contract, moving the ribs upwards and outwards	Relax, letting the ribs move downwards and inwards
Volume of ribcage	Increases	Decreases
Pressure inside the chest	Decreases below atmospheric pressure	Increases above atmospheric pressure
Movement of air	Moves into the lungs	Moves out of the lungs

Anaerobic respiration

In humans:

The equation for anaerobic respiration in humans is:

glucose → lactic acid

- Lactic acid builds up in the muscles;
- Causing pain and tiredness (fatigue);
- Can lead to cramp;
- Lactic acid is broken down when you start aerobic respiration again.

Fermentation

The equation for anaerobic respiration in yeast is:

glucose → ethanol + carbon dioxide

- Anaerobic respiration happens in microbes (eg bacteria);
- They need to release energy from glucose;
- Yeast (unicellular fungi) can carry out an anaerobic process called **fermentation;**
- Ethanol (alcohol) is produced;
- The ethanol is used to make beer and wine;
- The carbon dioxide helps bread rise.

	Aerobic	Anaerobic
Needs oxygen?	Yes	No
Needs glucose?	Yes	Yes
Product(s) formed	Carbon dioxide and water	Lactic acid
Energy released	More	Less

Impact of exercise - exercise causes an increase in:

- breathing rate;
- tidal volume (volume of air breathed in/out in one breath);

Regular exercise can increase the:

- strength of the **diaphragm** and **intercostal muscles**;
- vital capacity (volume of air that can be forcibly exhaled after inhaling fully).

Smoking
Smoking is very harmful to health. Smoke contains harmful substances. These include:
- tar
- nicotine
- carbon monoxide

Tar
- causes cancer of the lungs, mouth and throat;
- coats the inside of the lungs causing coughing;
- damages the alveoli, making gas exchange difficult.

Smoke
- Cells in the trachea, bronchi and bronchioles produce **mucus**;
- Mucus traps dirt and microbes;
- Cells with **cilia** move the mucus out of the lungs;
- Smoke and tar damages the cilia;
- Smokers cough to move the mucus and are more likely to get bronchitis.

Nicotine
- Nicotine is **addictive**;
- Nicotine increases heart rate and blood pressure, and makes blood vessels narrower;
- This can lead to **heart disease**.

Carbon monoxide
- Carbon monoxide takes the place of oxygen in red blood cells;
- This reduces amount of oxygen that the blood can carry;
- It means the circulatory system has to work harder, causing heart disease.

Smoking and pregnancy
Smoking can damage the foetus during gestation. For example, it can:
- increase the risk of complications in pregnancy and birth;
- make it less likely to have a healthier pregnancy and a healthier baby
- increase the risk of stillbirth;
- make it more likely to be born too early;
- be more likely to be born underweight.

Drugs
Drugs are a substance that has an effect on the body.
They can be:
- **medicines** are drugs that treat pain or disease;
- **recreational drugs** are taken because people like the effects they have on their bodies.

- Some recreational drugs are legal, eg **caffeine**, **tobacco** & **alcohol**;
- Most recreational drugs are illegal, eg **cannabis**, **ecstasy** and **heroin**;
- Recreational drugs can be classified as a **depressant** or a **stimulant;**
- Most recreational drugs can be **addictive**.

Science 9BB
Biological systems and processes

Asthma
- Asthma affects the bronchioles;
- Airways can become inflamed, swollen and constricted (narrowed);
- excess mucus is produced.

During an asthma attack:
- the lining of airways becomes **inflamed**;
- fluid builds up in the airways;
- muscles around bronchioles contract, which **constricts** airways.

Symptoms are:
- **wheezing**, **tight chest** and **difficulty breathing**.
- treated using drugs called **relievers** which relax and open up the airways.

Relievers are often administered using an **inhaler**, to breathe the medicine in directly into your lungs.

Stimulants
Stimulants speed up messages in the brain and along the nerves.

Legal Stimulants
- **Nicotine** and **caffeine** are legal stimulants;
- Caffeine is found in cola drinks, coffee and tea;
- Caffeine makes you feel more alert, but it can cause insomnia (difficulty in sleeping), headaches and nervousness;

Illegal Stimulants
- **Cocaine**, **ecstasy** and **amphetamines** are all illegal stimulants;
- Cocaine, ecstasy and amphetamines make you feel more energetic and confident, but damage the **liver** and **heart;**
- They cause loss of memory and concentration, and increase risk of mental illness;

Depressants
Depressants slow down messages in the brain and along the nerves;
- **alcohol**, **heroin** and **solvents** are depressants

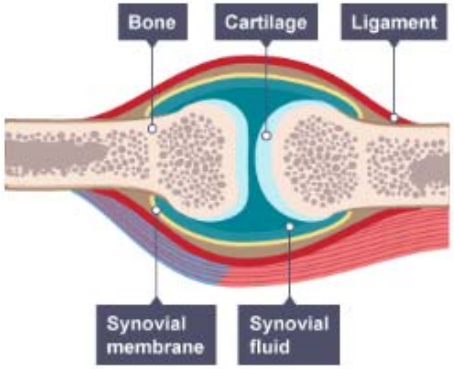
Here are some of the typical effects depressants have on the body:
- feelings of well-being;
- lowered inhibition;
- slowed thinking;
- slowed muscular activity;
- a distorted view of the world, or hallucinations.

Long-term effects of depressants:
- damage to the liver, brain and heart;
- alcohol can cause weight gain;
- solvent abuse causes a rash around the nose and mouth;
- loss of memory and concentration;
- increased risk of mental illness.

- Any drug that is misused can cause damage to the body, as well as personal and social problems.
- Injecting drugs with syringes that someone else has used may lead to diseases such as **HIV** and **hepatitis**.

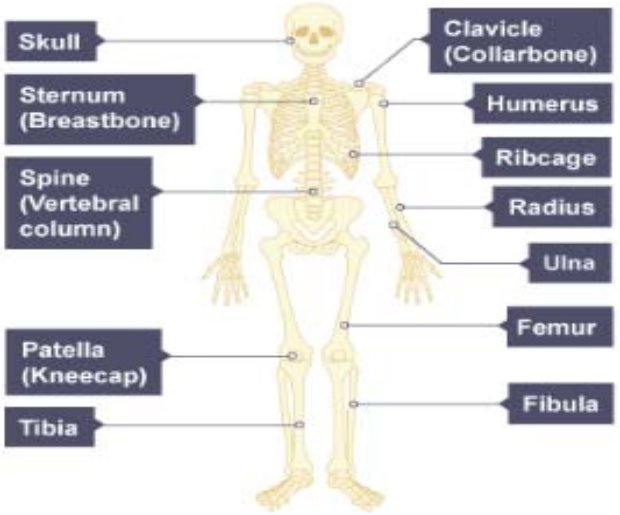
Joints

- Most joints allow parts of the skeleton to move;
- The human skeleton has joints called **synovial joints.**



The synovial joint

- The ends of the bones in a joint are covered with a tough, smooth substance called **cartilage**.
- This is kept slippery by a liquid called **synovial fluid**.
- Tough **ligaments** join the two bones in the joint;
- If two bones moved against each other, without cartilage they would eventually wear away;
- This is called **arthritis**.



The skeleton

- Bone is a living **tissue** with a blood supply.
- It is constantly being dissolved and formed
- It can repair itself if a bone is broken.
- Calcium and other minerals make bone strong but slightly flexible.

Four functions of the skeleton:

1) Support the body

The skeleton supports the body. For example, without a backbone we would not be able to stay upright.

2) Protection of vital organs

- the skull protects the brain
- the ribcage protects the heart and lungs
- the backbone protects the spinal cord

3) Movement

- Bones are linked together by joints;
- Some are **fixed joints** – eg in the skull;
- Some are **flexible joints** – eg the knee;
- Muscles move bones attached by joints.

4) Making blood cells

Two main types of blood cell:

- **red blood cells**, which carry oxygen;
- **white blood cells**, which destroy **harmful microbes** (pathogens);
- Both are made in the **bone marrow** - soft tissue inside large bones protected by the hard part of the bone around it.

Science 9BB
Biological systems and processes

Muscles and movement

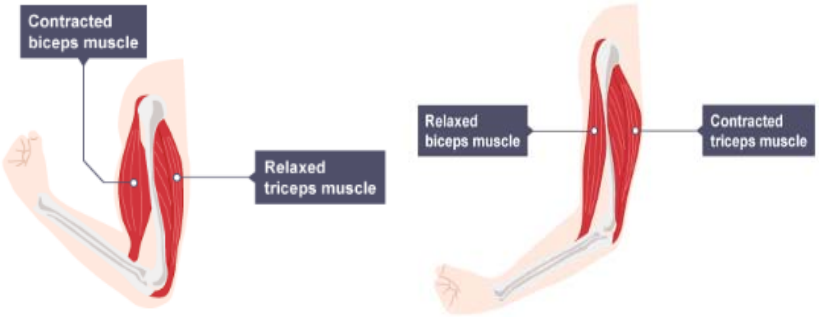
- Muscles work by getting shorter - they **contract**;
- Muscles are attached to bones by strong **tendons**.
- During muscle contraction, it pulls on the bone, moving it.

Antagonistic muscles

- Muscles can **only** pull, they **cannot push**;
- Muscles work in pairs, called **antagonistic muscles**;

Your elbow joint has two muscles that move your forearm up or down. These are the **biceps** and the **triceps:**

- to raise the forearm, the biceps contracts and the triceps relaxes;
- to lower the forearm again, the triceps contracts and the biceps relaxes.



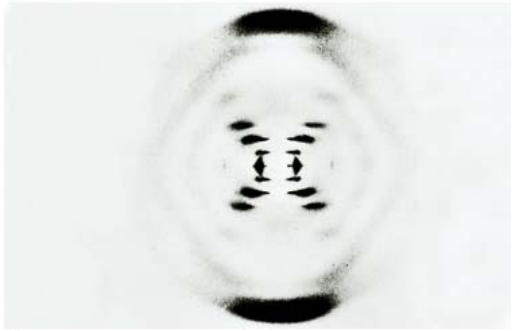
- Muscles exert a force on bones when they contract.
- You could work out the force exerted by the biceps muscle using the idea of **moments**.
- The way in which muscles and bones work together to exert forces is called **biomechanics**.

Type of joint	Examples	Movement allowed
Hinge joint	Knee, elbow	The same as opening and closing a door, with no rotation (turning)
Ball and socket	Hip, shoulder	Back and forth in all directions, and rotation

Structure of DNA
Genetic information is passed from one generation to the next.
This is called **heredity** and why we resemble our parents.

The genetic information itself is contained in a complex molecule called **DNA**.

Scientists worked out the structure of DNA in the 1950s. Rosalind Franklin made 'X-ray diffraction' images of DNA.



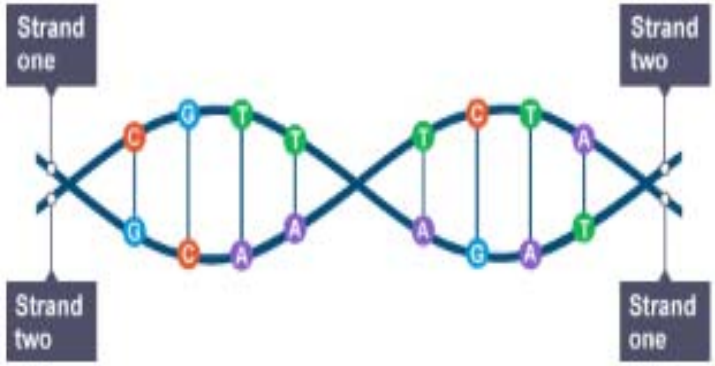
An X-ray diffraction image of DNA

James Watson and Francis Crick used information from one of her images to work out a model for the structure of DNA.

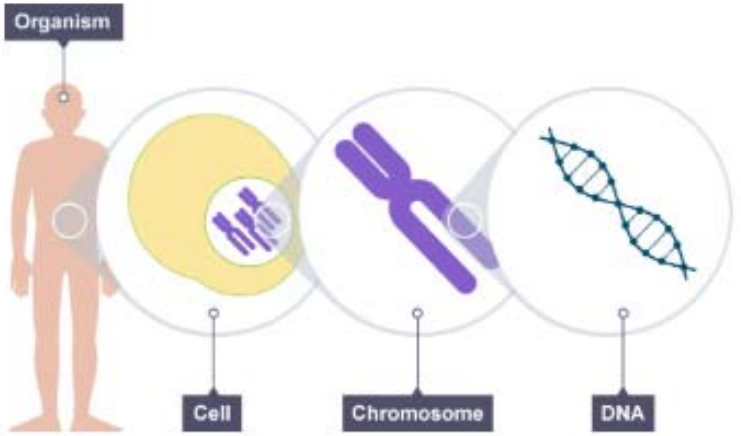
Work by Maurice Wilkins, a colleague of Franklin, supported their model.

Watson and Crick were able to work out how DNA was arranged.
They worked out that:
- DNA has two strands;
- the strands are twisted to form a **double helix;**
- the strands are held together by **bonds** between **base pairs**.

Key terms	Definition
Base Pair	the pair of nitrogenous bases that connects the (complementary) strands of DNA;
Bond	the chemical link that holds molecules together;
Chromosome	strands of DNA;
DNA	**D**eoxyribo**n**ucleic **a**cid. The chemical carrying the genetic code;
Double helix	the shape of DNA molecule, two strands twisted in a spiral;
Gene	a section of DNA which we inherit from our parents, and which controls part of a cell's chemistry (protein production);
Heredity	genetic information that determines an organism's characteristics, passed on from one generation to another.
Nucleus	controls what happens inside the cell, and contains chromosomes



A DNA molecule showing its base pairs, G–C and A–T



Each cell with a nucleus contains chromosomes, which are made from DNA

Science 9BB
Biological systems and processes

Chromosomes, DNA and genes
The DNA in all of your cells is approximately two metres long, except for:
- Red blood cells which have none;
- Sperm or eggs only have about one metre.

- It is coiled into structures called chromosomes.
- Chromosomes are found in the nucleus of each cell.

- Human body cells each contain **23 pairs of chromosomes**;
- Half of which are from each parent;
- Human gametes (eggs and sperm) each contain 23 chromosomes;
- When an egg is fertilised by a sperm, it becomes a cell with 23 pairs of chromosomes;
- We each have half of our chromosomes and DNA come from each parent;
- DNA makes up genes, which makes up chromosomes.
- One copy of all your chromosomes is called your **genome**.

Science 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

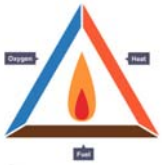
$2Mg + O_2 \rightarrow 2MgO$

- 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:

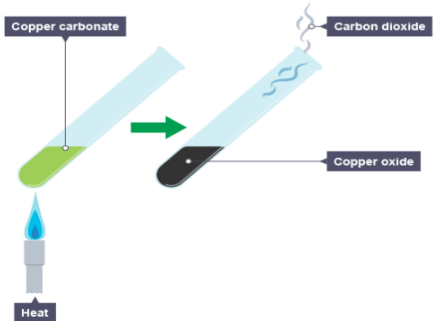
metal carbonate → metal oxide + carbon dioxide

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

Science Reactivity

Word equations to symbol equations:
- replace names of each substance symbols or formula
- use numbers to balance the equation

Example:

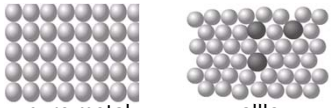
copper + oxygen → copper oxide

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



pure metal

allloy

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**chloric** 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.

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:

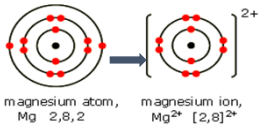
copper oxide + carbon → copper + carbon dioxide

$2CuO + C \rightarrow 2Cu + CO_2$

Why do metals react?

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

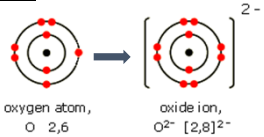
For example:
Magnesium loses its 2 outer electrons to become a +2 ion



Why do non-metals react?

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

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 all less reactive than carbon.