KNOWLEDGE ORGANISER

Seahaven Academy
The best in everyone™
Part of United Learning

YEAR 10:

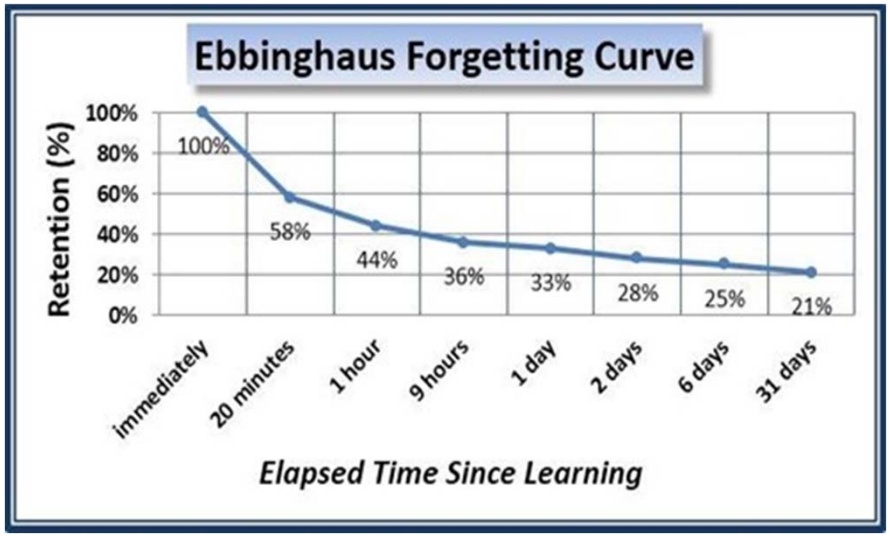
Terms 3 and 4

2023 - 2024

Core Subjects

Name: _____ Tutor Group: _____

Knowledge Organisers and The Forgetting Curve



Why are knowledge organisers important?

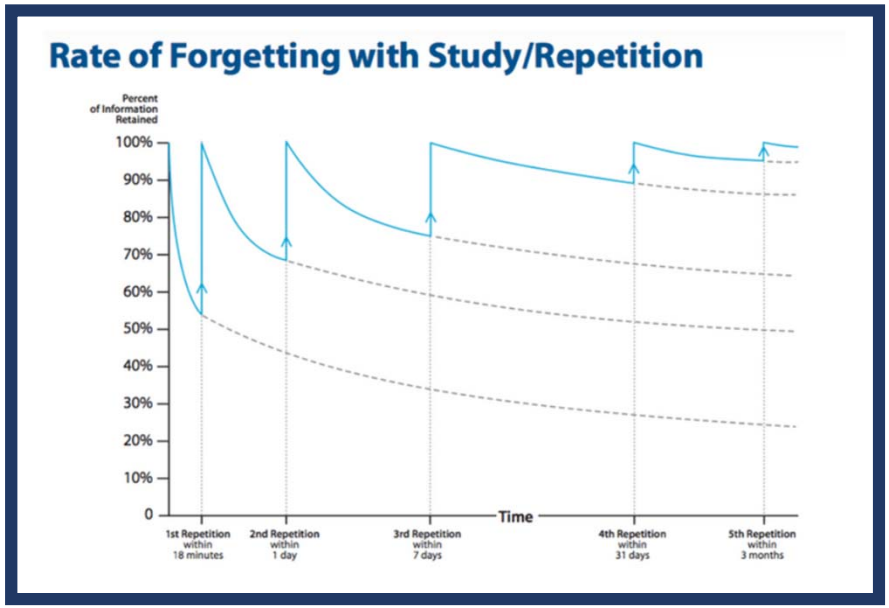
- Almost as soon as we have learnt something we begin to forget it
- In fact, it is surprising how quickly we begin to forget and within a few hours we usually only remember a fraction of what we have learnt ,the graph (left) is an example of how this happens

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?

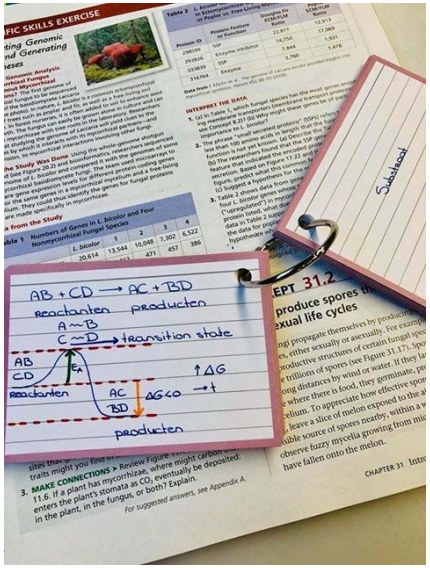
- You need to bring these to school each day in your bag, they may be used in lessons
- You will be set homework activities that use them
- You should use them to practice recall – there are tips on ways to do this in the next few pages
- You will use them to prepare for end of unit tests, including 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.

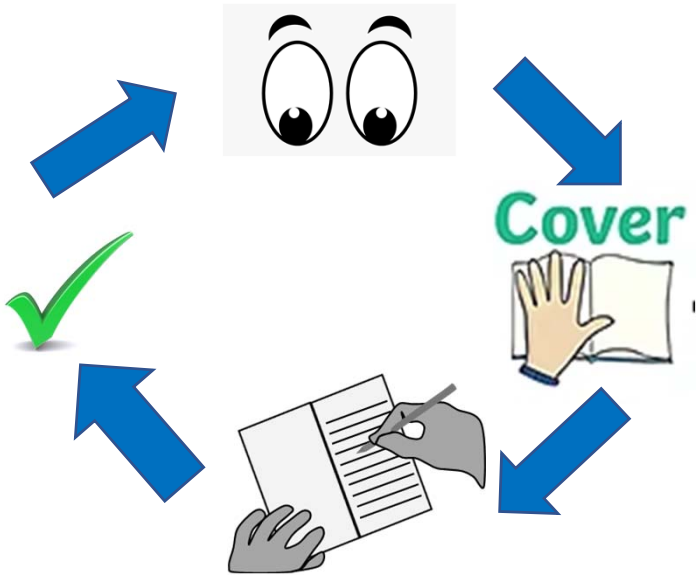
You start with all the cards in Box 1.
You learn these every day

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/

A Christmas Carol Knowledge Organiser

Very Brief Plot Summary

Stave 1: Scrooge is introduced; he refuses to make a charity donation; refuses to eat Christmas dinner with Fred; sees Marley's ghost who warns him he will be visited by three spirits to make him change his miserly ways.

Stave 2: The Ghost of Christmas Past takes Scrooge back in time to show him: his village; him alone at school; his sister collecting him from school; a party at Fezziwig's; Belle breaking off their engagement and Belle celebrating Christmas with her family.

Stave 3: The Ghost of Christmas Present shows Scrooge: Christmas morning in London; The Cratchit family celebrating Christmas; various celebrations around the country; Fred's Christmas party; Ignorance and Want.

Stave 4: The Ghost of Christmas yet to Come shows Scrooge: a group of businessmen discussing a dead man; a pawn shop where people are selling the possessions of a dead man; a couple expressing relief that the man they owe money to is dead; the Cratchit family grieving for Tiny Tim; a grave with the name Ebenezer Scrooge written on it.

Stave 5: Scrooge is transformed! He sends a turkey to the Cratchit family, makes a huge charity donation and attends Fred's Christmas party. He also gives Bob a raise and becomes a second father to Tiny Tim who does not die.

Characters

Ebenezer Scrooge: The main character. A mean old loner who hates Christmas.

Fred: Scrooge's patient, jovial nephew. The son of his beloved sister, Fan. Literally the complete opposite of Scrooge.

Bob Cratchit: Scrooge's hard-working and underpaid clerk.

Tiny Tim: Bob's ill and vulnerable son.

Belle: Scrooge's former fiancée who breaks off their engagement because he values money more than their relationship.

Fezziwig: Scrooge's generous former employer.

Marley: Scrooge's deceased business partner, who appears as a ghost warning Scrooge to change his ways.

Little Fan: Scrooge's deceased younger sister, the mother of Fred.

The Ghost of Christmas Past: a shape changing spirit who has light streaming from the top of its head. Represents memory.

The Ghost of Christmas Present: a jovial spirit (resembling a traditional 'Father Christmas') who represents generosity and Christmas spirit.

The Ghost of Christmas Yet to Come: a silent, sinister spirit in a black, hooded cloak who represents death.

Key Quotations

Stave 1:

'a squeezing, wrenching, grasping, scraping, clutching, covetous old sinner!'

'Hard and sharp as flint.'

'solitary as an oyster.'

"the cold within him froze his old features"

"`Bah!" said Scrooge, 'Humbug!"

'What reason have you to be merry? You're poor enough.'

'A kind, forgiving, charitable, pleasant time.'

'I can't afford to make idle people merry.'

'Are there no prisons?'

"And the Union workhouses?" demanded Scrooge. `Are they still in operation?"

"`If they would rather die," said Scrooge, 'they had better do it, and decrease the surplus population'"

`I wear the chain I forged in life,'

Stave 2:

'A solitary child neglected by his friends.'

'Father is so much kinder than he used to be.'

'The happiness he gives, is quite as great as if it cost a fortune."

'Another idol has displaced me'

Stave 3:

'I see a vacant seat.'

'I'll give you Mr Scrooge, the founder of the feast.'

'The whole quarter reeked with crime, with filth, with misery.'

'This boy is Ignorance. This girl is Want. Beware them both, and all of their degree,'

Stave 4:

'He frightened everyone away from us when he was alive, to profit us when he was dead.'

`I will honour Christmas in my heart, and try to keep it all the year. I will live in the Past, the Present, and the Future. The Spirits of all Three shall strive within me. I will not shut out the lessons that they teach.

Stave 5:

'I am as light as a feather. I am as happy as an angel. I am as merry as a schoolboy. I am as giddy as a drunken man.'

Wonderful party, wonderful games, wonderful unanimity, won-der-ful happiness!

'I'll raise your salary and endeavour to assist your struggling family.'

Themes

Christmas Spirit

- Scrooge learns the true meaning of Christmas is to spend time with your family and loved ones.
- He learns it's a time to be charitable and think about those less fortunate.
- Fezziwig's party shows him that small gestures at Christmas can make people feel valued and appreciated.

Family

- Scrooge is miserable and lonely because he refuses to socialise with his family.
- He is reminded of how much he loved his sister and how hurt he was by his father's behaviour.
- Fred never gives up on Scrooge and is loyal and forgiving towards his uncle.
- The closeness of the Cratchit family demonstrates how being together and supporting each other is more important to them than anything else.
- Seeing Belle reminds Scrooge that he is lonely in his old age due to his own actions. He chose money over a family with Belle.

Poverty and Social Injustice

- Scrooge learns that not all poor people are lazy.
- Scrooge learns that he can share some of his wealth to make other people's lives more comfortable.
- Tiny Tim shows how poverty can contribute to poor health.
- The Cratchits show how you can be poor but happy.
- Ignorance and Want remind Scrooge that turning a blind eye to the plight of the poor creates desperate people who turn to crime to support themselves.

Transformation

- Scrooge is cold, lonely and miserable at the start of the book.
- The spirits show him scenes that prompt his transformation.
- Memory reminds Scrooge of how he was once connected to other people.
- Empathy helps him to understand those less fortunate than himself.
- Being shown the reaction to the death frightens Scrooge into changing his personality to change his destiny.

Context

Poverty:

The 1834 Poor Law Amendment reduced the amount of help available the poor, forcing them to seek help at the workhouse if they couldn't support themselves. Conditions there were incredibly harsh and designed to humiliate people into not wanting to go there.

Ghosts and the supernatural:

Whilst the Victorians made many technological advances thanks to their interest in science and medicine, they were also fascinated in the supernatural and things that couldn't be easily explained by science. Ghost stories became extremely popular, as did trying to contact the dead via séances.

Christmas celebrations:

Christmas was a fairly low key celebration at the start of the 19th century, but Queen Victoria's German husband, Albert helped to introduce some European traditions, like a decorated tree, into the traditional British Christmas celebration during the 1840s. During Victoria's reign, workers started to be given two day's holiday to celebrate Christmas. The invention of the train enabled people to travel home to celebrate with family. The traditional figure of Father Christmas, dressed in green to symbolise the returning spring, was familiar at this time, but not the gift-distributing Santa Claus we know today. Rich people would give each other hand-made gifts and toys, but stockings did not become popular until the 1870s. Turkey was only eaten by rich families as it was expensive, goose was a cheaper option.

Key Vocabulary

Dickens
Dickensian
Victorian
poverty
workhouse
ignorance
miserly
redemption
transformation
ghost
spirit
Christmas
injustice
inequality
allegory
stave
novella

Language and Techniques

highly descriptive language
simile
metaphor
personification
pathetic fallacy
imagery
figurative language
dialogue
humour
repetition
symbolism
allusion
juxtaposition

Symbolism/Motifs

Light and dark; hot and cold; music, Scrooge's bed, Marley's chain; Ignorance and Want; Scrooge's gravestone; the three ghosts; fire;

YEAR 10 ENGLISH

KNOWLEDGE ORGANISER

POWER AND CONFLICT POETRY

Poem Title	What is it about?	Contextual knowledge	Key quotations
Ozymandias - Percy Shelly	An explorer comes across a statue of a pharaoh which is now ruined symbolising the fragility of power.	Shelly had strong political views Egyptian Pharaoh's were seen as Gods in human form to their people.	• *Half sunk a shattered visage lies* • *My name is Ozymandias, King of Kings* • *Nothing besides remain.*
London – William Blake	Someone walking though the penniless streets of Victorian London. The speaker of the poem blames the poor state on the rich and powerful.	There was a heavy class system which held many back. Blake felt common people were being abandoned.	• *Marks of weakness, marks of woe.* • *The mind-forged manacles I hear* • *The youthful Harlots curse*
Extract from The Prelude – William Wordsworth	This extract describes how Wordsworth went out in a boat on a lake at night. He was alone and a mountain peak loomed over him; its presence had a great effect and for days afterwards he was troubled by the experience.	Wordsworth was especially interested in the idea of growth and maturity. At this time the industrial revolution was beginning.	• *Small circles glittering idly in the moon, ...melted all into one track Of sparkling light.* • *A huge peak, black and white* • *Huge and mighty forms, that do not live like living men, moved slowly through the mind by day, and were a trouble to my dream.*
My Last Duchess – Robert Browning	A strange duke talking to someone about a painting he has of his dead ex-wife. He is very possessive of her. The conditions of her death are suspicious.	Browning alarmed his Victorian readers with realism. Women in marriages at the time had very little power, the husband would be in charge.	• *My gift of a nine-hundreds-years-old name* • *I gave commands / Then all smiles stopped together* • *Notice Neptune...taming a sea-horse.*

Maths – KS4 Foundation

Fact Sheets:

- Number, Ratio and Proportion
- Algebra
- Geometry and Measures
- Probability and statistics

Number Ratio and Proportion - Foundation

Estimate
Round each value to one significant figure

Standard form
$a \times 10^n$, where $1 \leq a < 10$

Reciprocal
Reciprocal of 7 is $\frac{1}{7}$, reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$ etc

Sequences
Fibonacci sequence: 1, 1, 2, 3, 5, 8, 13, 21
Geometric Sequence: each term is multiplied but he same constant to get the next number.
E.g. 3, 12, 48, 191, …. (x by 4 each time)

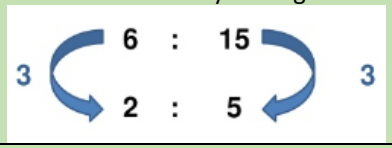
Squares and Cubes
Square numbers: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225 etc

Cube numbers: 1, 8, 27, 64, 125, 216, 343, 512, etc

Sharing in a given Ratio
A Add the ratio parts
D Divide the amount by the total parts
A and
M Multiply the ratio by the value of one part

e.g. share £420 in the ratio 2:5
2 + 5 = 7
420 ÷ 7 = £60
2: 5
(x60) (x60)
£120 : £300

Simplifying Ratio
Divide both sides by the highest common factor



Simplifying Ratio 1:n
Divide both sides by the highest factor of the left hand side
2m: 180cm
200cm: 180cm
2:1.8
1: 0.9

Fractions

Add and Subtract – ensure the fractions have the same denominator before adding numerators

$$\frac{4}{5} - \frac{1}{3} = \frac{12}{15} - \frac{5}{15} = \frac{7}{15}$$

Multiply – multiply numerators and denominators

$$\frac{4}{5} \times \frac{1}{3} = \frac{4}{15}$$

Divide – take reciprocal of the second fraction and then multiply the new numerators and denominators

$$\frac{4}{5} \div \frac{1}{3} = \frac{4}{5} \times \frac{3}{1} = \frac{12}{5} = 2\frac{2}{5}$$

Percentages

Finding percentages of an amount
1% ÷100
5% ÷20
20% ÷5
25% ÷4
50% ÷2

Multipliers:
To find the multiplier for a percentage, divide by 100

Use multipliers on a calculator paper
e.g. 35% of 370 = 0.35 x 370

Increasing and decreasing a given amount
Calculator:

$$Orginal\ Amount\ x\ mutiplier = new\ amount$$

Non-calculator: find the increase or decrease and add to the original amount

Finding percentage increase or decrease (profit/loss)

$$\frac{value\ of\ increase/decrease}{Original} \times 100$$

Writing an amount as a percentage of the original

$$\frac{Amount}{Original} \times 100$$

Reverse Percentage – finding the original amount

$$Orginal\ Amount = \frac{New\ Amount}{multiplier}$$

Growth & Decay / Compound interest

$$original\ amount \times multiplier^{time}$$

Where the multiplier is the percentage, increase or decrease from 100%, converted to a decimal.
e.g.
30% decrease is 70% = 0.7
30% increase is 130% = 1.3

Dividing by decimals:

1. Write the calculation as a fraction
2. Form an equivalent fraction to makes integers (multiply by powers of 10)
3. Use short division (bus stop) to calculate

e.g. $460 \div 0.4 = \frac{460}{0.4} = \frac{4600}{4} = 1150$

Conversions

10 millimetres = 1 centimetre	15 minutes = 0.25 hours
100 centimetres = 1 metre	30 minutes = 0.5 hours
1000 metres = 1 kilometre	45 minutes = 0.75 hours
$1000cm^3$ = 1 litre	1000g = 1 kilogram
1000ml = 1 litre	1000kg = 1 tonne

Compound Units (rearrange as necessary)

$$Speed = \frac{Distance}{Time}$$

$$Area = \frac{Force}{Pressure}$$

$$Density = \frac{Mass}{Volume}$$

Error Intervals
least possible value $\leq x <$ greatest possible value

e.g. A fence is 30 m long to the nearest 10 m.
$25\text{ m} \leq l < 35\text{ m}$

Truncation
Truncation is a method of approximating a decimal number by dropping all decimal places past a certain point without rounding.

e.g. Truncate 3.14159265 to 4 decimal places.
= 3.1415

Negative numbers
Adding and subtracting: (vertical number lines help)
-3 – 5 = - 8
-3 + 5 = 2
-3 - - 5 = -3 + 5 = 2
-3 - + 5 = -3 – 5 = -8
-3 + - 5 = -3 – 5 = -8

Multiplying and dividing:
Different signs – answer will be negative
+ x - = -, - x + = -
Same signs – answer will be positive
- x - = +

Ordering fractions
Calc: use division to write each fraction as a decimal
Non-calc: write fractions with common denominators

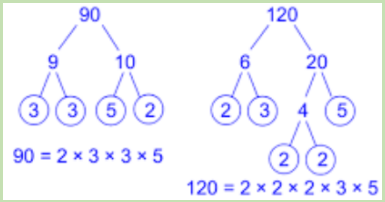
Order of operations
Bracket
Indices
Division and **M**ultiplication
Addition and **S**ubtraction

Rounding to significant figures
Start from the first **non-zero** number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF = 350,000
0.0060821 to 3SF = 0.0608

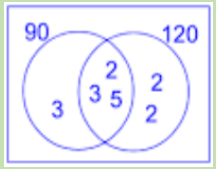
Index Laws

$$a^n \times a^m = a^{n+m}$$
$$a^n \div a^m = a^{n-m}$$
$$(a^n)^m = a^{nm}$$
$$a^0 = 1$$
$$a^{-n} = \frac{1}{a^n}$$
$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

Prime Factorisation



HCF and LCM of 90 and 120 (Factor Tree & Venn Diagram)
HCF is the product of common factors
LCM is the product of common factors and remaining factors.



HCF: 2x3x5
LCM: 2^3x3^2x5

Number Ratio and Proportion - Foundation

Estimate
Round each value to _____

Standard form
$a \times$ _____^{n}, where $1 \leq a < 10$

Reciprocal
Reciprocal of 7 is _____, reciprocal of $\frac{2}{3}$ is ___ etc

Sequences
Fibonacci sequence: _____
Geometric Sequence: _____
_____
E.g. 3, 12, 48, 191, …. (x by 4 each time)

Squares and Cubes
Square numbers: _____
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Cube numbers: _____
_____

Sharing in a given Ratio
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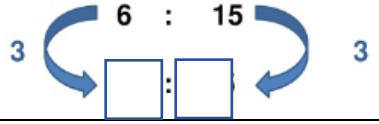
e.g. share £420 in the ratio 2:5

Simplifying Ratio
Divide both sides by the highest common factor



Simplifying Ratio 1:n
Divide both sides by the highest factor of the left hand side
Simplify: 2m: 180cm

Fractions

Add and Subtract – ensure the fractions have the same _____ before adding the _____

$$\frac{4}{5} - \frac{1}{3} =$$

Multiply – multiply _____ and _____

$$\frac{4}{5} \times \frac{1}{3} =$$

Divide – take _____of the second fraction and then _____the new _____and _____

$$\frac{4}{5} \div \frac{1}{3} =$$

Percentages

Finding percentages of an amount
1% ÷_____
5% ÷_____
20% ÷_____
25% ÷_____
50% ÷_____

Multipliers:
To find the multiplier for a percentage, divide by 100

Use multipliers on a calculator paper
e.g. 35% of 370 = 0.35 x 370

Increasing and decreasing a given amount
Calculator:

$$\_\_\_\_\_ = new\ amount$$

Non-calculator: find the increase or decrease and add to the original amount

Finding percentage increase or decrease (profit/loss)

$$\frac{\_\_\_\_\_}{Original} \times 100$$

Writing an amount as a percentage of the original

$$\frac{Amount}{\_\_\_\_\_} \times \_\_\_\_\_$$

Reverse Percentage – finding the original amount

$$Orginal\ Amount = \_\_\_\_\_$$

Growth & Decay / Compound interest

_____ × _____

Where the multiplier is the percentage, increase or decrease from 100%, converted to a decimal.
e.g.
30% decrease is 70% = _____
30% increase is 130% = _____

Dividing by decimals:

1.
2.
3.

e.g. 460 ÷ 0.4 =

Conversions

10 millimetres = _____
100 centimetres = _____
30 minutes = _____ hours
1000 metres = _____
45 minutes = _____ hours
1000cm^3 = _____ 1000g = _____
1000ml = _____ 1000kg = _____

Compound Units (rearrange as necessary)

$Speed =$ _____

$Area =$ _____

$Density =$ _____

Error Intervals

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e.g. A fence is 30 m long to the nearest 10 m.

_____ $\leq l <$ _____

Truncation

Truncation is _____
_____
_____

e.g. Truncate 3.14159265 to 4 decimal places.
= _____

Negative numbers

Adding and subtracting: (vertical number lines help)
-3 – 5 =
-3 + 5 =
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Multiplying and dividing:
Different signs – answer will be _____
+ x - = _____, - x + = _____
Same signs – answer will be _____
- x - = _____

Ordering fractions

Calc: use division to write each fraction as a decimal
Non-calc: write fractions with common denominators

Order of operations

B_____
I_____
D_____ and **M**_____
A_____ and **S**_____

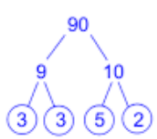
Rounding to significant figures

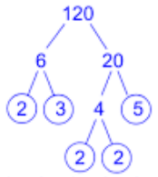
Start from the first _____ number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF =
0.0060821 to 3SF =

Index Laws

$a^n \times a^m =$
$a^n \div a^m =$
$(a^n)^m =$
$a^0 =$
$a^{-n} =$
$a^{\frac{n}{m}} =$

Prime Factorisation

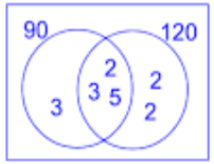




=_____ = _____

HCF and LCM of 90 and 120 (Factor Tree & Venn Diagram)

HCF is the _____
LCM is the _____



HCF: _____

LCM: _____

Notation

ab = a x b

a^2 = a x a

$(2a)^3$ = 2a x 2a x 2a

$(a + b)^2$ = (a + b)(a + b)

Definitions

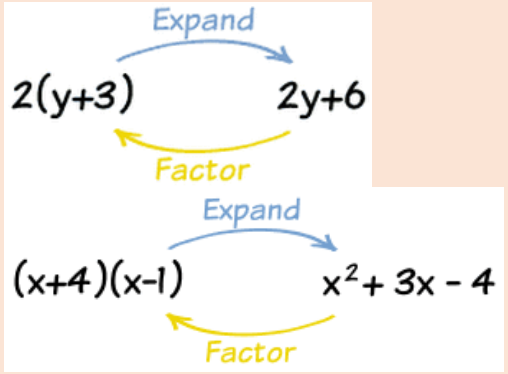
Expression – no equal signs e.g. 2x + 3, 2y, $(3x - 2)^2$

Equations – equal signs, can be solved, e.g. y + 4 = 10

Identities – identical/equivalent to e.g. 2(y + 4) ≡ 2y + 8

Formulae – equal signs, more than one unknown e.g. A= ½bh

Factorising and expanding



Straight line graphs

$y = mx + c$

$m = gradient$

$c = y - intercept$

positive gradient

negative gradient

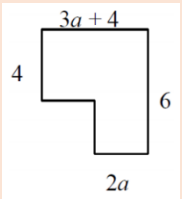
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{change\ in\ y}{change\ in\ x}$$

Parallel lines – have equal gradients

Simplifying expressions by collecting like terms

Always circle the sign IN FRONT of the term to avoid errors.

$$3x - 7b - x + 9b \equiv 2x + 2b$$



Typical Exam Q: Create an expression for the perimeter of the shape by adding and collecting like terms.

If the perimeter is given as 20cm, for example, you can create an equation:

$$4 + 3a + 4 + 6 + 2a = 20$$

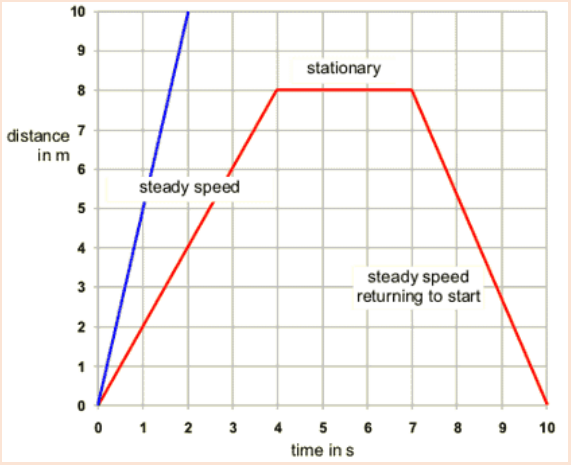
$$5a + 14 = 20$$

Simplifying expressions multiplication and division

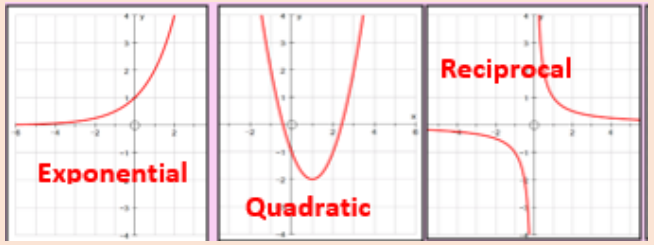
$2ma^2 \times 7ma = 14m^2a^3$

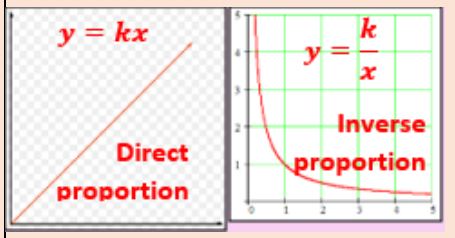
$\frac{18b^6}{3ab^2} = \frac{6b^4}{a}$

Distance / Time Graphs

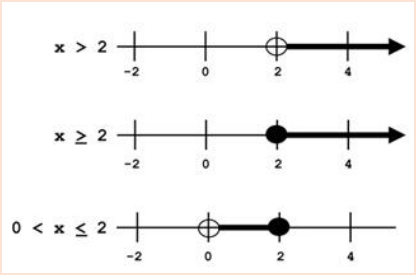


Graphs that need to be recognised





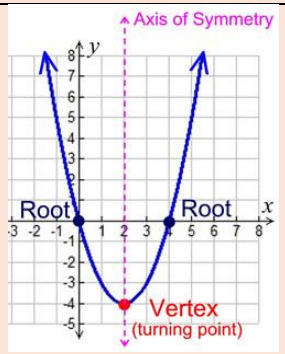
Inequalities



Open circle: </ >

Closed circle: ≤/ ≥

Turning point and roots of a quadratic equation



Finding the nth term of a linear sequence

5, 7, 9, 11, 13, ….

1. Find the common difference: 2
2. This is the coefficient of n: 2n
3. Find the difference between the coefficient of n and the first term 5 – 2 = 3
4. Add this to the amount of n

2n + 3

Notation

ab =

a^2 =

$(2a)^3$ =

$(a + b)^2$ =

Definitions

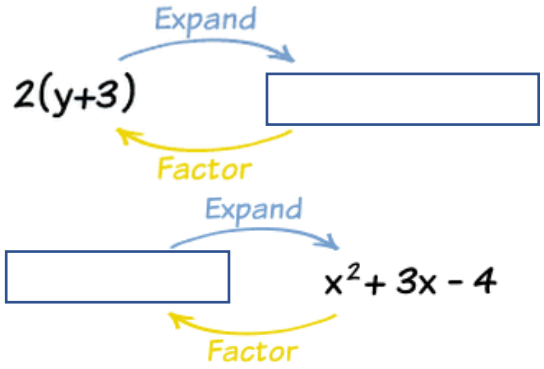
Expression –

Equations –

Identities –

Formulae –

Factorising and expanding



Straight line graphs

$y = mx + c$

$m =$ _____

$c =$ _____

_____ _____

gradient gradient

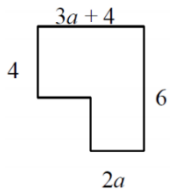
$m =$ _____ $=$ _____

Parallel lines – _____

Simplifying expressions by collecting like terms

Always circle the sign IN FRONT of the term to avoid errors.

$$3x - 7b - x + 9b \equiv 2x + 2b$$



Typical Exam Q: Create an expression for the perimeter of the shape by adding and collecting like terms.

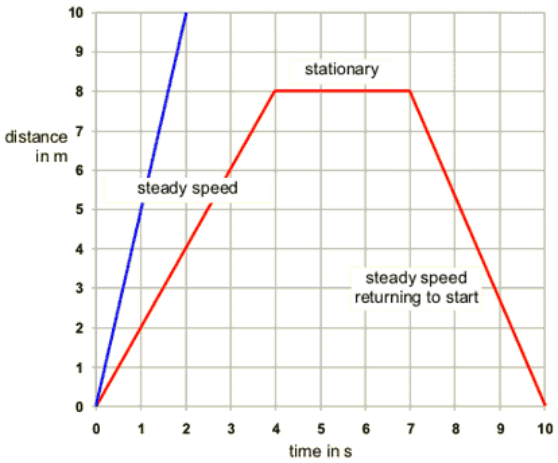
If the perimeter is given as 20cm, for example, you can create an equation:

ANSWER =

Simplifying expressions multiplication and division

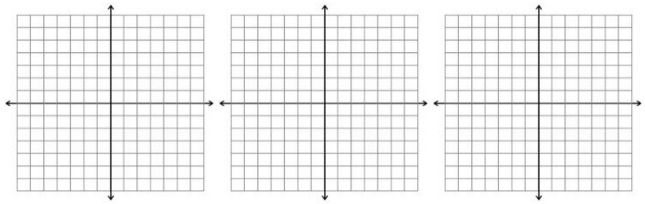
$2ma^2 \times 7ma =$ _____ $\frac{18b^6}{3ab^2} =$ _____

Distance / Time Graphs

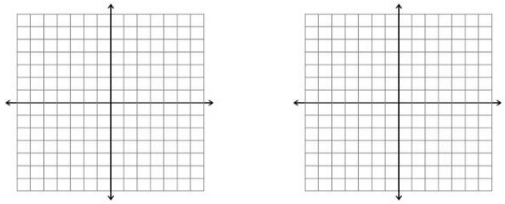


Graphs that need to be recognised: sketch

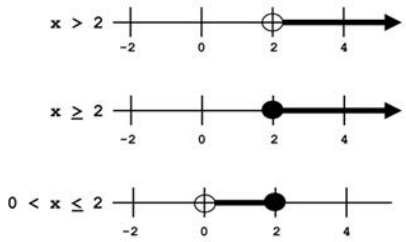
Exponential Quadratic Reciprocal



Direct Proportion Inverse Proportion



Inequalities



Open circle: _____

Closed circle: _____

Label the turning point, roots and axis of symmetry of the quadratic graph

Show how to find the nth term of a linear sequence

5, 7, 9, 11, 13, ….

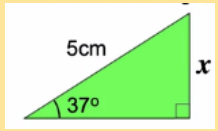
Geometry and Measures - Foundation

Trigonometry

$$S\frac{O}{H}C\frac{A}{H}T\frac{O}{A}$$

Example – finding a side:

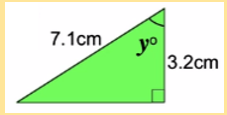
$\sin 37 = \frac{x}{5}$



x = 5 x sin 37^0

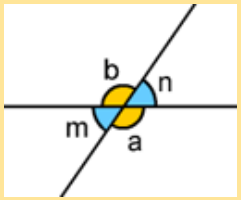
Example – finding a side:

$\tan y = \frac{3.2}{7.1}$

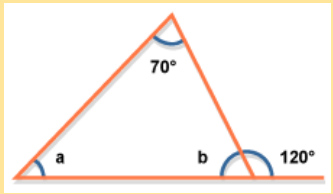


$y = tan^{-1}\left(\frac{3.2}{7.1}\right)$.

Angle Facts



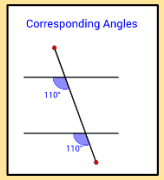
Vertically opposite angles are equal: a=b and m=n

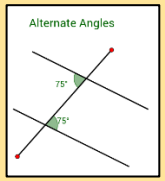


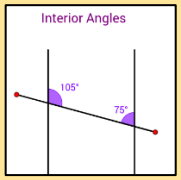
Angles in a triangle sum to 180^0.

Angles on a straight line sum to 180^0.
E.G: b=60^0 so a = 50^0

Angles in parallel lines







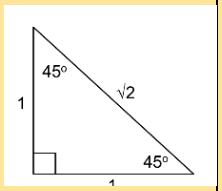
Corresponding angles are equal

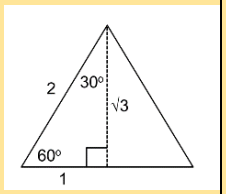
Alternate angles are equal

Co-interior angles are equal

Exact Trig values

Angle (θ)	sin(θ)	cos(θ)	tan(θ)
0°	0	1	0
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45°	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60°	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90°	1	0	undefined





Simple vector notation

$$\binom{a}{b}$$

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

$-a$: movement left $-b$: movement down

Operations with vectors

$\binom{2}{6} + \binom{7}{-3} = \binom{9}{3}$

If $b = \binom{4}{-2}$, then $3b = \binom{12}{-6}$

Volume & surface area

Volume = area of cross section x length

Surface area = area of all the faces of a 3D shape

Learn the cylinder

$$V = \pi r^2 h$$
$$SA = 2\pi r^2 + \pi dl$$

Types of triangles

Right angled
Isosceles
Equilateral
Scalene

Types of quadrilaterals

Square
Rectangle
Parallelogram
Rhombus
Trapezium
Kite

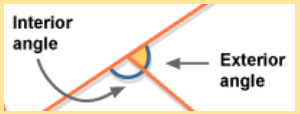
Area of key shapes

Triangle : A = $\frac{b \times h}{2}$ (h = perpendicular height)

Parallelogram: A = b x h (h = perpendicular height)

Trapezium: A = $\left(\frac{a+b}{2}\right)$ x h (add together the parallel sides, divide the total by 2, and then multiply by the perpendicular height between the parallel sides)

Angles in regular polygons



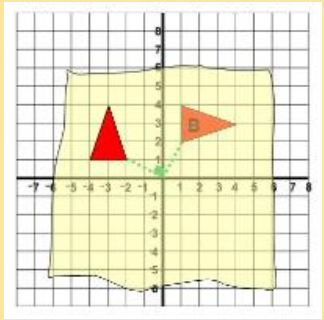
$n = number\ of\ sides$

Interior angle + exterior angle = 180^0

Exterior angle = $\frac{360}{n}$

$$n = \frac{360}{Exterior\ angle}$$

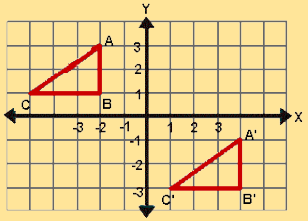
Transformations – rotation



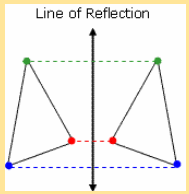
Always use tracing paper.
Describe:

1. It's a rotation
2. Size of rotation in degrees
3. Orientations: clockwise or anticlockwise
4. Centre of rotation given as a coordinate (x,y)

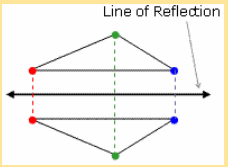
Transformations – translations and reflections



Translate triangle ABC to A'B'C' with the vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$

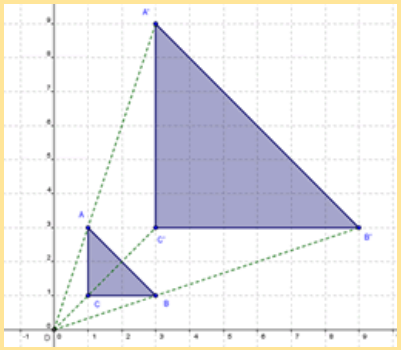


Reflection in the line x=a



Reflection in the line y=a

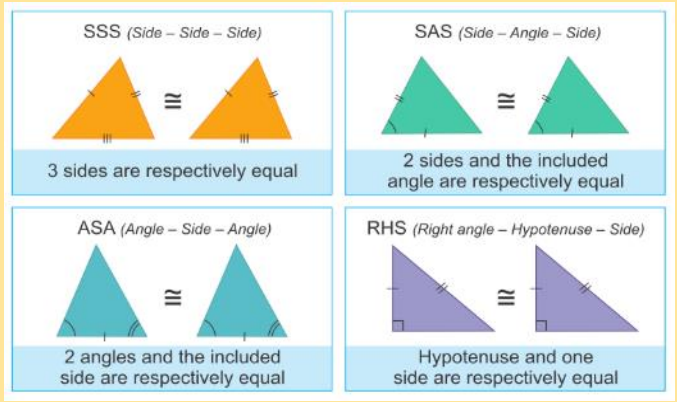
Transformations - enlargement



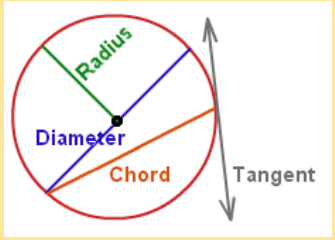
Describe:

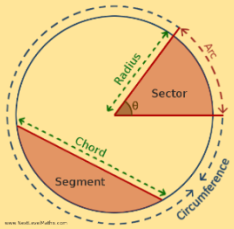
1. It's an enlargement
2. The scale factor (if the image is smaller than the object the scale factor is fractional e.g. ½)
3. The centre of enlargement given as a coordinate

Congruent triangles



Circles





$Area = \pi r^2$

Sector $Area = \frac{\theta}{360}\pi r^2$

$Circumference = \pi d$

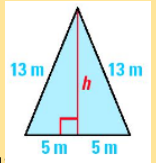
Arc length = $\frac{\theta}{360}\pi d$

Pythagoras' Theorem

$$a^2 + b^2 = c^2$$

Only applies to right angled triangles.

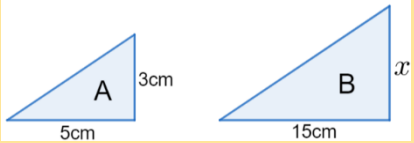
Can be used to find the height of an isosceles triangle



Can be used to find the length distance between two coordinates

Similar shapes

Same shape, different sides
The ratio of the lengths of corresponding sides are equal



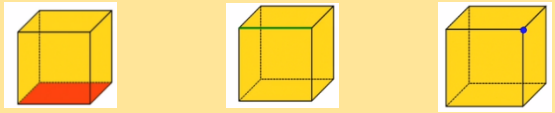
Length scale factor = 15 ÷ 5 = 3

x = 3cm x 3

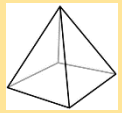
3D notation

<u>Cube:</u>

Faces: 6 Edges: 12 Vertices: 8



<u>Square based pyramid:</u>

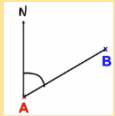


F = 5, E = 8, V = 5

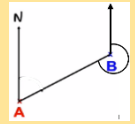
Bearings

Measure from the North
Measured in a clockwise direction
Written using 3 digits

Bearing of B **<u>from A</u>** (start at A)



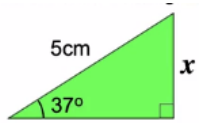
Bearing of A **<u>from B</u>** (start at B)



Trigonometry

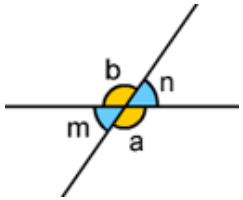
Fill the blanks: $S - C - T -$

Show how to find x:

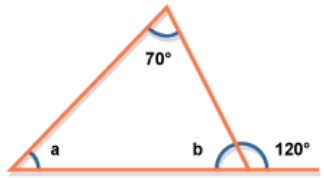


Show how to find y:

Angle Facts



Vertically opposite angles are _____

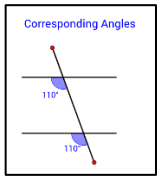


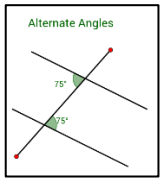
Angles in a triangle sum to _____.

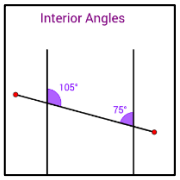
Angles on a straight line sum to _____.

E.G: b=_____ so a = _____

Angles in parallel lines







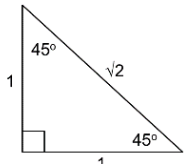
Corresponding angles are _____

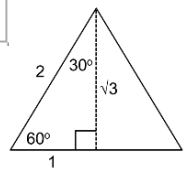
Alternate angles are _____

Co-interior angles are _____

Exact Trig values

	0°	30°	45°	60°	90°
sinθ					
cosθ					
tanθ					





Simple vector notation

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

a: movement along the _____ (_____)

b: movement along the _____ (_____)

$-a$: movement _____ $-b$: movement _____

Operations with vectors

$\begin{pmatrix} 2 \\ 6 \end{pmatrix} + \begin{pmatrix} 7 \\ -3 \end{pmatrix} = (\ )$ If $b = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$, then $3b = (\ )$

Volume & surface area

Volume = _____ x _____

Surface area = area of _____

Learn the cylinder

$V =$_____

$SA =$_____

Types of triangles

_____

_____

_____

_____

Types of quadrilaterals

_____

_____

_____

_____

_____

_____

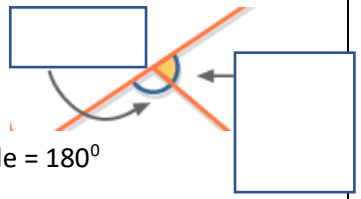
Area of key shapes

Triangle : A = ——— (h = _____ height)

Parallelogram: A = _____ (h = _____ height)

Trapezium: A = _____

Angles in regular polygons



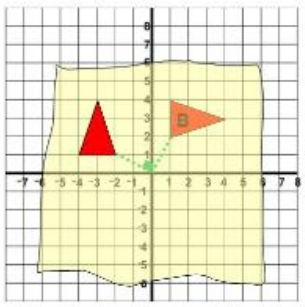
$n = number\ of\ sides$

Interior angle + exterior angle = 180^0

Exterior angle = ———

$n =$ _____

Transformations – rotation



Always use tracing paper.
Describe:

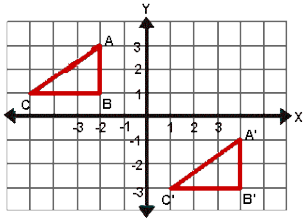
1.

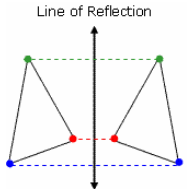
2.

3.

4.

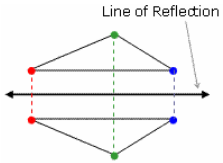
Transformations – translations and reflections





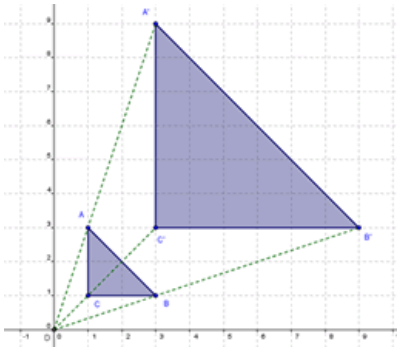
Reflection in the line _____

Translate triangle ABC to A'B'C' with the vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$



Reflection in the line _____

Transformations - enlargement

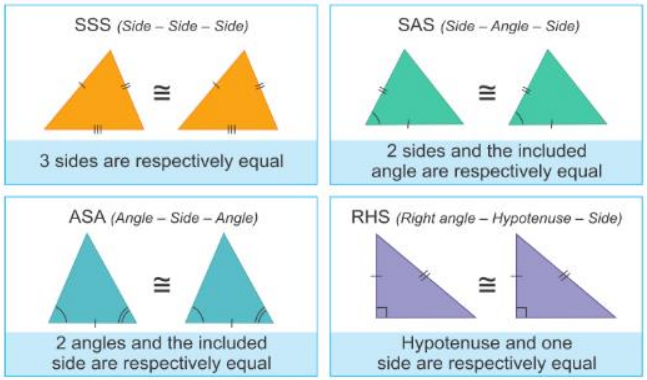


Describe:
1.

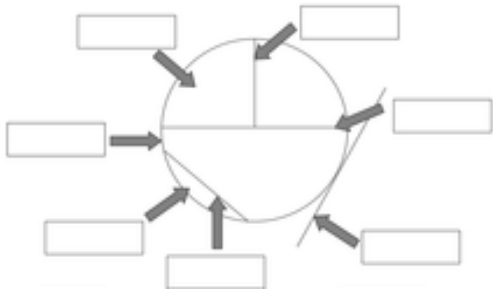
2.

3.

Congruent triangles



Circles



Draw your own arrow to label an arc on the diagram

$Area =$

Sector $Area =$

$Circumference =$

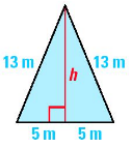
Arc length =

Pythagoras' Theorem

_____

Only applies to _____ triangles.

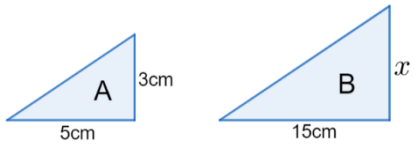
Can be used to find the height of an _____ triangle



Can be used to find the length distance between two _____

Similar shapes

Same shape, different sides
The ratio of the lengths of corresponding sides are equal



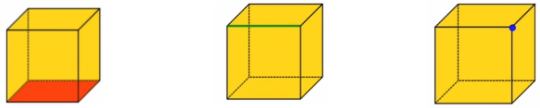
Length scale factor = _____

x = _____

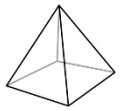
3D notation

<u>Cube:</u>

Faces: ____ Edges: ____ Vertices: ____



<u>Square based pyramid:</u>

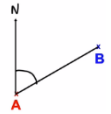


F = ____ , E = ____ , V = ____

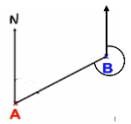
Bearings

Measure from _____
Measured in a _____ direction
Written using _____ digits

Bearing of B **<u>from A</u>** (start at _____)



Bearing of A **<u>from B</u>** (start at _____)



Probability and Statistics - Foundation

Averages

Mode: most common piece of data

Mean: Sum of the data ÷ total frequency

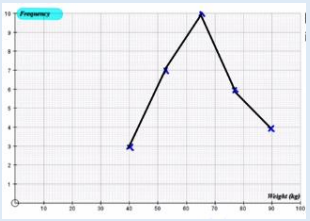
Median: order the data and find the middle value

Range: Highest value – lowest value

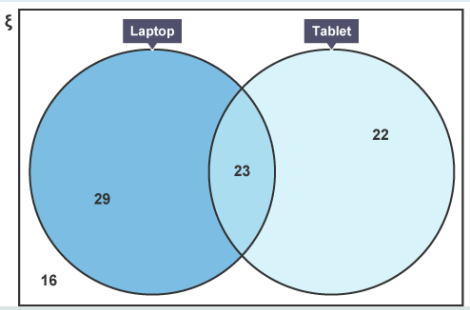
Frequency Polygons

1. Plot frequency at the mid-point
2. Join with straight lines

Weight w (kg)	Frequency
$30 \leq w < 50$	3
$50 \leq w < 55$	7
$55 \leq w < 75$	10
$75 \leq w < 80$	6
$80 \leq w < 100$	4



Venn Diagrams



Information given:
90 pupils were surveyed
52 said they owned a laptop.
45 said they owned a tablet.
23 said they owned both.

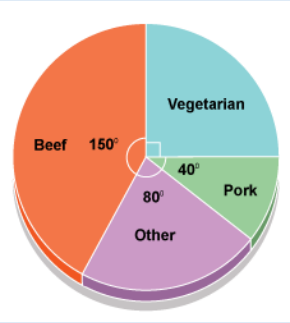
Probability Definitions

Total probability: adds to 1

Relative frequency: $frequency \div total\ trials$

Independent events: one event doesn't impact the other

Reading and Drawing Pie Charts



Find the fraction of the total

1000 people were surveyed

Beef: $\frac{150}{360} \times 1000$

Vegetarian: $\frac{90}{360} \times 1000$

Hair colour	People
Blonde	8
Brown	12
Red	3
Grey	2
Black	6

Find the fraction of the full circle.

Size of Blonde sector: $\frac{8}{31} \times 360°$

Expected outcomes

Expected outcome = probability x number of trials

E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

Result	Red	Green	Brown	Yellow
Probability		0.48	0.2	

P(Y) = (1 – 0.48 – 0.2) ÷ 2 = 0.32 ÷ 2 = 0.16

Expected yellow = 0.16 x 800 = 128

Averages from a frequency table

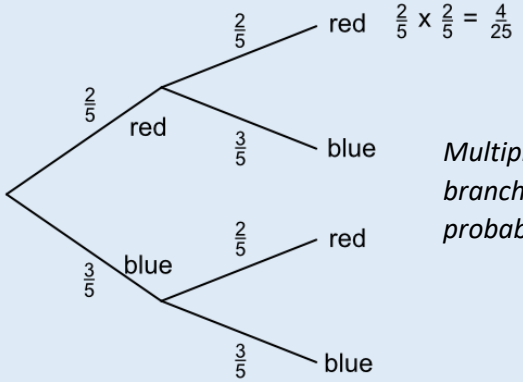
Mean: $\frac{\sum fw}{\sum f}$; where, w is the midpoint of the group.

Median group: find which group the $\frac{n+1}{2}th$, value lies. Where, n is the total frequency.

E.G. in this table 51.5th value which lies in group $8 < w \leq 12$ (using the cumulative frequency

Weight of box (w kg)	Frequency
$0 < w \leq 4$	11
$4 < w \leq 8$	16
$8 < w \leq 12$	29
$12 < w \leq 16$	26
$16 < w \leq 20$	20

Tree diagrams



Multiply along the branches to find each probability.

1. Probability that a red counter is picked both times $P(RR) = \frac{2}{5} \times \frac{2}{5} = \frac{4}{25}$
2. Probability that the counters are different colours = $P(RB) + P(BR) = \frac{2}{5} \times \frac{3}{5} + \frac{3}{5} \times \frac{2}{5} = \frac{12}{25}$

Probability and Statistics - Foundation

Averages

Mode: _____

Mean: _____

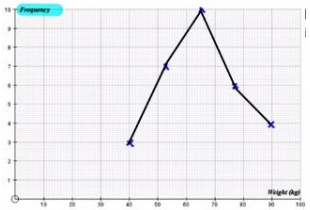
Median: _____

Range: _____

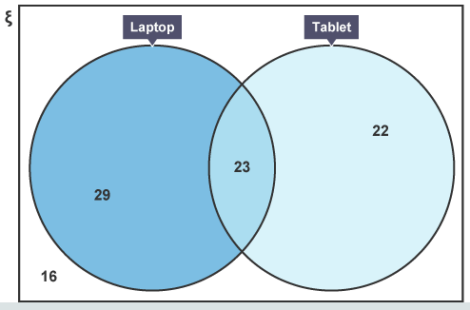
Frequency Polygons

1.
2.

Weight w (kg)	Frequency
$30 \leq w < 50$	3
$50 \leq w < 55$	7
$55 \leq w < 75$	10
$75 \leq w < 80$	6
$80 \leq w < 100$	4



Venn Diagrams



Information given:
____ pupils were surveyed
____ said they owned a laptop.
____ said they owned a tablet.
____ said they owned both.

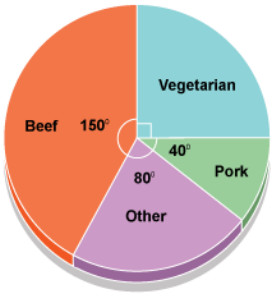
Probability Definitions

Total probability: adds to ____

Relative frequency: _____ ÷ _____

Independent events: one event _____ impact the other

Reading and Drawing Pie Charts



Find the fraction of the total

1000 people were surveyed

Beef: — × _____

Vegetarian: — × _____

Hair colour	People
Blonde	8
Brown	12
Red	3
Grey	2
Black	6

Find the fraction of the full circle.

Size of Blonde sector: _____

Expected outcomes

Expected outcome = _____ x number of _____

E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

Result	Red	Green	Brown	Yellow
Probability		0.48	0.2	

P(Y) =

Expected yellow =

Averages from a frequency table

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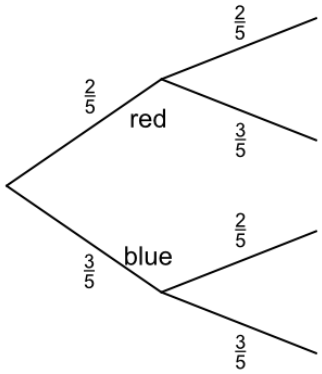
Tree diagrams



_____ *along the branches to find each probability.*

1. Probability that a red counter is picked both times P(RR) =

2. Probability that the counters are different colours =

Maths – KS4 Higher

Fact Sheets:

- Number, Ratio and Proportion
- Algebra
- Geometry and Measures
- Probability and Statistics

Number Ratio and Proportion - Higher

Estimate
Round each value to one significant figure

Standard form
$a \times 10^n$, where $1 \leq a < 10$

Reciprocal
Reciprocal of 7 is $\frac{1}{7}$, reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$ etc

Sequences
Fibonacci sequence: 1, 1, 2, 3, 5, 8, 13, 21
Geometric Sequence: each term is multiplied but he same constant to get the next number.
E.g. 3, 12, 48, 191, …. (x by 4 each time)

Simplifying Surds
Find a factor that is a square number

$$\sqrt{96} = \sqrt{16 \times 6} = 4\sqrt{6}$$

Manipulating surds

$$\sqrt{ab} = \sqrt{a} \times \sqrt{b}$$

$$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

Rationalising Surds
Rationalise by removing any surds from the denominator
E.G with surd.

$$\frac{2\sqrt{3}}{\sqrt{5}} = \frac{2\sqrt{3} \times \sqrt{5}}{\sqrt{5} \times \sqrt{5}} = \frac{2\sqrt{3 \times 5}}{\sqrt{5 \times 5}} = \frac{2\sqrt{15}}{\sqrt{25}} = \frac{2\sqrt{15}}{5}$$

E.G with surd expressions multiply by top and bottom by the denominator with the opposite sign.

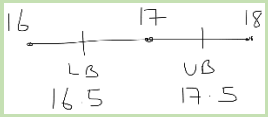
$$\frac{5}{3+\sqrt{2}} = \frac{5 \times (3-\sqrt{2})}{(3+\sqrt{2}) \times (3-\sqrt{2})} = \frac{5(3-\sqrt{2})}{9-\sqrt{4}}$$

$$= \frac{5(3-\sqrt{2})}{7}$$

Recurring Decimals
Form two equations where the digits following the decimal point are the same, and therefore can be cancelled

Upper and lower bounds
Look at the value above and below for the same place value. LB and UB will be half way between these points

e.g. 17 rounded to the nearest integer



e.g. 24.6 roudned to one decimal place.
LB = 24.55, UB = 24.65

Fractions

Add and Subtract – ensure the fractions have the same denominator before adding numerators

$$\frac{4}{5} - \frac{1}{3} = \frac{12}{15} - \frac{5}{15} = \frac{7}{15}$$

Multiply – multiply numerators and denominators

$$\frac{4}{5} \times \frac{1}{3} = \frac{4}{15}$$

Divide – take reciprocal of the second fraction and then multiply the new numerators and denominators

$$\frac{4}{5} \div \frac{1}{3} = \frac{4}{5} \times \frac{3}{1} = \frac{12}{5} = 2\frac{2}{5}$$

Percentages

Finding percentages of an amount

1%	÷100
5%	÷20
20%	÷5
25%	÷4
50%	÷2

Multipliers:
To find the multiplier for a percentage, divide by 100

Use multipliers on a calculator paper
e.g. 35% of 370 = 0.35 x 370

Increasing and decreasing a given amount
Calculator:

$$Orginal\ Amount\ x\ mutiplier = new\ amount$$

Non-calculator: find the increase or decrease and add to the original amount

Finding percentage increase or decrease (profit/loss)

$$\frac{value\ of\ increase/decrease}{Original} \times 100$$

Writing an amount as a percentage of the original

$$\frac{Amount}{Original} \times 100$$

Reverse Percentage – finding the original amount

$$Orginal\ Amount = \frac{New\ Amount}{multiplier}$$

Growth & Decay / Compound interest

$$original\ amount \times multiplier^{time}$$

Where the multiplier is the percentage, increase or decrease from 100%, converted to a decimal.
e.g.
30% decrease is 70% = 0.7
30% increase is 130% = 1.3

Dividing by decimals:

1. Write the calculation as a fraction
2. Form an equivalent fraction to makes integers (multiply by powers of 10)
3. Use short division (bus stop) to calculate

e.g. $460 \div 0.4 = \frac{460}{0.4} = \frac{4600}{4} = 1150$

Conversions

10 millimetres = 1 centimetre	15 minutes = 0.25 hours
100 centimetres = 1 metre	30 minutes = 0.5 hours
1000 metres = 1 kilometre	45 minutes = 0.75 hours
$1000cm^3$ = 1 litre	1000g = 1 kilogram
1000ml = 1 litre	1000kg = 1 tonne

Compound Units (rearrange as necessary)

$$Speed = \frac{Distance}{Time}$$

$$Area = \frac{Force}{Pressure}$$

$$Density = \frac{Mass}{Volume}$$

Error Intervals
least possible value $\leq x <$ greatest possible value

e.g. A fence is 30 m long to the nearest 10 m.
$25\text{ m} \leq l < 35\text{ m}$

Truncation
Truncation is a method of approximating a decimal number by dropping all decimal places past a certain point **without** rounding.

e.g. Truncate 3.14159265 to 4 decimal places.
= 3.1415

Negative numbers
<u>Adding and subtracting: (vertical number lines help)</u>
-3 – 5 = - 8
-3 + 5 = 2
-3 - - 5 = -3 + 5 = 2
-3 - + 5 = -3 – 5 = -8
-3 + - 5 = -3 – 5 = -8

<u>Multiplying and dividing:</u>
Different signs – answer will be negative
+ x - = -, - x + = -
Same signs – answer will be positive
- x - = +

Product rule
If there are ***m*** ways to do one thing and ***n*** ways to do another, then there are ***m*** x ***n*** ways to do *both*

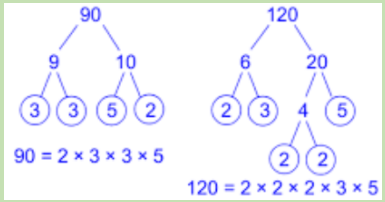
Order of operations
Bracket
Indices
Division and **M**ultiplication
Addition and **S**ubtraction

Rounding to significant figures
Start from the first **non-zero** number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF = 350,000
0.0060821 to 3SF = 0.0608

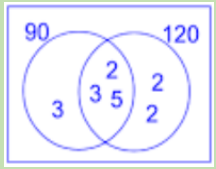
Index Laws

$$a^n \times a^m = a^{n+m}$$
$$a^n \div a^m = a^{n-m}$$
$$(a^n)^m = a^{nm}$$
$$a^0 = 1$$
$$a^{-n} = \frac{1}{a^n}$$
$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

Prime Factorisation



HCF and LCM of 90 and 120 <u>(Factor Tree & Venn Diagram)</u>
HCF is the product of common factors
LCM is the product of common factors and remaining factors.



HCF: 2x3x5
LCM: 2^3x3^2x5

Number Ratio and Proportion - Foundation

Estimate
Round each value to _____

Standard form
$a \times$ _____^{n}, where $1 \leq a < 10$

Reciprocal
Reciprocal of 7 is _____, reciprocal of $\frac{2}{3}$ is ___ etc

Sequences
Fibonacci sequence: _____
Geometric Sequence: _____
_____
E.g. 3, 12, 48, 191, …. (x by 4 each time)

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To change a recurring decimal into a fraction you _____
_____
_____
_____

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Look at the value above and below for the same place value. LB and UB will be half way between these points

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e.g. 24.6 roudned to one decimal place.
LB = _____, UB = _____,

Simplifying Surds
Find a factor that is a _____ number

$$\sqrt{96} =$$

Manipulating surds

$$\sqrt{ab} = \sqrt{\ } \times \sqrt{\ }$$

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Rationalise by removing any surds from the denominator
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E.G with surd expressions multiply by top and bottom by the denominator with the opposite sign.

$$\frac{5}{3+\sqrt{2}} =$$

Fractions

Add and Subtract – ensure the fractions have the same _____ before adding the _____

$$\frac{4}{5} - \frac{1}{3} =$$

Multiply – multiply _____ and _____

$$\frac{4}{5} \times \frac{1}{3} =$$

Divide – take _____of the second fraction and then _____the new _____and _____

$$\frac{4}{5} \div \frac{1}{3} =$$

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Finding percentages of an amount
1% ÷_____
5% ÷_____
20% ÷_____
25% ÷_____
50% ÷_____

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$$\frac{\_\_\_\_\_}{Original} \times 100$$

Writing an amount as a percentage of the original

$$\frac{Amount}{\_\_\_\_\_} \times \_\_\_\_\_$$

Reverse Percentage – finding the original amount

$$Orginal\ Amount = \_\_\_\_\_$$

Growth & Decay / Compound interest

_____ × _____

Where the multiplier is the percentage, increase or decrease from 100%, converted to a decimal.
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30% increase is 130% = _____

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1.
2.
3.

e.g. 460 ÷ 0.4 =

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100 centimetres = _____
30 minutes = _____ hours
1000 metres = _____
45 minutes = _____ hours
1000cm^3 = _____ 1000g = _____
1000ml = _____ 1000kg = _____

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Truncation is _____
_____
_____

e.g. Truncate 3.14159265 to 4 decimal places.
= _____

Negative numbers

Adding and subtracting: (vertical number lines help)

-3 – 5 =
-3 + 5 =
-3 - - 5 =
-3 - + 5 =
-3 + - 5 =

Multiplying and dividing:

Different signs – answer will be _____
+ x - = _____, - x + = _____
Same signs – answer will be _____
- x - = _____

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If there are ***m*** ways to do one thing and ***n*** ways to do another, then there are ***m*** x ***n*** ways to do *both*

Order of operations

B_____
I_____
D_____ and **M**_____
A_____ and **S**_____

Rounding to significant figures

Start from the first _____ number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF =
0.0060821 to 3SF =

Index Laws

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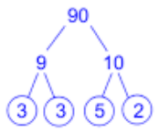
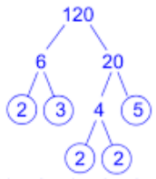
$a^n \div a^m =$
$(a^n)^m =$
$a^0 =$
$a^{-n} =$
$a^{\frac{n}{m}} =$

Prime Factorisation

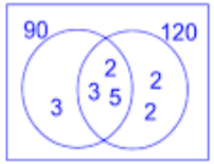




=_____ = _____

HCF and LCM of 90 and 120 (Factor Tree & Venn Diagram)

HCF is the _____
LCM is the _____



HCF: _____

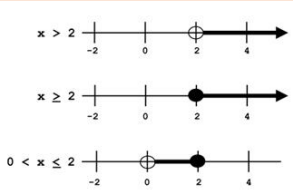
LCM: _____

Algebra - Higher

Quadratic Formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

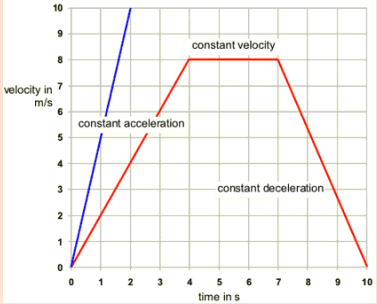
Linear Inequalities



Open circle: < / >

Closed circle: ≤ / ≥

Velocity / Time Graphs



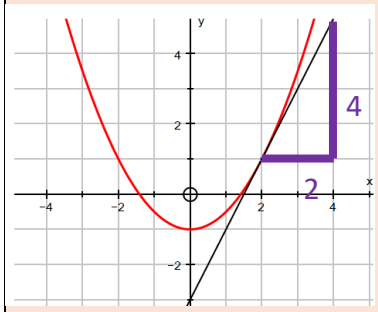
Gradient = acceleration

Area = distance travelled

Iteration – showing a root lies between 2 points:

If there is **a change in sign** for *y* for two particular values of *x* then we can say there is **a root** between these values of *x* and we can say that the equation f(*x*) = 0 will have a solution between these two values of *x*.

Gradients of curves



Gradient of a curve at a point = gradient of the tangent at the point

Algebriac proof – toolkit

Even numbers: 2n, 2n+2, 2n+4,…
Odd numbers: 2n+1, 2n+3, 2n+5,…
Sum: add
Product: multiply
Difference: subtract
Show it's a multiple: factorise
Show it's even: show it's a multiple of 2
Show it's odd: show it's a multiple of 2, plus 1

Completing the square

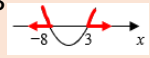
Quadratic expression factorised by completing the square:

$$(x + a)^2 + b$$

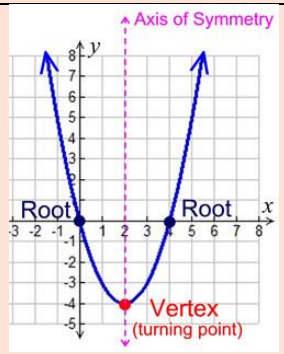
Turning point of graph occurs at $(-a, b)$

Solve quadratic inequalities

e.g solve $x^2 + 5x - 24 \geq 0$

1. Factorise: $(x + 8)(x - 3) \geq \mathbf{0}$
2. Solve: $x = -8$, $x = 3$
3. Sketch the graph 
4. Values that satisfy the inequality $x \leq -8$, $x \geq 3$

Turning point and roots of a quadratic equation



Straight line graphs

$y = mx + c$

$m = gradient$

$c = y - intercept$

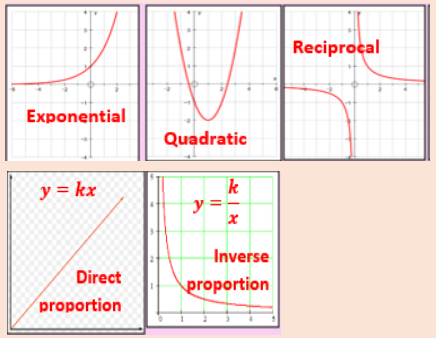
positive gradient / negative gradient

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{change\ in\ y}{change\ in\ x}$$

Parallel lines – have equal gradients

Perpendicular lines – If L_1 and L_2 are perpendicular then $m_2 = -\frac{1}{m_1}$

Graphs that need to be recognised:



Equation of a circle centre (0, 0)

$x^2 + y^2 = r^2$

Functions

$f(4)$: *Substitute 4 into the function*

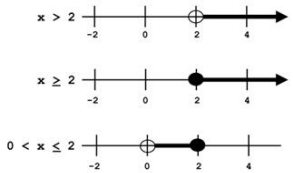
$f(g(x))$: *Substitute* $g(x)$ *into* $f(x)$ i.e. replace all values of x in $f(x)$ with the entire function $g(x)$

e.g. $f(x) = 2x + 3$, $g(x) = x - 3$, $fg(x) = 2(x-3) + 3$

Quadratic Formula

$x =$

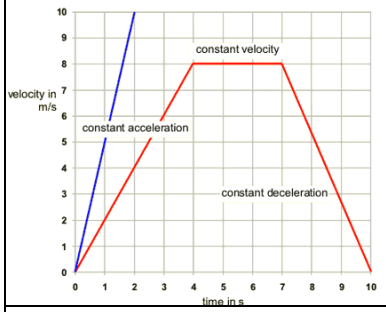
Linear Inequalities



Open circle: ____ or _____

Closed circle: ___ or _____

Velocity / Time Graphs



Gradient = _____

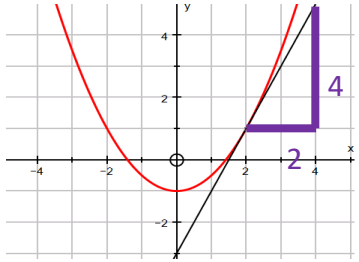
Area = _____

_____

Iteration – showing a root lies between 2 points:

If there is _____ for *y* for two particular values of *x* then we can say there is **a** _____ between these values of *x* and we can say that the equation f(*x*) = 0 will have a solution between these two values of *x*.

Gradients of curves



Gradient of a curve at a point = _____

_____

_____

Algebriac proof – toolkit

Even numbers: _____

Odd numbers: _____

Sum: _____

Product: _____

Difference: _____

Show it's a multiple: _____

Show it's even: show it's_____

Show it's odd: show it's _____

Completing the square

Quadratic expression factorised by completing the square:

$$(x + a)^2 + b$$

Turning point of graph occurs at (___, ___)

Solve quadratic inequalities

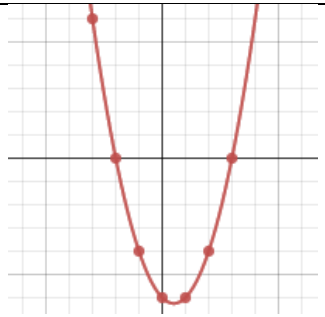
e.g solve $x^2 + 5x - 24 \geq 0$

1.

2.

3.

4.



Label the turning point, roots and axis of symmetry of the quadratic graph

Straight line graphs

$y = mx + c$

$m =$ _____

$c =$ _____

_____ _____

gradient gradient

$m =$ _____ $=$ _____

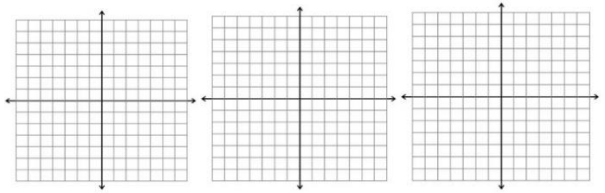
Parallel lines – have equal gradients

Perpendicular lines –

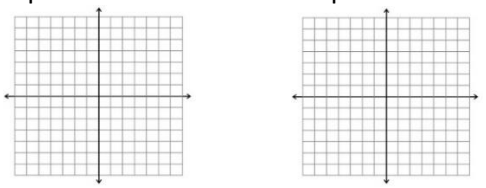
If L_1 and L_2 are perpendicular then m_2 =

Graphs that need to be recognised: sketch

Exponential Quadratic Reciprocal



Direct Proportion Inverse Proportion



Equation of a circle centre (0, 0) is _____

Functions

$f(4)$: _____

$f(g(x))$: _____. i.e. replace all values of ____ in _____ with the **entire** function _____

e.g. $f(x) = 2x + 3$, $g(x) = x - 3$, $fg(x)$ = _____

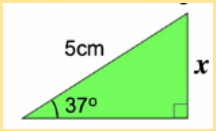
Geometry and measure - Higher

Trigonometry

$$S\frac{O}{H}C\frac{A}{H}T\frac{O}{A}$$

Example – finding a side:

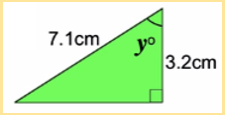
$\sin 37 = \frac{x}{5}$



x = 5 x sin 37^0

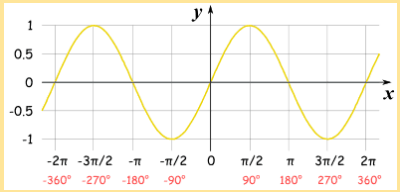
Example – finding a side:

$\tan y = \frac{3.2}{7.1}$

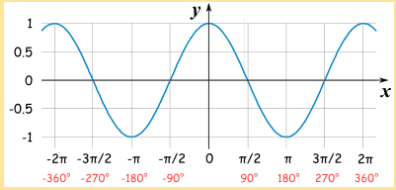


$y = tan^{-1}\left(\frac{3.2}{7.1}\right)$.

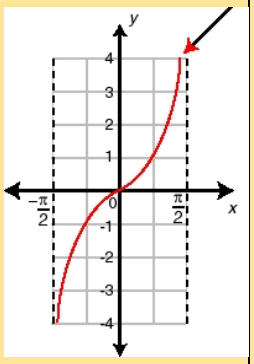
Sine Curve



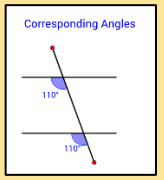
Cosine Curve

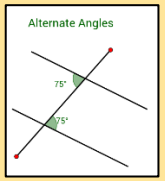


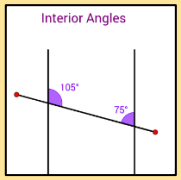
Tangent Curve



Angles in parallel lines







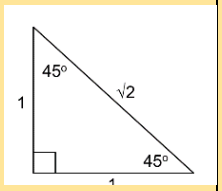
Corresponding angles are equal

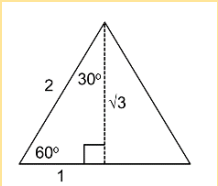
Alternate angles are equal

Co-interior angles are equal

Exact Trig values

Angle (θ)	sin(θ)	cos(θ)	tan(θ)
0°	0	1	0
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45°	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60°	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90°	1	0	undefined





Simple vector notation

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

a: movement along the x-axis (left or right)

b: movement along the y-axis (up or down)

$-a$: movement left $\quad\quad$ $-b$: movement down

Operations with vectors

$\begin{pmatrix} 2 \\ 6 \end{pmatrix} + \begin{pmatrix} 7 \\ -3 \end{pmatrix} = \begin{pmatrix} 9 \\ 3 \end{pmatrix}$

If $b = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$, then $3b = \begin{pmatrix} 12 \\ -6 \end{pmatrix}$

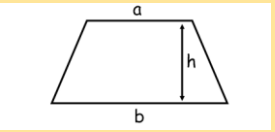
Volume & surface area

Learn the cylinder

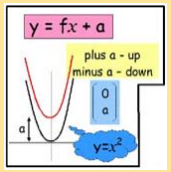
$$V = \pi r^2 h$$
$$SA = 2\pi r^2 + \pi dl$$

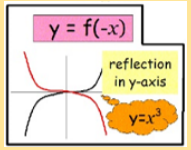
Area of a trapezium

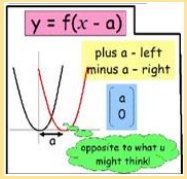
$$A = \frac{1}{2}(a+b)h$$

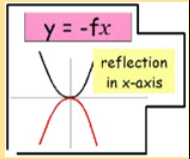


Transformation of a graph





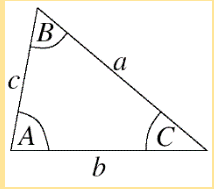




Sine rule

angles: $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

sides: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$



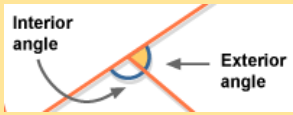
Cosine rule

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Area of a triangle

$$\frac{1}{2}ab\sin C$$

Angles in regular polygons



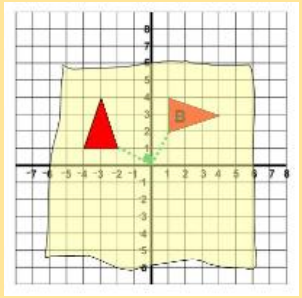
$n = number\ of\ sides$

Interior angle + exterior angle = 180^0

Exterior angle = $\frac{360}{n}$

$$n = \frac{360}{Exterior\ angle}$$

Transformations – rotation – describing:



Always use tracing paper.
Describe:

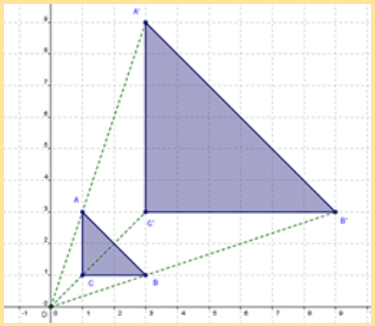
1. It's a rotation
2. Size of rotation in degrees
3. Orientations: clockwise or anticlockwise
4. Centre of rotation given as a coordinate (x,y)

Transformation – translation

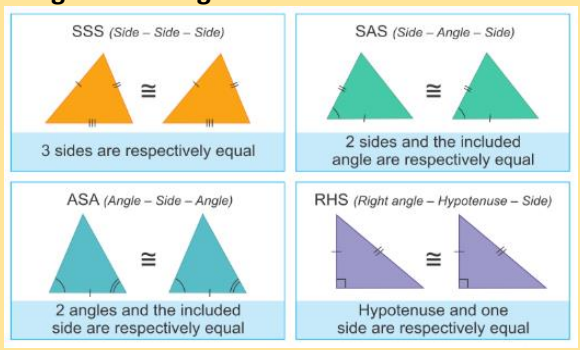
Vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$ 6 right, 4 down

Transformations – enlargement - describing:

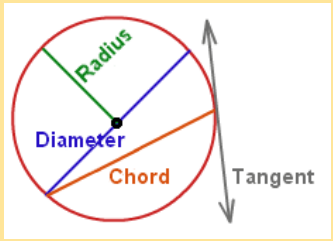
1. It's an enlargement
2. The scale factor (if the image is smaller than the object the scale factor is fractional e.g. ½)
3. The centre of enlargement given as a coordinate

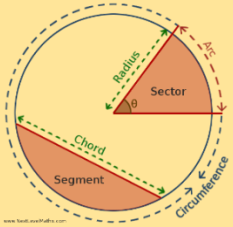


Congruent triangles



Circles





$Area = \pi r^2$

$Circumference = \pi d$

Sector $Area = \frac{\theta}{360}\pi r^2$

Arc length = $\frac{\theta}{360}\pi d$

Similar shapes

Same shape, different sides
The ratio of the lengths of corresponding sides are equal

Length scale factor = x

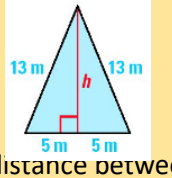
Area scale factor = x^2

Volume scale factor = x^3

Pythagoras' Theorem

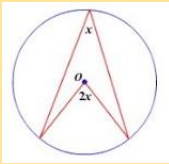
$$a^2 + b^2 = c^2$$

Only applies to right angled triangles.
Can be used to find the height of an isosceles triangle

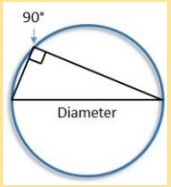


Can be used to find the length distance between two coordinates

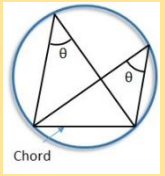
Circle Theorems



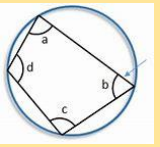
Angle at the centre is twice the angle at the circumference



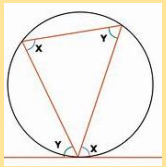
Angles in a semicircle are 90°.



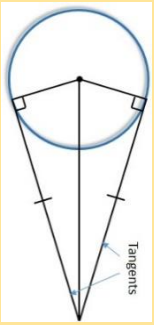
Angles in the same segment are equal.



Opposite angles of a cyclic quadrilateral add up to 180).



Alternate segment theorem.



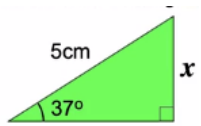
Tangents from an external point are equal in length.

The tangent to a circle is perpendicular (90°) to the radius

Trigonometry

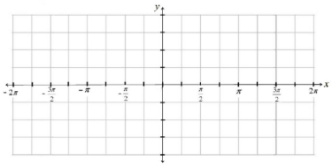
Fill the blanks: $S - C - T -$

Show how to find x:

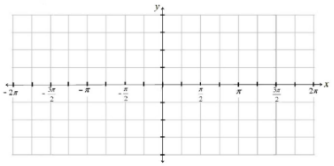


Show how to find y:

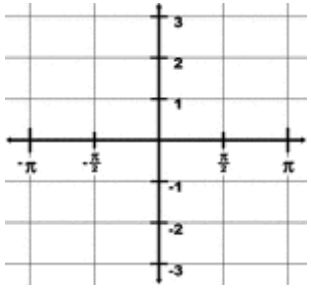
Sine Curve



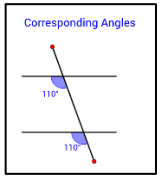
Cosine Curve

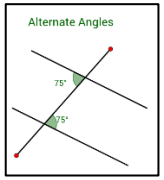


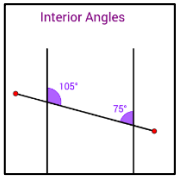
Tangent Curve



Angles in parallel lines







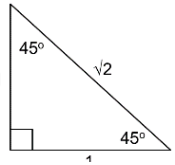
Corresponding angles are _____

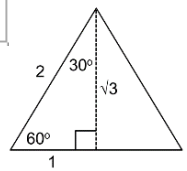
Alternate angles are _____

Co-interior angles are _____

Exact Trig values

	0°	30°	45°	60°	90°
sinθ					
cosθ					
tanθ					





Simple vector notation

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

a: movement along the _____ (_____)

b: movement along the _____ (_____)

$-a$: movement _____ $-b$: movement _____

Operations with vectors

$\begin{pmatrix} 2 \\ 6 \end{pmatrix} + \begin{pmatrix} 7 \\ -3 \end{pmatrix} = (\ )$ If $b = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$, then $3b = (\ )$

Volume & surface area

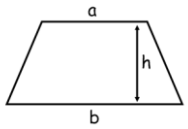
Learn the cylinder

$V =$

$SA =$

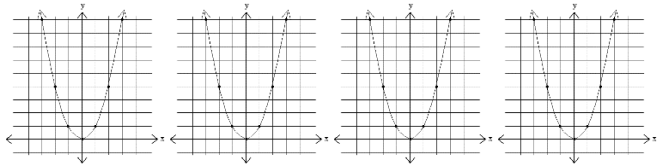
Area of a trapezium

$A =$



Transformation of a graph: sketch

y=fx + a **y=f(-x)** **y=f(x-a)** **y=-fx**



Write down:

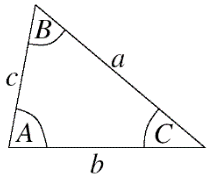
Sine rule

angles:

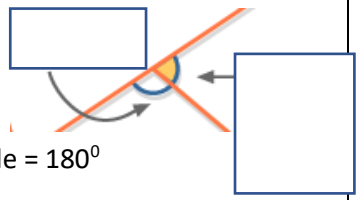
sides:

Cosine rule

Area of a triangle



Angles in regular polygons



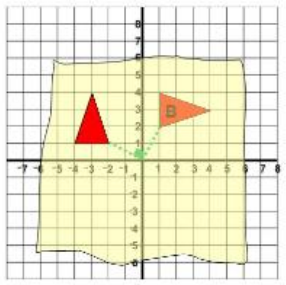
$n = number\ of\ sides$

Interior angle + exterior angle = 180^0

Exterior angle = ——

$n =$ _____

Transformations – rotation – describing:



Always use tracing paper.

Describe:

1.

2.

3.

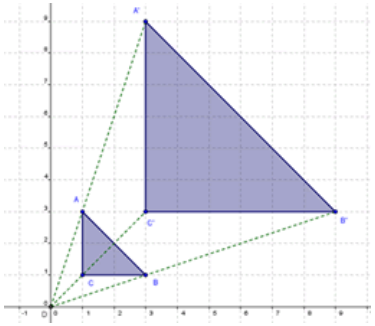
4.

Transformation – translation

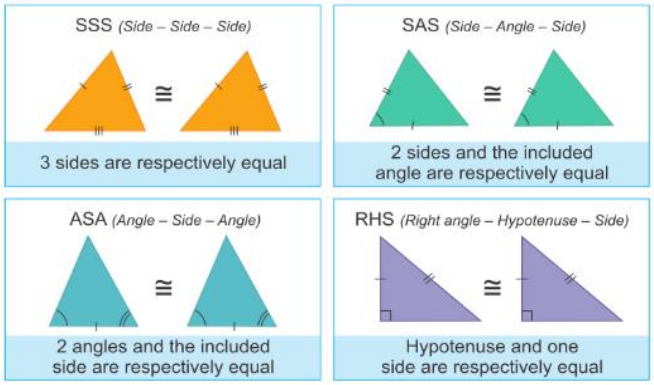
Vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$ 6 _____, 4 _____

Transformations – enlargement - describing:

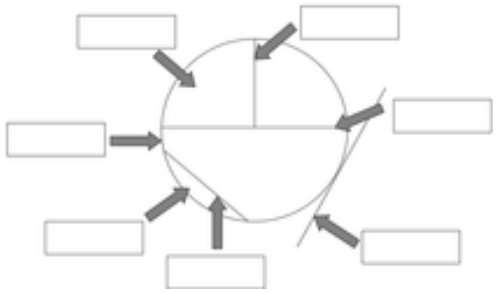
1.
2.
3.



Congruent triangles



Circles



Draw your own arrow to label an arc on the diagram

$Area =$

Sector $Area =$

$Circumference =$

Arc length =

Similar shapes

Same shape, different sides

The ratio of the lengths of corresponding sides are equal

Length scale factor =

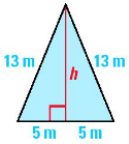
Area scale factor =

Volume scale factor =

Pythagoras' Theorem

_____

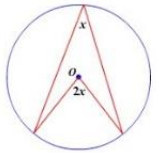
Only applies to _____ triangles.

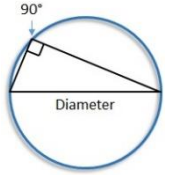


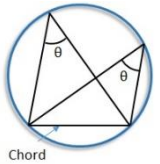
Can be used to find the height of an _____ triangle

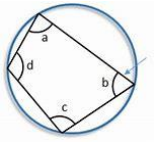
Can be used to find the length distance between two _____

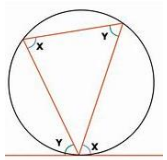
Circle Theorems

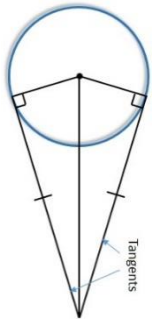










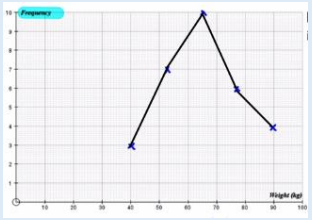


Probability and Statistics - Higher

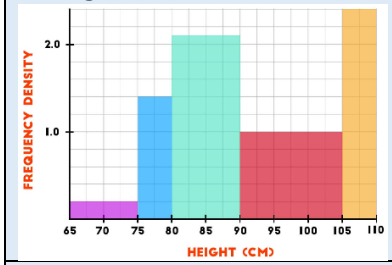
Frequency Polygons

1. Plot frequency at the mid-point
2. Join with straight lines

Weight w (kg)	Frequency
$30 \leq w < 50$	3
$50 \leq w < 55$	7
$55 \leq w < 75$	10
$75 \leq w < 80$	6
$80 \leq w < 100$	4



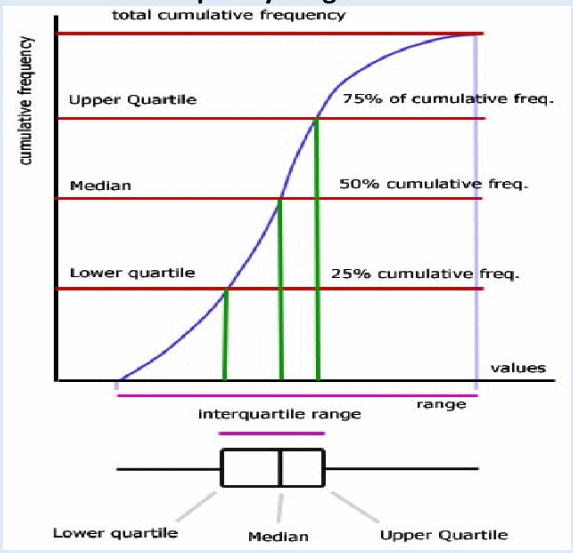
Histograms



FD = Frequency density

$$FD = \frac{Frequency}{Class\ Width}$$

Cumulative Frequency Diagrams and Box Plots



Averages from a frequency table

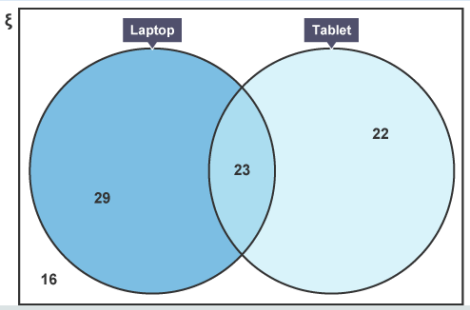
Mean: $\frac{\sum fw}{\sum f}$; where, w is the midpoint of the group.

Median group: find which group the $\frac{n+1}{2}th$, value lies.
Where, n is the total frequency.

E.G. in this table 51.5th value which lies in group $8 < w \leq 12$ (using the cumulative frequency

Weight of box (w kg)	Frequency
$0 < w \leq 4$	11
$4 < w \leq 8$	16
$8 < w \leq 12$	29
$12 < w \leq 16$	26
$16 < w \leq 20$	20

Venn Diagrams



Information given:
90 pupils were surveyed
52 said they owned a laptop.
45 said they owned a tablet.
23 said they owned both.

Notation

A – all elements **in A**
A' – all elements **not in A**
B – all elements **in B**
B' – all elements **not in B**
A ∪ B – all the elements **in A or B or both**
A ∩ B – all the elements **in both A and B**

Expected outcomes

Relative frequency: $frequency \div total\ trials$

Expected outcome = probability x number of trials

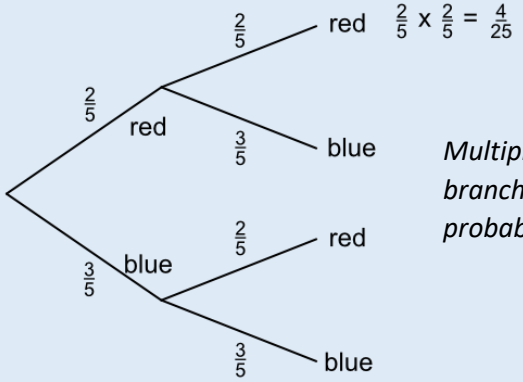
E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

Result	Red	Green	Brown	Yellow
Probability		0.48	0.2	

P(Y) = (1 – 0.48 – 0.2) ÷ 2 = 0.32 ÷ 2 = 0.16

Expected yellow = 0.16 x 800 = 128

Tree diagrams



Multiply along the branches to find each probability.

1. Probability that a red counter is picked both times $P(RR) = \frac{2}{5} \times \frac{2}{5} = \frac{4}{25}$

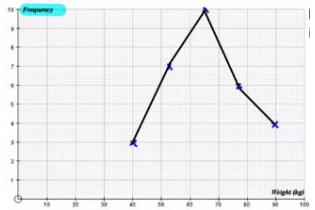
2. Probability that the counters are different colours = $P(RB) + P(BR) = \frac{2}{5} \times \frac{3}{5} + \frac{3}{5} \times \frac{2}{5} = \frac{12}{25}$

Probability and Statistics - Higher

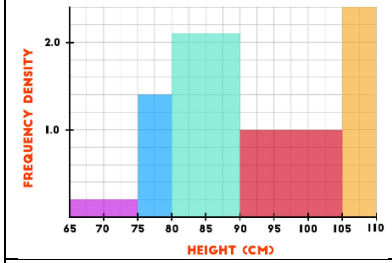
Frequency Polygons

1.
2.

Weight w (kg)	Frequency
$30 \leq w < 50$	3
$50 \leq w < 55$	7
$55 \leq w < 75$	10
$75 \leq w < 80$	6
$80 \leq w < 100$	4



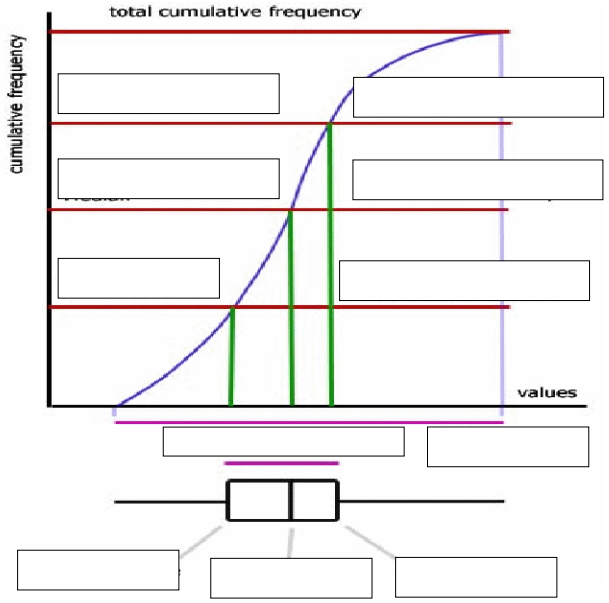
Histograms



FD = Frequency density

$FD =$

Cumulative Frequency Diagrams and Box Plots



Averages from a frequency table

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Median group: find which group the $\frac{n+1}{2}th$, value lies. Where, n is the total frequency.

E.G. in this table 51.5th value which lies in _____ (using the cumulative frequency)

Weight of box (w kg)	Frequency
$0 < w \leq 4$	11
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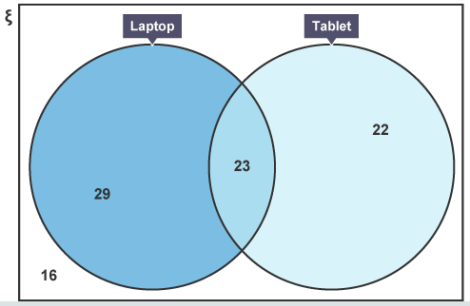
$8 < w \leq 12$	29
$12 < w \leq 16$	26
$16 < w \leq 20$	20

Venn Diagrams



Information given:
____ pupils were surveyed
____ said they owned a laptop.
____ said they owned a tablet.
____ said they owned both.

Notation

A –
A' –
B –
B' –
A ∪ B –
A ∩ B –

Expected outcomes

Expected outcome = _____ x number of _____

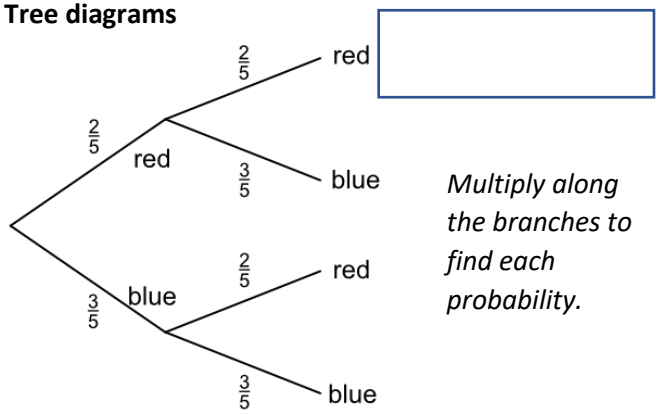
E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

Result	Red	Green	Brown	Yellow
Probability		0.48	0.2	

P(Y) =

Expected yellow =

Tree diagrams



Multiply along the branches to find each probability.

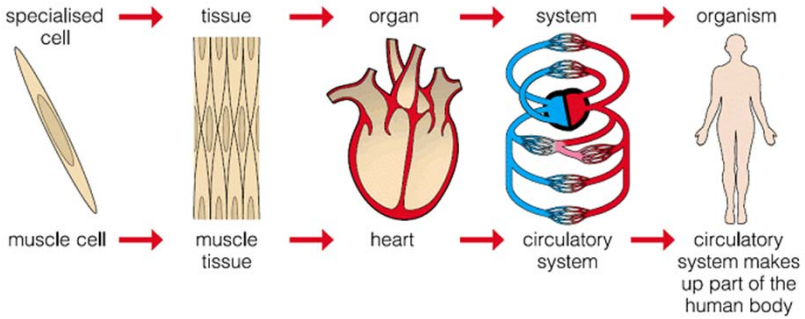
3. Probability that a red counter is picked both times P(RR) =

4. Probability that the counters are different colours =

Science B2 – Organisation

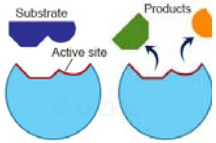
Levels of Organisation

Cells = basic building blocks of all living organisms.
A tissue = group of cells with a similar structure and function.
Organs = aggregations of tissues performing specific functions.
Organs systems = organs organised to form organisms.

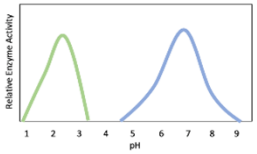


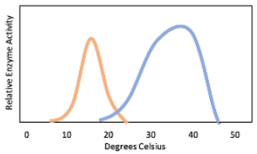
Enzymes

- Biological catalysts
- Digestive enzymes speed up the break down of insoluble food molecules
- Specific shape active site that matches substrate



Enzymes work best at certain temperatures or pH depending on their role.





Bile

The liver makes an **alkaline** solution called bile. Stored by the gall bladder.
Has two jobs:

- Emulsifies fats
- Neutralises stomach acid.

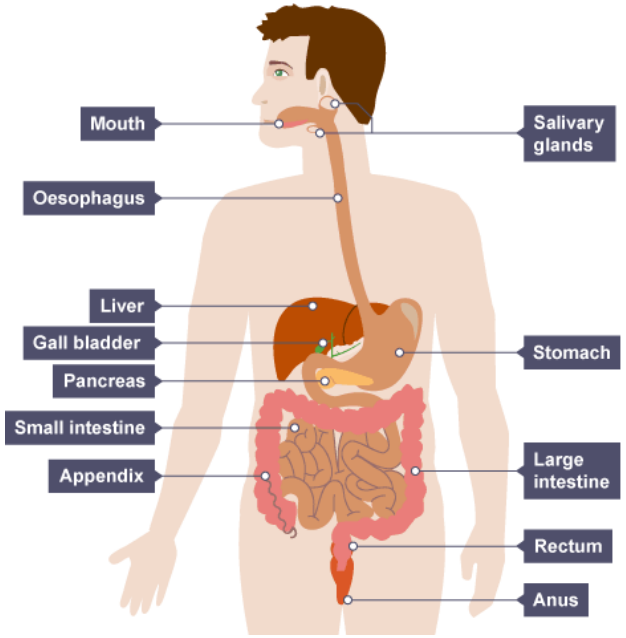
Digestive Enzymes

Starch —(amylase)→ Glucose

Protein —(protease)→ Amino Acids

Fats —(lipase)→ Fatty acids + Glycerol

Digestive System



Organ	Function
Mouth	Teeth and tongue to chew food.
Salivary Glands	Releases saliva containing enzymes.
Oesophagus	Muscle tube to squeeze food along.
Stomach	Contains enzymes and hydrochloric acid. Is made of muscle to churn food. Hydrochloric acid kills bacteria in food
Small Intestine	Where digestion is completed and soluble food particles (glucose, amino acids, fatty acids, glycerol). are absorbed
Large Intestine	Absorbs water.
Liver	Produces bile.
Gall Bladder	Stores bile.
Pancreas	Releases enzymes.

Where are the enzymes?

Enzyme	Salivary glands	Stomach	Pancreas	Small intestine
Amylase	X		X	X
Protease		X	X	X
Lipase			X	X

RP3 – Food Tests

Summaries of the four food tests.

Protein Add Biuret's reagent Positive test; Blue solution turns **Purple**	**Starch** Add Iodine Positive test; solution turns from orange to **Black**
Fats Add Ethanol and water Positive test – solution turns **Cloudy**	**Glucose** Add Benedict's and heat Positive test blue solution turns **Brick red** Water Bath

Science B2 – Organisation

1. What is an organ system?
2. What are group of cells with a similar structure and function?
3. Give an example of an organ.
4. Put these into order, starting with the smallest:
   tissue cell organ system organ

1. What is an enzyme?
2. What is the name of the part of the enzyme that the substrate fits into?
3. Give two factors that affect how enzymes work

1. Where is bile made?
2. Where is bile stored?
3. What are the two jobs of bile?

1. Which enzyme breaks down starch?
2. What are the products of fat digestion?
3. What are proteins made of?

1. Where are the salivary glands found?
2. What is the job of the oesophagus?
3. What is the job of the pancreas (in digestion)?
4. What is the job of the small intestine?
5. What is the function of the hydrochloric acid in the stomach?

1. Where is lipase released from?
2. Which enzyme is released in the stomach?
3. Which enzyme is found in the mouth?

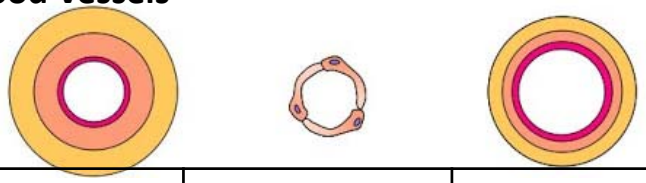
1. Which two chemicals are added to test for fats?
2. What is the colour change when Biuret is added to a food containing protein?
3. Which test needs to be placed in a water bath?

Science B2 – Organisation

The effect of pH on the rate of reaction of amylase

1. Add $2cm^2$ amylase solution, $2cm^2$ of starch solution and $2cm^2$ of pH2 buffer to a water bath (37°) in separate test tubes. Wait 10 minutes.
2. While waiting, add 2 drops of iodine solution to each well on the spotting tile.
3. Once the solutions in the water bath have reached 37° pour the amylase and PH2 buffer into the starch solution.
4. Immediately take a sample with a pipette and add to the first well of the spotting tile.
5. Repeat step 4 every 30 seconds until there is no colour change when testing with iodine solution.
6. Repeat steps 1-5 with pH4, pH6, pH8 and pH10 buffers.

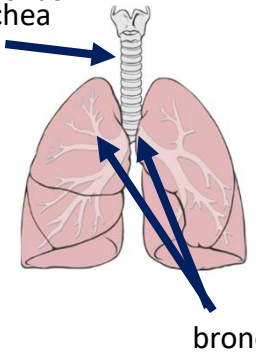
Blood Vessels



Arteries	Capillaries	Veins
• Blood carried away from heart • Thick muscular and elastic walls = withstands high pressure • Small lumen = maintains high pressure	• Walls only one cells thick = shorter diffusion pathway • Lumen just bigger than red blood cell • Blood flows very slowly • Diffusion takes place here	• Blood carried back to heart • Thin walls as blood is low pressure • Large lumen – lower resistance for blood passing through • Valves prevent back flow

Respiratory System

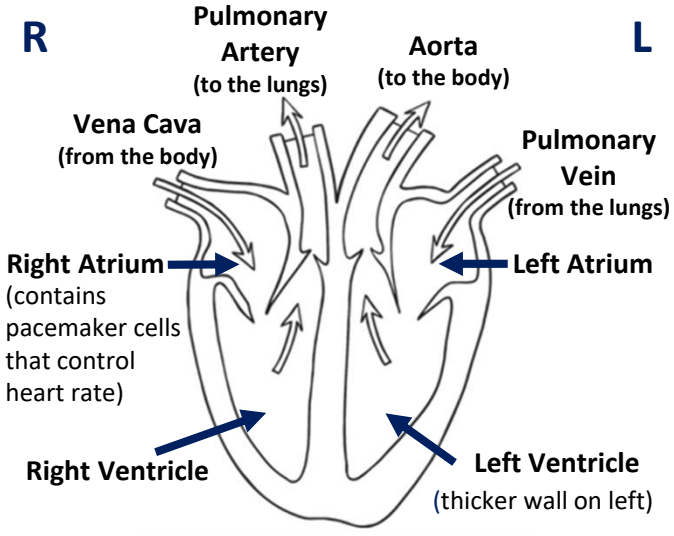
The lungs have two jobs – to get oxygen into the blood and remove carbon dioxide



Structures that cannot been seen on this diagram are the **alveoli and capillary network** – see 'unit 1 - diffusion'.

The Human Heart

Double pump because - left side pumps to whole body, right side pumps to the lungs.



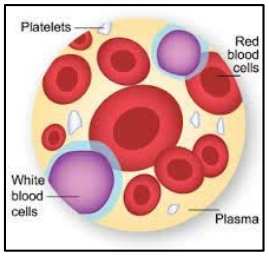
Blood – 4 components

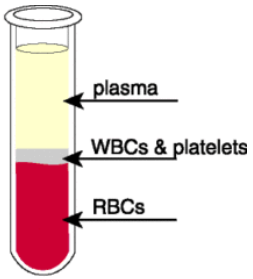
Red blood cells – contain haemoglobin to carry oxygen. More detail…

White blood cells – fight pathogens (see unit 3 – infection and response).

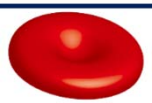
Platelets – cell fragments that clot blood.

Plasma – liquid part that transports cells, cell fragments and dissolved substances (salts, urea, CO_2, hormones…)



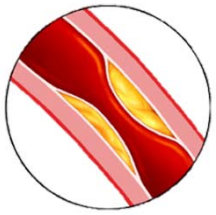


Red Blood Cells (RBCs)



- Contain chemical 'haemoglobin'.
- This reacts/ binds with oxygen to be carried around the body.
- RBCs are ~8µm (relative small animal cell) allows them to fit through capillaries
- Bi-concave disc shape for large SA:V

Coronary Heart Disease (CHD)



- Coronary arteries supply heart muscle with blood (containing glucose and oxygen for respiration)
- Can become narrowed/blocked by fatty deposits if cholesterol high, reducing blood flow.
- Reduced muscle contraction in heart

Science B2 – Organisation

The effect of pH on the rate of reaction of amylase

1. What temperature should the water bath be set at for the affect of pH on amylase practical?
2. What is the name of the chemical used to test for the presence of starch?
3. What is the independent variable in the investigation?

1. Which blood vessels contain valves?
2. Which vessels carry blood under very high pressure?
3. In which blood vessels does diffusion take place?
4. Which blood vessels have thick muscular walls?
5. Which vessels have a wide lumen?

1. What is the name of the tube that connects the throat to the lungs?
2. What is the name of the tubes that enter each lung?
3. What are the two jobs of the lungs?

1. Which blood vessel returns blood to the heart from the lungs?
2. Which blood vessel carries blood away from the heart towards the body?
3. Which ventricle wall is thicker?
4. Where are pacemaker cells found?
5. Why is the heart knowns as a double pump?

1. Name the two types of cells in blood.
2. What are platelets?
3. What do platelets do?
4. Name 3 substances plasma might have dissolved in it?

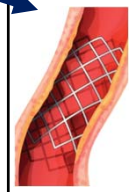
1. What chemical is found inside red blood cells?
2. What is the 3D shape of RBCs called? What is the advantage of this shape?

1. What do coronary arteries do?
2. What can block coronary arteries?
3. What will happen to the heart if they become blocked?

Science B2 – Organisation

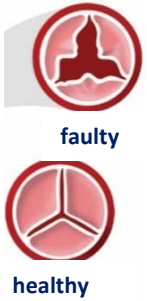
Heart Disease Treatment – Statins vs Stents

Statins	Stents
• Medication to be taken everyday • Lowers blood cholesterol • Does not work immediately	• Mesh tube to be inserted into artery to hold it open • Surgery required • Works immediately



Faulty Valves

- Valves in veins and the heart prevent backflow of blood
- Faulty valves = don't open or close fully
- Can be replaced with man-made valves or transplants from donors



Cancer

Uncontrolled cell growth

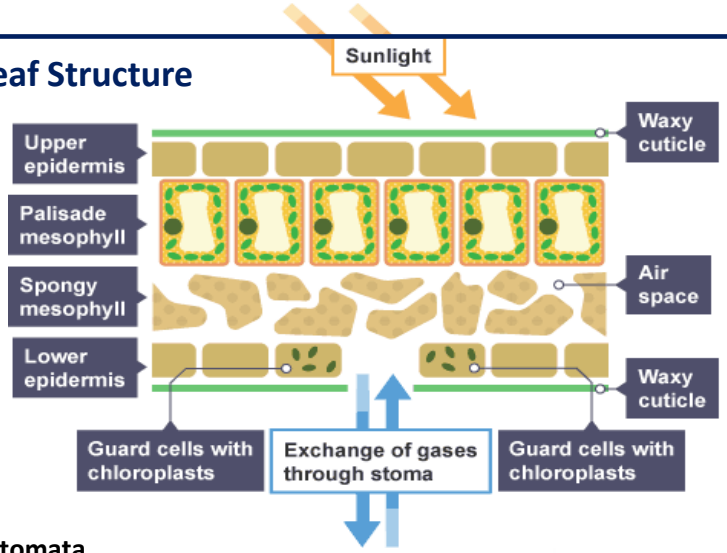
Benign tumours = abnormal cells, contained in one area, in a membrane, do not invade other parts of body.

Malignant tumours = cancer cells, not in a capsule, invade neighbouring tissue, and spread into blood and form secondary tumours.

Risk Factors

Lifestyle factors can have be risk factors for certain diseases. E.g. obesity is a risk factor for type 2 diabetes, or drinking and smoking while pregnant affects the development of the foetus.

Leaf Structure

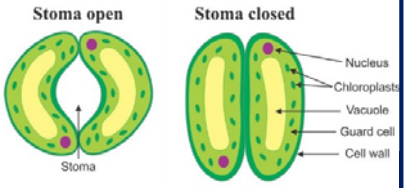


Stomata

Tiny pores on the underside of the leaf.

Allow oxygen and CO_2 to diffuse in and out

Guard cells surround the stomata and can open and close the pore

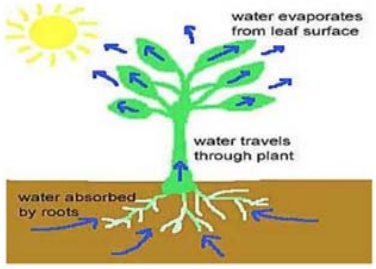


Interaction of Diseases

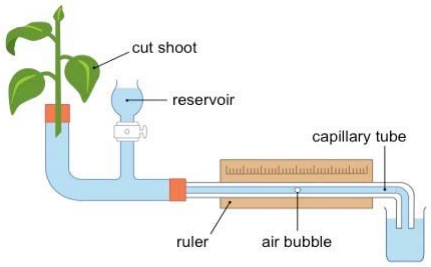
- Defects in the immune system - individual is more likely to suffer from infectious diseases.
- Viruses can trigger cancers, e.g. HPV can trigger cervical cancer.
- Immune reactions caused by pathogens can trigger allergies such as asthma or rashes
- Severe physical ill health can lead to depression and other mental illness.

Transpiration

Movement of water through plant from roots to leaves, driven by evaporation through the stomata



Measuring transpiration



Record the distance the bubble of air moves along the scale during set amount of time to calculate volume of water uptake per minute.

Transpiration	Translocation
Movement of water from roots to leaves	Movement of dissolved sugars from leaves all round the plant
Xylem - hollow tubes strengthened by lignin.	Phloem – tubes of elongated cells.
One way system – roots to leaves.	Two way system – sugars taken to wherever they are needed.

Increasing the rate of transpiration

- Higher temperature
- Lower humidity
- Higher light intensity
- Higher air movement

Science B2 – Organisation

1. How do stents treat CHD?
2. How do statins treat CHD?
3. Give an advantage of using stents rather than statins to treat CHD

1. What is the job of a valve?
2. How can faulty valves be treated?

1. What is a benign tumour?
2. Why do benign tumours not spread?
3. How can malignant tumours spread?
4. Name a disease linked with obesity

1. What are the cells called that surround the stomata?
2. What is the job of the stomata?
3. What the top layer of a leaf called?
4. Which tissue in a leaf has air spaces?
5. Which layer in the leaf contains cells with lots of chloroplasts?

1. Give and example of when cancer can be triggered by a virus.
2. Give an example of an immune reaction that can be triggered by a pathogen

1. What is transpiration?
2. What is translocation?
3. Which tissue carries out translocation?
4. Name 2 conditions that affect the rate of transpiration.
5. Describe how to investigate the rate of transpiration.

Science B3 – Infection and Response

Communicable Diseases – diseases caused by a pathogen

Disease	Pathogen	Symptoms	Spread by	Prevent spread	Treatment
Salmonella	Bacteria	Fever, cramps, vomiting, diarrhoea	Contaminated food	Vaccinating poultry, cooking food thoroughly	Antibiotics or management of symptoms
Gonorrhoea	Bacteria	Yellow/green discharge, pain when urinating	Sexual Contact	Using barrier protection, e.g. condoms	Antibiotics
Measles	Virus	Red rash and fever	Breathing in droplets from coughs/sneezes	Vaccination	No cure – only management of symptoms
HIV	Virus	Flu-like symptoms, develops into AIDS	Sexual contact	Using barrier protection, e.g. condoms	Antiretroviral drugs
Tobacco Mosaic Virus (plants)	Virus	'Mosaic' pattern of discolouration on the leaves	Soil	Destroy infected plants	No treatment
Rose Black Spot (plants)	Fungus	Black spots on leaves	Wind or water	Remove and destroy infected leaves	Fungicides
Malaria	Protist	Recurrent episodes of fever	Insect bites (mosquitoes)	Mosquito nets, insect repellent	Antimalarial drugs

Antibiotics & Painkillers

Antibiotics = kill bacteria (specific antibiotic for specific bacteria) **THEY DO NOT KILL VIRUSES** e.g. penicillin

Antibiotics cannot kill viruses because viruses live inside cells

Painkillers = stop pain (don't kill microbes, just help with symptoms) e.g. paracetamol

Development of Drugs

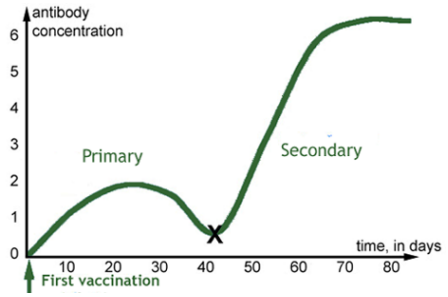
Testing for:

- Safety
- Efficacy (does it work)
- Dosage (how much is needed)

Stage		Description
1	pre-clinical	Tested on cells and tissues. Side effects? Efficacy?
2	pre-clinical	Tested on animals. Side effects?
3	clinical	Clinical trials = tested on humans. 1st health volunteers, 2nd patients with the illness. Dosage gradually increased to optimum.

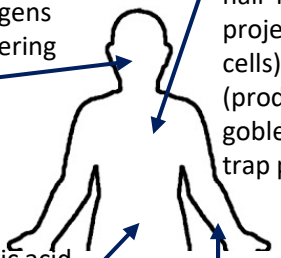
Vaccination

- Introducing small quantities of dead or inactive forms of pathogen into the body.
- Stimulates WBCs to produce antibodies.



- If same pathogen returns (X), WBCs remember how to make the right antibodies.
- They make MORE antibodies, MORE QUICKLY, and they stay in body for LONGER.

Non-specific Defence Systems



Nose
Hairs and mucus trap pathogens before entering lungs.

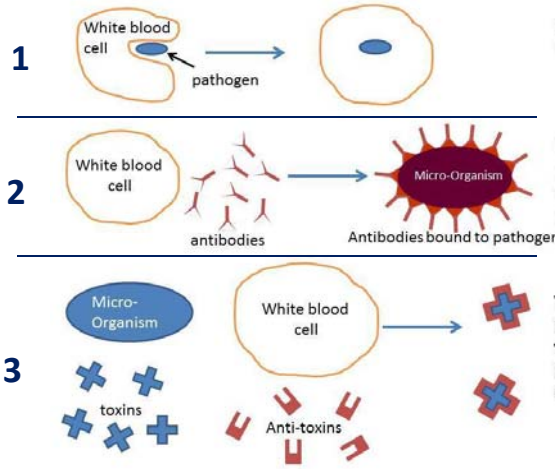
Trachea & Bronchi
Cilia cells (small hair-like projections from cells) and mucus (produced by goblet cells) trap pathogens.

Stomach
Contains hydrochloric acid to kill pathogens that have been eaten.

Skin
If damaged, repairs itself (scabs)

White Blood Cells (WBCs)

1. Phagocytosis – engulfing the pathogen
2. Producing antibodies – specific to the antigen
3. Producing antitoxins – to neutralise toxins



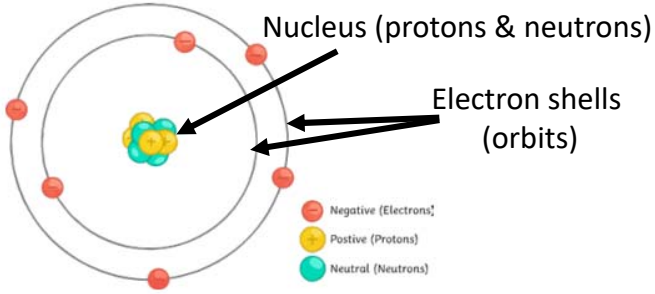
Science B3 – Infection and Response

1. What is a communicable disease? 2. What are the symptoms of gonorrhoea? 3. Which type of pathogen causes rose black spot? 4. How is measles spread? 5. How can we prevent the spread of malaria? 6. What is the **treatment** for salmonella? 7. How is salmonella spread? 8. How can HIV be treated?	1. What is the only type of pathogen antibiotics can kill? 2. What do painkillers do? 3. Why can antibiotics NOT kill viruses?	1. What are clinical trials? 2. What are the three things we test for before a drug can be used by the public? 3. What is the first stage of drug testing? 4. What are drugs tested on in preclinical trials?
1. What is in a vaccination? 2. Why do the white blood cells respond more quickly the second time they come into contact with a pathogen? 3. How does vaccination prevent us from becoming infected with the same pathogen in the future?	1. How are the trachea and bronchi help prevent infection? 2. What does the stomach contain to prevent infections?	1. What is phagocytosis? 2. What do antibodies attach to? 3. How to antitoxins make us feel better?

Science C1 – Atomic Structure and The Periodic Table

Atoms

- Made up of **protons, electrons** and **neutrons**.



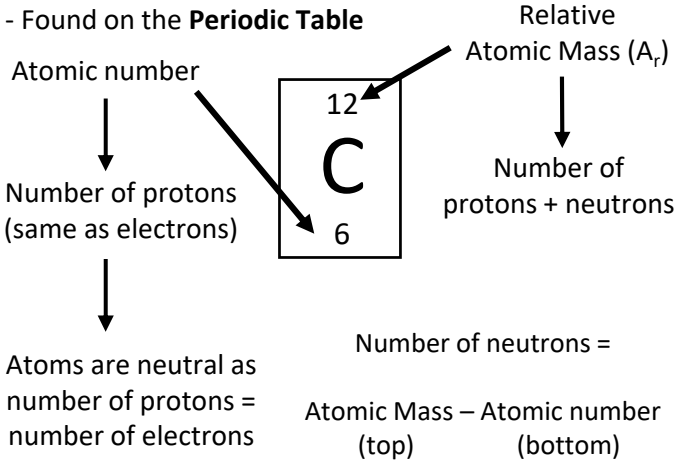
Subatomic particle	Relative Mass	Charge
Proton	1	Positive
Neutron	1	Neutral
Electron	Very small	Negative

Atoms have a radius of about 0.1nm ($1x10^{-10}$ m)

Radius of nucleus = about $1x10^{-14}$ m

Elements

- Only have **one type** of atom
- Found on the **Periodic Table**

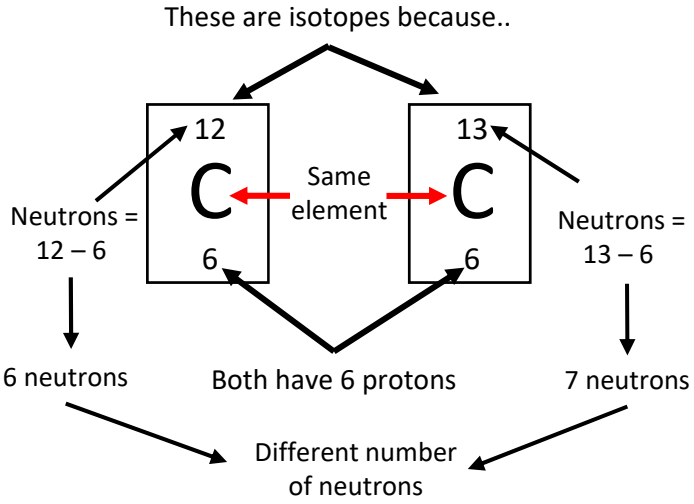


Compounds

- Two or more elements **chemically combined**.
- Formed by chemical reactions
- For example: CO_2 H_2O CH_4 HCl NaCl

Isotopes

Isotope = atoms of the **same element** which have the **same number of protons**, but **a different number of neutrons**.



Chemical Equations

- Shown by using a **word equation**.

e.g. magnesium + oxygen → magnesium oxide

Left of the arrow = **reactants**
Right of the arrow = **products.**

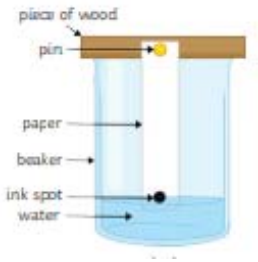
- Also can be shown by a **symbol equation**

e.g. $2Mg + O_2 \rightarrow 2MgO$

Mixtures and Separation

Mixtures – two or more elements or compounds **not** chemically joined.
This means the different components of the mixture can be separated by physical methods (below)
E.g. air is a mixture mainly made of nitrogen, oxygen and carbon dioxide.

Chromatography
to separate out mixtures (usually liquids)
(e.g. colours in ink)



Filtration
To separate insoluble solids from liquids
(e.g. sand and water)

Evaporation
To quickly separate soluble solids from a solution.
(e.g. salt and water)

Crystallisation
To slowly separate a soluble salt from a solution.
(e.g. copper sulfate crystals)

Science C1 – Atomic Structure and The Periodic Table

1. Name the three subatomic particles.
2. Which two subatomic particles are found in the nucleus of an atom?
3. What is the mass of a proton?
4. What is the radius of an atom?
5. What is the radius of the nucleus of an atom?

1. Where are elements found?
2. What does the relative atomic mass of an element show?
3. What does the atomic number show?
4. How do you calculate the amount of neutrons?

1. Define the word compound.
2. Give three examples of compounds.

1. What is an isotope?

2. Why are the two elements below isotopes? (use the numbers of **subatomic particles**)

14	15
N	N
7	7

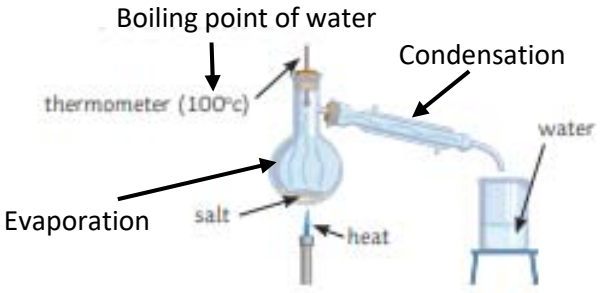
1. Where do you find the reactants in a chemical reaction?
2. Where do you find the products in a chemical reaction?

1. Is air an element, compound or mixture? Why?
2. What is chromatography used to separate?
3. What can be separated using filtration?
4. Give an example of a mixture that can be separated using filtration.
5. What is evaporation used to separate?
6. Give an example of a mixture that can be separated using evaporation.

Science C1 – Atomic Structure and The Periodic Table

Distillation

Simple distillation – separating a liquid from a solution.



- Liquid is heated to boiling point and evaporates
- Vapours travel up into the condenser
- Condenser has cold water around it.
- Vapours cool and condense (turn back into a liquid).

Electronic Structure

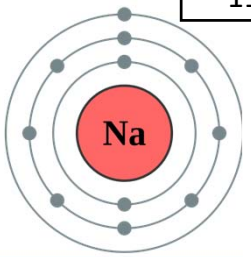
- Electrons are found on shells (orbits) orbiting the nucleus.
- There is a maximum number of electrons allowed on each shell:

First shell = 2 electrons
Second shell = 8 electrons
Third shell = 8 electrons.

11 electrons

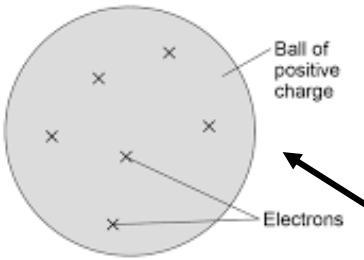
23
Na
11

1st shell = 2
2nd shell = 8
3rd shell = 1



Total = 11 electrons

History of the atom



Scientist	Time	Discovery
John Dalton	Start of the 19th century	Atoms were first described as solid spheres.
JJ Thomson	1897	Plum pudding model – atom is a ball of + charge with electrons scattered
Ernest Rutherford	1909	Alpha scattering experiment - mass concentrated at the centre, only the nucleus is + charged. Most of the atoms is empty space.
Niels Bohr	Around 1911	Electrons are in shells orbiting the nucleus
James Chadwick	Around 1940	Discovered that there are neutrons in the nucleus.

Differences to nuclear model
- Ball of positive charge (no protons)
- No nucleus
- No neutrons
- Evenly distributed mass

Rutherford tested the plum pudding model

What happened ?

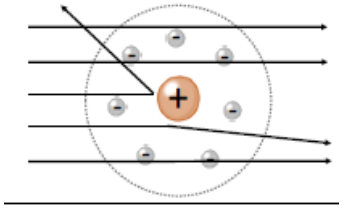
Rutherford's scattering experiment

alpha particles are positively charged

Fired at gold foil

some alpha particles are deflected/ repelled

most alpha particles passed straight through



Conclusions made

Observation	Conclusion
Most of the particles passed straight through	Most of the atom is empty space
Some were deflected to the sides	The particles had passed close by a positive charge
A very small number were repelled straight back	The alpha particles had approached the nucleus straight on. the tiny number told him that the positive charge is in a very small dense core

Science C1 – Atomic Structure and The Periodic Table

1. What two changes of state occur in distillation?
2. What temperature would the thermometer show when distilling salt and water?
3. Why does the water vapour condense in the condenser?

1. Who suggested the plum pudding model?
2. State three differences between the nuclear model and the plum pudding model.
3. What did Niels Bohr discover?
4. What did James Chadwick discover?
5. Put the particles into order of discovery:
   proton electron neutron

1. Where are electrons found?
2. How many electrons can be placed in the first, second and third shells?
3. Which number on the element shows the number of electrons?

1. Who conducted the scattering experiment?
2. What was fired at gold leaf during the scattering experiment?
3. Only a tiny number of the alpha particles were deflected, what did this show about the atom?
4. Some particles went straight through, what did this show about the atom?

Science C1 – Atomic Structure and The Periodic Table

Development of the Periodic Table

John Newlands – Law of Octaves

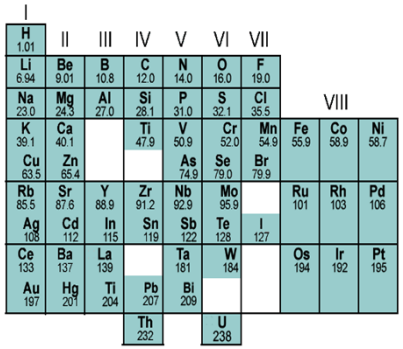
- Elements ordered by **atomic weight**.
- Noticed a pattern with every eighth element.
- Some elements placed inappropriately – metals and non-metals grouped together.
- Rejected by other scientists.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

John Newlands' Law of Octaves

Dimitri Mendeleev

- Still ordered by atomic weight
- Left gaps for **undiscovered elements**
- Could predict properties of undiscovered elements.
- Some elements didn't fit pattern – switched them to keep pattern of **similar properties**.



Dimitri Mendeleev left gaps for undiscovered elements

Eventually, knowledge of isotopes explained why elements could not be ordered by atomic weight.

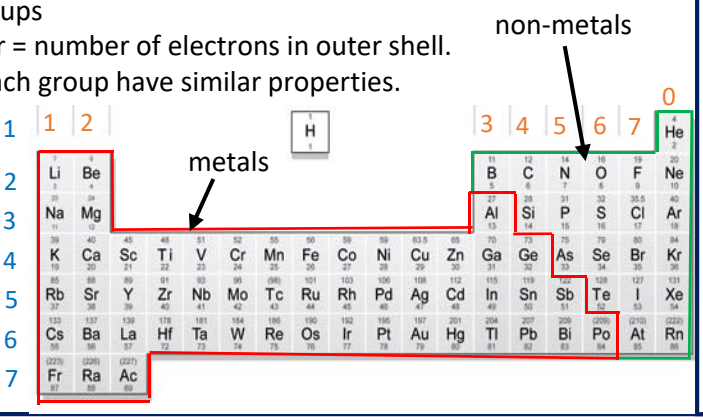
The Modern Periodic Table

- Ordered by **atomic (proton) number**.

Columns = groups

Group number = number of electrons in outer shell.

Elements in each group have similar properties.



Rows = periods

Period number = number of electron shells the atom has.

Group 0 (Noble Gases)

- Full outer shell – unreactive as they don't need to lose or gain any electrons

He
Ne
Ar
Kr
Xe
Rn

As you go down…
- Boiling point increases
- More electron shells
- Bigger atoms
- More intermolecular forces
- More energy needed to break forces.

Group 1 (alkali metals)

- Similar properties as all have 1 electron in outer shell.
- All lose one electron in reactions to form 1+ ions
- Soft, grey, shiny metals
- Stored in oil as would react with oxygen in air.
- When placed in water they produce an alkali (hence alkali metals) and hydrogen gas

E.g Lithium + water → lithium hydroxide + hydrogen

Reactivity of Group 1

Li
Na
K
Rb
Cs
Fr

As you go down the group…
- Elements are more reactive because:
- More electron shells
- Outer electron = further from nucleus and more shielded by the other shells
- The electrostatic force of attraction between outer electron and nucleus is weaker
- Easier for outer electron to be lost

Group 7 (Halogens)

- 7 electrons in outer shell – all react similarly
- All gain one electron when they react to form 1- ions
  - Form molecules (e.g. Cl_2, F_2)
  - Non-metals.
  - A more reactive halogen can replace a less reactive halogen in a reaction **(displacement)**

Reactivity of Group 7

F
Cl
Br
I
At

As you go down the group…
- Elements **are less** reactive because:
- More electron shells
- Outer shell is further from nucleus and is **more shielded** by the other shells
- The electrostatic force of attraction between free electron and nucleus is **weaker**
- Harder to attract an electron into the outer shell.

Science C1 – Atomic Structure and The Periodic Table

1. Who created the 'Law of Octaves'?
2. How were the elements ordered in old versions of the periodic table?
3. How did Dimitri Mendeleev order his elements?
4. Why did Mendeleev leave gaps in his periodic table?
5. The knowledge of what eventually explained why elements could not be ordered by atomic weight?

1. How are elements ordered in the modern periodic table?
2. Groups are rows or columns?
3. What does group number show?
4. What does period number show?

1. What are elements in group 0 known as?
2. Why are these elements unreactive?
3. What happens to boiling point as you go down group 0?

1. State 2 properties of Group 1 metals.
2. Why are they known as the alkali metals?
3. Are they reactive or unreactive?
4. As you go down the group, what happens to the reactivity of elements?
5. Explain your answer to Q4.

1. How many electrons do the halogens have in the outer shell?
2. What type of element are they?
3. State the trend in reactivity as you go down group 7.
4. Explain your answer to Q4.

Science C2 – Bonding, structure, and the properties of matter

Formation of Ions

- **Ions** = a charged particle made when atoms lose or gain electrons
- **Positive ion** = atom has lost electrons
- **Negative ion** = atom has gained electrons.

Metals form **positive ions**
Non-metals form negative ions

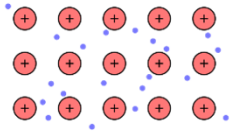
Group	Ions	Example
1	+1	$Li \rightarrow Li^+ + e^-$
2	+2	$Ca \rightarrow Ca^{2+} + 2e^-$
6	-2	$O + 2e^- \rightarrow O^{2-}$
7	-1	$Br + e^- \rightarrow Br^-$

Lost electrons

Gained electrons

Metallic Bonding

- Happens in **metals only.**
- Positive metal ions surrounded by **sea of delocalised electrons (can move).**

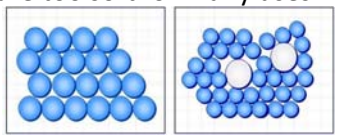


- Ions tightly packed in rows.
- Strong **electrostatic forces of attraction** between positive ions and negative electrons.

Alloys

- **Alloys** = mixture of two or more metal atoms
- Pure metals are too soft for many uses.

Pure Metal

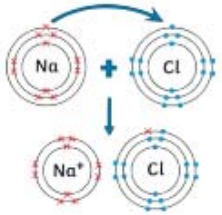


Alloy

- Atoms same size
- Layers slide
- Softer
- Different sized atoms
- Layers cannot slide
- Stronger

Ionic Bonding

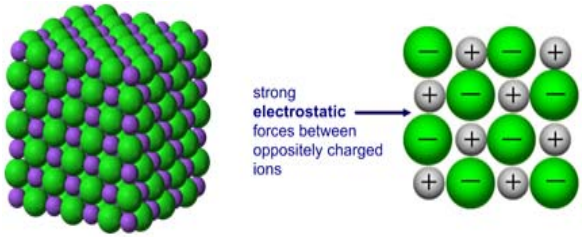
- Between a metal and non-metal.
- Metals give electrons to non-metals so both have a full outer shell.
- **Electrostatic force of attraction** between positive and negative ions.



E.g. Sodium loses one electron to become Na^+. Chlorine gains one electron to become Cl^-. The two ions attract to form sodium chloride.

Ionic compounds

- Form **giant lattices, as the attraction between ions acts in all directions**



Properties of Ionic Compounds

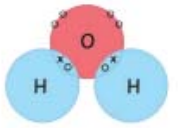
- **High melting point** – lots of energy needed to overcome electrostatic forces.
- **High boiling point**
- **Cannot conduct electricity as solid** – ions cannot move
- **Conducts electricity when molten or dissolved** – ions are free to move.

Covalent Bonding

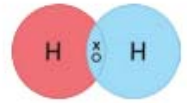
- **Covalent bonding** = sharing a pair or pairs of electrons for a full outer shell.
- Between **non-metals only.**

Dot and cross diagrams

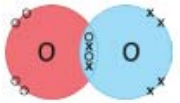
- Show the bonding in simple molecules.
- Uses the outer shell of the atoms
- Crosses and dots used to show electrons
- You should be able to draw the following:



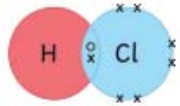
Water (H_2O)



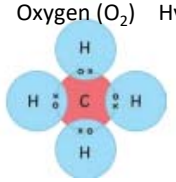
Hydrogen (H_2)



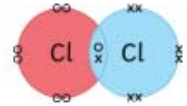
Oxygen (O_2)



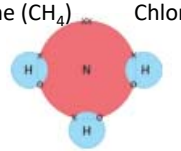
Hydrogen chloride (HCl)



Methane (CH_4)



Chlorine (Cl_2)



Ammonia (NH_3)

Simple Covalent Molecules

- Form when all atoms have full outer shells so bonding stops
- Examples are the molecules shown above.
- Have **low melting and boiling points**
- Due to **weak intermolecular forces**
- Do not conduct electricity

Science C2 – Bonding, structure, and the properties of matter

1. What is an ion?

2. What happens to form a positive ion?

3. What happens to form a negative ion?

4. What type of ions are formed by:
    1. metals
    2. non-metals

1. What are metal ions surrounded by?

2. Name the type of attraction between the electrons and ions.

3. Why do metals conduct electricity?

4. What is an alloy?

5. Why are pure metals too soft for some uses?

6. Why are alloys stronger than pure metals?

1. Ionic bonding happens between..

2. What do metals give to non-metals?

3. What type of attraction is between the positive and negative ions?

4. What structure do ionic compounds form?

5. What are the melting points of ionic compounds like?

6. Why can solid ionic compounds **not** conduct electricity?

7. When can ionic compounds conduct electricity?

1. What is covalent bonding?

2. What type of atoms does covalent bonding happen between?

3. Draw dot and cross diagrams for the following:

Water (H_2O)

Methane (CH_4)

Oxygen (O_2)

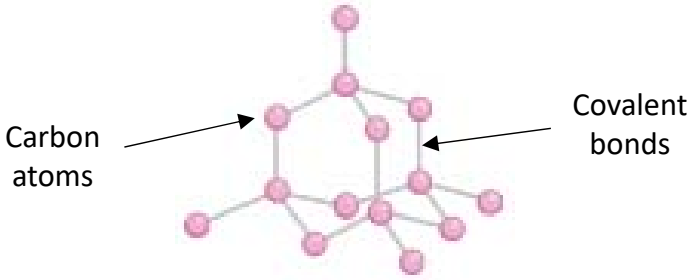
5. Do simple covalent molecules have a high/low melting point?

6. Why is this?

Science C2 – Bonding, structure, and the properties of matter

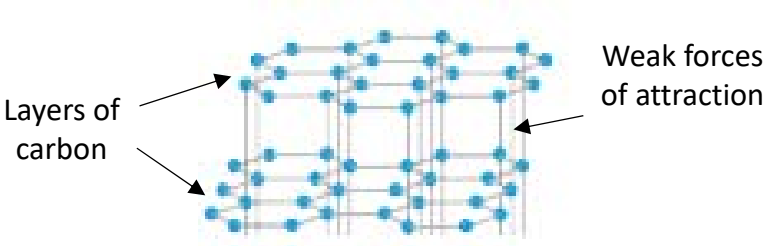
Giant Covalent Structure – Diamond

- Each carbon atom **covalently** bonded to **four** others.
- Forms a giant structure
- This makes diamond **strong** → a lot of **energy** needed to break lots of strong covalent bonds.
- **Does not conduct electricity** – has no free electrons.



Giant Covalent Structure – Graphite

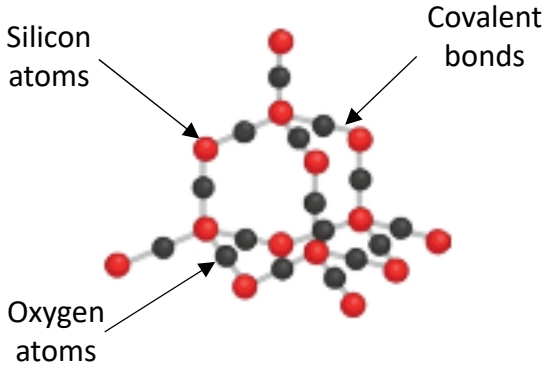
- Layers of **carbon** arranged in **hexagons.**
- Each carbon bonded to **three** other carbons.
- Leaves **one delocalised electron** → moves to carry electrical charge **throughout structure.**



- Layers held together by **weak forces**
- Layers can **slide** over each other easily
- Makes graphite **soft/slippery** → good lubricant.
- Has **high melting point** as has many strong covalent bonds.

Silicon Dioxide

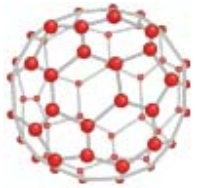
- Similar structure to diamond
- Giant covalent structure.
- Lots of **strong covalent bonds**.
- These require lots of **energy** to break.
- High melting and boiling points.



Fullerenes and Nanotubes

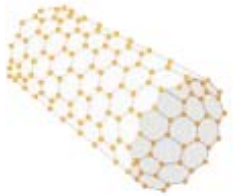
- Molecules of carbon shaped into hollow tubes or balls.
- Used to **deliver drugs into body**

Buckminsterfullerene
Formula = C_{60} →



- Carbon nanotubes = long narrow tubes
- Can conduct electricity

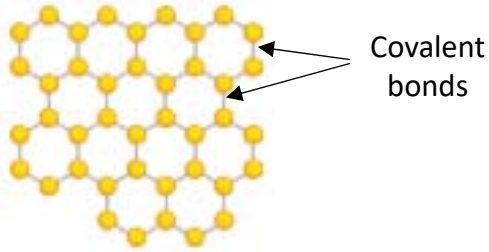
- Can strengthen materials without adding weight.



- Used in electronics and nanotechnology.

Graphene

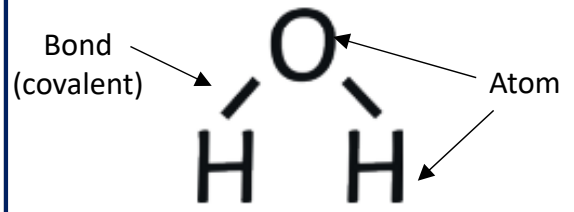
- Graphene = one layer of graphite.
- Very strong → lots of strong covalent bonds.

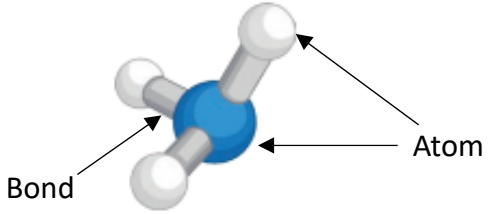


- Each carbon bonded to three others.
- One **free delocalised electron** → can move to **carry electrical current** throughout **the structure.**

Molecular models

- There are different ways to show a molecule other than dot and cross diagrams.





3D model

Science C2 – Bonding, structure, and the properties of matter

1. How many bonds do each carbon atom have in diamond?
2. What type of bonds are in diamond?
3. Why is diamond hard?
4. Why does diamond not conduct electricity?

1. What structure does silicon dioxide have?
2. Why does this structure have a high melting and boiling point?

1. What is graphene?
2. State a property of graphene.
3. How many bonds does each carbon have?
4. What does this allow graphene to do?

1. What element is graphite made from?
2. How many bonds does each carbon have?
3. Why can graphite conduct electricity?
4. What holds together the layers of graphite?
5. Why is graphite soft/slippery?
6. Does graphite have a high/low melting point?
7. Why?

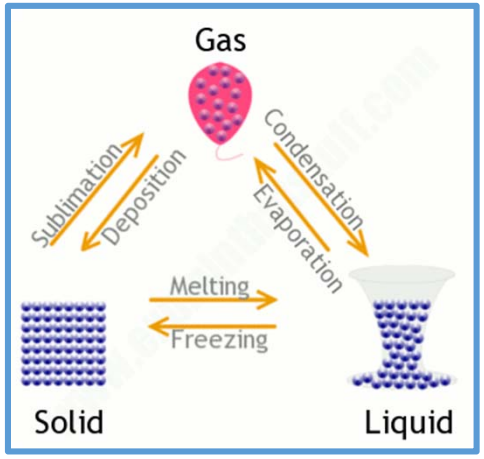
1. What can fullerenes be used for?
2. What is the formula of buckminsterfullerene?
3. State two uses of carbon nanotubes.

1. What are three ways that H_2O could be drawn?

Science C2 – Bonding, structure, and the properties of matter

States of Matter

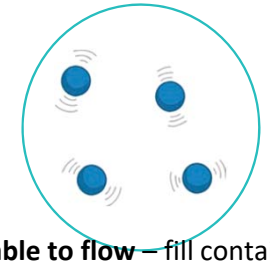
- Three states of matter: **solid, liquid & gas.**
- To change state, **energy** must be **transferred**.



- When heated, particles **gain energy**.
- **Attractive forces** between particles begin breaking when melting or boiling points are reached
- **Amount of energy** needed to change state depends on how strong forces are.

Gas

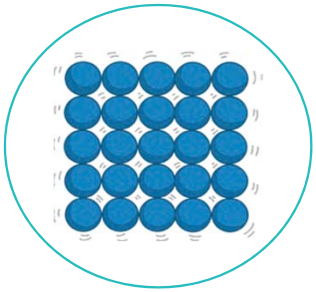
- Randomly arranged.
- Particles **move quickly** – all directions.
- Highest **amount** of **kinetic energy.**



- Gases **are able to flow** – fill containers
- **Can be compressed as there is space between particles**

Solid

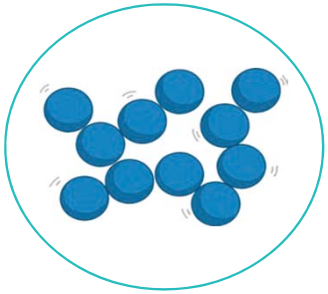
- **Regular** pattern (rows and columns)
- Particles **vibrate** in a **fixed position**.
- Particles have **low amount of kinetic energy.**



-
- Have a **fixed shape** – cannot flow because of strong forces of attraction between particles
- **Cannot be compressed** – particles close together.

Liquid

- Particles **randomly** arranged and touching.
- Particles can **move around.**
- **Greater amount** of **kinetic energy** than solid



- Liquids **able to flow** – take shape of containers.
- **Cannot be compressed** – particles are close together and cannot be pushed closer

State symbols

- States of matter shown in chemical equations:
- Solid **(s)**
- Liquid **(l)**
- Gas (**g)**
- Aqueous **(aq)**
- **Aqueous** solutions = substance dissolved in water.

Identifying Physical State of Substances

- If the temperature is **lower** than a substance's melting point – substance is **solid**.
- If the temperature is **between** the melting point and boiling point – substance is **liquid**.
- If the temperature is **higher** than the boiling point – substance is a **gas.**

Limitations of Particle Model (HT)

- No chemical bonds are shown.
- Particles shown as solid spheres – not the case, particles are mostly empty space like atoms.
- The diagrams don't show any of the forces between particles
- The diagrams are unable to show the movement of the particles.

Science C2 – Bonding, structure, and the properties of matter

1. What are the three states of matter?
2. What happens to particles when they are heated?
3. What happens to attractive forces when particles are heated?
4. What does the amount of energy needed to change state depend on?

1. How are gas particles arranged?
2. How do gas particles move?
3. Do particles in a gas have more or less kinetic energy than those in solids and liquids?
4. Can gases be compressed? Why?

1. How are solid particles arranged?
2. Do solid particles move?
3. Do particles in a solid have a high or low amount of kinetic energy?
4. Can solid particles flow?
5. Can solids be compressed?

1. How are liquid particles arranged?
2. Do particles in a liquid move?
3. Do the particles in a liquid have more or less kinetic energy than solids?
4. Can liquid particles flow?
5. Can liquids be compressed?

1. Where are state symbols used?
2. Write the symbols for solid, liquid, gas and aqueous.
3. What does aqueous mean?

1. If the temperature is lower than melting point, the substance is..
2. If the temperature is between melting and boiling point, the substance is..
3. When would a substance be gas?

1. State two limitations of the particle model.

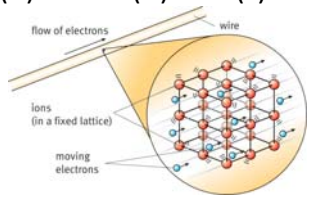
Science P2 – Electricity

Current, resistance and potential difference

Electrical current is the flow of electrical charge.
Current is measured in amps (A), charge is measured in Coulombs (C).
The size of the current depends on the rate of the flow of charge – ie how many coulombs of charge per second.

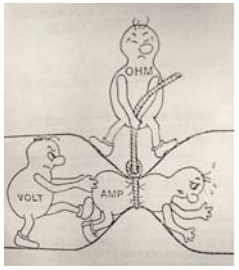
Q = I t

Charge = Current x time
(C) (A) (s)



Ohms Law

The current through a component depends on the potential difference and the resistance of the component.
If a component has high resistance, the current will be smaller for a given potential difference



potential difference = current x resistance

V = I R

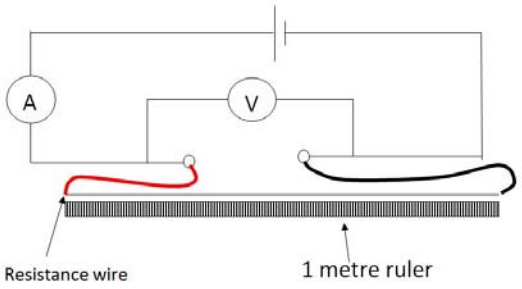
pd is measured in volts (V), resistance in Ohms (Ω)

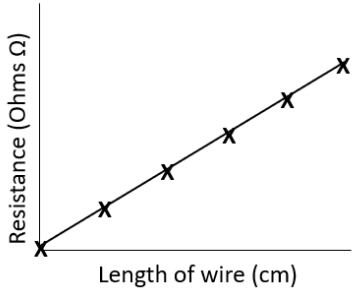
Hypothesis 'the length of the wire affects resistance'

Independent variable – length of wire
Dependent variable – resistance
Control variables – type of wire, temperature of the wire, diameter of the wire

1. Set up the circuit as shown, with an ammeter in the circuit and a voltmeter connected across the wire
2. Use crocodile clips to change the length of the wire in the circuit
3. Make the wire 10cm long and read the current and pd. Switch off the current between readings or the wire will got hot, increasing the resistance.
4. Repeat for 20, 30, 40, 50 cm. (5 minimum)
5. Calculate resistance using Ohms Law R = V/I

Plot length of wire (IV) against resistance (DV)



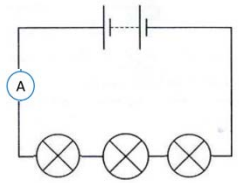


The relationship is directly proportional

Series and parallel circuits

Series circuits:

A series circuit is one single loop

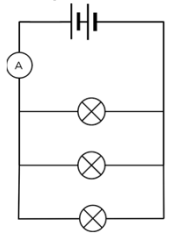


In a series circuit:

- the current is the same at all points in the circuit.
- potential difference is shared between components (equally if components are identical resistance)
- total resistance = sum of all resistors

Parallel circuits

A parallel circuit consists of more than one loop from the battery/cell.



In a parallel circuit:

- The current is shared amongst the branches
- The potential difference is the same across all components
- Resistance in the whole circuit is LESS than that of the smallest resistor

Science P2 – Electricity

Current, resistance and potential difference

1. What is current?
2. What is the unit for charge?
3. What is the unit for current?
4. What is the equation linking charge, current and time?
5. What is the equation linking current, potential difference and voltage?
6. If a component's resistance increases, what happens to current through that component?
7. What is the unit for resistance?

Hypothesis 'the length of the wire affects resistance'

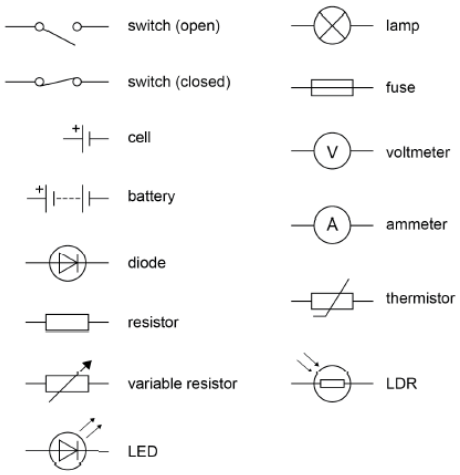
1. What is the independent variable in this investigation?
2. What is the dependent variable?
3. What is the minimum number of readings needed for a line graph?
4. What two readings are taken?
5. How is resistance calculated?
6. What sort of relationship is seen?
7. Why is it important to turn off the power in between readings?

Series and parallel circuits

1. What is a series circuit?
2. In a series circuit, the current is……
3. How do you find total resistance in a series circuit?
4. The potential difference is shared equally among components as long as……
5. What is a parallel circuit?
6. What is true about potential difference across all of the components in a parallel circuit?
7. How is total current calculated in parallel?
8. What is true for total resistance in a parallel circuit?

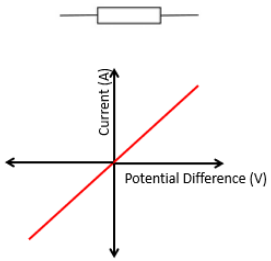
Science P2 – Electricity

Components

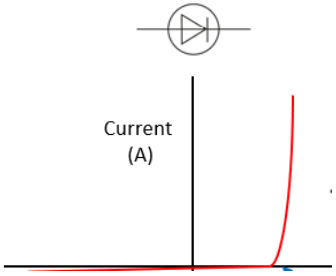


- A **diode** only allows current to flow one way in a circuit
- A **resistor** is a component that provides a fixed resistance in the circuit – e.g a 5 Ω resistor
- A **variable resistor** is a component whose resistance can be changed (e.g a dimmer switch)
- A **thermistor** is a resistor whose resistance changes with temperature – the higher the temperature the lower the resistance
- An **LDR** (light dependent resistor) has resistance that changes
- An LED (light emitting diode) is a light that only allows the flow of current one way

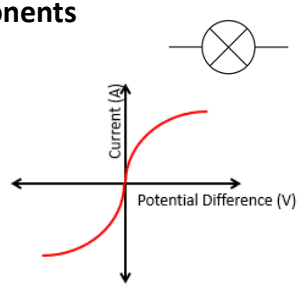
Current, potential difference and resistance for different components



A fixed (ohmic) resistor has fixed resistance
current is directly proportional to potential difference
Resistance remains constant (at constant temp)

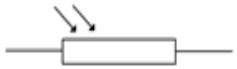


A diode very high resistance in one direction.
Only when the potential difference is positive does current flow

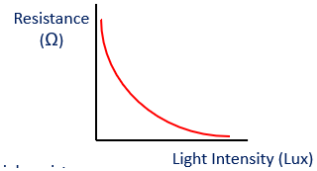


A filament bulb contains a thin wire that glows as current flows.
As the pd increases, the current initially increases.
However, at higher pd, the wire gets hot
The ions in the wire move faster and collide with the moving charges
Resistance increases, so current stops increasing

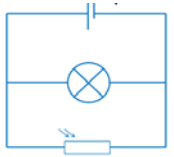
LDR



A light dependent resistor has varying resistance.
As the light intensity increases, the resistance decreases



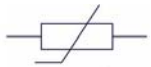
LDRs can be used to switch on lights at night time.



In this circuit, when it is day time, the resistance in the LDR is low, so all current flows through the LDR.

As light levels fall, resistance increases, until eventually there is less resistance in the bulb than the LDR, so current flows through the bulb – switching it on.

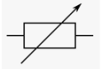
Thermistor



As the temperature increases, the resistance in a thermistor decreases.

Science P2 – Electricity

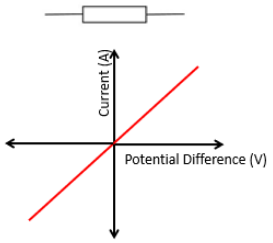
Components

Symbol	Name
	Cell
	
	fuse
	
	Voltmeter

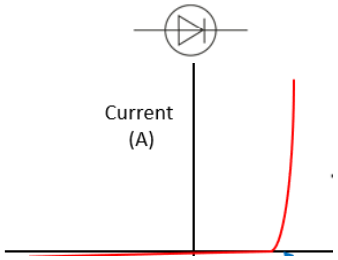
1. Complete the table opposite
2. Which component has a resistance that decreases as light intensity increases?
3. Which component only allows current to flow one way?
4. What is a fixed resistor?

Current, potential difference and resistance for different components

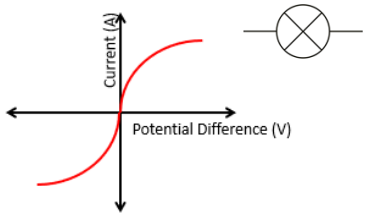
1. What readings would you need to take from a circuit to calculate resistance?



2. Describe the relationship shown



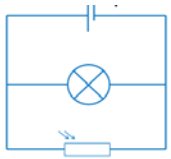
3. Why is there no current on one side of the graph?



4. What happens to current when the pd rises at first ?
5. What happens to the current as the pd gets higher?
6. Why does the resistance increase at higher pd?

LDR

1. Draw the symbol for an LDR
2. Draw the pattern you would expect for resistance as the light intensity increases.
3. The circuit below is for a night light. What is resistance in the LDR like during the day time? (high light levels)



4. Why does the light switch on when it goes dark?
5. Draw the symbol for a thermistor
6. Describe the relationship between temperature and resistance in a thermistor

Science P2 – Electricity

Domestic use of electricity

There are two types of electrical supply – direct (DC) and alternating current (AC)

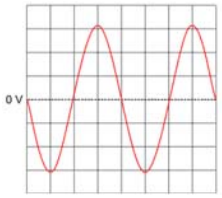
AC

The pd changes direction and magnitude, giving alternating current

The number of times the change of direction happens per second is the frequency.

UK mains is AC - **230V**

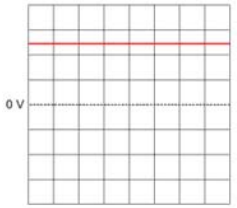
Frequency of **50 Hz**

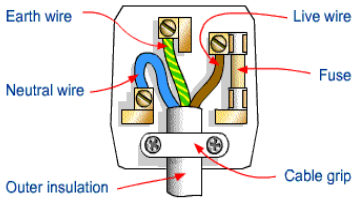


DC

A direct pd produces current that flows in one direction

Batteries supply DC



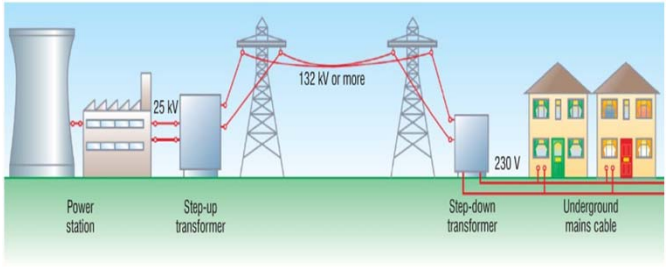


Electrical appliances are connected using 3 core cable

- Brown – live wire, with pd of 230V
- Blue – neutral, 0V, completes the circuit
- Yellow and green – Earth wire, is at 0V unless there is a fault, when it will become live

The National Grid

The National Grid is a system of cables and transformers connecting power stations to homes and businesses



The National Grid uses very high pd and low current.

High current causes heating in the wires and would result in large energy losses.

Step up transformers increase the pd from the power station (to around 400000V) so that low current can be used to transmit power.

This means the wires don't get hot, so less energy is lost.

Near homes and businesses, step down transformers reduce the pd to 230V for safety.

Appliances in the home and power

Power is measured in Watts (W) or kW

Power can be calculated by using:

Power = Voltage x current

$P = IV$

Power = current^2 x resistance

$P = I^2 R$

Appliances transfer energy.

Energy is measured in Joules (J) or kJ

The energy transferred can be calculated by using:

Energy = charge flow x potential difference

$E = Q V$

Energy = power x time

$E = p t$

For example

A kettle transfers energy from the thermal store of the filament in the kettle to the thermal store of the water inside.

Some energy is transferred to the thermal store of the surroundings.

Science P2 – Electricity

Domestic use of electricity

1. What are the two types of current?
2. What type of power supply produces DC current?
3. What are the two differences between AC and DC current?
4. What is the pd of the UK mains supply?
5. What is the frequency of UK mains supply?
6. What colour is the live wire in UK plugs?
7. What is the purpose of the blue wire in UK plugs?
8. When does the yellow and green wire carry a current?

The National Grid

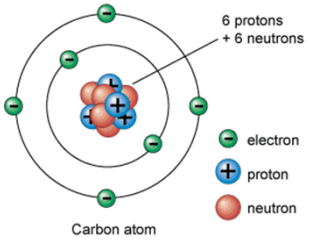
1. What is the National Grid?
2. What sort of pd does the National Grid use to transmit electrical power?
3. What is used to increase the pd from the power station?
4. What is used to reduce the pd near homes and businesses?
5. Why is such a high pd used?

Appliances in the home and power

1. What is the equation linking current, potential difference and power?
2. What is the equation linking current, resistance and power?
3. What two factors affect how much energy an appliance transfers?
4. What is the equation linking energy, power and time?
5. What are the units for power?
6. What is the equation linking charge, energy and potential difference?
7. What are the units for energy?

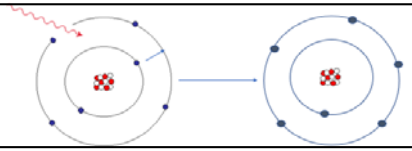
Science P4 – Atomic Structure

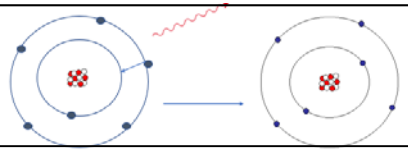
Atoms



- Atoms are tiny – around 10^{-10}m
- There is a positive nucleus made of protons and neutrons
- Electrons orbit in shells or energy levels
- The nucleus is 10,000 x smaller than the atom (4 orders of magnitude) so around 10^{-14} m

Electrons can move further away or closer to the nucleus





If EM waves (eg UV /light) are **absorbed** electrons can move up energy levels

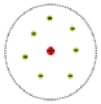
If EM waves are **emitted** by the atom, then electrons move closer to the nucleus

How the atomic model developed:

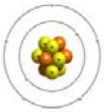
The atomic model has developed over time, when new evidence was discovered.

Atoms were first thought to be tiny spheres that could not be divided

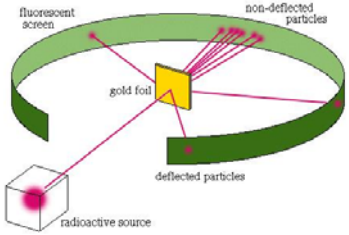
JJ Thomson then discovered the electron
Led to the plum pudding model
Atoms a cloud of positive charge with electrons randomly scattered



Rutherford discovered the positive charge is very small and in the nucleus
This discovery was from the Gold leaf experiment



Chadwick discovered neutrons
Bohr discovered the electrons orbit in shells



<u>Rutherford's experiment:</u>
Alpha particles fired at gold leaf
Most went straight through
Some deflected to the side
Some came straight back
This told him that most of the atom was empty space and that the positive charge was in a tiny nucleus

- Atoms of the same element have the same number of protons.
- This is the atomic (proton number)
- In an atom, the number of electrons is equal to the number of protons.
- The total number of protons and neutrons is called the mass number

(Mass number) 23
(Atomic number) 11 Na

Sodium has :
11 protons
11 electrons
12 neutrons (23-11)

Isotopes

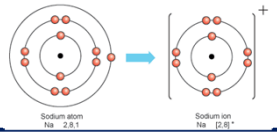
Isotopes are atoms with same number of **protons**, but different numbers of **neutrons** (different mass number)

E.g. $^{16}_{8}O$ $^{18}_{8}O$

These two isotopes both have 8 protons
One has 8 neutrons (16-8)
One has 10 neutrons (18 – 8)

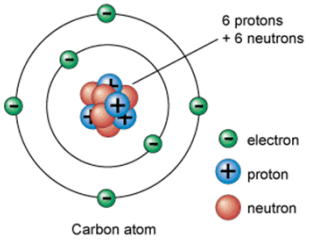
Ions

If atoms lose one or more outer electrons, they turn into positive ions

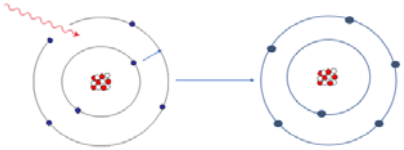


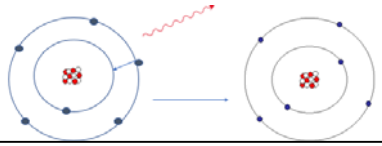
Science P4 – Atomic Structure

Atoms



1. What is the size of an atom?
2. What is in the nucleus?
3. What is the size of the nucleus?
4. How many orders of magnitude smaller than the atom is nucleus?





4. What can cause electrons to move further from the nucleus?

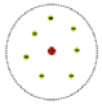
5. What can cause electrons to move closer to the nucleus?

1. What causes scientific ideas to change and develop?

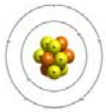
2. What was the thinking about atoms initially?

3. Which particle was discovered by JJ Thomson?

4. Where is the positive charge in this model?

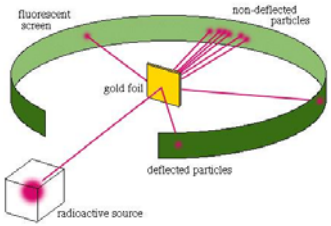


5. Where is the positive charge in this model?



6. Who discovered neutrons?

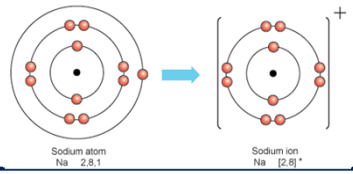
7. What was the discovery that Bohr made?



Rutherford's experiment:

1. What did Rutherford fire at gold leaf?
2. What happened to most of them?
3. What two conclusions did he come to?

1. What do all atoms of the same element have in common?
2. What does the bottom number on the elements in the periodic table represent?
3. What does the mass number show?
4. What is the number of electrons in an atom equal to?
5. What is an isotope?
6. What is an ion?
7. What type of ions are formed when atoms lose electrons?



Science P4 – Atomic Structure

Nuclear radiation

If an isotope is **unstable**, then **particles** and **energy** are emitted from the nucleus.
There are 3 main types :

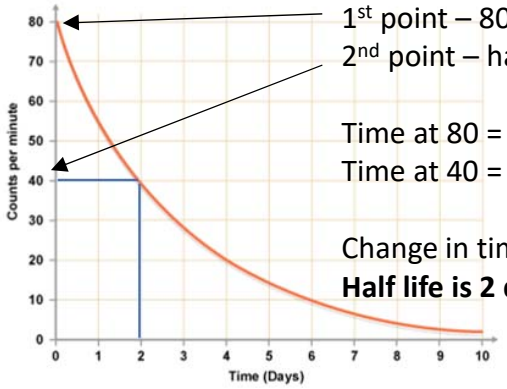
Radiation	What is it?	How far does it travel?	Ionising power	Penetrating power
Alpha α	2 protons and 2 neutrons	A few cm	Strong	Stopped by paper
Beta β	A fast moving electron	Metres	Medium	Stopped by aluminium
Gamma γ	An electromagnetic wave	kilometres	Weak	Takes thick concrete or lead to stop it

Neutrons can also be emitted from the nucleus**.**

Half life

Radioactive decay is random.
The half life of an isotope is the time it takes for half of the atoms in the sample to decay OR for the count rate to fall by half

Half life is calculated from a graph by reading two points off the y axis – one value being half the other.
Read the corresponding change in time**.**



1st point – 80
2nd point – half of that, so 40

Time at 80 = 0
Time at 40 = 2 days

Change in time = 2 days
Half life is 2 days

Isotopes are selected for use depending on their properties and half life – e.g. a medical tracer needs to have a short half life so it isn't in the body for very long

Alpha decay:

An unstable nucleus gives out 2 protons and 2 neutrons
An alpha particle is written as : $^{4}_{2}\alpha$

So when a particle gives out alpha radiation, it loses 2 from the proton number and 4 from the mass number
E.g

$$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}\alpha$$

Beta decay:

In an unstable nucleus, a neutron changes into a proton and an electron.
The electron is fired out as the beta particle
Beta particles are written as $^{0}_{-1}\beta$ or $^{0}_{-1}e$

The proton number increases
The mass number stays the same
E.g. $^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}e$

The emission of a gamma ray **does not change the nucleus**

Irradiation is the exposure to alpha, beta or gamma radiation

Contamination is the presence of radioactive atoms on materials.

Science P4 – Atomic Structure

Nuclear radiation

1. Why do atoms give out particles or energy from the nucleus?

2. Which radiation is the most strongly ionising?

3. What is an alpha particle made of?

4. Which radiation is the most difficult to stop?

5. Which radiation is a fast moving electron?

6. Which radiation can only travel a few cm?

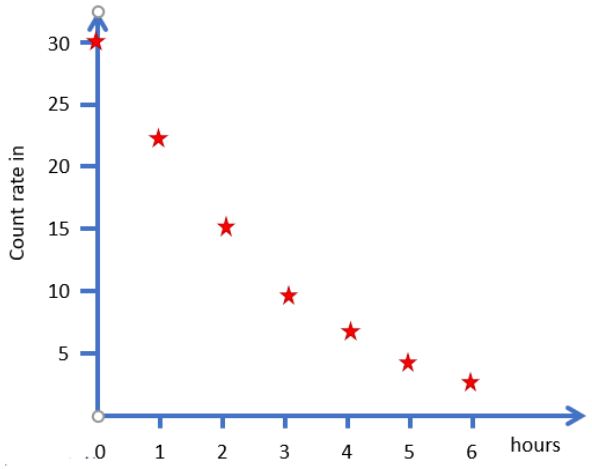
Half life

1. What is half life?

2. What is the unit missing from the Y axis on the graph opposite?

3. Draw a line of best fit onto the graph

4. What sort of half life would you want in an isotope being used as a medical tracer?



Alpha decay:

1. How is an alpha particle written?

2. What happens to the proton number of an atom when alpha decay happens?

3. What happens to the mass number when alpha decay happens?

4. What happens in the nucleus during beta decay?

5. How is a beta particle written?

6. What happens to the proton number during beta decay?

7. What happens to the mass number during beta decay?

8. What is irradiation?

9. What is contamination?