# KNOWLEDGE ORGANISER

Seahaven Academy
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Part of United Learning

## YEAR 11:

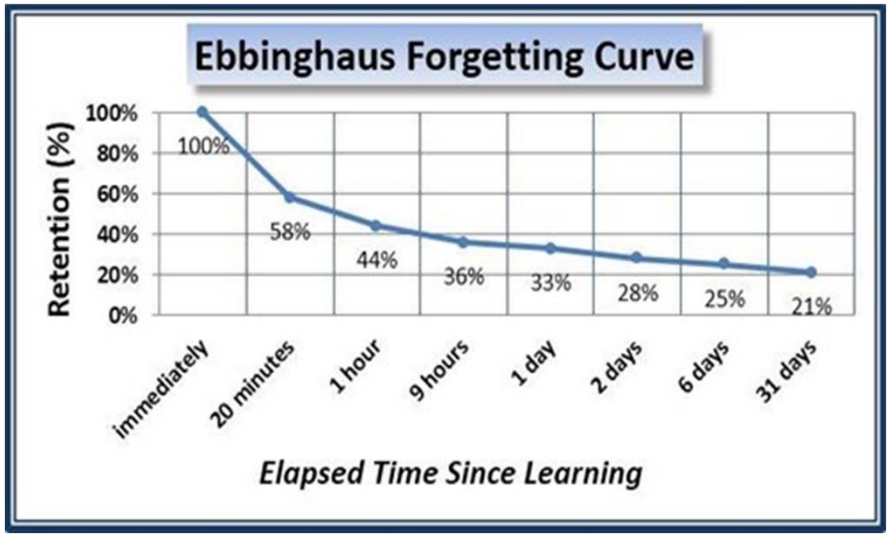
## Terms 3 and 4

## 2023 - 2024

## Core Subjects

Name: _____ Tutor Group: _____

# Knowledge Organisers and The Forgetting Curve




## Why are knowledge organisers important?

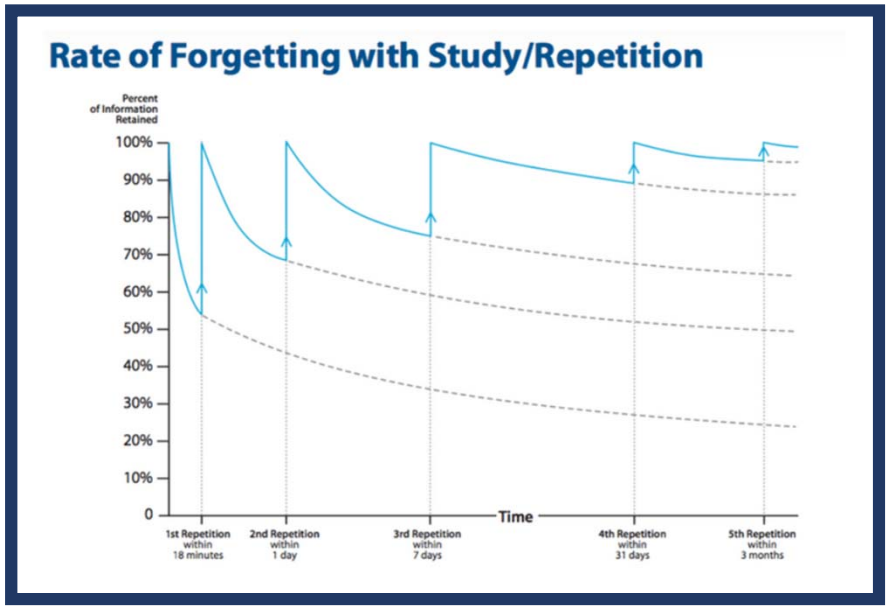
- Almost as soon as we have learnt something we begin to forget it
- In fact, it is surprising how quickly we begin to forget and within a few hours we usually only remember a fraction of what we have learnt ,the graph (left) is an example of how this happens

## 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?

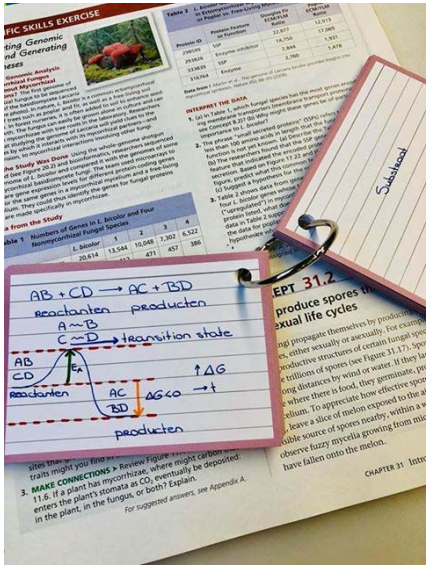
- You need to bring these to school each day in your bag, they may be used in lessons
- You will be set homework activities that use them
- You should use them to practice recall – there are tips on ways to do this in the next few pages
- You will use them to prepare for end of unit tests, including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

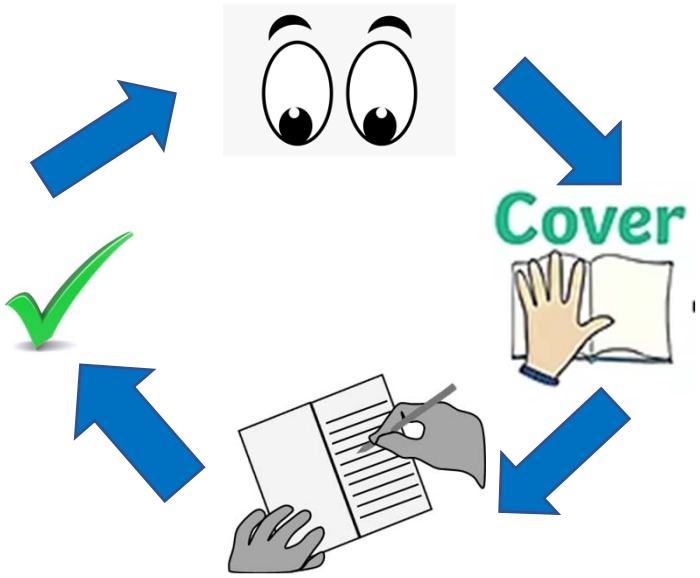
**You start with all the cards in Box 1.**
You learn these every day

**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

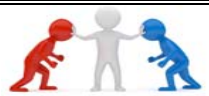
Dickens
Dickensian
Victorian
poverty
workhouse
ignorance
miserly
redemption
transformation
ghost
spirit
Christmas
injustice
inequality
allegory
stave
novella

## 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;



# POWER AND CONFLICT POETRY KNOWLEDGE ORGANISER

| 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<br>Egyptian Pharaoh's were seen as Gods in human form to their people. | • *Half sunk a shattered visage lies*<br>• *My name is Ozymandias, King of Kings*<br>• *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.<br>Blake felt common people were being abandoned. | • *Marks of weakness, marks of woe.*<br>• *The mind-forged manacles I hear*<br>• *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.<br>At this time the industrial revolution was beginning. | • *Small circles glittering idly in the moon, ...melted all into one track Of sparkling light.*<br>• *A huge peak, black and white*<br>• *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.<br>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*<br>• *I gave commands / Then all smiles stopped together*<br>• *Notice Neptune...taming a sea-horse.* |
| The Charge of the Light Brigade – Alfred Lord Tennyson | An army of men are driven into a bloody battle which it seems they might not come back from. | Tennyson tries to instil a sense of glory and myth into the poem and the soldiers.<br>During this time Britain was in the Crimean War. Britain, France and Turkey were at war with Russia. | • *Into the valley of Death rode the six hundred.*<br>• *Theirs not to make reply, theirs not to reason why, theirs but to do and die.*<br>• *Honour the Light Brigade, Noble six hundred.* |
| Exposure – Wilfred Owen | Men are stuck in the cold, dark, damp trenches, waiting for something to happen. | In 1915 Owen enlisted in the Artists' Rifles.<br>His anti-war poetry stood in stark contrast to the official propaganda about the glories of trench warfare and the heroism of British soldiers. | • *The merciless iced east winds that knive us*<br>• *Dawn massing in the east her melancholy army / Attacks once more in ranks on shivering ranks of grey.*<br>• *All their eyes are ice, but nothing happens.* |
| Storm on the Island – Seamus Heaney | The poem describes the experience of being in a cliff-top cottage on an island off the coast of Ireland during a storm. The people can do nothing against the powerful and violent weather. | Heaney was born in Northern Ireland in 1939.<br>The imagery is quite war like and could be symbolic of the Northern Irish troubles. There were bombings throughout Northern Ireland and Britain from the 1970s to 1990s. | • *We are prepared: we build our houses squat*<br>• *Spits like a tame cat turned savage.* |

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| | | | • *Space is a salvo, / We are bombarded with the empty air.* |
| Bayonet Charge – Ted Hughes | The poem describes the experience of 'going over-the-top'; when soldiers in trenches were ordered to 'fix bayonets' (attach knives to the end of their rifles) and charge an enemy. | He was fascinated by the First World War experiences of his father and uncle, imagining fearful images of trench warfare. | • *He lugged a rifle numb as a smashed arm*<br>• *King, honour, human dignity, etcetera*<br>• *His terror's touchy dynamite.* |
| Remains – Simon Armitage | A soldier is haunted by the memory of shooting looter during war. The memory keeps coming back despite is efforts to drown it out. | The poem itself is set in a modern warzone. Because of what he has seen, the soldier now has Post Traumatic Stress Disorder (PTSD) which is common among veterans of all wars. | • *Well myself and somebody else and somebody else*<br>• *He is here in my head when I close my eyes, dug in behind enemy lines.*<br>• *His bloody life in my bloody hands.* |
| Poppies – Jane Weir | A mother is reminiscing about life with her son and is experiencing the pain of loss as he is sent off to war. It is unclear whether or not he survives. | Poppies are worn to remember those who have been killed in war. When Poppies was written, British soldiers were still dying in wars in Iraq and Afghanistan. | • *Three days before Armistice Sunday*<br>• *All my words, flattened, rolled, turned into felt.*<br>• *Hoping to hear / Your playground voice catching on the wind.* |
| War Photographer – Carol Ann Duffy | A war photographer is developing his photographs in a dark room. He is traumatised by the memory of taking the pictures and despairs as he realises the people who see them in the newspaper will not care. | Duffy perhaps shares an affinity with these photojournalists - while they use photography, she uses words and language to do the same job. Duffy provokes us to consider our own response with the photographs. | • *With spools of suffering set out in ordered rows.*<br>• *A half-formed ghost*<br>• *The reader's eyeballs prick with tears between the bath and pre-lunch beers.* |
| Tissue – Imtiaz Dharker | Tissue explores the varied uses of paper and how they relate to life itself. The speaker in this poem uses tissue paper as an extended metaphor for life. | Dharker was born in Lahore, Pakistan, and grew up in Glasgow, Scotland. She is interested in social issues including the impact of war and politics on everyday family life. | • *Paper that lets the light shine through, this is what could alter things*<br>• *Maps too. The sun shines through their borderlines*<br>• *With living tissue, raise a structure never meant to last.* |
| The Émigrée – Carol Rumens | A displaced person pictures the country and the city where he or she was born. Neither the city nor the country is ever named and this seems intentional so it can apply to as many people who have left their home as possible. | This poem ties in heavily to ideas of asylum and refugees. It is never clear why the speaker has left their home or when and where this was, however it is focused on the conflict of emotions from child and adulthood. | • *My memory of it is sunlight clear.*<br>• *The frontiers rise between us, close like waves*<br>• *My shadow falls as evidence of sunlight.* |
| Checking out Me History – John Agard | Agard had to follow a history curriculum biased towards whites. He challenges this view of history and cites some major black figures to balance the bias and create a basis for his own identity. | John Agard was born in British Guiana (now called Guyana) in the Caribbean, in 1949. He moved to the UK in the late 1970s. He writes about what it is like being black to challenge racist attitudes, especially those which are unthinking. | • *Bandage up me eye with me own history Blind me to me own identity*<br>• *Toussaint de beacon / fire-woman struggle / a healing star*<br>• *But now I checking out me own history I carving out me identity* |
| Kamikaze – Beatrice Garland | A poem about a kamikaze pilot who returns home and faces rejection for his perceived cowardice. Unlike many of his comrades, this | During the Second World War, the term 'kamikaze' was used for Japanese fighter | • *A shaven head full of powerful incantations* |

| | | | |
|---|---|---|---|
| | pilot turns back from his target and returns home. | pilots who were sent on suicide missions. They were expected to crash their planes into enemy warships. | • *A tuna, the dark prince, muscular, dangerous.*<br>• *And sometimes, she said, he must have wondered which had been the better way to die.* |

# Y11 English
# Macbeth Knowledge Organiser


| | |
|---|---|
| Macbeth | Thane of Glamis/Brave and successful captain |
| Lady Macbeth | Wife of Macbeth |
| The Witches | Three weird sisters who appear to Banquo and Macbeth |
| Banquo | Macbeth's friend and fellow captain. Father to Fleance |
| Macduff | Thane of Fife-has a family |
| Duncan | Well-loved king of Scotland |
| Malcolm | Duncan's eldest son and heir |
| Ross | Thane – brings messages to various characters across the play |
| Fleance | Son of Banquo |

**Big ideas:**

- Pursuing selfish ambition leads to the destruction of society
- Hubris leads to personal downfall
- A corrupted view of masculinity leads to great harm
- Guilt and conscience are powerful and cannot be ignored
- When faced with supernatural forces, one must always stay on the side of moral good

1.While returning from a battle victory, Macbeth, a powerful lord, meets three Witches who predict that he will become King of Scotland.

2.Macbeth tells his wife of the Witches' predictions and she encourages him to murder the current king, Duncan, who is staying with them as a guest.

3.After Macduff discovers the murder, Duncan's sons flee the country, leaving the way clear for Macbeth to become king.

4.Banquo, Macbeth's best friend, becomes suspicious of what his friend has done so Macbeth has him murdered too.

5.Macbeth pays a second visit to the Witches and receives more predictions.

6.In England, Malcolm (Duncan's elder son) and his chief supporter, Macduff, plan to invade Scotland to win back the throne. An enraged Macbeth has Macduff's wife and children killed; Macduff swears revenge.

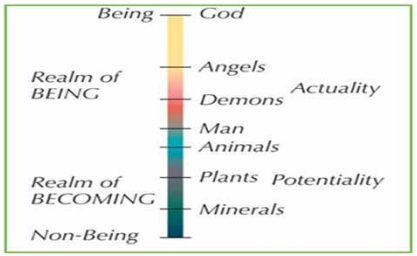
7.Lady Macbeth suffers from guilt for what she has done and eventually commits suicide.

8.Malcolm's invasion is successful and Macduff kills Macbeth. Malcolm becomes the new King of Scotland and the country counts the cost of Macbeth's short but bloody reign.

# Y11 English
# Macbeth Knowledge Organiser

1606: Written year after **Gunpowder Plot** (Guy Fawkes and co-conspirators planned to blow up Houses of Parliament to kill King James)

**The Great Chain of Being:** Jacobeans believed there was a "natural order" which must not be upset. The chain starts from God and progresses downward

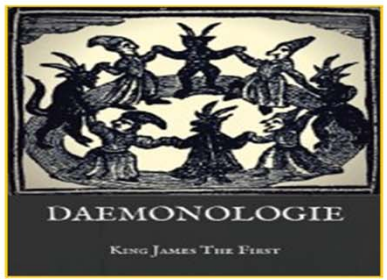



## CONTEXT

**Tragedy -Conventions:** Main character has a fatal flaw (hamartia) which leads to their downfall. This is often a characteristic that the audience can relate to (jealousy/ambition/passion) but which ultimately leads to catastrophe.

**Divine Right of KIngs:** A monarch is not subject to rules of earth-they have the right to rule directly from the will of God. It implies that only God can judge an unjust king and that any attempt to depose, dethrone or restrict his powers is against the will of God and may be a terrible sin.The action of killing a king is called regicide.

King James was fascinated by **dark magic.** Violent death of his mother (Mary Queen of Scots) may have initiated this. His wife to be survived two violent storms at sea. James became convinced these storms were caused by a witches' curse and he ordered a widespread witch hunt. He wrote the book Daemonologie.



## KEY Quotations (Act 1 and 2)

| Act/Scene | Quote | Meaning /theme |
|---|---|---|
| 1:1 Witches | **Fair is foul and foul is fair** | Nothing is quite what it seems |
| 1:2 Battle report | **Brave Macbeth, well he deserves that name** | Macbeth starts play as noble hero |
| 1:3 Macbeth +Banquo meet witches | **So foul and fair a day I have not seen** | Macbeth eches witches with first line |
| 1:3 Macbeth +Banquo meet witches | **The instruments of darkness tell us truths** | Banquo is suspicious, Macbeth is 'rapt' (hypnotised) |
| 1:4 Malcolm named heir | **Stars hide your fires; let not light see my black and deep desires** | Macbeth reveals his dark side – (hamartia- ambition) |
| 1:5 Lady Macbeth's plan | **Unsex me here / take my milk for gall** | Lady Macbeth asks the spirits to take away her womanhood |
| 1:5 Lady Macbeth's plan | **Look like the innocent flower but be the serpent under't** | Pretend to be good but in reality be evil (duplicity) |
| 1:7 Macbeth makes up his mind | **When you durst do it then you were a man** | Lady M challenges Macbeth's manhood |
| 2:1 Vision of a dagger | **Is this a dagger I see before me?** | Macbeth 's vision before killing Duncan |
| 2:2 The murder of the king | **I could not say 'Amen'** | Macbeth's fear and remorse |
| 2:2 The murder of the king | Will **all** great **Neptune's ocean** wash this blood clean from my hand?/ A little water clers us of this deed | Lady Macbeth and Macbeth's differing reactions to the murder |
| 2:3 Duncan's body discovered | **Horror, horror, horror/**<br>**Silver skin laced with his golden blood** | Macduff's genuine shock and horror vs Macbeth's fakery |
| 2:4 Nature has gone wrong | **Thou seest, the heavens, as troubled with man's act** | God is unhappy as the king has been killed |

## KEY Quotations (Act 3 and 4)

| Act/Scene | Quote | Meaning /theme |
|---|---|---|
| 3:1 Plot to murder Banquo | **I fear, Thou play'dst most foully for't:** | Banquo's suspicions revealed |
| 3:1 Plot to murder Banquo | **Upon my head they placed a fruitless crown** | Macbeth has no heir |
| 3:2- Lady M and Macbeth | **Make our faces vizards to our hearts** | Macbeth is masking his true feelings |
| 3:2-Lady M and Macbeth | **Be innocent of the knowledge dearest chuck** | Macbeth is now in charge over LM |
| 3:3- Banquet (Banquo's ghost) | **Avaunt! and quit my sight! let the earth hide thee!** | Banquo's ghost appears – Macbeth is terrified |
| 3:3- Banquet (Banquo's ghost) | **Blood will have blood** | Macbeth recognises that there is no turning back |
| 3:5 Hecate and the witches | **Security is mortals' chiefest enemy** | If Macbeth feels unbeatable he will make mistakes |
| 3:7 Lord and Lennox talk | **'tyrant'** | Macbeth has become a cruel and feared ruler |
| 4:1 Macbeth returns to witches | **Something wicked this way comes** | Even the witches refer to Macbeth as wicked and non-human |
| 4:3 Macduff visits Malcolm in England | **Not in the legions**<br>**Of horrid hell can come a devil more damned**<br>**In evils to top Macbeth.** | Macduff reveals is true thoughts about Macbeth |
| 4:3 Macduff learns of the brutal murder of his family | **I must also feel it as a man** | Macduff reveals himself to be more complex and emotional |

## KEY Quotations (Act 5)

| Act/Scene | Quote | Meaning /theme |
|---|---|---|
| 5:1 Lady Macbeth sleepwalking | Out, damned spot! out, I say | LM relives the murder and hallucinates blood on her hands |
| 5:2 Scottish lords defect to join English forces | now does he feel his title<br>Hang loose about him, like a giant's robe<br>Upon a dwarfish thief. | Macbeth revealed as unfit to rule |
| 5:3 Macbeth holed up in his castle | I'll fight till from my bones my flesh be hack'd. | Echoes Macbeth's violent bravery from the start |
| 5:5-Lady M dies | it is a tale<br>Told by an idiot, full of sound and fury,<br>Signifying nothing | Macbeth reflects on the pointlessness of life after the death of LM |
| 5:7 – Macduff and Macbeth seek each other out | If thou be'st slain and with no stroke of mine,<br>My wife and children's ghosts will haunt me still. | Macduff reveals his need for revenge |
| 5:8 The final fight | Turn, hell-hound, turn | Final confrontation – Macbeth seen as inhuman |
| 5:8 The final fight | Macduff was from his mother's womb<br>Untimely ripp'd. | The witches trickery is revealed- Macduff was not literally 'born' of woman |
| 5:9 Macbeth dead – Malcolm crowned king | 'Hail, king! for so thou art: behold, where stands<br>The usurper's cursed head | Natural order has been restored. Cyclical structure – the traitor' head has been cut off – just like at the start. |

# 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)

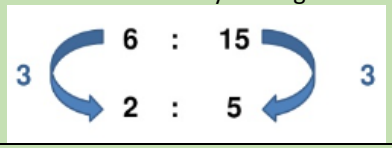
**Squares and Cubes**
Square numbers: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225 etc

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

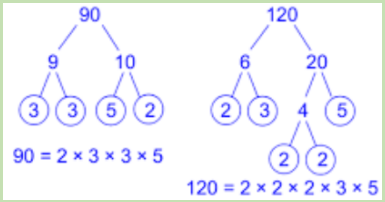
**Order of operations**
**B**racket
**I**ndices
**D**ivision and **M**ultiplication
**A**ddition and **S**ubtraction

**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

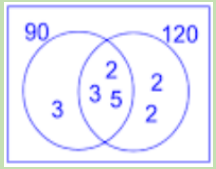
**Index Laws**

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

**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: _____
_____

Cube numbers: _____
_____

**Sharing in a given Ratio**
A Add the ratio parts
D Divide the amount by the total parts
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e.g. share £420 in the ratio 2:5

**Simplifying Ratio**
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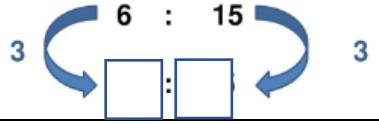


**Simplifying Ratio 1:n**
Divide both sides by the highest factor of the left hand side
Simplify: 2m: 180cm

**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:

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

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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.
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)**

$Speed =$ _____

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**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)
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Multiplying and dividing:
Different signs – answer will be _____
+ x - = _____, - x + = _____
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**Ordering fractions**

Calc: use division to write each fraction as a decimal
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**Order of operations**

**B**_____
**I**_____
**D**_____ and **M**_____
**A**_____ and **S**_____

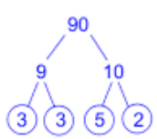
**Rounding to significant figures**

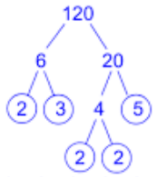
Start from the first _____ number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF =
0.0060821 to 3SF =

**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**

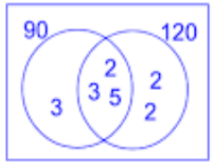



=_____ = _____

**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

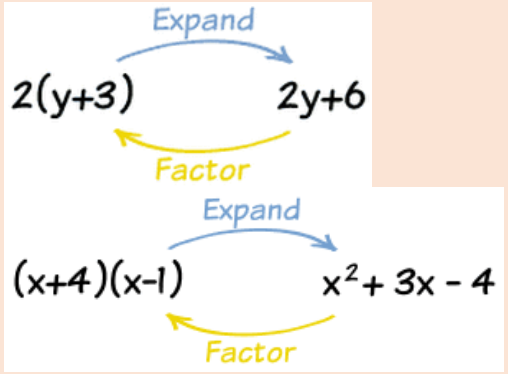
Expression – no equal signs e.g. 2x + 3, 2y, $(3x - 2)^2$

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

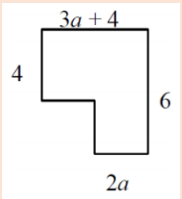
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{change\ in\ y}{change\ in\ x}$$

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:

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

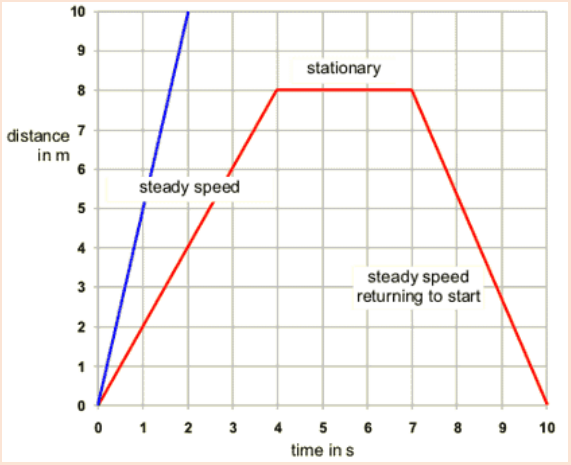
$$5a + 14 = 20$$

## Simplifying expressions multiplication and division

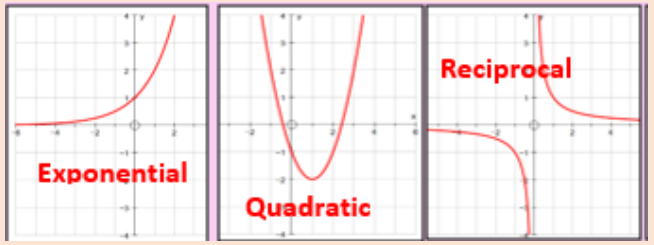
$2ma^2 \times 7ma = 14m^2a^3$

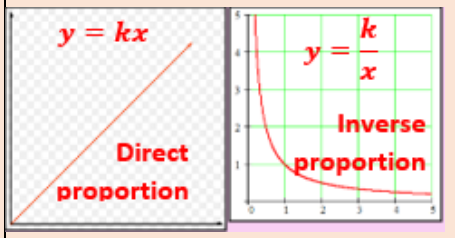
$\frac{18b^6}{3ab^2} = \frac{6b^4}{a}$

## Distance / Time Graphs

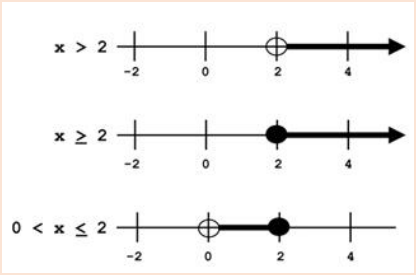



## Graphs that need to be recognised



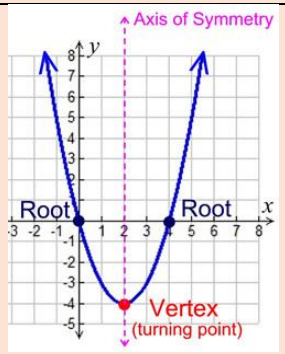

## Inequalities




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**

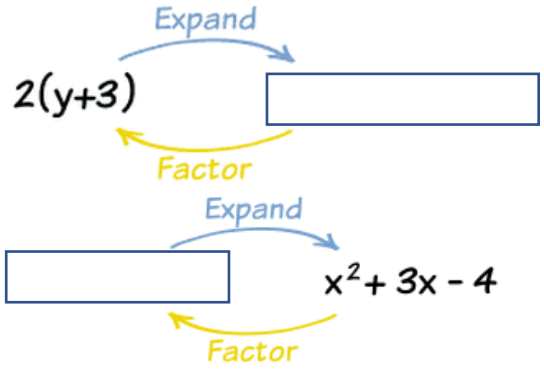
Expression –

Equations –

Identities –

Formulae –

**Factorising and expanding**




**Straight line graphs**

$y = mx + c$

$m =$ _____

$c =$ _____

_____ _____

gradient gradient

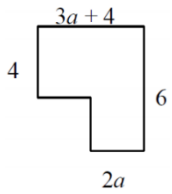
$m =$ _____ $=$ _____

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.

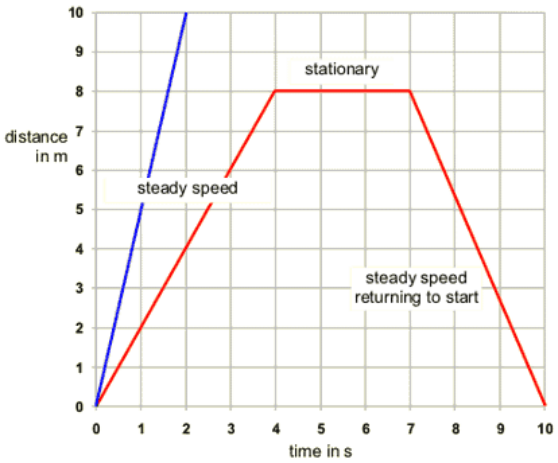
If the perimeter is given as 20cm, for example, you can create an equation:

**ANSWER =**

**Simplifying expressions multiplication and division**

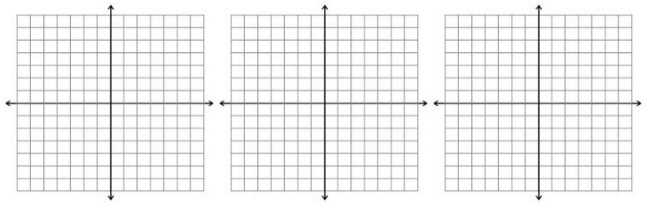
$2ma^2 \times 7ma =$ _____ $\frac{18b^6}{3ab^2} =$ _____

**Distance / Time Graphs**

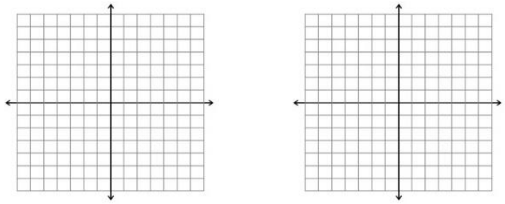



**Graphs that need to be recognised: sketch**

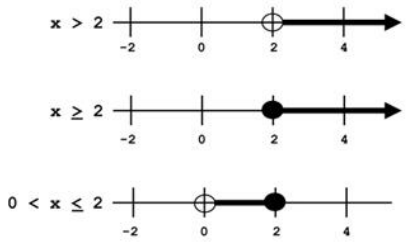
Exponential Quadratic Reciprocal



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, ….

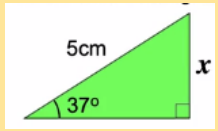
# Geometry and Measures - Foundation

## Trigonometry

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

Example – finding a side:

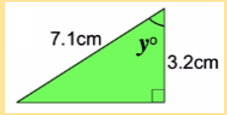
$\sin 37 = \frac{x}{5}$




$x$ = 5 x sin $37^0$

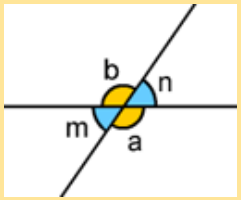
Example – finding a side:

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

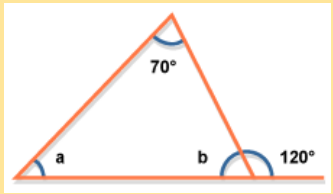



$y = tan^{-1}\left(\frac{3.2}{7.1}\right)$.

## Angle Facts



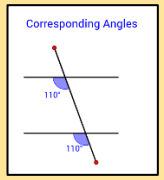

Vertically opposite angles are equal: a=b and m=n

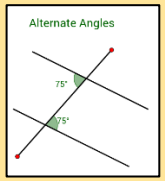


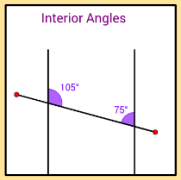

Angles in a triangle sum to $180^0$.

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

## Angles in parallel lines



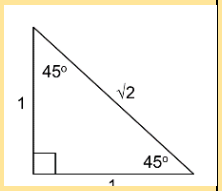

Corresponding angles are equal

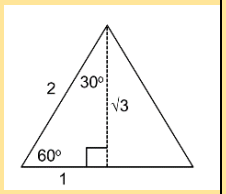
Alternate angles are equal

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

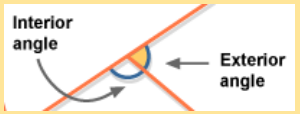
## Area of key shapes

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



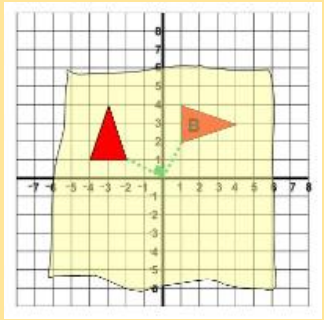

$n = number\ of\ sides$

Interior angle + exterior angle = $180^0$

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

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

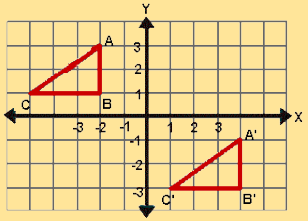
## Transformations – rotation



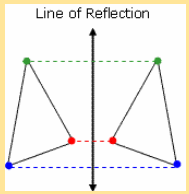
Always use tracing paper.
Describe:

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)

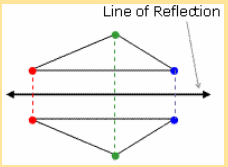
## Transformations – translations and reflections



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

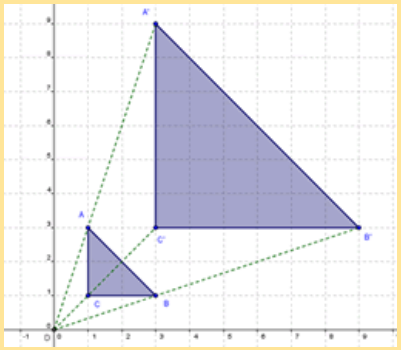



Reflection in the line x=a




Reflection in the line y=a

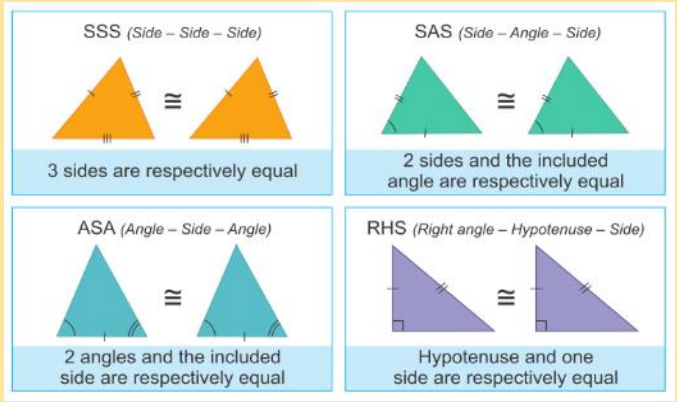
## Transformations - enlargement



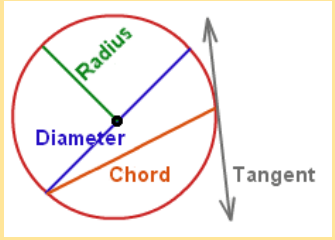
Describe:

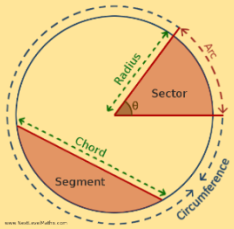
1. It's an enlargement
2. The scale factor (if the image is smaller than the object the scale factor is fractional e.g. ½)
3. The centre of enlargement given as a coordinate

## Congruent triangles




## Circles




$Area = \pi r^2$

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

$Circumference = \pi d$

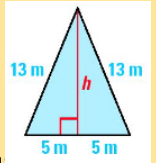
Arc length = $\frac{\theta}{360}\pi d$

## Pythagoras' Theorem

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

Only applies to right angled triangles.

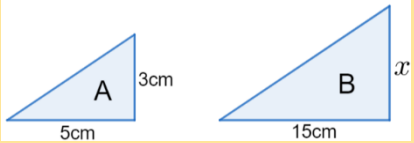
Can be used to find the height of an isosceles triangle




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



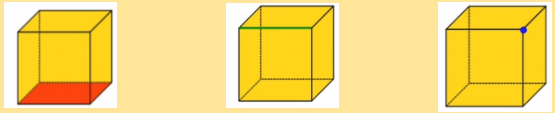

Length scale factor = 15 ÷ 5 = 3

$x$ = 3cm x 3

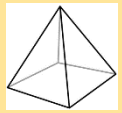
## 3D notation

<u>Cube:</u>

Faces: 6 Edges: 12 Vertices: 8



<u>Square based pyramid:</u>

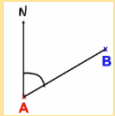


F = 5, E = 8, V = 5

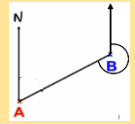
## Bearings

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

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



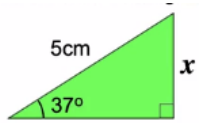

Bearing of A **<u>from B</u>** (start at B)



## Trigonometry

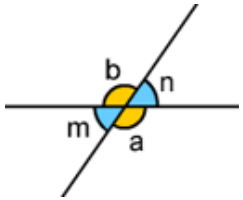
Fill the blanks: $S - C - T -$

Show how to find x:

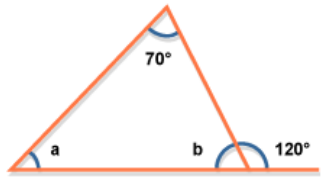



Show how to find y:


## Angle Facts




Vertically opposite angles are _____

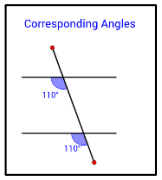


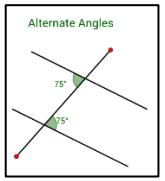

Angles in a triangle sum to _____.

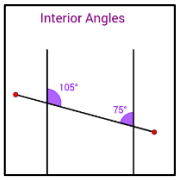
Angles on a straight line sum to _____.

E.G: b=_____ so a = _____

## Angles in parallel lines



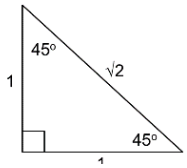

Corresponding angles are _____

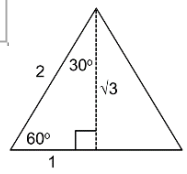
Alternate angles are _____

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

_____

_____

_____

_____

_____

_____

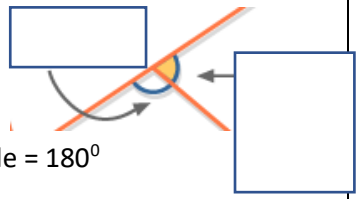
## Area of key shapes

Triangle : A = ——— ($h$ = _____ height)

Parallelogram: A = _____ ($h$ = _____ height)

Trapezium: A = _____

## Angles in regular polygons



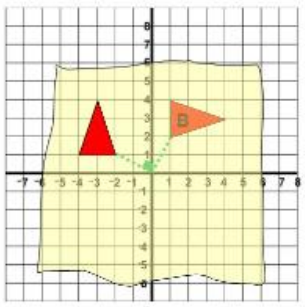
$n = number\ of\ sides$

Interior angle + exterior angle = $180^0$

Exterior angle = ———

$n =$ _____

## Transformations – rotation



Always use tracing paper.
Describe:

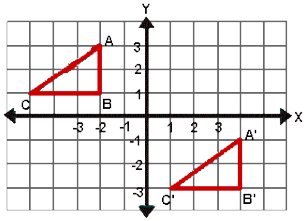
1.

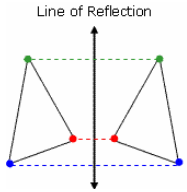
2.

3.

4.

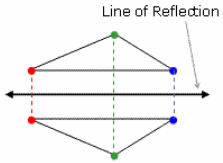
## Transformations – translations and reflections





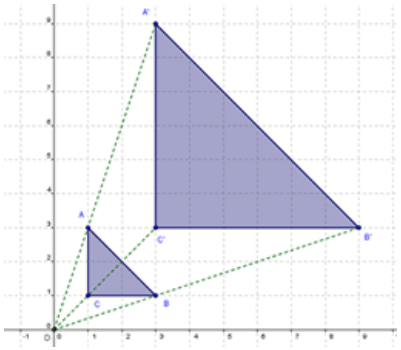

Reflection in the line _____

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




Reflection in the line _____

## Transformations - enlargement

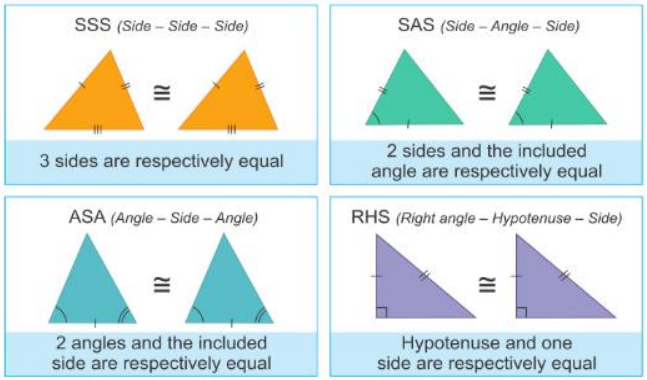


Describe:
1.

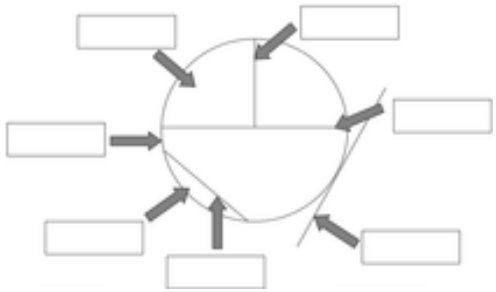
2.

3.

## Congruent triangles




## Circles



Draw your own arrow to label an arc on the diagram

$Area =$

Sector $Area =$

$Circumference =$

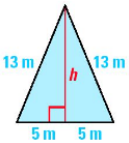
Arc length =

## Pythagoras' Theorem

_____

Only applies to _____ triangles.

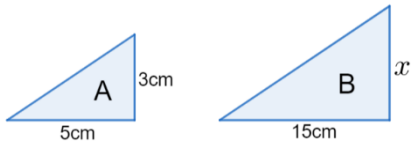
Can be used to find the height of an _____ triangle




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



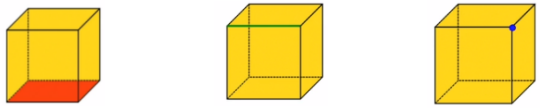

Length scale factor = _____

$x$ = _____

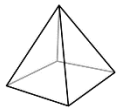
## 3D notation

<u>Cube:</u>

Faces: ____ Edges: ____ Vertices: ____



<u>Square based pyramid:</u>

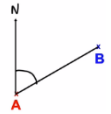


F = ____ , E = ____ , V = ____

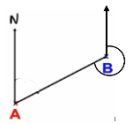
## Bearings

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

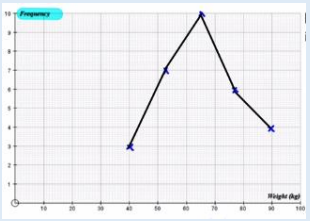
Median: order the data and find the middle value

Range: Highest value – lowest value

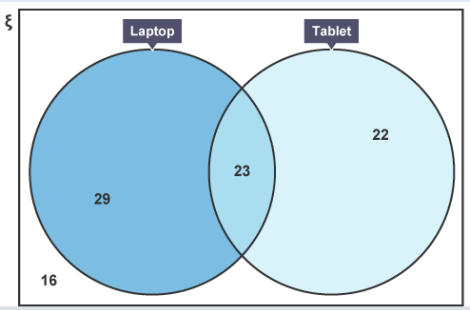
## Frequency Polygons

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.

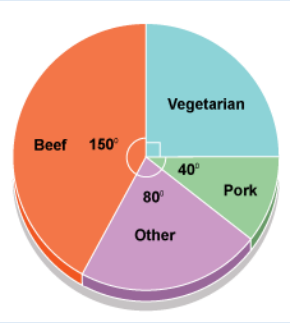
## Probability Definitions

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

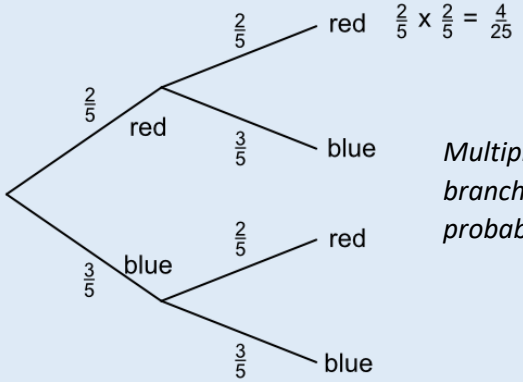
Mean: $\frac{\sum fw}{\sum f}$; where, $w$ is the midpoint of the group.

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: _____

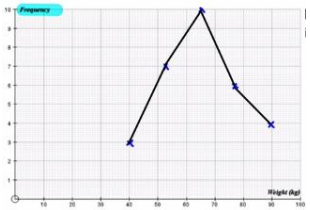
Median: _____

Range: _____

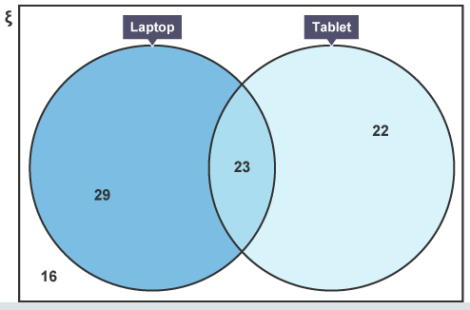
## Frequency Polygons

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.

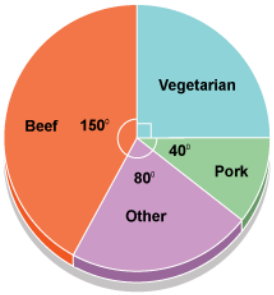
## Probability Definitions

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

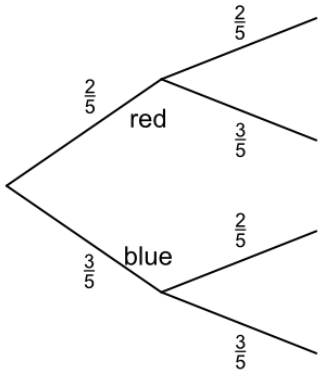
Mean: $\frac{\sum fw}{\sum f}$; where, $w$ is the _____ of the group.

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 _____ (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




_____ *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.

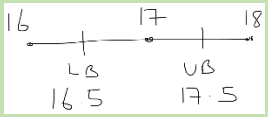
$$\frac{5}{3+\sqrt{2}} = \frac{5 \times (3-\sqrt{2})}{(3+\sqrt{2}) \times (3-\sqrt{2})} = \frac{5(3-\sqrt{2})}{9-\sqrt{4}}$$

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

**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*

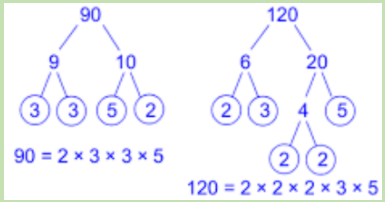
**Order of operations**
**B**racket
**I**ndices
**D**ivision and **M**ultiplication
**A**ddition and **S**ubtraction

**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

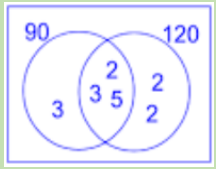
**Index Laws**

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

**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)

**Recurring Decimals**
To change a recurring decimal into a fraction you _____
_____
_____
_____

**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 = _____, UB = _____,

**Simplifying Surds**
Find a factor that is a _____ number

$$\sqrt{96} =$$

**Manipulating surds**

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

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

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

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

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 _____

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

**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

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Calculator:

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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.
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)**

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

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

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

Multiplying and dividing:

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

**B**_____
**I**_____
**D**_____ and **M**_____
**A**_____ and **S**_____

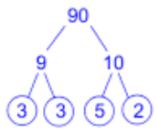
**Rounding to significant figures**

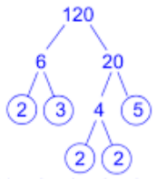
Start from the first _____ number and round as normal, but ensure the place value is correct
e.g. 345,635 to 2SF =
0.0060821 to 3SF =

**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**

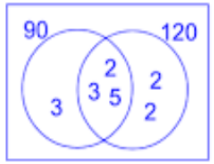



=_____ = _____

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

HCF is the _____
LCM is the _____




HCF: _____

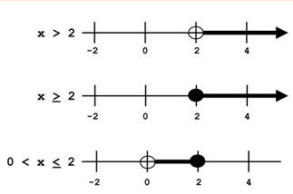
LCM: _____

# Algebra - Higher

## Quadratic Formula

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

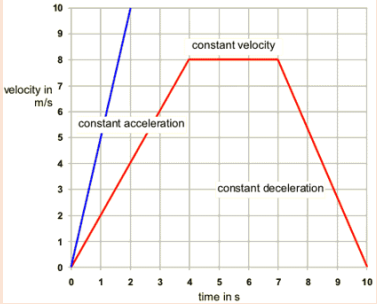
## Linear Inequalities




Open circle: < / >

Closed circle: ≤ / ≥

## Velocity / Time Graphs



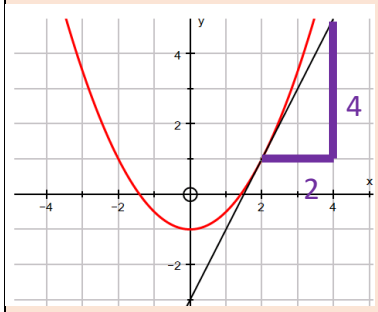

Gradient = acceleration

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

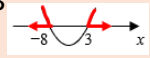
Quadratic expression factorised by completing the square:

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

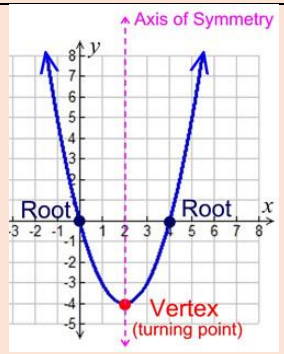
Turning point of graph occurs at $(-a, b)$

## 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

$y = mx + c$

$m = gradient$

$c = y - intercept$

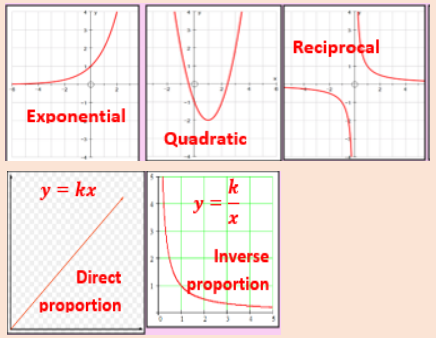
positive gradient / negative gradient

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

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*

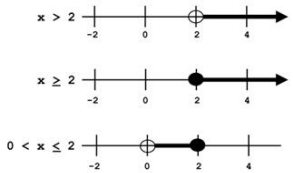
$f(g(x))$: *Substitute* $g(x)$ *into* $f(x)$ i.e. replace all values of $x$ in $f(x)$ with the entire function $g(x)$

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

**Quadratic Formula**

$x =$

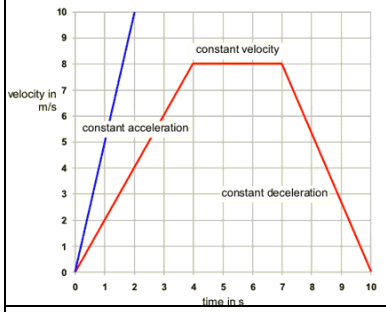
**Linear Inequalities**




Open circle: ____ or _____

Closed circle: ___ or _____

**Velocity / Time Graphs**




Gradient = _____

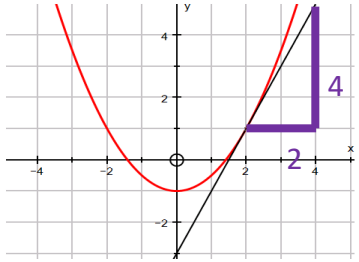
Area = _____

_____

**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**

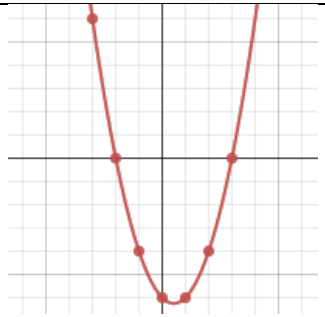
e.g solve $x^2 + 5x - 24 \geq 0$

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

$m =$ _____ $=$ _____

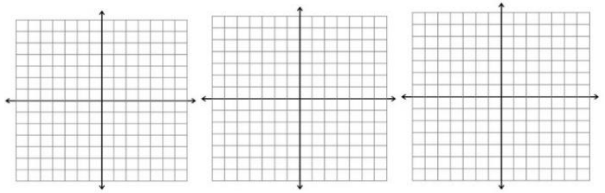
Parallel lines – have equal gradients

Perpendicular lines –

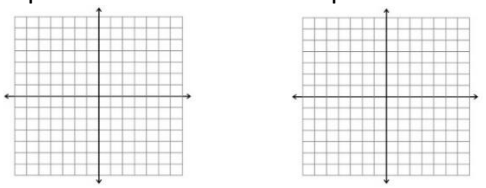
If $L_1$ and $L_2$ are perpendicular then $m_2$ =

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

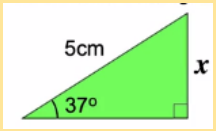
# Geometry and measure - Higher

## Trigonometry

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

Example – finding a side:

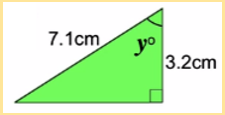
$\sin 37 = \frac{x}{5}$




$x$ = 5 x sin $37^0$

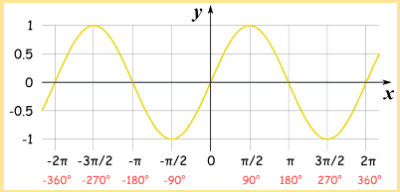
Example – finding a side:

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

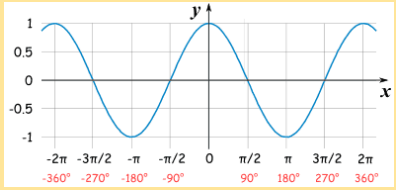



$y = tan^{-1}\left(\frac{3.2}{7.1}\right)$.

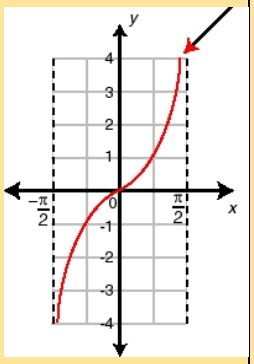
## Sine Curve



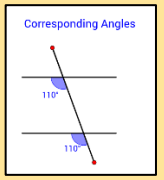

## Cosine Curve

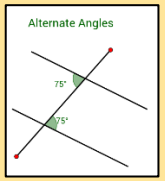


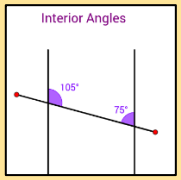

## Tangent Curve




## Angles in parallel lines



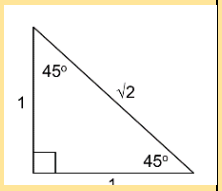

Corresponding angles are equal

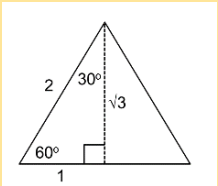
Alternate angles are equal

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 $3b = \begin{pmatrix} 12 \\ -6 \end{pmatrix}$

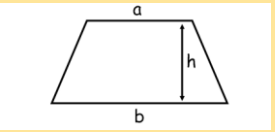
## Volume & surface area

Learn the cylinder

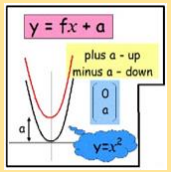
$$V = \pi r^2 h$$
$$SA = 2\pi r^2 + \pi dl$$

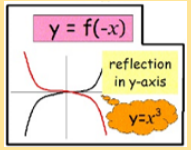
## Area of a trapezium

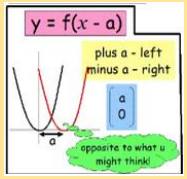
$$A = \frac{1}{2}(a+b)h$$

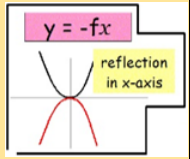



## Transformation of a graph



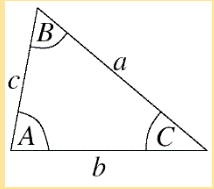




## Sine rule

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

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



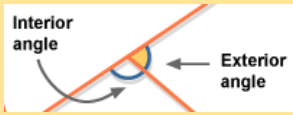

## Cosine rule

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

## Area of a triangle

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

## Angles in regular polygons



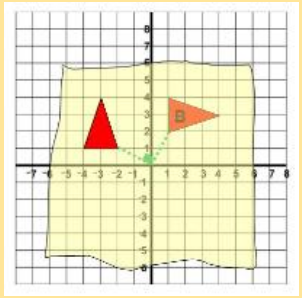

$n = number\ of\ sides$

Interior angle + exterior angle = $180^0$

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

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

## Transformations – rotation – describing:



Always use tracing paper.
Describe:

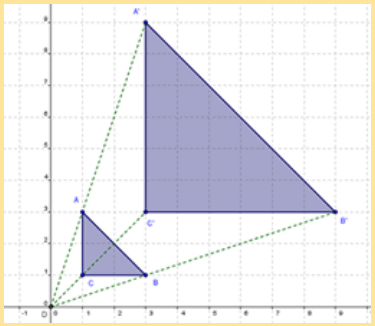
1. It's a rotation
2. Size of rotation in degrees
3. Orientations: clockwise or anticlockwise
4. Centre of rotation given as a coordinate (x,y)

## Transformation – translation

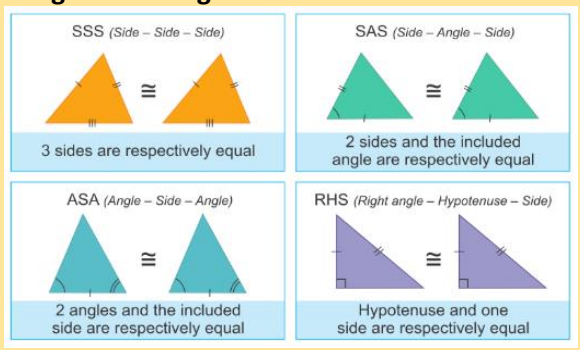
Vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$ 6 right, 4 down

## Transformations – enlargement - describing:

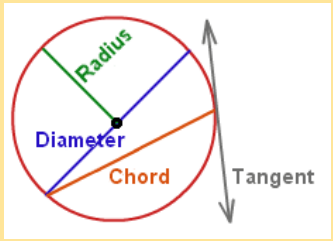
1. It's an enlargement
2. The scale factor (if the image is smaller than the object the scale factor is fractional e.g. ½)
3. The centre of enlargement given as a coordinate

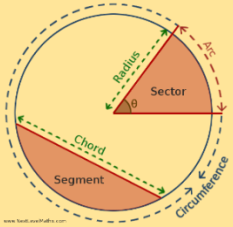


## Congruent triangles




## 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 = $x$

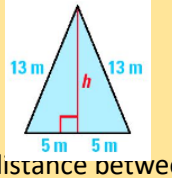
Area scale factor = $x^2$

Volume scale factor = $x^3$

## Pythagoras' Theorem

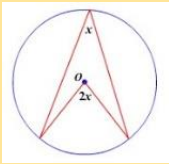
$$a^2 + b^2 = c^2$$

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

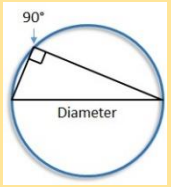



Can be used to find the length distance between two coordinates

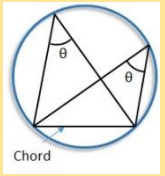
## Circle Theorems



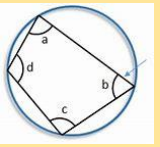

Angle at the centre is twice the angle at the circumference



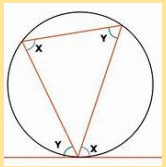

Angles in a semicircle are 90°.



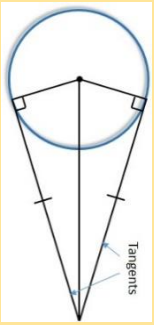

Angles in the same segment are equal.




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




Alternate segment theorem.



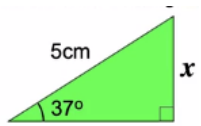

Tangents from an external point are equal in length.

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

**Trigonometry**

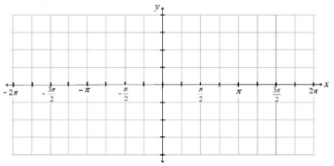
Fill the blanks: $S - C - T -$

Show how to find x:

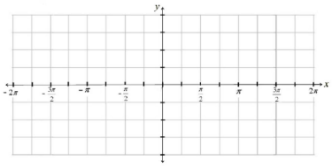



Show how to find y:

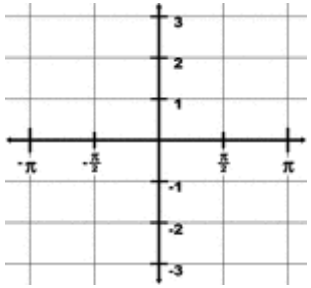

**Sine Curve**



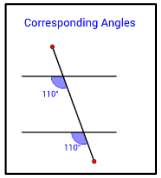
**Cosine Curve**

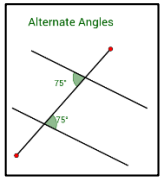


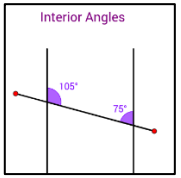
**Tangent Curve**




**Angles in parallel lines**



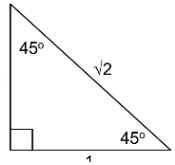

Corresponding angles are _____

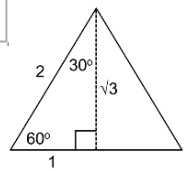
Alternate angles are _____

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**

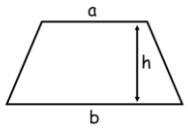
Learn the cylinder

$V =$

$SA =$

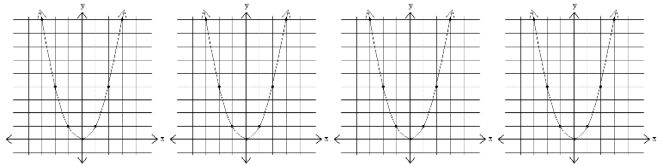
**Area of a trapezium**

$A =$




**Transformation of a graph: sketch**

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



**Write down:**

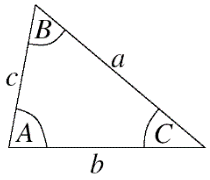
**Sine rule**

**angles**:

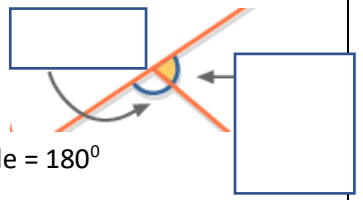
**sides**:

**Cosine rule**

**Area of a triangle**




**Angles in regular polygons**



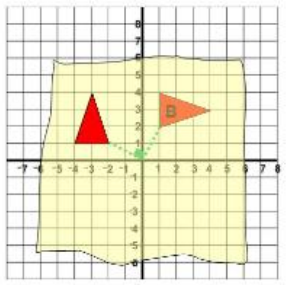
$n = number\ of\ sides$

Interior angle + exterior angle = $180^0$

Exterior angle = ——

$n =$ _____

## Transformations – rotation – describing:



Always use tracing paper.

Describe:

1.

2.

3.

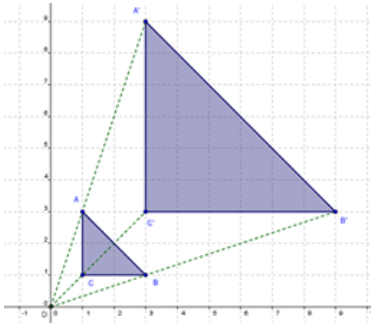
4.

## Transformation – translation

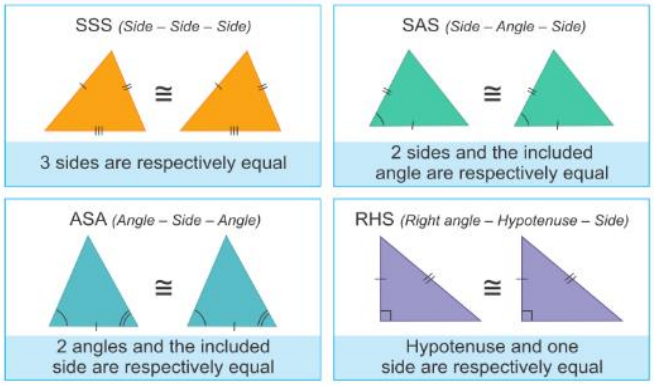
Vector $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$ 6 _____, 4 _____

## Transformations – enlargement - describing:

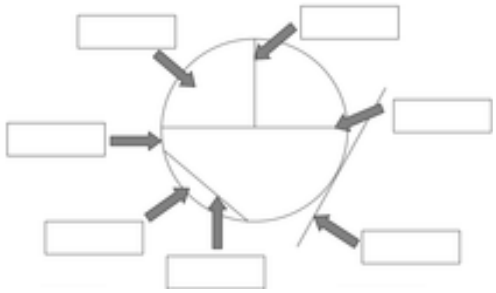
1.
2.
3.



## 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 =

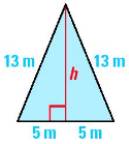
Area scale factor =

Volume scale factor =

## Pythagoras' Theorem

_____

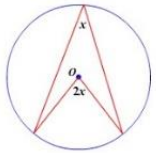
Only applies to _____ triangles.

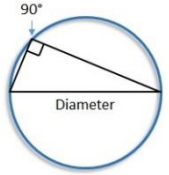


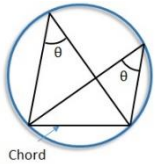

Can be used to find the height of an _____ triangle

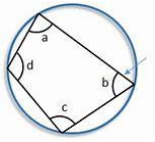
Can be used to find the length distance between two _____

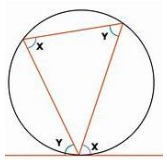
## Circle Theorems

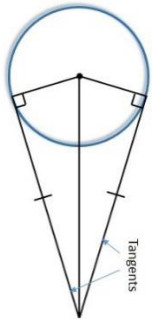


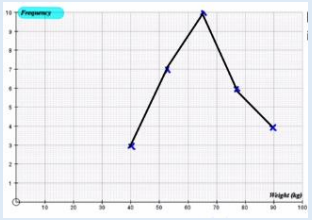



# Probability and Statistics - Higher

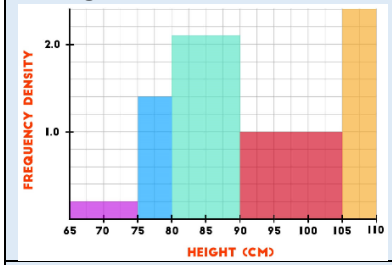
## Frequency Polygons

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 |



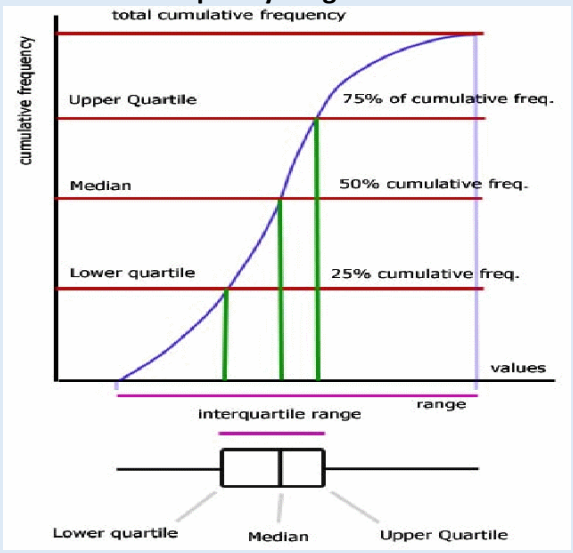
## Histograms




FD = Frequency density

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

## Cumulative Frequency Diagrams and Box Plots




## Averages from a frequency table

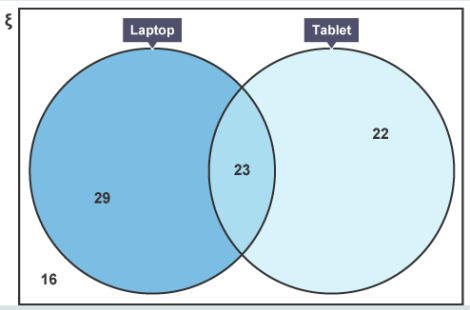
Mean: $\frac{\sum fw}{\sum f}$; where, $w$ is the midpoint of the group.

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*

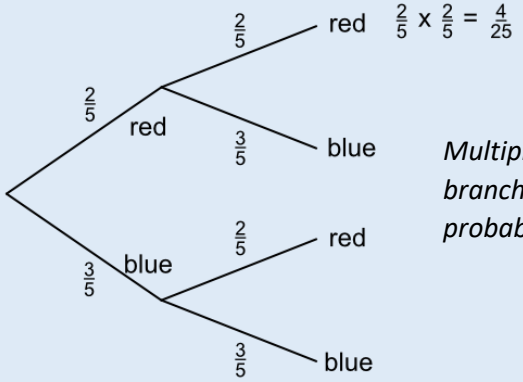
E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

| 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 |
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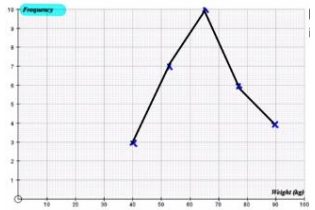

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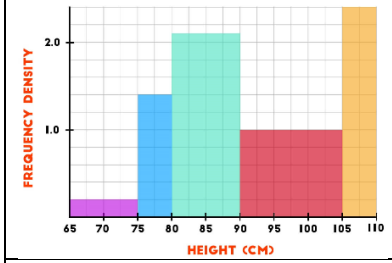
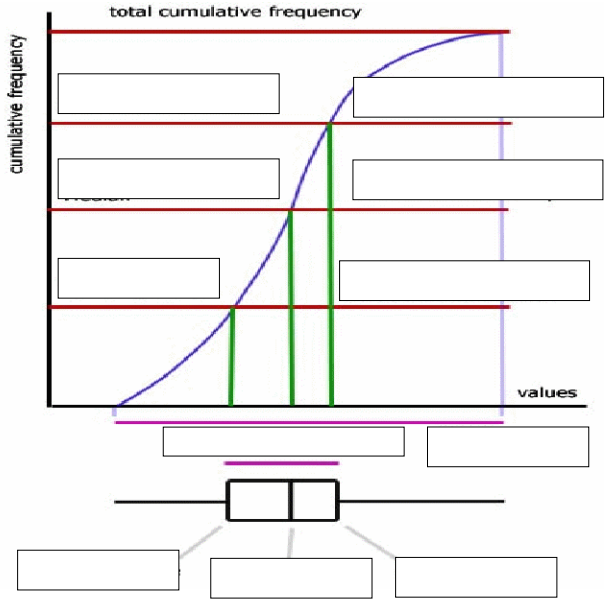



FD = Frequency density

$FD =$

## Cumulative Frequency Diagrams and Box Plots




## Averages from a frequency table

Mean: $\frac{\sum fw}{\sum f}$; where, $w$ is the _____ 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 _____ (using the cumulative frequency)

| Weight of box ($w$ kg) | Frequency |
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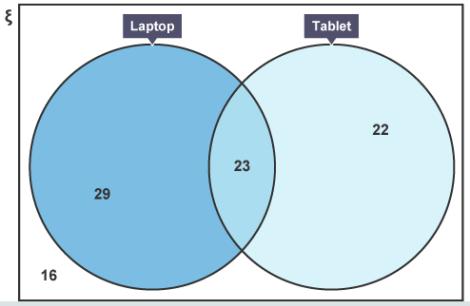
## Venn Diagrams




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 _____*

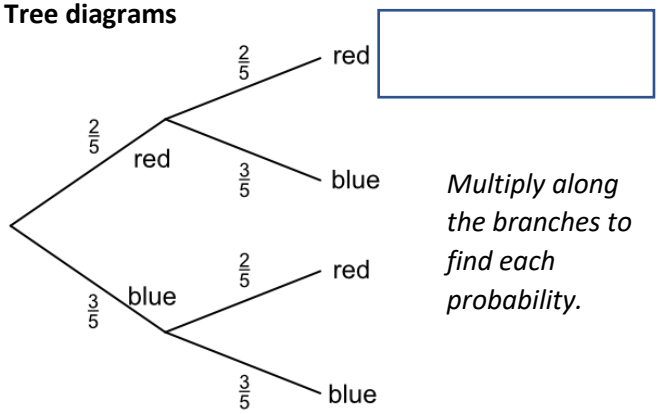
E.g. A biased spinner is spun 800 times. The probabilities is lands on each colour is below. The probability of it landing on red is the same as the probability of it landing on green. How many times would you expect yellow to come up.

| Result | Red | Green | Brown | Yellow |
|---|---|---|---|---|
| Probability | | 0.48 | 0.2 | |

P(Y) =

Expected yellow =

## Tree diagrams



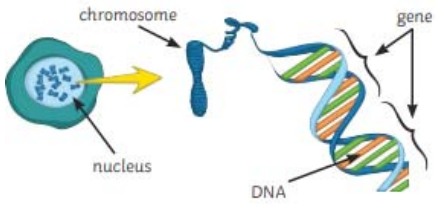

*Multiply along the branches to find each probability.*

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

4. Probability that the counters are different colours =

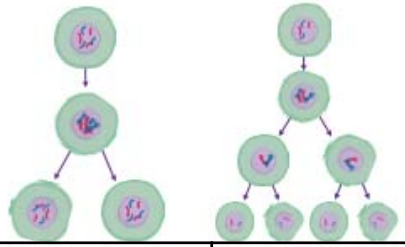
# Science B6 – Inheritance, Variation and Evolution

## Cells and cell division




The chromosomes are in the nucleus of cells
Humans have 46 chromosomes.
Chromosomes contain genes, which code for proteins.
In body cells, chromosomes are in pairs – one from each parent.
In sex cells (gametes) they are not in pairs and there is half the number of chromosomes (e.g. 23 in humans)

## Cell division – two types:



| Mitosis (in all body cells) | Meiosis (in testes and ovaries) |
|---|---|
| 2 daughter cells | 4 daughter cells |
| Daughter cells = genetically identical | Daughter cells = not genetically identical |
| Cell divides once | Two divisions |
| Daughter cells **have same number** of chromosomes as original cell | Daughter cells **have half** the chromosomes as original cell |
| Used for growth and repair. | Produces gametes for sexual reproduction |

## Reproduction

Two types of reproduction – sexual and asexual.

| | Sexual | Asexual |
|---|---|---|
| **Number of parents** | 2 | 1 |
| **gametes used?** | Yes | no |
| **Variation in the offspring** | lots | None (unless mutations occur) Offspring are clones |

## Sexual reproduction

The sperm and egg have half of the genes for the offspring. (in humans 23 chromosomes)
At fertilisation, the sperm and egg nuclei join. (23 + 23 = 46 chromosomes)

There are two genes for any one characteristic – one on the chromosome from mum and one from Dad
Different forms of the same gene are called **alleles**
If the alleles are the same, the person is **homozygous**
If the alleles are different the person is **heterozygous**

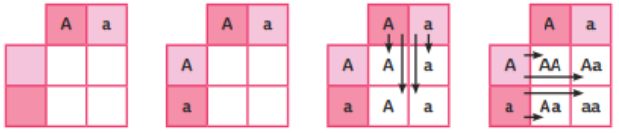
**E.g.:**
**B = brown hair (dominant)**
**b = red hair**

BB = homozygous, brown hair
Bb = heterozygous, brown hair
bb = homozygous, red hair

Gene from each parent

## How to complete a punnet square

If A = blue eyes, a = green eyes
Calculate the probability of two heterozygous people having a green eyed child




Step 1
Put one parents alleles into the boxes at the top

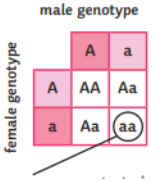
Step 2
Put the other parents alleles into the boxes down the side

Step 3
Write the alleles from parent one in all boxes underneath

Step 4
Put the alleles from the second parent into the boxes to the right

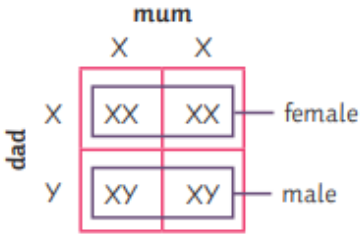
### Probability

A green eyed child would have aa genotype.




One of these four has the type aa – that's ¼ , 25% or 0.25.

## Sex Determination




**Fem**ales carry two X chromosomes (XX)
Males carry one X and one Y chromosome (XY)
50% chance of male and female.

# Science B6 – Inheritance, Variation and Evolution

1. Put these in order from smallest to biggest:

   Allele, Cell, Chromosome, Gene, Nucleus

2. What are the two types of cell division?

3. When does mitosis take place?

4. Where does meiosis take place?

5. How does the number of chromosomes in a gamete differ from those of a body cell?

6. What do genes do?

1. What are the two types of reproduction?

2. How many parents are needed for asexual reproduction?

3. What are the offspring of asexual reproduction known as?

4. What is the term for when a sperm and an egg join?

5. How many genes do we have for any single characteristic?

6. What term is used to describe a person that has two alleles that are the same for a particular characteristic?

1. What two sex chromosomes do females carry?

2. What two chromosomes do males carry?

3. What is the probability of having a boy?

4. Complete the punnet square:

| | D | d |
|---|---|---|
| d | | |
| d | | |

5. What is the chance of having an offspring with the allele pair dd?

# Science B6 – Inheritance, Variation and Evolution

## Inherited disorders

**Cystic fibrosis**
Disorder of cell membranes
Caused by a recessive allele
Causes thick mucus to form in membranes
Main organs affected are lungs, digestive & reproductive organs – pancreas and intestines.

Alveoli get blocked with mucus
Increases diffusion path so less $O_2$ gets into the blood

♂ Father

| ♀ Mother | C | c |
|---|---|---|
| C | CC | Cc |
| c | Cc | cc |

**Polydactyly**
Disorder of the hands and feet
Caused by a dominant allele
Causes extra digits, fingers and toes.

**Embryo screening**
Parents that have inherited disorders may opt for embryo screening

1. Multiple embryos are made in IVF
2. One cell is removed from each embryo
3. The cells are screened for faulty genes
4. Only embryos without the genes for disorders are transferred to the womb of the mother.

\+ Babies born free of that inherited disorder
- no guarantee child will be free of other health issues
- Many embryos are destroyed, which are potential human lives

## Variation

May be due to differences in:
- Genes that have been inherited(genetic causes)
- Conditions which they have lived in (environmental causes)

- Combination of genes and the environment.

**Mutation** = a change in the DNA during copying (randomly). Often has no effect on the gene, but sometimes leads to new proteins being made and a new characteristic being seen

## Evolution

Evolution = a change in inherited characteristics of a population over time through natural selection – could lead to a new species.
A **species** is a group of organisms that can successfully breed.
Theory of evolution states that all species have evolved from a simple life forms more than 3 billion years ago.

## Natural Selection

Described by Darwin
1. **Variation** within a species – different genes. (due to **mutation**)

2. One gene may give characteristics that are better **adapted** for survival in the environment.

3. Those with **advantageous genes** will survive and reproduce – passing genes to **offspring**.

4. Over long periods of time, all members of that species have the characteristic, may even lead to a new **species**.

## Extinction

Extinction = no remaining individuals of a species still alive on Earth.

**Factors which could cause extinction**:
- New disease
- Rapid change in environment (e.g. meteor/volcano eruption)
- New predators
- New competitors (often man)

## Evidence for evolution

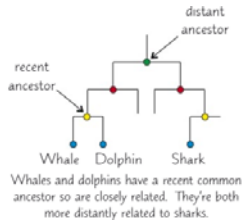
### Fossils

Fossils are the **remains of plants or animals** from **millions of years ago:**
They are formed in different ways:
- Remains of an organism that has not fully decayed as one of the decay conditions was absent (e.g. too cold, not enough $O_2$)
- Mineralised forms of the harder parts of an organisms (such as bones)
- Traces of organisms such as footprints or burrows.

Many early life forms were **soft bodied** so have left few traces behind, as they decayed so we cannot be sure how life started on Earth. Many have been destroyed by Earth's rock cycle. Fossils help us understand how much or little organisms have changed as life developed on Earth.

### Evolutionary trees

Show how species have volved from and are related to others



## Science B6 – Inheritance, Variation and Evolution

1. What is cystic fibrosis a disorder of?
2. Is the allele for cystic fibrosis dominant or recessive?
3. Why do cystic fibrosis sufferers struggle to get oxygen into the body?
4. What is polydactyly?
5. Is the allele for polydactyly dominant or recessive?
6. Give one advantage of embryo screening
7. Give one disadvantage of embryo screening

1. What are the two causes of variation?
2. What is a mutation?
3. Which scientist proposed the theory of evolution by natural selection?
4. What is the theory of evolution?
5. What is a species?
6. Why do mutations sometimes lead to new characteristics being seen?

1. What does 'extinct' mean?
2. What are fossils?
3. Describe one way fossils can form
4. What do fossils show us?
5. Why is the fossil record incomplete?
6. What factors can cause extinction?

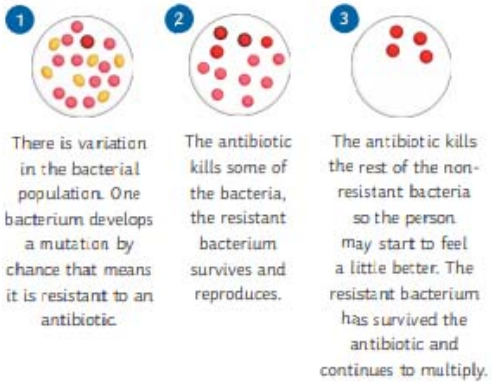
# Science B6 – Inheritance, Variation and Evolution

## Resistant Bacteria

- Bacteria **evolve** rapidly as they reproduce at a fast rate. (reproduce approx. every 20 mins)
- Mutations of bacteria can produce new strains.

- Some strains are **resistant** to antibiotics (so are not killed).
- They **survive** and **reproduce** – population of resistant strain rises.
- Resistant strain will spread because people are not **immune** and there is no effective treatment.

- **MRSA** is **resistant** to antibiotics.




**How to reduce antibiotic resistant strains:**

- Doctors should not prescribe antibiotics for viral infections

- Patients must complete courses of antibiotics

- Agricultural use of antibiotics should be restricted.

## Genetic Engineering

- Process which involves modifying the **genome** of an organism by introduction a gene from another organism to give a **desired characteristic**.

**Uses of genetic engineering:**

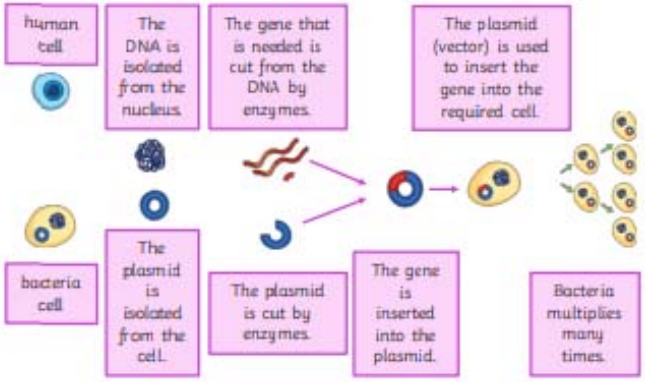
- Plant crops to be **resistant** to diseases or produce bigger, better fruits.

- Bacteria cells to produce useful substances, such as human insulin to treat diabetes.

**Genetically modified (GM) crops**

| Advantages | Disadvantages |
|---|---|
| Resistant to insect attack | Not sure on long term effects when eating GM crops |
| Produce increased yields | Could affect populations of wild flowers and insects |

## Process of Genetic Engineering (HT only)

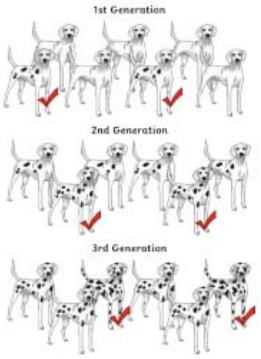



## Selective Breeding

- Process which humans breed plants and animals for particular **genetic characteristics**.

**Steps of selective breeding:**

1. Choose a male and female with **desired characteristics.**




2. Breed together

3. Pick the offspring which have the desired characteristic and breed together.

4. Continue over many generations, selecting the best offspring each time, until all offspring show desired characteristics.

## Classification

Linnaeus classified things into: Kingdom, phylum, class, order, family genus and species.

Organisms are named by the **binomial system** of genus and species. (2 names)

Due to evidence from chemical analysis, there is now a 'three-domain system' by Carl Woese:

| **Domain** | bacteria | archaea | eukaryota | | | |
|---|---|---|---|---|---|---|
| **Kingdom** | eubacteria | archaebacteria | protista | fungi | plantae | animalia |

# Science B6 – Inheritance, Variation and Evolution

1. Why do bacteria evolve rapidly?
2. What can cause new strains of bacteria?
3. Name a bacteria which is resistant to antibiotics.
4. What are the three ways to reduce antibiotic resistance strains?

1. What is genetic engineering?
2. State two uses of genetic engineering.
3. What does ‘GM’ stand for?
4. State two advantages of GM crops.
5. State two disadvantages of GM crops.
6. Describe the stages of genetic engineering (HT only).

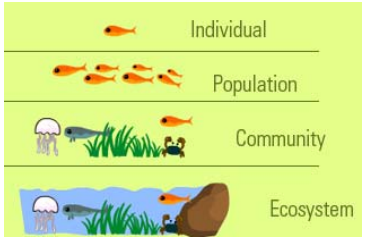
1. 1. What is selective breeding?
2. Describe the four stages of selective breeding.
3. Why might a characteristic be chosen?
4. Give 3 examples of characteristics humans may choose.

1. How did Linnaeus classify organisms?
2. What are Carl Woese’s three domains?
3. What does ‘binomial’ mean?

# Science B7 – Ecology

## Ecosystems

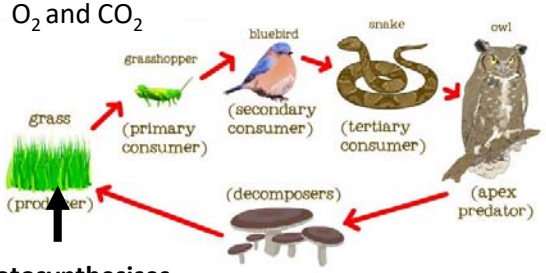
An ecosystem is all the living organisms within an area (community) plus the physical habitat




## Interdependence

Organisms rely on each other for…

- Food
- Shelter / nesting sites
- Seed dispersal
- $O_2$ and $CO_2$



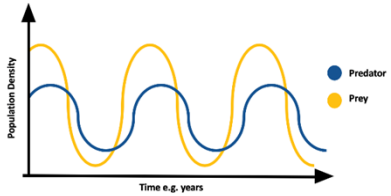

**photosynthesises**

## Biotic and Abiotic Factors

Factors that affect the number of organisms

| Biotic – living | Abiotic – non-living |
|---|---|
| • availability of food<br>• new predators arriving<br>• new pathogens<br>• one species outcompeting another so the numbers are no<br>• longer sufficient to breed. | • light intensity<br>• temperature<br>• moisture levels<br>• soil pH and mineral content<br>• wind intensity and direction<br>• carbon dioxide levels for plants<br>• oxygen levels for aquatic animals. |

## Predator-Prey Relationships




Population increases and decreases follow similar pattern in a cycle because they affect each other – more prey = more food for predator.

However predator and prey not 'in phase', e.g. predator population changes are delayed as it takes time for the predator population to grow.

## Competition

| Plants | Animals |
|---|---|
| Light<br>Space<br>Minerals ions<br>Water | Food<br>Mates<br>Territory |

## Plant adaptations

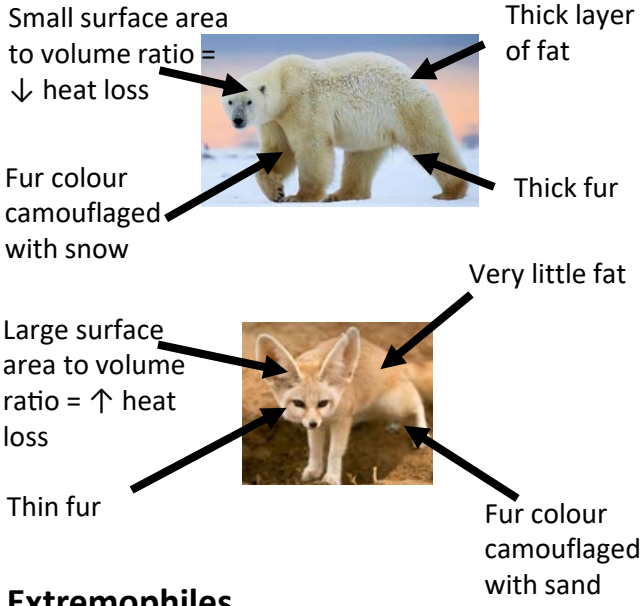
Plants in desert areas have :

- deep roots to maximise water uptake
- thin/no leaves to minimise water loss
- Spines to stop them being eaten

## Animal Adaptations

Can be:

- Structural – a feature of the organism's body (e.g. thick fur, bright colours, camouflage)
- Behavioural – responses from the organism (e.g. hibernation, migration, huddling together)
- Functional – a body process (e.g. camel breaking down hump of fat into water, producing little urine




## Extremophiles

Extremophiles are organisms that live in extreme environments.
Extreme environments = high temperatures, high pressure or high salt concentration.

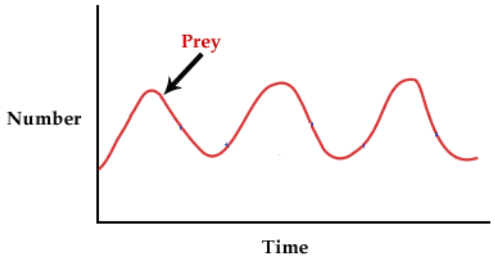
E.g. bacteria living in deep sea vents = extremophiles.

# Science B7 – Ecology

## Ecosystems

1. What is a community?
2. What is an ecosystem?
3. Give two things that animals rely on plants for
4. Give two things that plants rely on animals for
5. What is the term given to the predator at the very top of a food chain?
6. Why are green plants known as producers?
7. Name two biotic factors that can affect organisms within a habitat
8. What does the term 'abiotic' mean?
9. Name two abiotic factors

1. Name two things plants compete for
2. Name two things animals compete for
3. Sketch the line to show how the predator population would change on the graph below

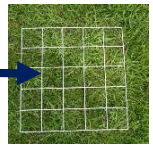



4. Why do some plants have spines instead of leaves?
5. Name two ways plants are adapted for living in desert climates.

1. Name the three types of adaptations
2. Name one behavioural adaptation
3. How are animals adapted to live in cold climates?
4. What are extremophiles?
5. What is the surface area : volume ratio like on desert animals?
6. Give an example of an extremophile

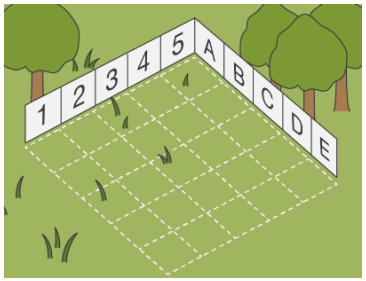
# Science B7 – Ecology

## RP7 – Estimating Populations Part 1



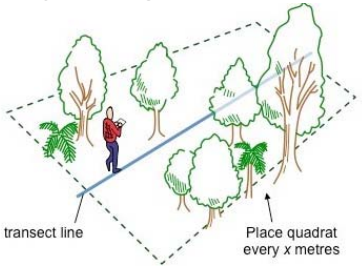

1. Calculate area of site.
2. Divide site up into a numbered grid
3. Use a random number generator to pick coordinates.
4. Randomly throw the 0.25m$^2$ quadrat at those coordinates.
5. Count the number of particular organism in the quadrat.
6. Repeat steps 3-5 **ten times (minimum).**
7. Calculate mean number of organism.
8. Calculate estimated number organism in site using the following equation

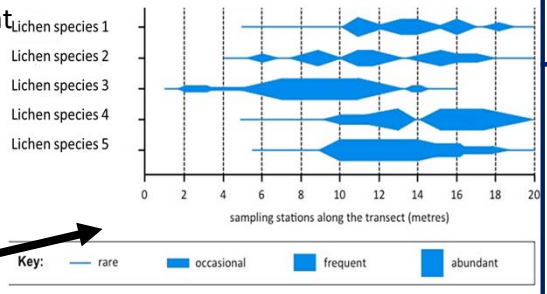
$$\frac{area\ of\ site}{area\ of\ quadrat}\ x\ mean$$



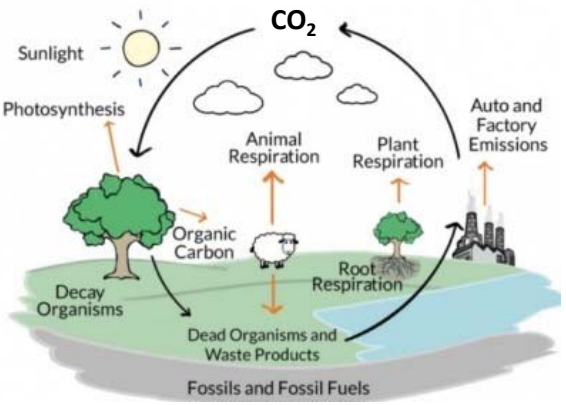

## RP7 – how populations may change over a distance

1. Place tape measure (a transect line) through ecosystem being investigated.
2. Place quadrat at regular, random intervals along the transect line and count the number of particular organisms.
3. Draw a distribution graph of your results. (They might look like this.)

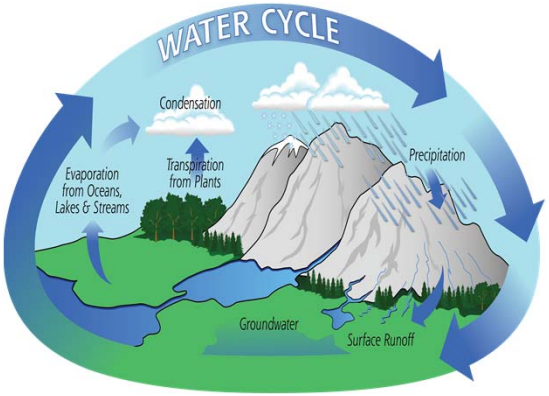



## The Carbon Cycle




## The Water Cycle




## Human Impact on Biodiversity

| | |
|---|---|
| Waste management | Rapid growth in the human population = more resources are used and more waste is produced – this contributes to pollution. Can occur in water, in air and on land. |
| Land Use | Humans reduce the amount of land available for other animals and plants by building, quarrying, farming, dumping waste and the destruction of peat bogs. |
| Deforestation | In tropical areas it has occurred to provide land for cattle and rice fields or grow crops for biofuels. |
| Global Warming | Levels of carbon dioxide, methane and water vapour in the atmosphere are increasing, and contribute to 'global warming'. |

## Decay

Microbes such as fungi and bacteria break down dead or dying material. This returns carbon to the atmosphere as carbon dioxide and mineral ions to the soil.

## Maintaining Biodiversity

- breeding programmes for endangered species
- protection of rare habitats
- reintroduction of hedgerows
- reduction of deforestation and $CO_2$ emissions
- increased recycling to avoid landfill

# Science B7 – Ecology

1. What is the minimum number of times the organism should be counted when estimating population size?
2. What is a quadrat?
3. What is the equation used to estimate population size?
4. How can you ensure the quadrat is randomly placed throughout the site?

1. What is a transect line?
2. What is a transect line used to investigate?
3. How is the quadrat placed?

1. Which process takes carbon into plants?
2. What do plants make with the carbon (and water)
3. Name 2 process that releases carbon into the atmosphere as carbon dioxide.
4. What happens to carbon that gets trapped deep underground for millions of years?
5. By which process do plants return water from the ground to the air?

1. Why has large scale deforestation occurred in tropical areas?
2. Name two ways humans use land that reduces biodiversity.
3. Which three gases contribute to global warming?
4. Name 3 types of pollution.

1. Which types of microbes cause decay?
2. What can decay release into the environment?

1. What has been done to prevent some species from becoming extinct?

# Science C10 – Using Resources

## Earth's Resources

We use Earth's resources to provide **warmth, shelter, food and transport**. E.g.:

- metals from the Earth's crust to build buildings and cars
- Timber and oil to burn for warmth
- Crop plants for food
- Products from crude oil to serve as fuels in cars, trains and planes

**Finite resources** – ones that will run out as they are being used much faster than they can be replaced, e.g. oil

**Renewable resources** – resources that will not run out, e.g. wood, wind etc.

Chemistry plays an important part in finding improvements or alternatives to current resources.

| Natural | Improved or replaced by…. |
|---|---|
| Wood for furniture | Plastic/polymers |
| Food crops | Fertilisers/artificially grown foods such as Quorn |
| Oil for fuel | Ethanol/hydrogen fuel cells |
| Rubber for tyres | Polymers |

## Life-Cycle Assessments (LCA)

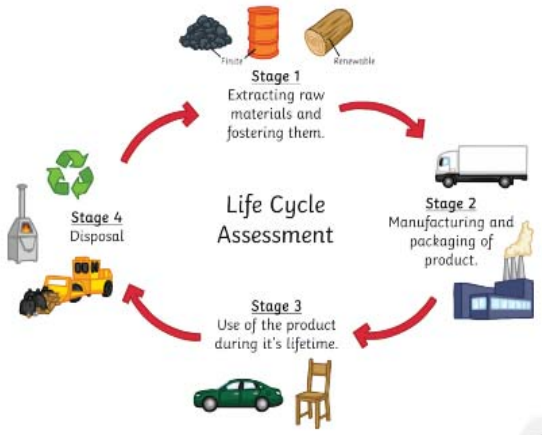
- These assess the environmental impact of a product in these stages:

**Stage 1 – extracting raw materials needed to make products.**
- Energy cost and effect on habitats of extraction
- Are the raw materials finite/renewable?

**Stage 2 – Manufacturing and packaging product**
- How much energy and resources are needed?
- What waste products/pollution are released?
- Transportation of goods from factors to user need considering.

**Stage 3 – Use of product during its lifetime**
- E.g. a car has a significant impact as needs filled up with petrol which is a finite resource.

**Stage 4 – Disposal at end of product's life.**
1) Landfill – high environmental impact
2) Incineration – burning of product
3) Recycling – e.g. batteries contain metals that are harmful to environment – recycling means no new compounds need to be taken out of the ground.




## Example LCA for plastic vs paper bags:

| Stage of Life Cycle Assessment | Plastic Bag | Paper Bag |
|---|---|---|
| Stage 1 – raw material | Uses finite resource. Process of fractional distillation, cracking and polymerisation all require energy. | Made from trees/recycled paper. Making paper from trees required more energy than recycled paper. Less energy than plastic bags. |
| Stage 2 – Manufacture | Cheap to make | More expensive to make |
| Stage 3 – Use | Low environmental impact as can be re-used many times. Much stronger product. | Only be reused a limited number of times – short lifetime. |
| Stage 4 - disposal | Do not biodegrade easily in landfill. | Paper bags degrade easily in landfill sites. |

- Different people have different opinions and so depends on who completes the LCA. Bias may be added.
- Some companies may only discuss some of environmental impacts of their product.
- Accurate numerical values should be used where possible – for example to show how much energy has been used.

# Science C10 – Using Resources

1. What are the 4 main uses of the Earth's materials?

2. What is a renewable resource?

3. What is a finite resource?

4. Give an example of a finite resource

5. Give an example of a renewable resource

6. Give an example of a natural product that has been replaced by modern chemistry or farming.

1. What does LCA stand for?

2. What does an LCA assess?

3. What are the 4 stages that are assessed in an LCA?

4. Suggest one environmental impact of extraction of raw materials such as metals or oil.

5. Name two ways products are disposed of at the end of their 'life'

1. Why might an LCA be inaccurate?

2. What are the raw materials for a
a) paper bag
b) plastic bag

3. Why might the disposal of a plastic bag have a greater environmental impact than the disposal of a paper one?

# Science C10 – Using Resources

## Reducing the use of resources

Metals, glass, ceramics, building materials and most plastics are produced from limited resources.

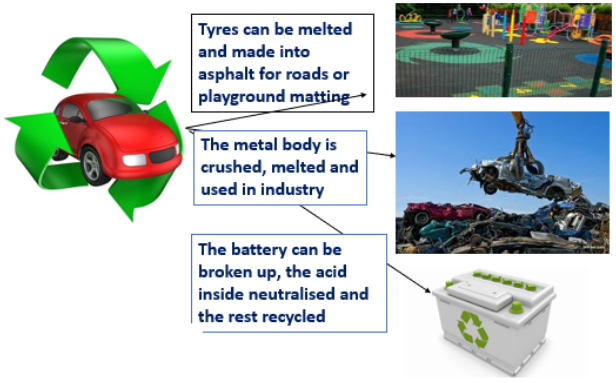
The energy for the processes involved in making/extracting raw materials also comes from limited resources – e.g. oil.

We can reduce the use of limited resources by reducing use, reusing materials and recycling materials at the end of their life.

**Reduce, reuse, recycle.**

E.g.

- Glass bottles can be reused.
- Metals can be melted down and recast and so recycled.
- Scrap steel can be added to extracted iron to reduce the amount of iron that has to be extracted in the blast furnace.




## Evaluating methods to reduce, reuse, recycle

| Advantages | Disadvantages |
|---|---|
| Fewer resources such as mines and quarries are needed to extract finite materials | Requires collection and transport of items – involving staff, vehicles and use of fuel |
| Crude oil does not need to be extracted – avoids high energy costs for fractional distillation etc. | Materials, such as metals, very often have to be separated from other materials first |
| Less greenhouse gases produced. | Some metals need melting before being reused – energy costs. |
| Less items in landfill | |

## Biological extraction techniques (HT only)

- Earth's supply of metal ores is limited.
- There are fewer sites that give lots of copper (high grade ore sites)
- New ways of extracting from low grade ore sites are:

- Phytomining
- Bioleaching

Disadvantage = **slow processes**

Advantage = reduce need for the traditional mining methods of digging, moving and disposing of large amounts of rock.

## Phytomining (HT only)

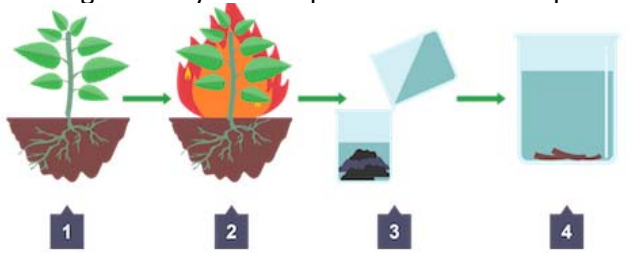
1) Plants are grown on a low-grade ore

2) The plants absorb metal ions through their roots

3) The plants are harvested and burnt

4) Ash left behind contains metal compounds

5) Ash is dissolved in acid and copper is extracted using electrolysis or displacement with scrap iron.




## Bioleaching (HT only)

- Uses **bacteria** to produce a solution called **leachate** – contains copper ions.
- The copper can be extracted by using iron to **displace** the copper from the leachate.

- Does not need high temperatures
- Produces **toxic substances** which can damage the environment.

- Iron is cheaper than copper – use of scrap iron is a cost-effective way to produce copper from leachate.

- Can also undergo **electrolysis** to produce copper.

# Science C10 – Using Resources

1. Give three ways we can reduce our use of limited resources.
2. Give an example of a product that can be reused
3. What has to be done to metals before they can be recast?
4. How is scrap iron used to reduce the amount of iron needing to be extracted?

1. State two advantages of recycling.
2. State two disadvantages of recycling.

1. What is a ‘high grade ore’ site?
2. Name the two biological extraction techniques
3. State a disadvantage of biological extraction techniques.

1. What organisms are used in phytomining?
2. What happens to the plants once they’ve grown?
3. What is used to displace the copper ions from solution?
4. What organisms are used in bioleaching?

# Science C10 – Using Resources  Water

## Potable Water

- Water is **essential** for life.
- **Potable water is** water that is safe to drink.
- Potable water is not pure as it contains some dissolved substances.

In the UK – rain water provides water with low levels of dissolved substances that collects in the ground and in lakes and rivers. This is fresh water.

Most potable water is produced by:
1) Choosing an appropriate source of fresh water
2) Passing the water through filter beds
3) Sterilising to kill bacteria

Sterilising agents used for potable water include:
- Chlorine
- Ozone
- Ultraviolet light

## Desalination of Sea Water

- **Potable** water can be made from sea water through desalination.
- Required a lot of **energy** to **remove salt** in sea water.

Can be done by:

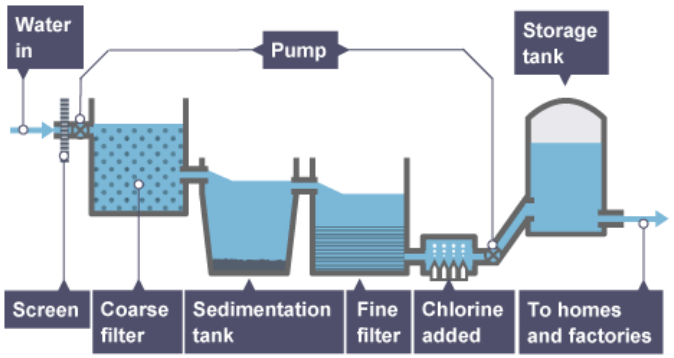
**Distillation**
- Sea water heated until it boils
- Steam is **condensed** to make potable water
- Requires a lot of **energy**

**Reverse Osmosis**
- Water put under **high pressure** and passed through **membrane** with tiny holes in.
- Holes allow water through but not salt/ions
- Very **expensive**
- Produces **large volumes** of waste water.

## Waste Water Treatment

- Waste water needs to be treated before being released back into environment

**Pollutants** can be present in waste water including:
- Human waste contains harmful **bacteria** and nitrogen – can harm aquatic ecosystems.
- Industrial waste can contain **toxic** substances
- Agricultural waste water can contain **fertilisers** or **pesticides** – disrupt ecosystems.




**Sewage treatment involves:**

1) Screening and grit removal to remove large particles

2) Sedimentation – allows tiny particles to settle – produces sewage sludge and effluent (liquid that remains on the top)

3) Sewage sludge is digested anaerobically by specific bacteria

4) Effluent is treated with aerobic bacteria to reduce volume of solid waste.

# Science C10 – Using Resources

1. What is potable water?

2. What is fresh water?

3. Where does fresh water collect in the UK?

4. After finding an appropriate source of water, what two stages are needed to make it potable?

5. What are the 3 methods of sterilising water?

6. Why is water treated with chlorine?

1. How can potable water be made from sea water?

2. Give a disadvantage of this technique.

3. Describe the process of distillation.

4. Describe the process of reverse osmosis.

1. State three pollutants that may be present in waste water.

2. Complete the table to explain the steps in treating waste water.

| **Step** | **Explanation** |
|---|---|
| Screening | |
| Sedimentation | |
| Anaerobic digestion | |
| Aerobic digestion | |

# Science C10 – Using Resources – Required Practical – Analysis and purification of water

## Analysing the pH of Water Samples

- Test pH of each water sample using pH probe or universal indicator.
- Compare to pH chart if using universal indicator

## Analysis the Mass of Dissolved Solids

1) Measure out 50 $cm^3$ of water sample using measuring cylinder.

2) Take the mass of evaporating basin using top pan balance.

3) Heat the sample in the evaporating basin gently until all liquid evaporates.

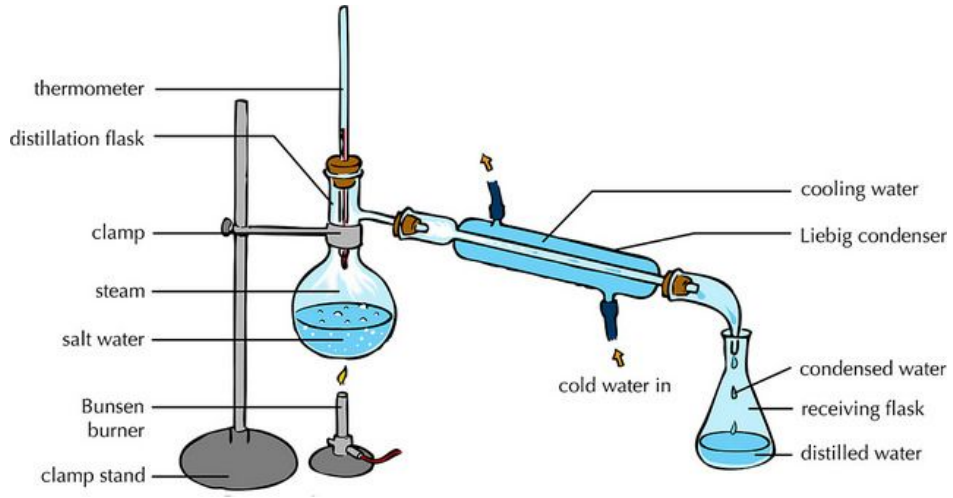
4) Let the evaporating basin cool

5) Re-take the mass of the evaporating basin.

6) Calculate the mass of the solid left behind by doing: final mass – initial mass.

7) Repeat with different water samples (e.g. rainwater, salt water, spring water)

## Distillation of water Sample




1) Set up apparatus as shown in picture with the sample of water in the round bottom flask.

2) Heat water sample until it boils gently.

3) Water vapour enters the tube at the side (condenser)

4) There is cold water surrounding the tube

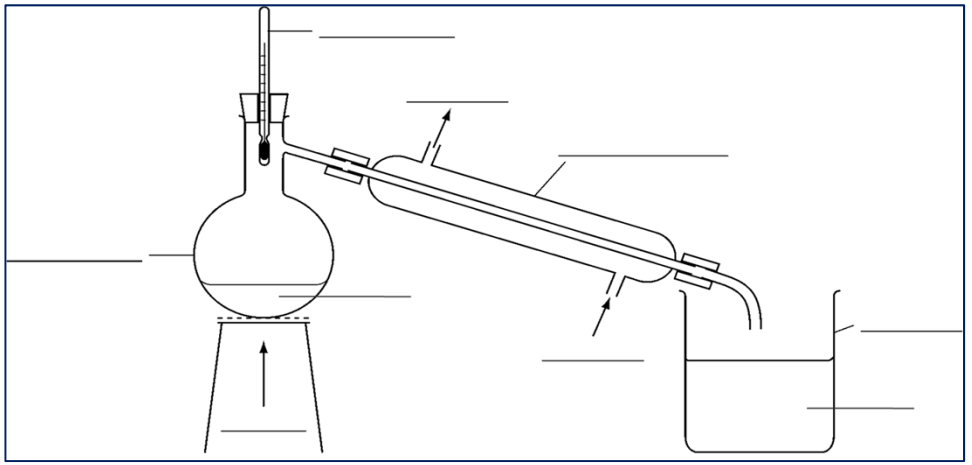
5) The water vapour cools and condenses and collects in the flask.

6) The water collected should be **pure**.

# Science C10 – Using Resources – Required Practical – Analysis and purification of water

1. Write a method of how to investigate the mass of solids in different samples of water.

1. Label the diagram below to show how to purify salt water.



Bunsen, water sample, water, beaker, condenser, water in, water out, thermometer, round bottom flask

2. What is the name of this technique?

3. What two changes of state happen during this?

4. Describe the water that is collected in the beaker

# Science C7 – Organic Chemistry

## Crude oil

Crude oil = a mixture of **hydrocarbons.**

- It is a **non-renewable resource (fossil fuel)**
- Made from remains of dead sea creatures **compressed** over millions of years

**Hydrocarbons -** molecules containing **hydrogen** and **carbon only**.

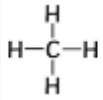
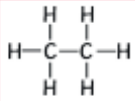
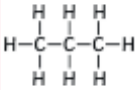
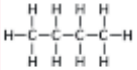
Two types of hydrocarbons are **alkanes** and **alkenes**.

The hydrocarbons in crude oil are mostly alkanes.

## Alkanes

- Alkanes = **saturated** hydrocarbons.
- Held together by **single covalent bonds**.
- General formula = $C_nH_{2n+2}$
- Have different boiling points – longer the chain, higher the boiling point

**You need to remember the names, and formulas of the first 4 alkanes.**

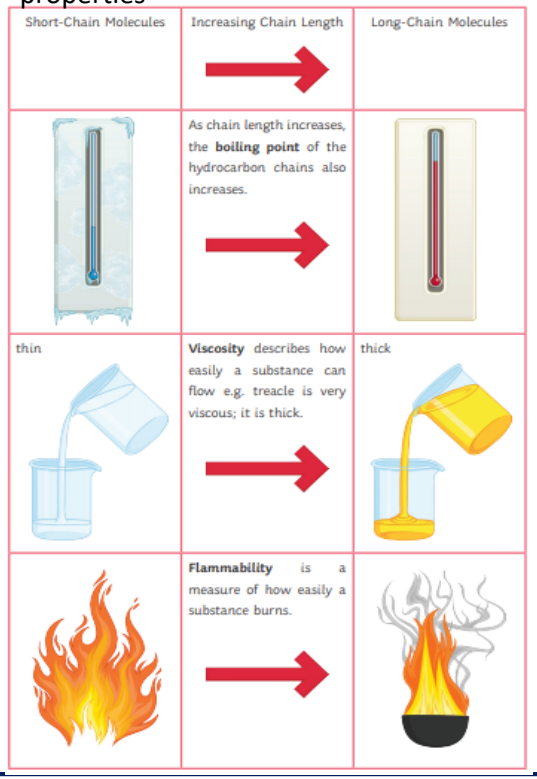
| Name of Alkane | Structural Formula | Molecular Formula |
|---|---|---|
| methane |  | $CH_4$ |
| ethane |  | $C_2H_6$ |
| propane |  | $C_3H_8$ |
| butane |  | $C_4H_{10}$ |

## Fractional Distillation

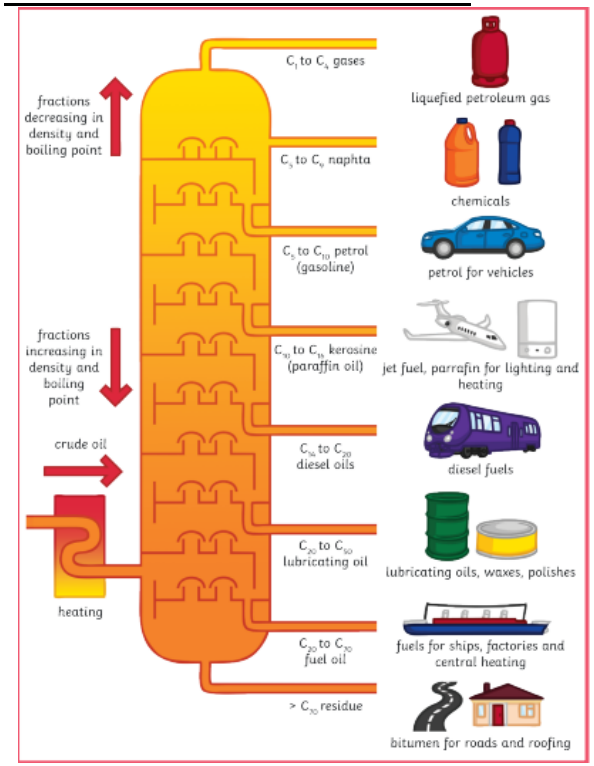
- Used to **separate** the mixtures of hydrocarbons in **crude oil**.

**Steps in Fractional Distillation**

1. Crude oil enters **fractioning column** and is heated to boiling point so the hydrocarbons evaporate.
2. It is **cooler** at the **top** of the fractionating column and **hotter** at the **bottom**.
3. Vapours rise up the column and, as they rise, they cool
4. The different hydrocarbons condense at different **boiling points**
5. The different 'fractions' have different properties




## Uses of the different fractions




## Supply and demand

| Product | Supply in tonnes | Demand in tonnes |
|---|---|---|
| petrol | 100 | 300 |
| diesel | 200 | 100 |
| heating oil | 250 | 50 |

After fractional distillation, we find:

- we have more of the long chain hydrocarbons than we need
- There are not enough short chain hydrocarbons.
- Short chain are more useful as they are more flammable so can be used as fuels.

## Science C7 – Organic Chemistry

1. What is crude oil?
2. What is a hydrocarbon?
3. What type of hydrocarbons are alkanes?
4. State the general formula for alkanes.
5. Name the first four alkanes.
6. What sort of bonding is found in hydrocarbons?

1. What is the name for the process that results in the separation of the fractions of crude oil?
2. What happens to the boiling point of hydrocarbons as the chain length **increases**?
3. What happens to the viscosity of hydrocarbons as the chain length **increases**?
4. What does flammable mean?
5. What are the two changes of state that occur during fractional distillation?
6. Which physical property is used to separate the fractions?

1. What is one use for the hydrocarbons that are between 14 and 20 carbons long?
2. What is the range of lengths of hydrocarbons in fuel oil?
3. What are the smallest hydrocarbons used for?
4. What happens to the flammability of hydrocarbons as the chain length **increases**
5. What is the range of hydrocarbon lengths found in petrol?
6. What is the problem with supply and demand of the different hydrocarbon chains?

# Science C7 – Organic Chemistry

## Cracking

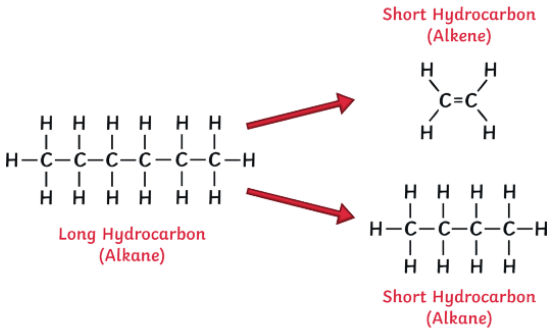
- This is done to solve the problem of having too many long chain hydrocarbons and not enough short ones
- Long hydrocarbons are **broken down** into smaller, more useful hydrocarbons.
- Short chain hydrocarbons are more useful as they are more flammable

**Two types of cracking: catalytic and steam cracking.**

**Catalytic cracking –** needs a **high temperature** and a **catalyst.**

**Steam cracking – high temperature and steam**

- Cracking produces a **short-chain alkane** and an **alkene.**




## Cracking equations

Same number of carbon and hydrogen atoms on both sides of the equation:

$C_{20}H_{42} \rightarrow C_{14}H_{30} + C_6H_{12}$

long chain hydrocarbon — shorter, more useful alkane — alkene

## Alkenes

- Alkenes are **unsaturated** hydrocarbons.
- Contain carbon-carbon **double bonds.**

## Test for Alkenes

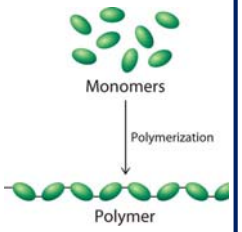
Use bromine water to test for alkenes.
If an alkene is present, the bromine water turns from orange/brown to colourless.
Alkanes do not react with bromine water.


## Uses for alkenes:

- Can be used as fuels
- Can be used as a starting material for other chemicals
- Can be used to make polymers (e.g. plastic)

## Polymers

- Polymers are large molecules made of many repeating units (monomers)
- Alkenes (small molecules) are joined together to make polymers



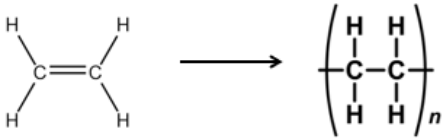

**Poly(ethene)** – plastic bags/drinks bottles

**Poly(propene)** – strong tough plastics

## Drawing and naming polymers

1. Redraw the **monomer given**, but without the double bond. Make sure to copy all other elements exactly.
2. Put brackets around the monomer and extend joining bonds out through the brackets on both sides
3. Add an 'n' at the bottom right of the bracket
4. To name the polymer, you put **poly** in front of the monomer name

E.g.:
Draw and name the polymer made from the monomer ethene:




## Combustion of Hydrocarbons

Combustion means burning.

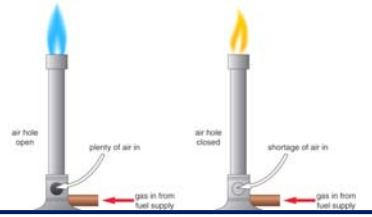
**Complete combustion -** when there is a good supply of **oxygen** for a fuel to burn.

**Fuel + oxygen → carbon dioxide + water**

**Incomplete combustion - not enough oxygen**

Products are **carbon monoxide** and water.

**Carbon monoxide = poisonous gas**



# Science C7 – Organic Chemistry

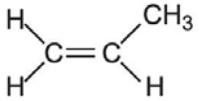
1. What is cracking?
2. Why is cracking done?
3. What are the two types of cracking?
4. What conditions are needed for catalytic cracking?
5. Complete this cracking equation by putting numbers in the boxes:

$$C_{30}H_{62} \rightarrow C_{22}H_{\square} + C_{\square}H_{\square}$$

6. What two types of hydrocarbons are formed during cracking?

1. Why are alkanes called 'unsaturated'?
2. Which chemical is used to test for alkenes?
3. What is the colour change for a positive alkene test?
4. Give two uses for alkenes
5. What are polymers?
6. What is the name for the small molecules that make up polymers?

1. What is the name of the polymer formed from the monomer butene?
2. Draw the polymer made from the monomer propene given below:




3. Name the polymer made in question 2
4. What is combustion?
5. When does incomplete combustion happen?
6. What are the waste products of complete combustion?
7. Which toxic gas is formed during incomplete combustion?

# Science C8 – Chemical Analysis

## Pure substances

Pure = single element or compound – not mixed with any other substance.

**Testing to see if a substance is pure:**
- Pure substances have specific melting and boiling points

- Compare your data to a library of known values.

E.g. Water has a boiling point of 100°C, if it is above or below this, it is not pure.

## Formulations

**Formulation =** a mixture that is designed as a useful product.

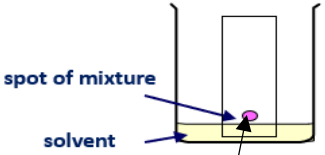
- Components mixed carefully to get the required **properties**.

Examples of formulations:
- Fuels
- Cleaning agents
- Paints
- Medicines
- Alloys
- Fertilisers
- Food

## Chromatography

- Technique used to separate mixtures of **soluble substances**.
- How soluble a substance is determines how far it travels across paper.

**More soluble = travels further (higher up paper)**

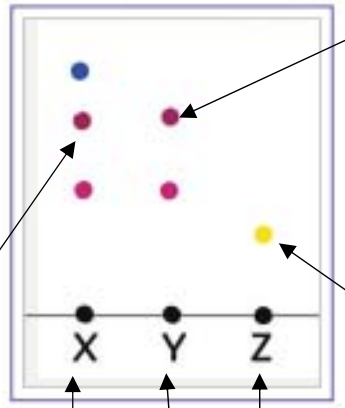



**Mobile phase**
- **Solvent** is the mobile phase
- The substances dissolve in the solvent
- The solvent then moves through the stationary phase.

**Stationary phase**
- Does not move. The paper is the stationary phase.

**Important** – start line on paper must be drawn in **pencil** as pencil is **insoluble** and **will not run**

The spot and start line must be **above the solvent line** so the colours won't just wash into the solvent in the beaker.




Y is a mixture as it contains 2 substances (2 spots)

X is a mixture as it contains 3 substances (3 spots)

Z is pure as it only contains one substance (1 spot)

Three samples (x, y and z)

## Rf Values

This is the ratio of the distance moved by a substance to the distance moved by the compound

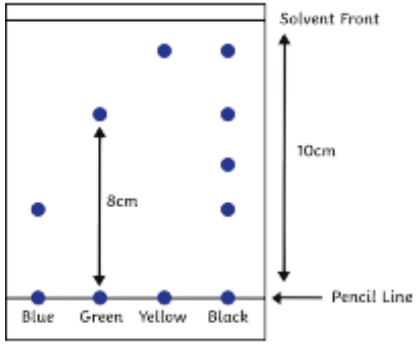
$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$

- Should always be between 0 and 1.

- Each substance has a unique Rf value.

- Can compare Rf values to a library of known substances

- Can identify unknown substances.




Rf value of green:

8cm / 10cm = 0.8

# Science C8 – Chemical Analysis

1. What is a pure substance?

2. How can you test that a substance is pure?

1. What is a formulation?

2. Give 3 examples of formulations.

1. What is chromatography used for?

2. What determines how far the substance travels?

3. What is the mobile phase in paper chromatography?

4. What is the stationary phase in paper chromatography?

5. How would you be able to identify a pure substance on a chromatogram?

6. Draw and label a diagram of the experiment to Investigate how many different colours there are in food colouring using paper chromatography.

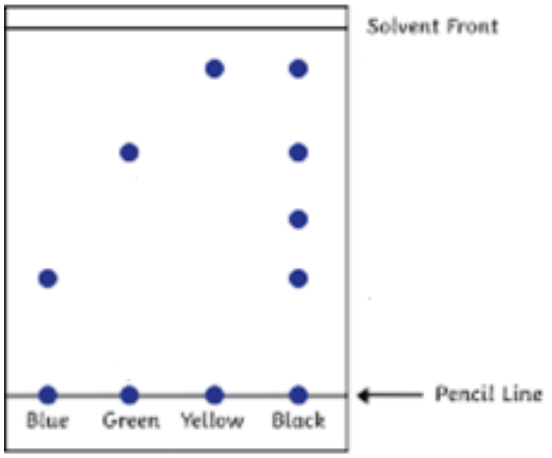
1. How do you calculate the Rf value?

2. Rf values should always be between…

3. Use a ruler to measure the distance the solvent moved in the diagram below.

4. Use a ruler to measure how far the yellow spot moved

5. Calculate the Rf value for yellow



# Science C8 – Chemical Analysis

**Required Practical – Paper Chromatography**

Aim: Investigate how paper chromatography can be used to separate and distinguish between coloured substances.

**Method**

1) Using a ruler, measure 1cm from bottom of chromatography paper and draw a line across the paper with a **pencil**.

2) Using a pipette, drop small spots of each ink onto pencil line (leave a gap so do not merge).

3) Pour solvent into a beaker, do not fill solvent above the pencil line on the paper.

4) Place chromatograph paper into beaker and allow solvent to move up the paper.

5) Remove paper just before solvent reaches top of the paper and leave to dry.

6) Calculate $R_f$ values of all the spots using the equation below:

$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$

**Common questions**

**Q1)** Why is a pencil used instead of a pen?
**A1)** Ink in the pen would move up the paper with the substances.

**Q2)** Why do you not fill the solvent above the line?
**A2)** Substances would wash off into the solvent instead of rising up the paper

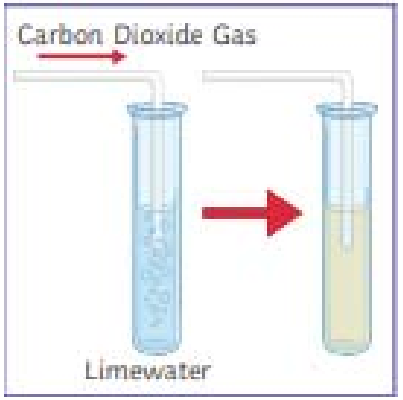
**Q3)** Why might water not work as a solvent?
**A3)** Some substances are **insoluble** in water.

## Identification of the Common Gases

**Test for hydrogen –** Place a **burning** splint at the opening of a test tube. If hydrogen gas is present, it will burn with a **squeaky-pop sound.**

**Test for Oxygen** – Place a **glowing** splint inside a test tube. The splint will **relight** in the presence of oxygen.

**Test for Carbon Dioxide** –Bubble the gas through the lime water – if the gas is carbon dioxide, the limewater turns **cloudy**.




**Test for Chlorine** – **Damp litmus paper** is held over the of gas. If the tube contains chlorine, the litmus paper becomes **bleached** and **turns white**.

## Science C8 – Chemical Analysis

1. Describe how you would carry out paper chromatography to separate and identify the different colours in food dye.

2. Why is a pencil used instead of a pen?

3. Why do you not fill the solvent above the pencil line?

4. Why might water not work as a solvent?

1. Describe the tests and the positive results for:

a) Hydrogen

b) Carbon dioxide

c) Oxygen

d) Chlorine

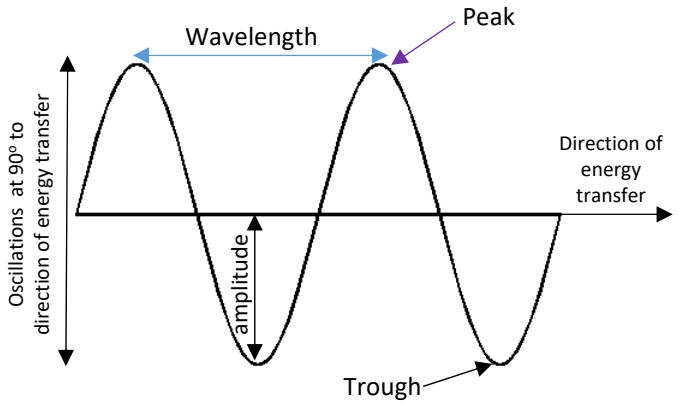
# Science P6 – Waves

## Transverse Waves

- Oscillations (vibrations) **perpendicular** to direction of energy transfer.

**Examples:**

- Electromagnetic waves
- Ripples on water.

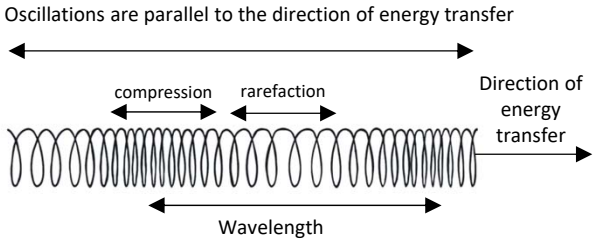



## Longitudinal Waves

- Oscillations (vibrations) are **parallel** to direction of energy transfer.

**Examples:**

- Sound waves




Sound waves have areas of compression and rarefaction.

Compression = particles pushed closer together

Rarefaction = particles are further apart

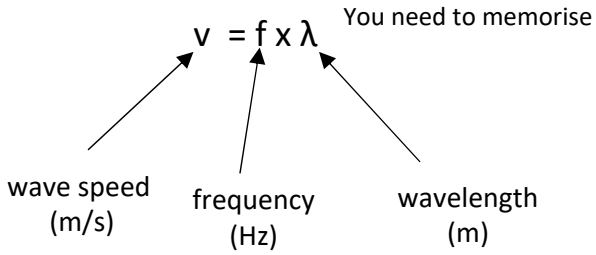
## Properties of Waves

**Amplitude –** maximum displacement from undisturbed position.

**Wavelength** – distance from a point on one wave to the equivalent point on the next wave.

**Frequency** – number of waves passing a point each second.
Frequency is measured in Hertz (Hz)
1Hz = 1 wave per second.

**Wave speed** – the speed at which energy is transferred through a medium.




## Measuring speed of sound waves in air

- Stand 50m from a large flat wall.

- One person claps/bangs bricks

- Measure time taken to hear the echo.

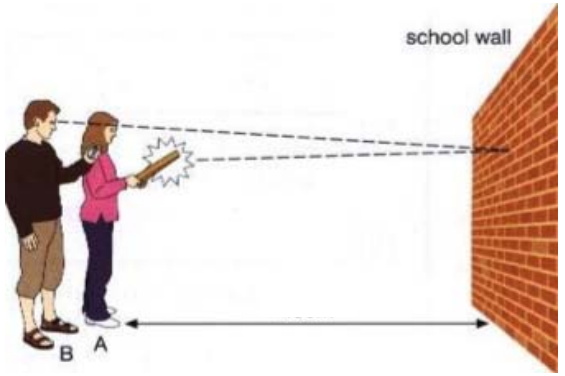
- Calculate speed of sound using:

**Speed = distance x time**

- Remember distance is double (in this case, 100m) as it travels to the wall and back.

- Take several measurements and calculate the mean to reduce error.

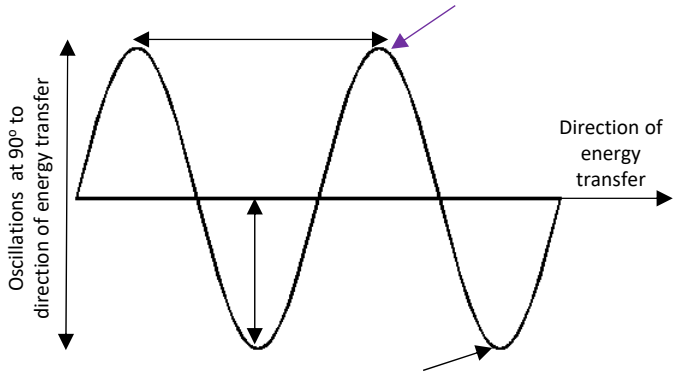
This is unlikely to produce an accurate value for sound in air (330 m/s) as the reaction time of the person operating the stopwatch is likely to be a significant proportion of the time measurement.



# Science P6 – Waves

1. How are transverse waves produced?

2. Label the wave features below.




1. Describe a longitudinal wave

2. Give an example of a longitudinal wave.

3. Label an area of compression and rarefaction in the diagram below

1. Define the following:

Amplitude

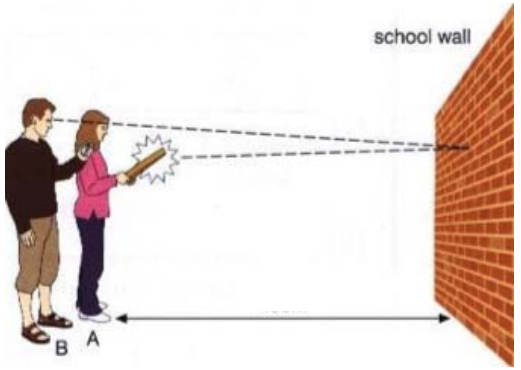
Wavelength

Frequency

2. What are the units for frequency?

3. What is the equation linking frequency, speed and wavelength?

1. Describe a method to investigate the speed of sound waves in air.

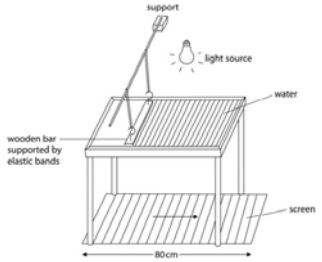



2. What is the biggest source of error in this investigation?

3. What is the speed of sound in air?

# Science P6 – Waves – Required Practical – investigating wave in a solid and a ripple tank

**Measuring waves in a liquid**




## Equipment

- Ripple tank
- Measuring ruler
- Stop watch

## Method

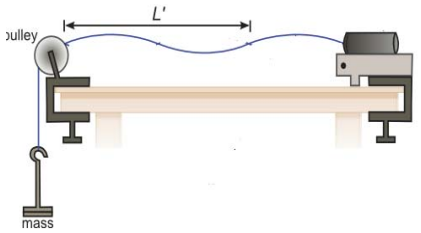
1. Set up the equipment as shown and turn on the motor to produce low frequency waves so that they are able to be counted.
2. Adjust the lamp until pattern is seen clearly on white screen underneath
3. Use a ruler to measure the length of a number of waves (e.g 10) and divide the length by the number of waves to give wavelength. This improves the accuracy of the measurement.
4. Record the waves using a camera or mobile phone. Count the number of waves passing a point in 10 seconds using a stopwatch and slowing the recording down.
5. Divide the number of waves counted by the time to give frequency.
6. Use $v = f \times \lambda$ to calculate the wave speed. Repeat for different frequencies of the motor.

| Exp | Length of 10 waves (cm) | Wavelength of 1 wave (cm) | Number of waves in 10 s | Frequency (Hz) | Speed (cm/s) |
|---|---|---|---|---|---|
| 1 | 65 | 0.65 | 121 | 12.1 | 7.9 |
| 2 | 50 | 0.5 | 155 | 15.5 | 7.9 |
| 3 | 42 | 0.42 | 187 | 18.7 | 7.9 |

**Measuring waves in a solid**

## Equipment

- string, vibration generator, hanging mass set and pulley




## Method

1. Set up the equipment as shown.
2. Turn on the vibration generator
3. Adjust the length of the string until a standing wave is achieved
4. The frequency can be read from the vibration generator
5. Measure as many complete waves as possible using a ruler
6. Divide the length by the number of waves to give wavelength
7. Calculate speed using $v = f \times \lambda$

**Conclusion:**

In both experiments, when you increase the frequency, the wavelength decreases – the speed remains the same in the same medium

# Science P6 – Waves – Required Practical – Ripple Tank

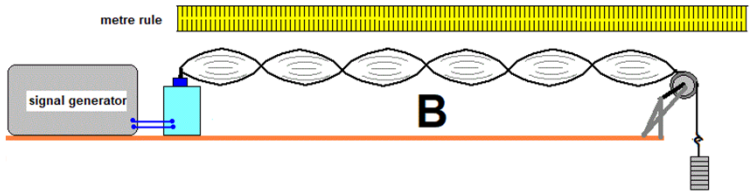
1. Complete the table below to explain the method in calculating the speed of waves in a ripple tank.

| Step | Reason |
|---|---|
| Fill the ripple tank with water, switch on a lamp and place white card underneath the tank. | |
| Switch on the motor and adjust it to give low frequency waves | |
| Place a stopwatch next to the card and record the waves, with the stopwatch in view for 10 seconds | |
| Play the recording in slow motion, count the number of waves passing a certain point and divide this by 10 | |
| Measure the length of 10 waves by taking a picture of the card with a ruler on it. | |
| Divide the length by 10 | |

2. If the length of 10 waves is 55cm, what is the wavelength of 1 wave?

3. If there are 210 waves in 10 seconds, what is the frequency?

1. When investigating waves produced by a vibration generator on a string, how do we know the frequency?




2. How many complete waves are shown in the image above?

3. If the length from the generator to the pulley was measured at 66 cm, what is the wavelength?

4. Why is it better to measure multiple waves and divide to find wavelength rather than measure one single wave?

5. What happens to wavelength when frequency increases?

6. What happens to wavelength when frequency decreases?

# Science P6 – Waves

## The Electromagnetic Spectrum

- All **transverse waves**
- Transfer energy from the source of waves to an absorber.
- All travel at the same **velocity** through a vacuum or air – **speed of light**.
- Speed of light = 300,000,000 m/s

You must remember all the electromagnetic waves in order!

Long wavelength → Short wavelength

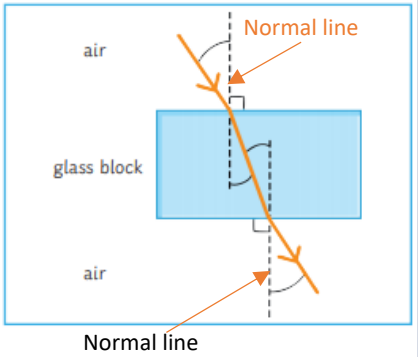
| Radio waves | Microwaves | Infrared | Visible light | Ultraviolet | X-rays | Gamma rays |
|---|---|---|---|---|---|---|

Low frequency → High frequency

| Wave | Use | Other information |
|---|---|---|
| Radio waves | Television and radio | Easily transmitted through the air. Harmless if absorbed by the body. |
| Microwaves | Satellite communications and cooking food | Can be harmful when internal body cells become heated by over exposure. |
| Infrared | Electrical heaters, cooking food and infrared cameras | Can cause burns to skin |
| Visible light | Fibre optic communications | Only EM wave detectable by human eye. |
| Ultraviolet | Energy efficient lamps, sun tanning | Causes skin tanning and can lead to burns or **skin cancer**. |
| X-rays | Medical imaging and airport security scanners. | Very little energy is absorbed by body tissues. Passes through the body.<br><br>They can lead to gene mutation and cancer. |
| Gamma rays | Sterilising medical equipment or food and treatment for some cancers. | |

## Ray diagrams

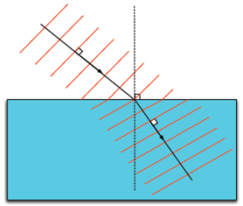
- You need to construct **ray diagrams** to show how a wave is **refracted** at the boundary of a different medium.




Less dense → More dense (e.g. air to glass)
- Ray **slows down** and bends **towards the normal** line.

More dense → Less dense (e.g. glass to air)
- Ray **speeds up** and bends **away from the normal** line.

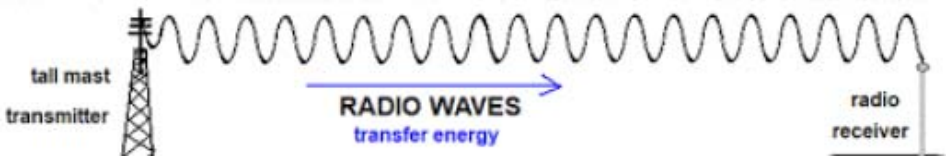
The ray bends because different parts of the wavefront cross the boundary at slightly different times –



If wave hits medium at an angle of 90° then the ray will slow down but will not be refracted.

## Radio waves (HT only)

- Radio waves can be produced by **oscillations** in **electrical circuits**.
- Those radio waves can travel for long distances to receivers.
  - When absorbed by the receiver, the radio wave creates an **alternating current** with same **frequency** as the wave itself.
  - This is how TV and radio are broadcast.



## Science P6 – Waves

1. State two properties of electromagnetic waves.

2. Write the EM spectrum in order of **increasing** wavelength

3. Write the EM spectrum in order of **increasing** frequency

4. How fast do electromagnetic waves travel?

5. State the uses of:

a) radio waves

b) microwaves

c) infrared

d) visible light

e) ultraviolet

f) x-rays

g) gamma rays

1. What happens when a ray goes from a less dense → more dense medium?

2. What happens when a ray moves from a more dense → less dense medium?

3. What is the line at $90^{o}$ to a surface called?

4. 4. What happens if a ray hits a medium at $90^{o}$?

1. What type of current do radio waves create when absorbed?

2. What is the frequency of the current produced by a radio wave of frequency 250Hz?

# Science P6 – Waves – Required Practical – Infrared radiation

## Aim

Investigate how the amount of infrared radiation **emitted** (given out) by a surface depends on the nature of that surface.

In this investigation you are finding out which type of surface emits the most infrared radiation:

- **Dark and matt**
- **Dark and shiny**
- **Light and matt**
- **Light and shiny**

## Method

1. Place **Leslie cube** on a heat proof mat.
2. Once the kettle has boiled, fill the Leslie cube with water.
3. Hold the infrared thermometer 5cm from the first surface
4. Record the temperature
5. Repeat the experiment three times on each surface and calculate mean for each surface.

**Independent variable**: surface
**Dependent variable:** temperature of the air (infrared radiation emitted)
**Control variables:** Temperature of the water inside, the distance between the cube surface ad the infrared thermometer

In this investigation you are finding out which type of surface absorbs the most infrared radiation:


## Method

1. Fill a black and a silver can with water from the tap.
2. Take the temperature of the water in each can
3. Place the infrared thermometer 5cm from the cans
4. Leave for at least 10 minutes
5. Record the temperature of the water in each can and calculate the rise in temperature

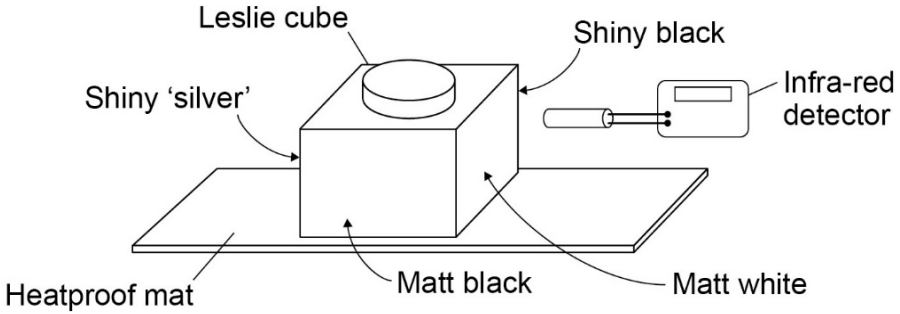
**Independent variable:** surface of the can
**Dependent variable:** Temperature increase of the water (infrared radiation absorbed)
**Control variables:** Temperature of the water inside, the distance between the cube surface ad the infrared thermometer

## Conclusion

Black matt surfaces absorb and emit the most infrared radiation.
White/silver and shiny surfaces are poor emitters and poor absorbers of infrared radiation

# Science P6 – Waves – Required Practical – Infrared radiation

1. Describe how you could use the equipment below to investigate the emission of infrared by different surfaces.




1. A student was investigating the amount of infrared radiation absorbed by water in cans with different surfaces.


Name the…
Independent variable:

Dependent variable :

Control variables :

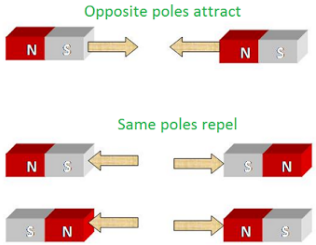
2. What kind of surfaces are the best emitters of infrared radiation?

3. Why does the water in the silver can heat up less than the black can?

# Science P7 – Magnetism and Electromagnetism

## Magnets

- Have two poles - **north** and **south**.




- **Like poles** will **repel** each other (e.g. N-N or S-S)
- **Opposite poles** will **attract** (e.g. N-S)

- Magnetism is a **non-contact** force – magnets do not need to be touching for effect to be observed.

**Magnetic materials:** only **iron/steel, cobalt** and **nickel** are magnetic.

## Types of magnets

**Permanent magnet**

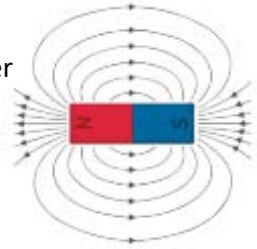
- Produces its own magnetic field.
- Magnetism cannot be turned on or off.

**Induced magnet**

- Induced magnet = a material which becomes magnetic when placed in a magnetic field.
  - Induced magnets only attract other materials and lose magnetism when removed from the magnetic field.

## Magnetic Fields

**Magnetic field =** the area surrounding a magnet where the force will act on another magnet or magnetic material.




- Magnet field is strongest at the **poles** where the field lines are **closest together**.

- Field lines always go away from **magnetic north** and towards **magnetic south**.

## Earth's Magnetic Field

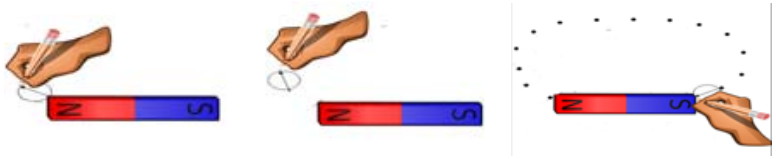
- Earth produces a magnetic field.
- Magnetic compasses use this to help navigation.
- The core of the Earth is made of **iron** (magnetic).

## Plotting Magnetic Field Lines

A magnetic compass can be used to plot and draw the magnetic field lines around a magnet.

**You need to be able to describe this method!**

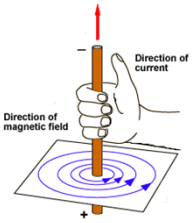
1. Place the bar magnetic in centre of paper.
2. Place a plotting compass at one end of the magnet.
3. Put a pencil dot at the place the compass arrow is pointing to
4. Move the compass to line up the tail of the compass needle to the dot you just made.
5. Repeat until you reach the other end of the magnet



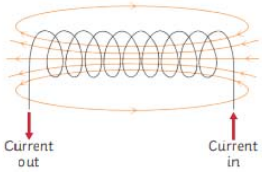

6. Join the dots using a line – this is the magnetic field line. Mark on the direction the arrow pointed – it should run N→S

## Electromagnetism

- When a current passes through a wire, a **magnetic field** is produced
- The direction of the field can be found by the right hand thumb rule
- curl the fingers of the right hand around the wire and point the thumb in the direction of the current (+ to -)
- The direction of the circular field is shown by the fingers
- Strength of magnet can be increased by increasing the current
- When the current is switched off, the magnetic field is lost




Coiling the wire will form a **solenoid**.




To increase strength of magnetic field around a solenoid you can:

- Add an **iron core**
- **Increase number of turns** in coil
- **Increase the current** passing through wire

## Electromagnets

- Electromagnet is a solenoid with an iron core.
- Are **induced magnets** (can be turned on and off)

Uses = electric motors, loudspeakers, electric bells, scrapyards.

# Science P7 – Magnetism and Electromagnetism

1. Name the two poles on a magnet.
2. What will like poles do?
3. What will opposite poles do?
4. Why is magnetism a 'non-contact' force?
5. Which metals are magnetic?

1. What is a magnetic field?
2. Where is the magnetic field the strongest?
3. Which direction do the field lines go?
4. Draw the magnetic field around a bar magnet.
5. What is the Earth's core made of?
6. What can the Earth's magnetic field be used for?

1. What are the two types of magnets?
2. Name two differences between these two types of magnets.

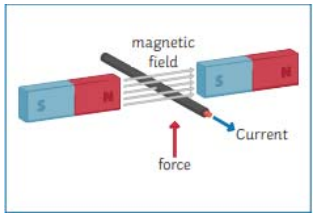
1. Describe a method to plot the magnetic field of a bar magnet.

1. What is produced when a current flows through a wire?
2. How can you increase the strength of a magnetic field of a straight wire?
3. What is produced when you coil the wire?
4. How can you increase the magnetic field around a solenoid? (3 ways)
5. What is an electromagnet?
6. What is meant by induced magnet?
7. State 2 uses of electromagnets.

# Science P7 – Magnetism and Electromagnetism

## The Motor Effect (HT only)

- When a wire carry a **current** is placed in a magnetic field, the two magnetic fields interact and a **force** is exerted on the wire. .
- This is called **motor effect.**




- The force produced by the motor effect can be calculated using:

**Force (N) = magnetic flux density (T) x current (A) x length (m)**

F = B x I x l

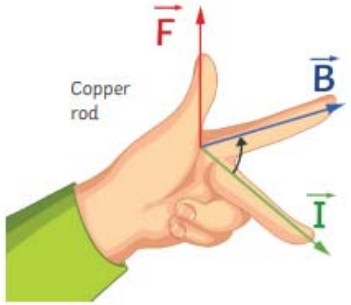
For example:
A current of 8A is flowing through a wire that is 75cm long. The magnetic field acting at a right angle on the wire is 0.5T.
Calculate the force.

Remember: the equation uses length in m. The question has given you the length in cm so you need to convert it before you answer.
F = 0.5 x 8 x 0.75
F = 3N

- If current flowing through wire is **parallel** to magnetic field, **no force** is produced.

**Fleming's left-hand rule.**

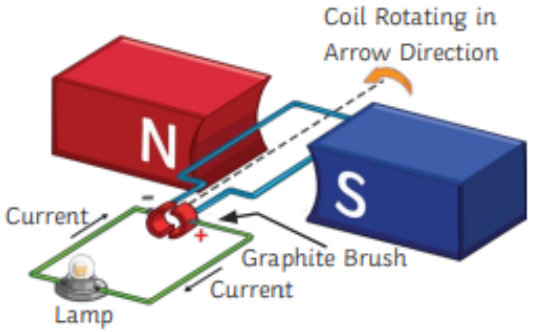
- You may be asked a diagram and asked to indicate direction of force.
- You can use Fleming's left-hand rule to do this (picture)




Remember ( **F B I** ):
- Use your **left hand!**
- The angle between index and middle should be **right angle**.
- Thumb = direction of **force**
- First finger = direction of **magnetic field**
- Second finger = direction of **current** through wire.

## Electric Motors (HT only)

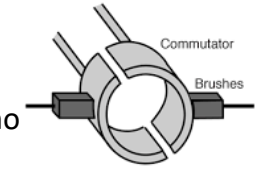
- When wire carrying current is **coiled**, the motor effect causes wire to **rotate**.
- This is how an **electric motor** works.




- Current flows  force produced acts in **opposite directions** causing coil to **rotate** overall.

- When coil reaches a **vertical position,** force is parallel so would be zero – stops rotating.

- A gap in the **split ring commutator** in the motor cuts the current temporarily.




- Momentum ensures the coil carries on mo

- The commutator reconnects and **changes the direction of the current** to maintain a **constant rotation** in one direction overall.
- Increase speed of rotation by increasing the:
- current
- strength of magnet
- number of turns on the coil

# Science P7 – Magnetism and Electromagnetism

1. What is the ‘motor effect’?

2. State the equation for calculating the force produced by the motor effect.

3. What happens to the force if the current flowing through the wire is parallel to the magnetic field?

4. What is Fleming’s left-hand rule used to indicate?

5. What does your thumb represent?

6. What does your first finger represent?

7. What does your second finger represent?

1. What happens when a wire carrying a current is coiled?

2. How does an electric motor work?

3. Why is a **split ring commutator** used?

4. How can we increase the speed of rotation of the motor?