NAME: _____

TERM 5&6

YEAR 10

CORE

PLYMPTON ACADEMY

# HANDBOOK

TERM 5&6

## Ozymandias by Percy Bysshe Shelley

**Content, Meaning and Purpose -**The narrator meets a traveller who tells him about a decayed statue that he saw in a desert. -The statue was of a long forgotten ancient King: the arrogant Ozymandias, 'king of kings.' -The poem is ironic and one big metaphor: Human power is only temporary – the statue now lays crumbled in the sand, and even the most powerful human creations cannot resist the power of nature.

**Language**
-'sneer of cold command': the king was arrogant, this has been recognised by the sculptor, the traveller and then the narrator.
-'Look on my works, ye Mighty, and despair.': 'Look' = imperative, stressed syllable highlights commanding tone;
ironic – he is telling other 'mighty' kings to admire the size of his statue and 'despair', however they should really despair because power is only temporary.
'The lone and level sands stretch far away.': the desert is vast, lonely, and lasts far longer than a statue

## My Last Duchess by Robert Browning

**Content, Meaning and Purpose -**The Duke is showing a visitor around his large art collection and proudly points out a portrait of his last wife, who is now dead. He reveals that he was annoyed by her over-friendly and flirtatious behaviour. -He can finally control her by objectifying her and showing her portrait to visitors when he chooses. - He is now alone as a result of his need for control. -The visitor has come to arrange the Duke's next marriage, and the Duke's story is a subtle warning about how he expects his next wife to behave.

**Language**
-'Looking as if she was alive': sets a sinister tone.
-'Will't please you sit and look at her?' rhetorical question to his visitor shows obsession with power.
-'she liked whate'er / She looked on, and her looks went everywhere.': hints that his wife was a flirt.
-'as if she ranked / My gift of a nine-hundred-yearsold name / With anybody's gift': she was beneath him in status, and yet dared to rebel against his authority.
-'I gave commands; Then all smiles stopped together': euphemism for his wife's murder.
-'Notice Neptune, though / Taming a sea-horse': he points out another painting, also about control.

# Cluster Three- The Power of Identity.

## Tissue by Imtiaz Dharker

**Content, Meaning and Purpose -**Two different meanings of 'Tissue' (homonyms) are explored: firstly, the various pieces of paper that control our lives (holy books, maps, grocery receipts); secondly, the tissue of a human body. -The poet explores the paradox that although paper is fragile, temporary and ultimately not important, we allow it to control our lives. -Also, although human life is much more precious, it is also fragile and temporary.

**Language**
-Semantic field of light: ('Paper that lets light shine through', 'The sun shines through their borderlines', 'let the daylight break through capitals and monoliths') emphasises that light is central to life, a positive and powerful force that can break through 'tissue' and even monoliths (stone statues).
-'pages smoothed and stroked and turned': gentle verbs convey how important documents such as the Koran are treated with respect.
-'Fine slips […] might fly our lives like paper kites': this simile suggests that we allow ourselves to be controlled by paper.

## Checking Out Me History by John Agard

**Content, Meaning and Purpose -**Represents the voice of a black man who is frustrated by the Eurocentric history curriculum in the UK – which pays little attention to the black history. -Black history is quoted to emphasise its separateness and to stress its importance.

**Language**
-Imagery of fire and light used in all three stanzas regarding black historic figures: "Toussaint de beacon", "Fire-woman", "yellow sunrise".
-Uses non-standard phonetic spelling ("Dem tell me wha dem want", to represent his own powerful accent and mixes Caribbean Creole dialect with standard English.
-"I carving out me identity": metaphor for the painful struggle to be heard, and to find his identity.

# Blood Brothers- Literature Paper Two.

| Vocabulary | Definition |
|---|---|
| Poverty | Lacking in money linked to deprivation in social conditions, housing and education |
| Wealth | The abundance of money or possessions |
| Liverpudlian | A person who comes from Liverpool (often with a distinct accent) |
| Deceit | Concealing or misrepresenting the truth |
| Death | Ending of life |
| Innocence | The state of being pure and lacking in corrupt behaviour |
| Superstition | Irrational belief in widely held supernatural instances |
| Class System | The concept that there is more than one social class of people: working class, middle class and upper class and the rules which govern the lives of people in different classes lead to societal unfairness |
| Hierarchy | Ranking of members of society due to status or authority |
| Disillusioned | Disappointment in someone or something that appears to be less good than initially thought |
| Condescension | A patronising, condescending attitude towards others |
| Snobbery | The character or quality of being a snob |
| Underprivileged | Not having access to the same standard of living as other people in society |
| Omniscient Narrator | All knowing narrative voice |
| Dialogue | Speech |
| Accent | A distinctive way of pronouncing words |
| Dramatic Irony | From Greek tragedy: the audience is aware of the importance of events but the characters are not |
| Foreshadowing | Predicting or warning of a future event in the text |
| Pathetic Fallacy | Linking of nature and weather to human emotions/moods |
| Metaphor | Where one thing becomes another in a comparison |
| Musical | The form of the play: music plays an important part in revealing the action/events |
| Symbolism | Using symbols in literature to represent ideas or qualities |
| Motif | A dominant or recurring idea in the play |

## SKILLS

**Analysis Points:**

**Link to the question**

**Link to the terminology (Lang/Structure – evaluating choice)**

**Short Quote(s) -or Moment**

**Explain meaning and effect – both obvious and hidden (explicit and implicit)**

**Zoom in on words/explore connotations and effect**

**Suggest what other readers might think/feel (offering an alternative opinion)**

**Link to the writer's intentions (step out from the close analysis to give an overview of meaning)**

**Explore a linking quote/supporting idea**

## KEY THEMES

**Wealth, Poverty, Class, Superstition, Childhood, Death**

## EXAM REQUIREMENTS

**ESSAY QUESTION– 45 mins (including planning time)**

Typical Questions

**Write about the theme of _____ and how it is presented at different points in the play/text**

**In your response you should:**

**refer to the extract and the play as a whole;**

**show your understanding of theme and events in the play. [35+5]**

***5 of this question's marks are allocated for accuracy in spelling, punctuation and the use of***

***vocabulary and sentence structures.***

***This question assesses AO1, AO2 and AO4 (5 additional marks).***

## Event Guide:

### Act 1

- The narrator introduces the plot in a Greek Chorus (we realise the play is a tragedy)
- Meet two very different women, Mr J v poor agrees to give away one of her twins to Mrs L who is rich.
- Meet the twins ages 7: they are very different in many ways (nurture) but do have quite similar natures. They're treated differently by the police/school.
- Mrs L is paranoid her son will discover his adoption so moves the family to the country to get away from Mickey and Mrs J. Years later, the council rehouses the Johnstone family in the country.

### ACT 2

- The boys meet again aged 14 and their friendship continues. The boys, again, display similar natures. They have very different qualities if education. Mickey is in love with Linda.
- Mrs L becomes increasingly mad at the thought of Edward finding out and tries to kills Mrs J.
- Aged 18, Edward goes to university and Mickey to a full-time job which he hates. The gap is widening between them.
- Linda is pregnant so she & Mickey marry. Mickey loses his job, helps Sammy rob a garage & is sent to prison. Nothing is the same for him and Linda again.
- Mickey is released from prison but is addicted to anti-depressants. Desperate, Linda asks Edward for help. He gets them a house & Mickey a job, but starts a brief affair with Linda.
- Mrs L tells Mickey about the affair, he

## MRS JOHNSTONE

- "He told me I was sexier than Marilyn Monroe" Recurring motif – Her looks were all she had going for her and when they were gone so was her husband.
- "By the time I was twenty-five, I looked like forty-two" Hyperbole – showing the impact on her appearance of having a hard life and so many children so young.
- "during the dance, she acquires a brush, dusters and a mop" stage directions – showing that she is happy to be working even if it is in a menial job
- "never put new shoes on a table" Foreshadowing – this superstition suggests that something bad will happen right from the start of the play. Mrs Johnstone believes in these superstitions.
- "silver trays to take meals on" / "a bike with both wheels on" – Mrs J & Mrs L Juxtaposition – Highlights the different lifestyles both boys would have. Envy from Mrs J. too
- "Mrs Lyons shows the Bible to Mrs Johnstone" Religious imagery and stage directions – showing how once a pact has been made and sworn on the bible you can't change your mind. Important symbolically as this is the point of no return in giving a baby away.
- "don't you ever come round here again" / "I'm very sorry, but it's Edward's bedtime" – Mrs J and Mrs L

## THE NARRATOR

- "I'm up to here with hard luck stories" – Milkman/narrator
- First person – shows a lack of caring and the poverty that the family live in.
- "the devil's got your number" – narrator
- Foreshadowing –song shows us that she won't get away with giving up her son
- did you never hear how the Johnstones died" – narrator Foreshadowing - the narrator tells us the ending at the start of the play
- "the mother, so cruel, there's a stone in place of her heart" – narrator Hyperbole – The narrator exaggerates how horrible Mrs J. is which we find out if not true. He is being very judgemental and patronising towards her.
- "a debt is a debt, and must be paid" – narrator repetition – here the narrator is giving a double meaning, physical money and the fact that she will have to pay for giving up her child.
- "There's a mad man" – narrator Alliteration – referring to Mickey and his desire to kill Edward with the gun from Sammy's robbery.
- "Do we blame superstition for what came to pass? Or could it be what we, the English, have come to know as class?" – the narrator
- Rhetorical questions – questioning tone as to whether the blame lies with society rather than the characters themselves.
- "Did you ever hear the story of the Johnstone twins, as like each other as two new pins" – narrator Cyclical structure of the novel – repetition of the opening – showing their deaths were inevitable from the start.
- "the music pulsates and builds" stage directions – showing the culmination of the action and the building to the deaths

## EDWARD/MICKEY

- "mam" / "mummy" "pissed off" / "you say smashing things" "the two of them immediately wriggle and giggle with glee" – Edward and Mickey Juxtaposition and difference in speech patterns
- "we're blood brothers" Mickey and Edward Symbolism – childhood ritual and the fact they are actually twins
- "if you cross your fingers and if you count from one to ten" – the children Foreshadowing – showing childhood beliefs and superstitions
- "Peter Pan" Symbolism of never growing up – foreshadowing later difficulty when both boys do grow up
- "take a flying fuck at a rolling donut" / "it's borin'" Juxtaposition - of trouble at school for Mickey and Edward
- "a game of piggy-in-the-middle" the stage directions and foreshadowing – showing where Linda is in the middle of Mickey and Edward throughout both their childhood and into adulthood too.
- "workin' overtime" / "I go away to university tomorrow" – Mickey and Edward statements – shows the contrast in lifestyles and class for both boys
- "How come you got everything… an' I got nothin'?" – Mickey, to Edward Dialogue – jealousy from Mickey to Edward showing he sees the unfairness in society
- "I could have been him!" – Mickey shouting accusatory tone –how unfair the whole situation has been and despondency Mickey at his poverty
- "walkin' round in circles" – Mickey Tone – Mickey is resentful and angry at what has happened
- "I grew up. An' you didn't, because you didn't need to" – Mickey to Edward Emotive language – shows jealousy of Edward's freedom, money and Uni.
- "chronically depressed" – Mickey Emotive language – Mickey is reliant on pills after prison.
- "You sorted it out. You and Councillor Eddie Lyons" – Mickey Sarcastic tone –not grateful for Eddie's help.
- Edward is "on a platform" stage directions –Edward is isolated and an easy target

## MRS LYONS

- "give one to me" imperative – demanding tone showing that she is desperate for a baby and will do anything to get one.
- "How can you possibly avoid some of them being put into care?" Rhetorical Question – persuade her to give one of the twins to her.
- "You'll be locked up" Directive – threatening Mrs J.
- "It's just… just this place" repetition – shows her bad state of mind
- "has a lethal-looking kitchen knife in her hand" Stage directions – she is trying to stab Mrs J. showing that she is going mad.

## MINOR CHARACTERS

Mr Lyons
"it's a sign of the times, Miss Jones"
Statement – showing that there is no work for anyone (linking to Mickey being unemployed and unable to find a job).

Police
"he was about to commit a serious crime" / "it was more of a prank, really"
juxtaposition of the treatment of Mickey and Edward by the police – unfairness and class stereotyping

Sammy
"Sammy burnt the school down"
Foreshadowing – that he will be trouble and lead Mickey into trouble too.

Schoolteacher
"This is a boys' school, Lyons" –negative tone – showing Edward getting into trouble.

# ENGLISH LITERATURE

## BIDMAS N3

...or BODMAS. Use the correct order of operations; take care when using a calculator.

- **B**rackets
- **I**ndices (or p**O**wers)
- **D**ivision and **M**ultiplication
- **A**ddition and **S**ubtraction

## Types of number N4

Integer: a "whole" number
Factors; the divisors of an integer
➔ Factors of 12 are 1, 2, 3 ,4, 6, 12
Multiples; a "times table" for an integer (will continue indefinitely)
➔ Multiples of 12 are 12, 24, 36 ...
Prime number: an integer which has exactly two factors (1 and the number itself). Note: 1 is not a prime number.

## HCF, LCM N4

**H**ighest **C**ommon **F**actor (HCF)
➔ Factors of 6 are 1, 2, 3, 6
Factors of 9 are 1, 3, 9
HCF of 6 and 9 is 3
**L**owest **C**ommon **M**ultiple (LCM)
➔ Multiples of 6 are 6, 12, 18, 24, ...
Multiples of 9 are 9, 18, 27, 36, ...
LCM of 6 and 9 is 18

## Prime factors N4

Write a number as a product of its prime factors; use indices for repeated factors:
➔ $720 = 5 \times 3^2 \times 2^4$

## Powers and roots N6, N7

Special indices: for any value $a$:

$$a^0 = 1$$

$$a^{-n} = \frac{1}{a^n}$$

➔ $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$

## Calculating with fractions N8

Adding or subtracting fractions; use a common denominator...
➔ $\frac{4}{5} - \frac{1}{3} = \frac{12}{15} - \frac{5}{15} = \frac{7}{15}$
Multiplying fractions; multiply numerators and denominators...
➔ $\frac{4}{7} \times \frac{2}{3} = \frac{8}{21}$
Dividing fractions; "flip" the second fraction, then multiply...
➔ $\frac{2}{7} \div \frac{5}{6} = \frac{2}{7} \times \frac{6}{5} = \frac{12}{35}$

## Surds N8

Look for the biggest square number factor of the number:
➔ $\sqrt{80} = \sqrt{16 \times 5} = 4\sqrt{5}$

## Standard form N9

Standard form numbers are of the form $a \times 10^n$ where $1 \le a < 10$ and $n$ is an integer.

## Standard units N13

1 tonne = 1000 kilograms
1 kilogram = 1000 grams

1 kilometre = 1000 metres
1 metre = 100 centimetres
= 1000 millimetres
1 centimetre = 10 millimetres

1 day = 24 hours
1 hour = 60 minutes = 3600 seconds
1 minute = 60 seconds

## Fractions, decimals N10

Fraction is numerator ÷ den
➔ $\frac{5}{8} = 5 \div 8 = 0.625$
Use place values to change decimals to fractions. Simplify where possible.
➔ $0.45 = \frac{45}{100} = \frac{9}{20}$
Learn the most frequently used ones:

| $\frac{1}{2}$ | $\frac{1}{4}$ | $\frac{1}{10}$ | $\frac{1}{5}$ | $\frac{3}{4}$ |
|---|---|---|---|---|
| 0.5 | 0.25 | 0.1 | 0.2 | 0.75 |

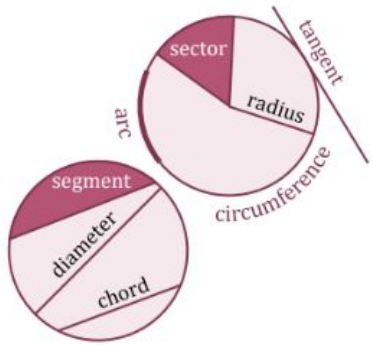
## Rounding N15

Truncate the number, then use a "decider digit" to round up or down.
Decimal places: use the decimal point
➔ 162.3681 to 2dp;
162.36 | 81 = 162.37 to 2dp
Significant figures: use the first non-zero digit.
➔ 162.3681 to 2sf;
16 | 2.3681 = 160 to 2sf
➔ 0.007 039 to 3sf;
0.007 03 | 9 = 0.007 04 to 3sf

## Error intervals N15

Find the range of numbers that will round to a given value:
➔ $x = 5.83$ (2 decimal places)
$5.825 \le x < 5.835$
➔ $y = 46$ (2 significant figures)
$45.5 \le y < 46.5$
Note use of ≤ and <, and that the last significant figure of each is 5

## Parts of a circle G9




## Transformations

Reflection
- Line of reflection

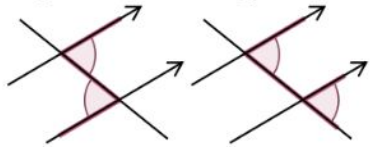
Translation
- Vector

Rotation
- Centre of rotation
- Angle of rotation
- Clockwise or anticlockwise

Enlargement
- Centre of enlargement
- Scale factor (if SF < 1 the shape will get smaller).

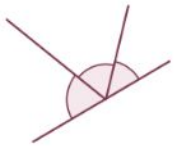
## Angle facts

Equal angles in parallel lines: always use correct terminology...

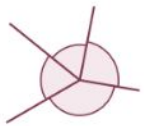


Alternate angles Corresponding angles

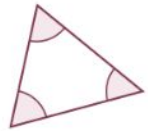
Angles on a straight line total 180°



Angles in a full turn total 360°



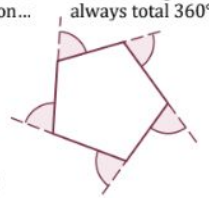
Interior angles in a triangle total 180°



Use this for the interior angles of any polygon...

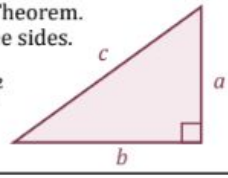
...or 180° × (n − 2)

Exterior angles always total 360°



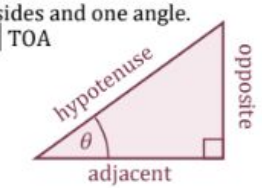
## Right angled triangles G20, G22

Pythagoras Theorem.
Links all three sides.
No angles.
$a^2 + b^2 = c^2$




The longest side of any right angled triangle is the hypotenuse; check that your answer is consistent with this.

Trigonometry.
Links two sides and one angle.
SOH | CAH | TOA




$\sin\theta = \frac{\text{opp}}{\text{hyp}}$ $\cos\theta = \frac{\text{adj}}{\text{hyp}}$ $\tan\theta = \frac{\text{opp}}{\text{adj}}$

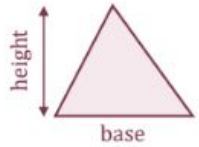
Use "2ndF" or "SHIFT" key to find a missing angle

Special values of sin, cos, tan
Learn (or be able to find without a calculator)...

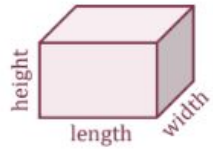
| $\theta°$ | $\sin\theta°$ | $\cos\theta°$ | $\tan\theta°$ |
|---|---|---|---|
| 0 | 0 | 1 | 1 |
| 30 | $\frac{1}{2}$ | $\frac{\sqrt{3}}{2}$ | $\frac{1}{\sqrt{3}}$ |
| 45 | $\frac{1}{\sqrt{2}}$ | $\frac{1}{\sqrt{2}}$ | 1 |
| 60 | $\frac{\sqrt{3}}{2}$ | $\frac{1}{2}$ | $\sqrt{3}$ |
| 90 | 1 | 0 | |

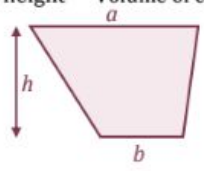
## Areas and volumes G16, G17, G18, G23

Area of triangle = $\frac{1}{2} \times$ base × height



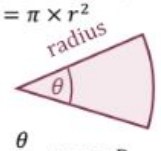

Volume of cuboid = length × width × height

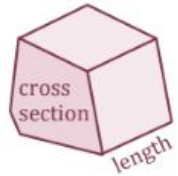


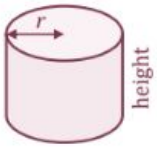




Area of trapezium = $\frac{1}{2}(a + b) \times h$

Circumference of circle = $\pi \times D$
Area of circle = $\pi \times r^2$




Arc length = $\frac{\theta}{360°} \times \pi \times D$

Area of sector = $\frac{\theta}{360°} \times \pi \times r^2$

Volume of cylinder = $\pi r^2 \times$ height

Volume of prism = area of cross section × length

Number · Algebra · Ratio, proportion and rates of change · Geometry & measures · Probability · Statistics

## Quadratics A18

Solve a quadratic by factorising.

➔ **Solve $x^2 - 8x + 15 = 0$**

Put into brackets (taking care with any negative numbers)...

$$(x-3)(x-5) = 0$$

...then either $x - 3 = 0$ or $x - 5 = 0$ so that $x = 3$ or $x = 5$.

## Difference of two squares A4

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

➔ $x^2 - 25 = (x+5)(x-5)$

## Simultaneous equations A19

➔ **Solve** $\begin{cases} 2x + 3y = 11 \\ 3x - 5y = 7 \end{cases}$

Multiply to match a term in $x$ or $y$

$$\begin{cases} 10x + 15y = 55 \\ 9x - 15y = 21 \end{cases}$$

Add or subtract to cancel...

$$19x = 76, \text{ so } x = 4$$

Finally, substitute and solve...

$$2 \times 4 + 3y = 11, \text{ so } y = 1$$

## Rearrange a formula A5

The subject of a formula is the term on its own. Use rules that "balance" the formula to change its subject

➔ **Make $x$ the subject of**

$$2x + 3y = z$$

Here, subtract $3y$ from both sides...

$$2x = z - 3y$$

...then divide both sides by 2

$$x = \frac{z - 3y}{2}$$

## Laws of indices A4

For any value $a$:

$$a^x \times a^y = a^{x+y}$$

$$\frac{a^x}{a^y} = a^{x-y}$$

$$(a^x)^y = a^{xy}$$

➔ $\left(\frac{2pq^4}{p^3q}\right)^3 = \frac{8p^3q^{12}}{p^9q^3} = \frac{8q^9}{p^6}$ or $8q^9p^{-6}$

## $y = mx + c$ A9

Equation of straight line $y = mx + c$

m is the gradient; c is the $y$ intercept:

➔ **Find the equation of the line that joins (0 , 3) to (2 , 11)**

Find its gradient...

$$\frac{11-3}{2-0} = \frac{8}{2} = 4$$

...and its y intercept...

**Passes through (0 , 3), so c = 3**

**Equation is $y = 4x + 3$**

Parallel lines: gradients are equal;

➔ **$y = 2x + 3$ and $y = 2x - 5$ both have gradient 2 so are parallel.**

## Expanding brackets A4

$$p(q+r) = pq + pr$$

➔ $5(x - 2y) = 5x - 10y$

$$(x+a)(x+b) = x^2 + ax + bx + ab$$

➔ $(2x-3)(x+5)$

$$= 2x^2 - 3x + 10x - 15$$

$$= 2x^2 + 7x - 15$$

Reverse of expanding is factorising - putting an expression into brackets.

## Algebraic notation A1

$$ab = a \times b$$

$$3y = y + y + y$$

$$a^2 = a \times a$$

$$a^3 = a \times a \times a$$

$$a^2b = a \times a \times b$$

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

## Equations and identities A3

An equation is true for some particular value of $x$

➔ **$2x + 1 = 7$ is true if $x = 3$**

...but an identity is true for every value of $x$

➔ $(x+a)^2 \equiv x^2 + 2ax + a^2$

(note the use of the symbol ≡)

## Sequences A24, A25

Triangular numbers:

| 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|
| 1 | 3 | 6 | 10 | 15 |

Square numbers ($n^2 = n \times n$):

| $1^2$ | $2^2$ | $3^2$ | $4^2$ | $5^2$ |
|---|---|---|---|---|
| 1 | 4 | 9 | 16 | 25 |

Cube numbers ($n^3 = n \times n \times n$):

| $1^3$ | $2^3$ | $3^3$ | $4^3$ | $5^3$ |
|---|---|---|---|---|
| 1 | 8 | 27 | 64 | 125 |

$n$th term of an arithmetic (linear) sequence is $an + d$

➔ **$n$th term of 5, 8, 11, 14, ... is $3n+2$ (always increases by 3 first term is $3 \times 1 + 2 = 5$)**

Geometric sequence; multiply each term by a constant ratio

➔ **3, 6, 12, 24, ... (ratio is 2)**

Fibonacci sequence; make the next term by adding the previous two ...

➔ **2, 4, 6, 10, 16, 26, 42, ...**

## Division using ratio R5

Use a ratio for unequal sharing

➔ **Divide £480 in the ratio 7 : 5**

**7 + 5 = 12, then £480 ÷ 12 = £40**

**7 × £40 = £280, 5 × £40 = £200**

(check: £280 + £200 = £480 ✓)

## Ratio and fractions R8

Link between ratios and fractions

➔ **Boys to girls in ratio 2 : 3**

**$\frac{2}{5}$ are boys, $\frac{3}{5}$ are girls.**

## Percentages R9

$$y \text{ percent of } x = \frac{y}{100} \times x$$

➔ **Increase £58 by 26%.**

$$\frac{26}{100} \times £58 = £15.08$$

**£58 + £15.08 = £73.08**

$$y \text{ as a percentage of } x = \frac{y}{x} \times 100\%$$

➔ **The population of a town increases from 3500 to 4620**

**Find the percentage increase.**

$$\frac{1120}{3500} \times 100\% = 32\%$$

Note: fraction $= \frac{\text{increase}}{\text{original}}$

Learn the most frequently used ones:

| $\frac{1}{2}$ | $\frac{1}{4}$ | $\frac{1}{10}$ | $\frac{1}{5}$ | $\frac{1}{100}$ |
|---|---|---|---|---|
| 50% | 25% | 10% | 20% | 1% |

## Averages S4

Mode: most frequently occurring

Median: put the data in numerical order, then choose the middle one

$$\text{Mean} = \frac{\text{total of items of data}}{\text{number of items of data}}$$

## Correlation S6

Positive correlation

Negative correlation

## Probability P8, P9

$$p = \frac{n(\text{equally likely favourable outcomes})}{n(\text{equally likely possible outcomes})}$$

| | |
|---|---|
| $p = 0$ | impossible |
| $0 < p < 0.5$ | unlikely |
| $p = 0.5$ | evens |
| $0.5 < p < 1$ | likely |
| $p = 1$ | certain |

## Probability rules P8, P9

Multiply for independent events

➔ **P(6 on dice and H on coin)**

$$\frac{1}{6} \times \frac{1}{2} = \frac{1}{12}$$

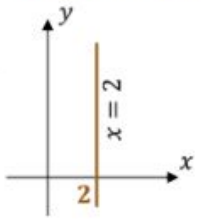
Add for mutually exclusive events

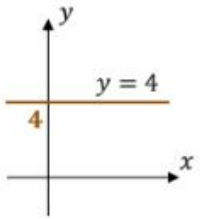
➔ **P(5 or 6 on dice)**

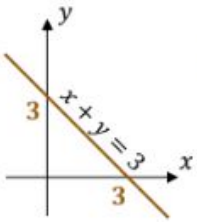
$$\frac{1}{6} + \frac{1}{6} = \frac{2}{6}$$

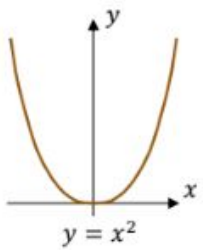
Apply these rules to tree diagrams.

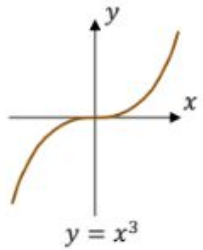
## Standard graphs A12

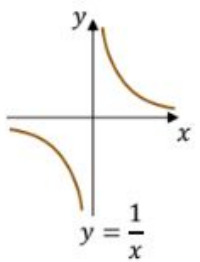



**MATHEMATICS - Foundation**

## Listing strategies N5

Product rule for counting:
➔ $4 \times 3 \times 2 \times 1 = 24$ ways to arrange the letters P, I, X and L

## Powers and roots N6, N7

Special indices: for any value $a$:

$$a^0 = 1$$
$$a^{-n} = \frac{1}{a^n}$$
$$a^{\left(\frac{p}{q}\right)} = \sqrt[q]{a^p}$$

➔ $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$

➔ $8^{\left(\frac{2}{3}\right)} = \sqrt[3]{8^2} = 4$

## Surds N8

Look for the biggest square number factor of the number:
➔ $\sqrt{80} = \sqrt{16 \times 5} = 4\sqrt{5}$

## Rationalise the denominator N8

Multiply the numerator and denominator by an expression that makes the denominator an integer:

➔ $\frac{4}{\sqrt{7}} = \frac{4 \times \sqrt{7}}{\sqrt{7} \times \sqrt{7}} = \frac{4\sqrt{7}}{7}$

➔ $\frac{2}{4+\sqrt{5}}$

$= \frac{2}{4+\sqrt{5}} \times \frac{4-\sqrt{5}}{4-\sqrt{5}} = \frac{2(4-\sqrt{5})}{11}$

## Standard form N9

Standard form numbers are of the form $a \times 10^n$, where $1 \leq a < 10$ and $n$ is an integer.

## Recurring decimals N10

Make a recurring decimal a fraction:
➔ $n = 0.2\dot{3}\dot{6}$
(two digits are in the recurring pattern, so multiply by 100)
$100n = 23.\dot{6}$
(this is the same as $23.6\dot{3}\dot{6}$)
$99n = 23.6\dot{3}\dot{6} - 0.2\dot{3}\dot{6} = 23.4$
$n = \frac{23.4}{99} = \frac{234}{990} = \frac{13}{55}$

## Error intervals N15

Find the range of numbers that will round to a given value:
➔ $x = 5.83$ (2 decimal places)
$5.825 \leq x < 5.835$
➔ $y = 46$ (2 significant figures)
$45.5 \leq y < 46.5$
Note use of ≤ and <, and that the last significant figure of each is 5

## Equations and identities A3

An equation is true for some particular value of $x$
➔ $2x + 1 = 7$ is true if $x = 3$
...but an identity is true for every value of $x$
➔ $(x + a)^2 \equiv x^2 + 2ax + a^2$
(note the use of the symbol ≡)

## Transformations of curves A13

Starting with the curve $y = f(x)$:
Translate $\begin{pmatrix} 0 \\ a \end{pmatrix}$ for $y = f(x) + a$
Translate $\begin{pmatrix} -a \\ 0 \end{pmatrix}$ for $y = f(x + a)$
Reflect in $x$ axis for $y = -f(x)$
Reflect $y$ axis for $y = f(-x)$

## Velocity - time graph A15

Gradient = acceleration (you may need to draw a tangent to the curve at a point to find the gradient);
Area under curve = distance travelled.

## Laws of indices A4

For any value $a$:

$$a^x \times a^y = a^{x+y}$$
$$\frac{a^x}{a^y} = a^{x-y}$$
$$(a^x)^y = a^{xy}$$

➔ $\left(\frac{2pq^4}{p^3q}\right)^3 = \frac{8p^3q^{12}}{p^9q^3} = \frac{8q^9}{p^6}$ or $8q^9p^{-6}$

## Difference of two squares A4

$$a^2 - b^2 = (a + b)(a - b)$$
➔ $x^2 - 25 = (x + 5)(x - 5)$

## Rearrange a formula A5

The subject of a formula is the term on its own. Rearrange to
➔ Make $x$ the subject of
$2x + ay = y - bx$
$2x + bx = y - ay$
$x(2 + b) = y - ay$
$x = \frac{y - ay}{2 + b}$

## Functions A7

Combining functions:
$fg(x) = f(g(x))$
➔ If $f(x) = x + 3$ and $g(x) = x^2$
$fg(x) = x^2 + 3$
$gf(x) = (x + 3)^2$

The inverse of $f$ is $f^{-1}$
➔ If $f(x) = 2x + 5$ then
$f^{-1}(x) = \frac{x - 5}{2}$

## $y = mx + c$ A9

Equation of straight line $y = mx + c$
m is the gradient; c is the $y$ intercept:
➔ Find the equation of the line that joins (0 , 3) to (2 , 11)
Find its gradient...
$\frac{11 - 3}{2 - 0} = \frac{8}{2} = 4$
...and its y intercept...
Passes through (0 , 3), so c = 3
Equation is $y = 4x + 3$

Parallel lines: gradients are equal; perpendicular lines: gradients are "negative reciprocals".
➔ $y = 2x + 3$ and $y = 2x - 5$ are parallel to each other; $y = 2x + 3$ and $y = -\frac{1}{2}x + 3$ are perpendicular

## Iteration A20

You will be given the formula to use:
➔ Solve $x^3 + 6x + 4 = 0$ by using the iteration $x_{n+1} = \sqrt[3]{6x_n - 4}$
Start with $x_1 = -2.8$
$x_2 = \sqrt[3]{6 \times (-2.8) - 4} = -2.750\ldots$
$x_3 = \sqrt[3]{6 \times (-2.750\ldots) - 4} = \cdots$
Repeat until you know the solution, or you do as many as the question says.

## Equation of a circle A16

$x^2 + y^2 = r^2$ is a circle with centre (0 ,0) and radius $r$.
➔ $x^2 + y^2 = 25$ has centre (0 , 0) and radius 5

## Quadratics A11, A18

If a quadratic equation cannot be factorised, use the formula

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

➔ Solve $2x^2 + 3x - 7 = 0$

$x = \frac{-3-\sqrt{9-(-56)}}{2\times2} = -2.73$

or $x = \frac{-3+\sqrt{9-(-56)}}{2\times2} = 1.23$

Complete the square to find the turning point of a quadratic graph.
➔ $y = x^2 - 6x + 2$
$y = (x - 3)^2 - 9 + 2$
$y = (x - 3)^2 - 7$
Turning point is at (3 , −7)

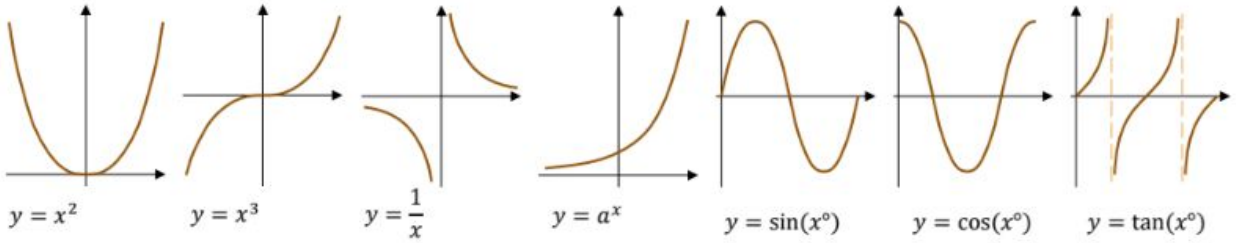
## Simultaneous equations A19

One linear, one quadratic;
➔ Solve $\begin{cases} x + 3y = 10 \\ x^2 + y^2 = 20 \end{cases}$
Rearrange the linear, and substitute into the quadratic
$x = 10 - 3y$
so $(10 - 3y)^2 + y^2 = 20$
Expand and solve the quadratic
$100 - 60y + 9y^2 + y^2 = 20$
$10y^2 - 60y + 80 = 0$
$y = 2$ or $y = 4$
Finally, substitute into the linear and solve, pairing values...
$x + 3 \times 2 = 10$ so $(x , y) = (4 , 2)$
$x + 3 \times 4 = 10$ so $(x , y) = (-2 , 4)$

## Sequences A24, A25

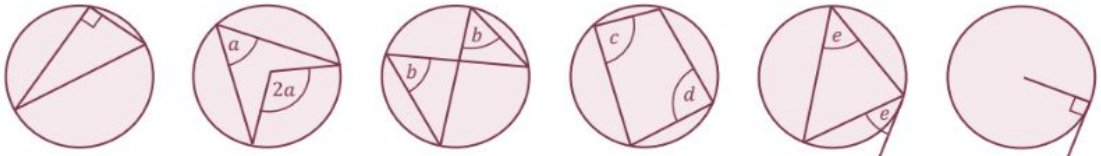
$n$th term of an arithmetic (linear) sequence is $bn + c$
➔ $n$th term of 5, 8, 11, 14, ... is $3n+2$ (always increases by 3 first term is $3 \times 1 + 2 = 5$)
$n$th term of a quadratic sequence is $an^2 + bn + c$
➔ First three terms of $n^2 + 3n - 1$ are 3, 9, 17, ...
Geometric sequence; multiply each term by a constant ratio
➔ 3, 6, 12, 24, ... (ratio is 2)
Fibonacci sequence; make the next term by adding the previous two ...
➔ 2, 4, 6, 10, 16, 26, 42, ...

## Standard graphs A12



Number | Algebra | Ratio, proportion and rates of change | Geometry & measures | Probability | Statistics

## Circle theorems G10




Angle in a semicircle is 90°

Angle at the centre is double the angle at the circumference

Angles in the same segment are equal

Opposite angles in a cyclic quadrilateral total 180°

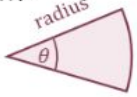
Alternate segment theorem

Tangent and radius are perpendicular

## Areas and volumes G16, G17, G18, G23

Circumference of circle = $\pi \times D$

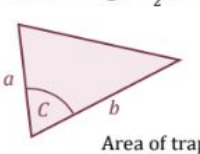
Area of circle = $\pi \times r^2$

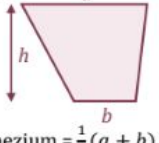



Arc length = $\frac{\theta}{360°} \times \pi \times D$

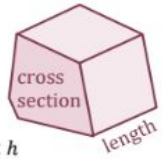
Area of sector = $\frac{\theta}{360°} \times \pi \times r^2$

Area of triangle = $\frac{1}{2}ab\sin C$




Area of trapezium = $\frac{1}{2}(a+b) \times h$




Volume of prism = area of cross section × length


Volume of cone = $\frac{1}{3}\pi r^2 h$

Volume of frustum is difference between the volumes of two cones

## Percentages: multipliers R9, R16

Percentage increase or decrease; use a multiplier (powers for repetition)

➔ **Initially there were 20 000 fish in a lake. The number decreases by 15% each year. Estimate the number of fish after 6 years.**

$20\,000 \times 0.85^6 = 7500$ (2sf)

Formula for compound interest

Total accrued = $P\left(1+\frac{r}{100}\right)^n$

➔ **I invest £600 at 3% compound interest. What is my account worth after 5 years?**

$£600 \times \left(1+\frac{3}{100}\right)^5 = £695.56$

## Direct & inverse proportion R10

$y$ is directly proportional to $x$:
$y = kx$ for a constant $k$

➔ **$b$ is directly proportional to $a^2$**
**$a = 6$ when $b = 90$ Find $b$ if $a = 8$**
$b = ka^2$ $a = 6$ and $b = 90$ for $k$
$90 = k \times 6^2$ so $k = 2.5$, $b = 2.5a^2$
$b = 2.5 \times 8^2 = 160$

$y$ is inversely proportional to $x$

$yx = k$ or $y = \frac{k}{x}$ for a constant $k$

## Similar shapes G19

Ratios in similar shapes and solids:

| | | |
|---|---|---|
| • Length/perimeter | $1:n$ | $a:b$ |
| • Area | $1:n^2$ | $a^2:b^2$ |
| • Volume | $1:n^3$ | $a^3:b^3$ |

## Probability rules P8, P9

Multiply for independent events

➔ **P(6 on dice and H on coin)**

$\frac{1}{6} \times \frac{1}{2} = \frac{1}{12}$

Add for mutually exclusive events

➔ **P(5 or 6 on dice)**

$\frac{1}{6} + \frac{1}{6} = \frac{2}{6}$

Apply these rules to tree diagrams.

In general...

P($A$ or $B$) = P($A$) + P($B$) − P($A$ and $B$)

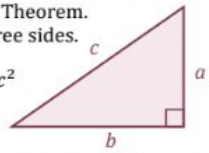
P($A$ and $B$) = P($A$ given $B$) × P($B$)

## Transformations G7, G8

| Reflection | Rotation | Enlargement |
|---|---|---|
| • Line of reflection | • Centre of rotation | • Centre of enlargement |
| Translation | • Angle of rotation | • Scale factor (if −1 < SF < 1 the shape will get smaller). |
| • Vector | • Clockwise or anticlockwise | |

## Right angled triangles G20

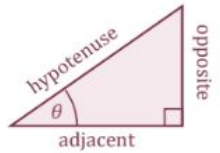
Pythagoras Theorem.
Links all three sides.
No angles.
$a^2 + b^2 = c^2$




Trigonometry.
Links two sides and one angle.
SOH | CAH | TOA

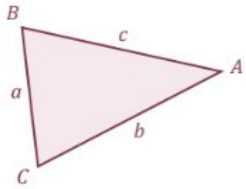
$\sin\theta = \frac{\text{opp}}{\text{hyp}}$ $\cos\theta = \frac{\text{adj}}{\text{hyp}}$ $\tan\theta = \frac{\text{opp}}{\text{adj}}$

Use "2ndF" or "SHIFT" key to find a missing angle




The longest side of any right angled triangle is the hypotenuse; check that your answer is consistent with this.

## Advanced trigonometry G21, G22




$A$ is opposite $a$
$B$ is opposite $b$
$C$ is opposite $c$

Sine Rule
Use if you are given an angle-side pair

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

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

Cosine Rule
Use if you can't use the sine rule

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

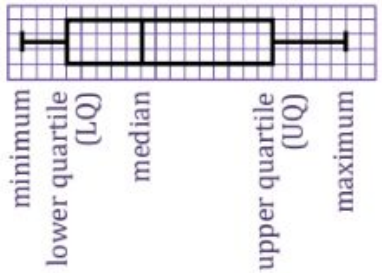
Missing angle: $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

Special values of sin, cos, tan
Learn (or be able to find without a calculator)...

| $\theta°$ | $\sin\theta°$ | $\cos\theta°$ | $\tan\theta°$ |
|---|---|---|---|
| 0 | 0 | 1 | 1 |
| 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 | |

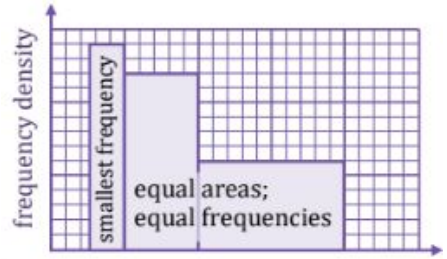
## Box plots S4

Interquartile range (IQR) = UQ − LQ




## Histograms S3

Frequency = frequency density multiplied by class width. This means that bars with the same frequency have the same area.




# MATHEMATICS - Higher

# Trilogy B9: Respiration

Bioenergetics

**Knowledge Organiser**

## Key points to learn

| | |
|---|---|
| .Breathing | Not the same as respiration. Method of obtaining oxygen from the air |
| Aerobic respiration | Process by which all living things get energy from glucose and oxygen |
| | Happens continuously in plants an animals. Provides lots of energy |
| | Glucose + Oxygen □ Carbon + Water dioxide |
| | $C_6H_{12}O_6 + 6O_2$ □ $6CO_2 + 6H_2O$ |
| | Exothermic reaction - gives off heat |
| | Occurs within mitochondria in cells |
| Response to exercise | During exercise body needs more energy so rate of aerobic respiration increases. This needs:<br>1. Heart rate increases - blood carries glucose and oxygen faster<br>2. Breathing rate and volume increases - lungs obtain more oxygen<br>3. Glycogen stores turned into glucose - more glucose available |
| | More respiration means you get hotter and may need to cool down |
| Anaerobic respiration | Provides energy from glucose if there is not enough oxygen available |
| Anaerobic respiration in plants and yeast | Called fermentation. Used to make bread and alcohol |
| | Glucose □ Ethanol + Carbon dioxide |
| Enzymes | Biological catalyst. Helps reactions to happen in living things |

## Key points to learn

| | |
|---|---|
| Anaerobic respiration in animal cells | Glucose □ Lactic acid |
| | Much less energy provided than aerobic respiration |
| actic acid | Leads to an oxygen debt which requires more oxygen after exercise is complete to break down the lactic acid |
| | Causes muscles to tire and cramp |
| Metabolism | The sum of all the reactions in a cell or the body of an organism |
| | Energy provided by respiration is used in these metabolic reactions to make new molecules |
| Metabolic reactions | Includes these 5 reactions:<br>1. Turning glucose into starch, glycogen and cellulose<br>2. Making lipids from glycerol and fatty acids<br>3. Using glucose and nitrate ions to make amino acids<br>4. Respiration<br>5. Turning excess proteins into urea |
| Metabolic rate | The rate at which reactions happen in an organism |
| Lipids | Fats and oils |
| Starch | Carbohydrate store in plants |
| Glycogen | Carbohydrate store in animals |
| Cellulose | Makes cell walls in plants |
| Urea | Waste product from liver |

## Big picture (Biology Paper 1)

- Cells and organisation
  - Cell structure and transport
  - Cell division
  - Organisation and the digestive system
  - Organising animals and plants
- Disease and bioenergetics
  - Communicable diseases
  - Preventing and treating disease
  - Non-communicable diseases
  - Photosynthesis
  - Respiration

## Background

It is one of the R's in MRS GREN. All living things do it, all of the time. Every single one of your 10 trillion living body cells are doing it right now. As are the 100trillion microbes living in your intestines!

## Additional information

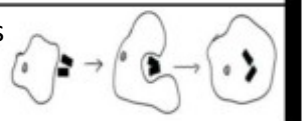
The five metabolic reactions are all covered in more detail in this course. Remember that they all use enzymes.

'Aerobic respiration' is often known as just 'respiration'. It is photosynthesis in reverse.

## Key points to learn

| | |
|---|---|
| Bacteria | Large microbe<br>Living  |
| | Divide by splitting in two |
| | May produce toxins to make us ill |
| | Cause:<br>• Salmonella - food poisoning<br>• Gonorrhoea - sexually transmitted disease (STD) |
| Viruses | Smallest microbe<br>Not alive  |
| | Live and reproduce inside cells |
| | Cause:<br>• Measles - can be fatal<br>• HIV - can turn into AIDS<br>• Tobacco mosaic virus (TMV) affects photosynthesis in plants |
| Fungi | The other type of microbe. Living |
| | Cause:<br>• Rose black spot - affects photosynthesis in plants |
| Pathogens | Microbes/microorganisms that cause diseases |
| | Spread by air, contact and water |
| Communicable diseases | Infectious diseases that can be passed from one person to another |
| | Caused by pathogens |
| Malaria | Is a protist disease. Spread by mosquito bites |

## Key points to learn

| | |
|---|---|
| Causes of ill health | Pathogens, diet, stress, life situations/conditions |
| Non-communicable diseases | Cannot be transmitted from one person to another |
| | Eg heart disease, arthritis |
| Ignaz Semmelweis | Doctor in mid-1850s who persuaded doctors to wash their hands |
| Louis Pasteur | Showed that microbes caused disease. Developed vaccines |
| Vaccines | An inactive form of a pathogen used to prepare your immune system |
| Human defences against pathogens | 1. Skin barrier - covers your body<br>2. Nose - hair and mucus act as trap<br>3. Trachea and bronchi - covered in cilia and mucus<br>4. Stomach - makes acid to destroy<br>5. Immune system - white blood cells defend us in three ways |
| Trachea | Pipe from mouth to bronchi |
| Bronchi | Pipe into each lung |
| Cilia | Tiny hair-like cells |
| White blood cells | 1. Phagocytosis ingest microbes  |
| | 2. Produce antibodies chemicals to destroy microbes  |
| | 3. Produce antitoxins chemicals to cancel-out toxins made by pathogens  |

# Trilogy B5: Communicable diseases

Collins Revision Guide: Infection and response

## Knowledge Organiser

## Big picture (Biology Paper 1)

- Cells and organisation
  - Cell structure and transport
  - Cell division
  - Organisation and the digestive system
  - Organising animals and plants
- Disease and bioenergetics
  - Communicable diseases
  - Preventing and treating disease
  - Non-communicable diseases
  - Photosynthesis
  - Respiration

## Background

Nobody likes getting ill. To better avoid diseases, we need to understand what causes and how our bodies try and defend us from them.

## Additional information

This topic links really well with B6 which is all about how we can further defend against these diseases.

**BIOLOGY**

# Trilogy: B6 Preventing and treating diseases

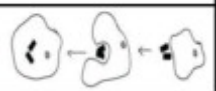
Infection and response

## Knowledge Organiser

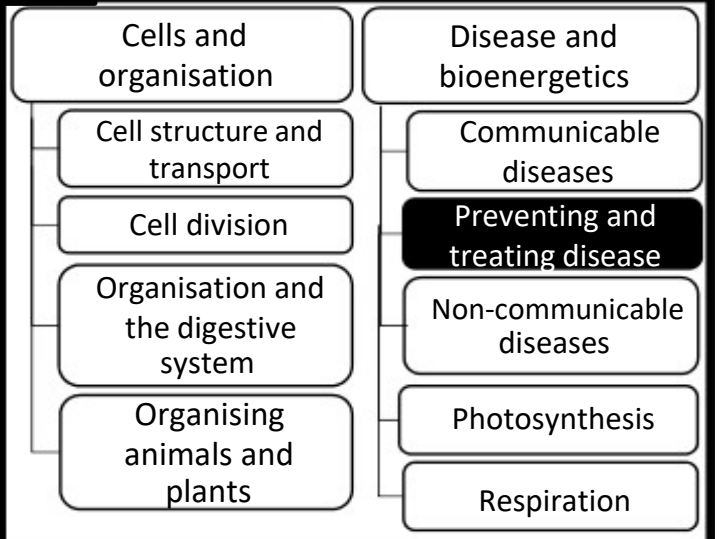
## Key points to learn

| | |
|---|---|
| Bacteria | Large microbe. Living |
| | Divide by splitting in two |
| | May produce toxins to make us ill |
| | Cause: - Salmonella<br>- Gonorrhoea |
| Viruses | Smallest microbe. Not alive |
| | Live and reproduce inside cells |
| | Cause: - Measles<br>- HIV<br>- Tobacco mosaic virus (TMV) |
| Pathogens | Microbes/microorganisms that cause diseases |
| | Spread by air, contact and water |
| Communicable diseases | Infectious diseases that can be passed from person to person |
| | Caused by pathogens |
| Louis Pasteur | Showed that microbes caused disease. Developed vaccines |
| Painkillers | No effect on the pathogens but do reduce the symptoms of illness. Eg aspirin and paracetamol |
| Destroying viruses | Is very difficult without damaging body tissue as they live inside cells |
| Discovery of new drugs | Medicines used to be extracted from plants and microorganisms eg<br>• Heart drug *digitalis* from foxglove<br>• Painkiller aspirin from willow tree<br>• Penicillin from mould |
| Placebo | A tablet with no active medicine content |

## Key points to learn

| | |
|---|---|
| Vaccines | An inactive form of a pathogen used to prepare your immune system |
| | White blood cells are able to respond quickly to prevent infection |
| | MMR is a vaccine against mumps, measles and rubella |
| Antibiotics | Medicines that kill specific bacteria. Greatly reduced deaths from bacterial diseases |
| | Cannot kill viruses |
| | Some bacteria are becoming resistant which is very concerning |
| | Alexander Fleming discovered penicillin |
| Making new medicines | Need to be checked for toxicity (safety), efficacy (effectiveness) and dose |
| | First trials are done using cells, tissues and live animals |
| | Clinical trials use healthy volunteers and patient:<br>1. Very low doses at start of trial<br>2. If safe, more trials done<br>3. In double blind trial some patients given placebo |
| White blood cells | 1. Phagocytosis ingest microbes  |
| | 2. Produce antibodies chemicals to destroy microbes  |
| | 3. Produce antitoxins chemicals to cancel-out toxins made by pathogens  |

## Big picture (Biology Paper 1)

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## Additional information

This topic links really well with B6 which is all about how we can further defend against these diseases.

BIOLOGY

## Key points to learn

| | |
|---|---|
| Non-communicable diseases | Cannot be transmitted from one person to another |
| | Eg heart disease, arthritis |
| Causes of ill health | Pathogens, diet, stress, life situations/conditions |
| Communicable diseases | Infectious diseases that can be passed from one person to another |
| | Caused by pathogens (microbes) |
| Coronary heart disease | Layers of fat build up inside coronary arteries, reducing blood flow and oxygen for the heart |
| | Stents used to keep arteries open |
| | Statin medicines used to reduce blood cholesterol levels which reduces rate of fatty build up |
| Heart failure | A failed heart can be replaced by a donor heart |
| Faulty heart valves | Can be replaced by biological/mechanical valves |
| Coronary arteries | Blood vessels that supply the heart |
| Cancer | Uncontrolled growth and division of cells |
| | Lifestyle and genetic factors can increase risks of some cancers |
| Tumour | Lump or growth in a part of the body, uncontrolled cell division |
| Health | State of physical and mental well-being |

## Key points to learn

| | |
|---|---|
| Malignant tumour | Are cancers |
| | Invade neighbouring tissues and spread throughout body forming secondary tumours |
| Benign tumour | Not cancers |
| | Growths of abnormal cells in one area that do not invade other parts of the body |
| Different diseases can interact | • A defective immune system can lead to more infections<br>• Viruses can trigger cancer<br>• Pathogens can trigger allergies<br>• Physical ill health can lead to depression and mental illness |
| Smoking and risk of disease | Carbon monoxide harms unborn babies |
| | Carcinogens increase risk of cancers |
| | Increases risk of coronary heart disease |
| | Increases risk of lung disease and lung cancer |
| Risks of diet, exercise and obesity | Increases risk of coronary heart disease and high blood pressure |
| | Obesity can lead to Type 2 diabetes |
| Alcohol and risk of disease | Damages the liver and carcinogens increase risk of liver cancer |
| | Affects brain function |
| | Passes to and harms unborn babies |
| . Exposure to ionising radiation | EM Waves (UV rays, X-rays Gamma rays) and radioactive material |
| | Can increase risk of cancers |

# Trilogy B7: Non-communicable diseases

Organisation

**Knowledge Organiser**

## Big picture (Biology Paper 1)

- Cells and organisation
  - Cell structure and transport
  - Cell division
  - Organisation and the digestive system
  - Organising animals and plants
- Disease and bioenergetics
  - Communicable diseases
  - Preventing and treating disease
  - **Non-communicable diseases**
  - Photosynthesis
  - Respiration

## Background

A reported 25% of people in the UK are now obese. Around 17% of adults smoke and many more consume alcohol. So, what are the risks of these lifestyle choices?

## Maths skills

Use scatter diagrams to identify correlation between factors.


Using samples to estimate population trends

# WORKING SCIENTIFICALLY

| Key terms | Definition |
|---|---|
| **Independent variable** | A variable in an experiment that you change to find out its effect on the dependent variable |
| **Dependent variable** | Variable that is measured in an experiment to see how it changes |
| **Control variable** | Variables that are kept the same in an experiment to ensure it doesn't affect the dependent variable |
| **Repeats** | The number of times the experiment is carried out to collect data from which to calculate a mean |
| **Mean** | The average when repeated data is added together and divided by the number of repeats (anomalous data is not included in the calculation) |
| **Equipment** | The scientific apparatus used to make the experiment accurate. |
| **Anomalous** | Results that do not fit the pattern seen in other data or are much higher or lower than other repeated readings (outliers). |
| **Equipment** | The scientific apparatus used to make the experiment accurate. |
| **Valid** | Suitability of the method used to answer the question being asked. |
| **Hypothesis** | A proposal intended to explain certain facts or observations. |
| **Prediction** | A forecast or statement about what should happen in an experiment. |

**Key Facts:**
**Investigating** an **independent variable** and its' effect on a **dependent variable** allows us to look for a **correlation**. This means we can describe a relationship between the two variables.
To do this we need to:

- Make a **predication** based on some previous scientific knowledge.
- Use **equipment** that allows us to make **accurate** measurements
- Identify **hazards** and take **precautions** against them
- **Record** our **results** in a meaningful way
- **Repeat** the test to make sure the **data** we get is the same each time
- **Process** the **data**
- **Analyse data** to identify relationships
- **Evaluate** the method and the data to show it is accurate and valid

## Hypothesise and Variables

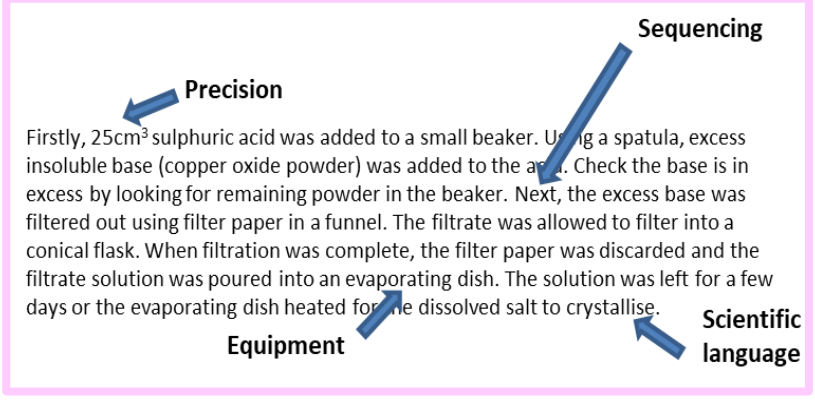
- A hypothesis is a predication made about an experiment based on some previous scientific knowledge.
- The hypothesis is then tested by carrying out the experiment.
- When designing experiments, there are three types of variable that we need to consider:

1. The dependent variable (what we measure)
2. The independent variable (what we change)
3. The control variables (what we keep the same)

## Methods

When writing a method you should include:

1. A clear sequence
2. Information on which equipment to use
3. Volumes and masses for reagents
4. Scientific language




SCIENCE

## Equipment

This is some of the most common laboratory equipment that you will be using.
Ensure that you learn each piece.

| Equipment | Picture | Use |
|---|---|---|
| Beaker |  | For pouring and transferring liquids and solutions. |
| Conical Flask |  | For carrying out reactions |
| Bunsen Burner |  | To heat substances |
| Tripod |  | To support |
| Gauze |  | To place an object on for example conical flask that you are going to heat. |
| Heatproof mat |  | To protect the desk from the heat produced by the Bunsen Burner and any spillages from the substances which are being heated |
| Evaporating basin |  | To evaporate the water from solutions. Leaving behind the solute. |

| Equipment | Picture | Use |
|---|---|---|
| Test Tube |  | For carrying out chemical reactions with small amounts of liquid |
| Boiling Tube |  | A boiling tube is used to heat substances in a Bunsen Burner |
| Measuring Cylinder |  | To accurately measure out volumes of liquid |
| Spatula |  | To move small amounts of solid powders |
| Stirring Rod |  | To stir solutions. |
| Thermometer |  | To measure the temperature of a substance |
| Tongs |  | To hold an move hot solids for example pieces of metal |

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## Results Tables

- In a results table the independent variable should always go on the left.
- When drawing a results table the following things are good practice::

1. Show all repeat measurements
2. Include the units in the headings
3. Circle anomalies
4. Discount these when calculating a mean

For example:

| Concentration of acid (M) | Time taken for reaction to complete (s) | | | Mean (s) |
|---|---|---|---|---|
| 0.1 | 102.1 | 105.6 | 103.4 | 103.7 |
| 0.2 | 88.8 | 86.5 | 87.2 | 87.5 |
| 0.3 | 69.1 | 67.3 | 64.2 | 66.9 |
| 0.4 | 56.2 | 40.1 | 53.3 | 54.8 |
| 0.5 | 32.1 | 30.1 | 33.2 | 31.8 |

## Maths skills

To calculate a mean:

- Add together the values for collected data.
- Divide the total by the number of data values used.

E.g. No anomalies:
102.1 + 105.6 + 103.4 = 311.1
then 311.1 ÷ 3 = **103.7**

E.g. With anomaly:
56.2 + 53.3 = 109.5
then 109.5 ÷ 2 = **54.75**

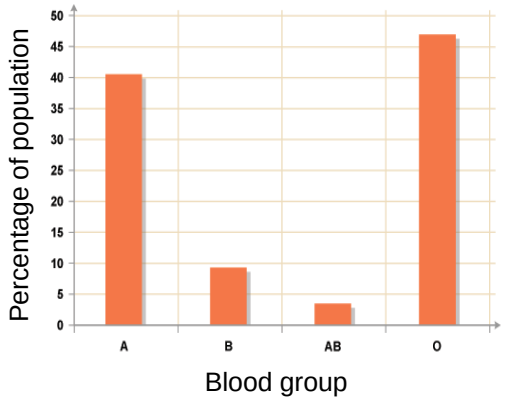
Notice that we left out the smaller number **40.1** and divided by **2.**

In the table the values are all to **1 decimal place** so we round **54.75** to **54.8**

| Key terms | Definition |
|---|---|
| **Continuous data** | Can take any value as whole number or decimals; usually collected by measuring variables, such as mass, volume or density. |
| **Discrete data** | Can only take exact whole number (integer) values; usually collected by counting. |
| **Bar chart** | Used when one variable is categorical (a label, name or group) |
| **Line Graph** | Used when both variables are continuous (have numerical data from measuring) |
| **Line of best fit** | Drawn so that plotted points are evenly distributed either side of the line; can be straight or curved. |
| **Evaluate** | Use the information supplied, as well as knowledge and understanding, to consider evidence for and against when making a judgement. |
| **Hazard** | Something that can cause harm e.g. an object, a property of a substance or an activity |
| **Risk** | The likelihood that a hazard will actually cause harm. |
| **Precaution** | Action to remove or reduce a risk |

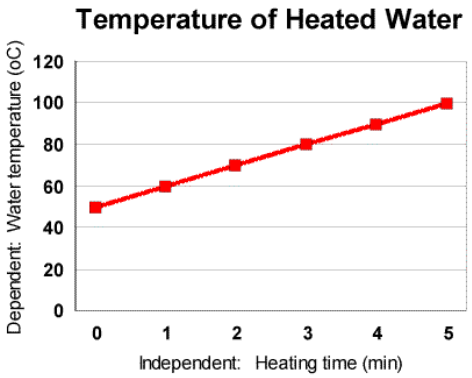
## Discontinuous data

Discontinuous or categoric data can only take certain values for example eye colour and blood group, these should be plotted on a bar graph.




## Continuous data

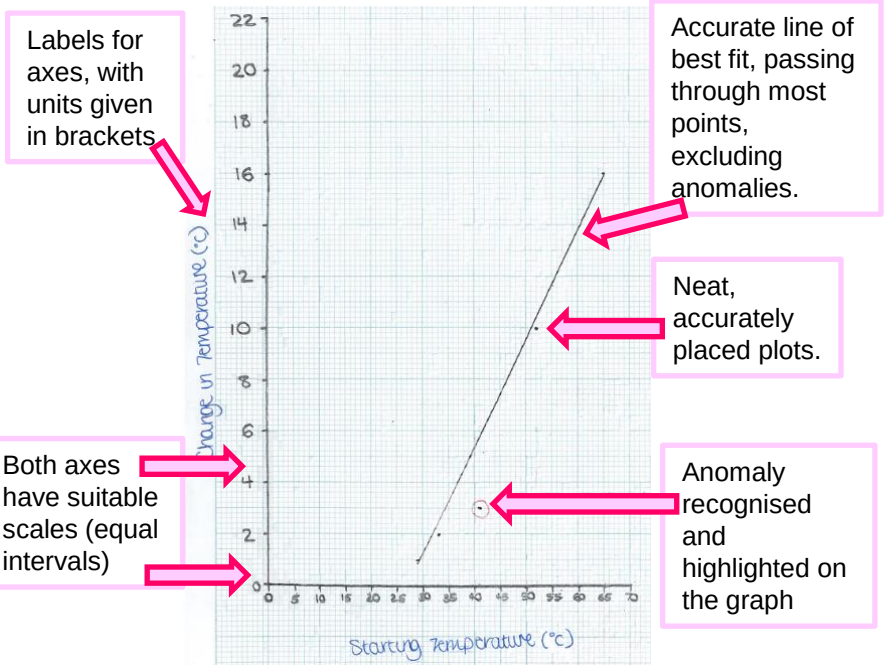
Continuous data can take any value, for example height or temperature.
This should be plotted on a line graph.




## Drawing good line graphs

When drawing a graph you should:

1. Plot the dependent variable on the y axis and independent variable on the x axis
2. Label axis and include units
3. Use small precise crosses to mark your points
4. Add a line of best fit which goes smoothly though as many points as possible (this does not have to be a straight line, it can be a curve but it is not a dot to dot exercise!)
5. Circle anomalies and don't include them when drawing the line of best fit




SCIENCE

## The Reactivity Series

Here's a mnemonic to help you learn the order:

**purple** (potassium)
**slime** (sodium)
**can** (calcium)
**make** (magnesium)
**a** (aluminium)
**careless** (carbon)
**zebra** (zinc)
**insane** (iron)
**try** (tin)
**learning** (lead)
**how** (hydrogen)
**camels** (copper)
**surprise** (silver)
**gorillas** (gold)

carbon →
hydrogen →

| |
|---|
| potassium |
| sodium |
| calcium |
| magnesium |
| aluminium |
| zinc |
| iron |
| tin |
| lead |
| copper |
| silver |
| gold |
| platinum |

The reactivity series is a league table for metals. The more reactive metals are near the top of the table with the least reactive near the bottom. In chemical reactions, a more reactive metal will displace a less reactive metal.

## Reactions of Metals with Water

Metals, when reacted with water, produce a metal hydroxide and hydrogen.

lithium + water ⟶ lithium hydroxide + hydrogen

$2Li + 2H_2O \longrightarrow 2LiOH + H_2$

The more reactive a metal is, the faster the reaction.

## Reactions of Metals with Dilute Acid

Metals, when reacted with acids, produce a salt and hydrogen.

Sodium + hydrochloric acid ⟶ sodium chloride + hydrogen

$2Na + 2HCl \longrightarrow 2NaCl + H_2$

Metals that are below hydrogen in the reactivity series **do not** react with dilute acids.

## Reactions of Acids

The general formula for the reaction between an acid and a metal is:
acid + metal ⟶ salt + hydrogen

For example: hydrochloric acid + sodium ⟶ sodium chloride + hydrogen

$2HCl + 2Na \longrightarrow 2NaCl + H_2$

When an acid reacts with an alkali, a neutralisation reaction takes place and a salt and water are produced.

The general formula for this kind of reaction is as follows:

acid + alkali ⟶ salt + water

hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

$HCl + NaOH \longrightarrow NaCl + H_2O$

## Naming Salts

The first part comes from the metal in the metal carbonate, oxide or hydroxide. The second part of the name comes from the acid that was used to make it.

For example, sodium chloride.

| Acid Used | Salt Produced |
|---|---|
| hydrochloric | chloride |
| nitric | nitrate |
| sulfuric | sulfate |

## Redox Reactions (Higher Tier Only)

When metals react with acids, they undergo a redox reaction. A **redox reaction** occurs when both **oxidation** and **reduction** take place at the **same time.**

For example:

$2H^+ + Ca \longrightarrow Ca^{2+} + H_2$

The ionic equation can be further split into two half equations.

$Ca \longrightarrow Ca^{2+} + 2e^-$

Oxidation is loss of electrons.

$2H^+ + 2e^- \longrightarrow H_2$

Reduction is gaining of electrons.

## Reactions with Bases

The general formula for the reaction between an acid and a metal oxide is:
acid + metal oxide ⟶ salt + water

sulfuric acid + copper oxide ⟶ copper sulfate + water

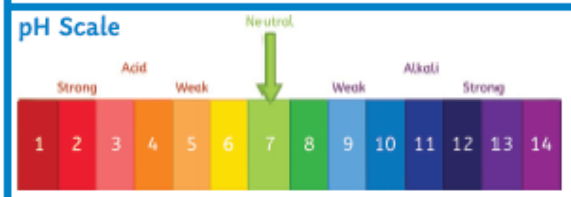
$H_2SO_4 + CuO \longrightarrow CuSO_4 + H_2O$

## Reactions with Carbonates

The general formula for the reaction between an acid and a carbonate is:
acid + carbonate ⟶ salt + water + carbon dioxide

hydrochloric acid + calcium carbonate ⟶ calcium chloride + water + carbon dioxide

## pH Scale




In aqueous solutions, acids produce $H^+$ ions and alkalis produce $OH^-$ ions.

Neutral solutions are pH7 and are neither acids or alkalis.

For example, in neutralisation reactions, hydrogen ions from an acid react with hydroxide ions from an alkali to produce water:

$H^+ + OH^- \longrightarrow H_2O$

## Making Soluble Salts

1. Make a saturated solution by stirring copper oxide into the sulfuric acid until no more will dissolve.

2. Filter the solution to remove the excess copper oxide solid.

3. Half fill a beaker with water and set this over a Bunsen burner to heat the water. Place an evaporating dish on top of the beaker.

4. Add some of the solution to the evaporating basin and heat until crystals begin to form.

5. Once cooled, pour the remaining liquid into a crystallising dish and leave to cool for 24 hours.

6. Remove the crystals with a spatula and pat dry between paper towels.

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carbon →
hydrogen →

| |
|---|
| potassium |
| sodium |
| calcium |
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| tin |
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| gold |
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hydrochloric acid + calcium carbonate ⟶ calcium chloride + water + carbon dioxide

## pH Scale


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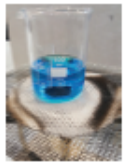

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5. Once cooled, pour the remaining liquid into a crystallising dish and leave to cool for 24 hours.

6. Remove the crystals with a spatula and pat dry between paper towels.

## Required Practical – Paper Chromatography

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

**Step 1** – Using a ruler, measure 1cm from the bottom of the chromatography paper and mark with a small dot using a pencil. Rule a line across the bottom of the chromatography paper with a pencil, going through the dot you have just made.

**Step 2** – Using a pipette, drop small spots of each of the inks onto the pencil line. Leave a sufficient gap between each ink spot so that they do not merge.

**Step 3** – Pour a suitable solvent into the bottom of a container such as a beaker. The solvent should just touch the chromatography paper. The solvent line must not go over the ink spots as this will cause the inks to run into each other.

**Step 4** – Place the chromatography paper into the container and allow the solvent to move up through the paper.

**Step 5** – Just before the solvent line reaches the top of the paper, remove the chromatogram from the container and allow to dry.

**Step 6** – Once the chromatogram has dried, measure the distance travelled by the solvent.

**Step 7** – Measure the distance travelled by each ink spot.

**Step 8** – Calculate the $R_f$ value. Compare the $R_f$ values for each of the spots of ink.

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

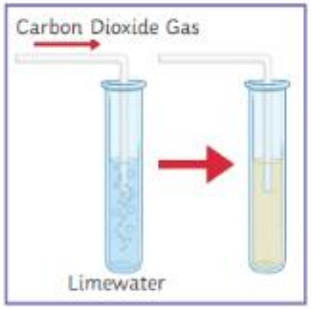
## Identification of the Common Gases

**The Test for Hydrogen**

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

**The Test for Oxygen**

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




**The Test for Carbon Dioxide**

**Calcium hydroxide (lime water)** is used to test for the presence of carbon dioxide. When carbon dioxide is bubbled through or shaken with limewater, the limewater turns **cloudy**.

**The Test for Chlorine**

**Damp litmus paper** is used to test for chlorine gas. The litmus paper becomes **bleached and turns white**.

# Chemistry Topic 10: Using resources

| 1. Keywords | |
|---|---|
| Finite resources | Resources that will run out |
| Renewable resources | Resources that can be re-grown or will not run out |
| Sustainable development | Building things with depleting natural resources |
| Potable water | Water that is safe to drink |
| Pure water | Water without anything added to it<br>Eg 100% $H_2O$ |
| Desalination | Removing salt by distillation or reverse osmosis |
| Sterilisation | Killing bacteria and microbes (eg chlorine, ozone or UV) |
| Distillation | Evaporation followed by condensation, uses a lot of energy |
| Reverse osmosis | A process using membranes to remove the salt. Uses a lot of energy |
| Effluent | Liquid waste sewage discharged into rivers and seas |
| Sludge | Solid sewage waste. Dried and used as fertiliser or burned to generate electricity |
| Life cycle assessments (LCAs) | A way of assessing the impact of the production transport use and disposal of a product on the environment |

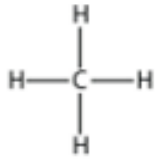
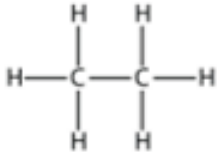
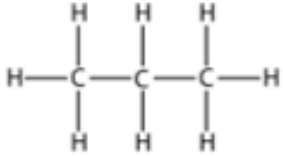
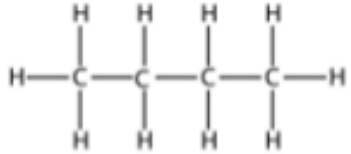
| 2. Waster water treatment | | |
|---|---|---|
| | Name | Description |
| 1 | Screening | Solid waste and grit removed by a metal grid |
| 2 | Primary treatment | Sediments are allowed to settle out from the mixture |
| 3 | Secondary treatment | Bacteria feed on the remaining organic waste. The tank has air bubbled through it so aerobic respiration can occur |
| 4 | Final treatment | Bacteria allowed to settle out. Water is sterilised and ready to drink |

| 3. Alternative methods of extracting metals (HT ONLY) | |
|---|---|
| Phytomining | 1. Plants absorb metal compounds<br>2. Plants are harvested and burnt<br>3. Ash contains metal compounds |
| Bioleaching | 1. Bacteria absorb metal compounds<br>2. Bacteria excrete a solution of metal called Leachate<br>3. Electrolysis can extract the metal |

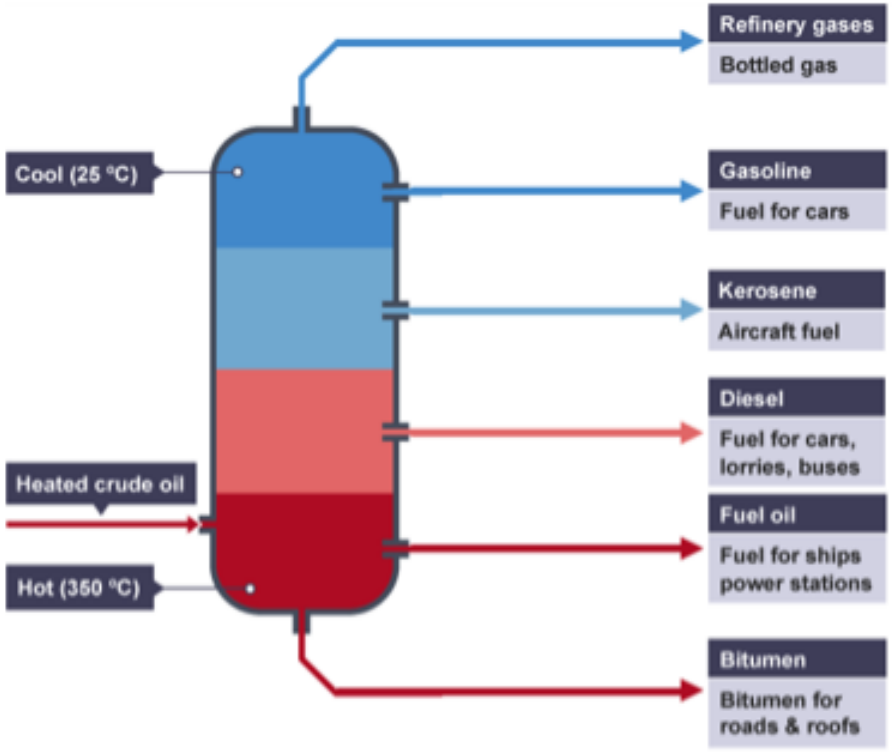
| 4. Corrosion and its prevention (TRIPLE ONLY) | | |
|---|---|---|
| Corrosion | Destruction of materials by chemical reactions. eg rusting | |
| Prevention method | Works by | Examples |
| Coating | Providing a barrier | Greasing<br>Painting<br>Electroplating |
| Sacrificial protection | Reacts with the oxygen instead of the metal | Galvanising by Zinc |

# Chemistry Topic 7: Organic chemistry

| 1. Carbon compounds as fuels and feedstock | |
|---|---|
| Hydrocarbon | A chemical made of only carbon and hydrogen |
| Crude oil | A mixture of hydrocarbons found in rock |
| Alkanes | Saturated hydrocarbons (without double bond) |
| Alkene | Unsaturated hydrocarbon (with double bond). They turn bromine water from brown to colourless. |
| Fractional distillation | A process of separating crude oil using the different boiling points of fractions |
| Viscosity | How thick a liquid is |
| Flammability | How easily a fraction catches fire |
| Boiling point | The temperature at which a substance turns from a liquid to a gas |
| Combustion | A reaction where a fuel is oxidised releasing heat energy |
| Cracking | Breaking less useful long-chain alkanes into useful short-chain alkanes and alkenes |

| 2. Alkanes | | |
|---|---|---|
| General formula | $C_nH_{2n+2}$ | |
| Name | Molecular formula | Displayed formula |
| Methane | $CH_4$ |  |
| Ethane | $C_2H_6$ |  |
| Propane | $C_3H_8$ |  |
| Butane | $C_4H_{10}$ |  |

| 3. Fractional distillation | |
|---|---|
| 1. | The column is cooler at the top than the bottom |
| 2. | The crude oil is heated |
| 3 | The fractions evaporate and rise up the column |
| 4 | The fractions condense at different points according to their boiling point |
| 5 | The liquid fractions run off and are collected |




| 4. Properties of hydrocarbons | |
|---|---|
| Property | Change as carbon change gets longer |
| Boiling point | Increases |
| Viscosity | Increases (less runny) |
| Flammability | Decreases |

| 5. Cracking | |
|---|---|
| Type of cracking | Conditions |
| Catalytic | Hot (500°C) + catalyst |
| Steam | Very hot (850°C) + Steam |
| Short chain = desirable | Long chain = undesirable |

# Electricity – Foundation and Higher

## Required Practical

**Investigating Resistance in a Wire**

**Independent** variable: length of the wire.

**Dependent** variable: resistance.

**Control** variables: type of metal, diameter of the wire.

**Conclusion**: As the length of the wire increases, the resistance of the wire also increases.

**Investigating Series and Parallel Circuits with Resistors**

**Independent** variable: circuit type (series, parallel).

**Dependent** variable: resistance.

**Control variables**: number of resistors, type of power source.

**Conclusion**: Adding resistors in series increases the total resistance of the circuit. In a parallel circuit, the more resistors you add, the smaller the resistance.

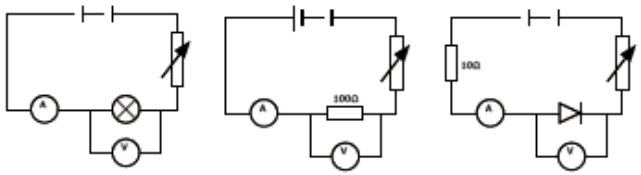
**Investigating I-V Relationships in Circuits** (Using a filament bulb, ohmic conductor, diode.)

**Independent** variable: potential difference/volts (V).

**Dependent** variable: current (A).

**Control** variable: number of components (e.g. 1 filament bulb, 1 resistor), type of power source.

Set up the circuits as shown below and measure the current and the potential difference.




Draw graphs of the results once collected.

## Equations and Maths

**Equations**

| | |
|---|---|
| Charge: | $Q = It$ |
| Potential difference: | $V = IR$ |
| Energy transferred: | $E = Pt$ |
| Energy transferred: | $E = QV$ |
| Power: | $P = VI$ |
| Power: | $P = I^2R$ |

**Maths**

1kW = 1000W

0.5kW = 500W

## Charge

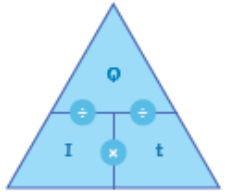
Electric current is the flow of electric charge. It only flows when the circuit is complete.

The **charge** is the current flowing past a point in a given time. Charge is measured in **coulombs (C)**.

**Calculating Charge**

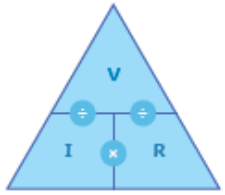
charge flow (C) = current (A) × time (s)

$Q = It$




potential difference = current x resistance

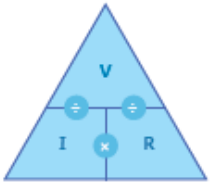
V (V) = I (A) × R (Ω)




## Resistance

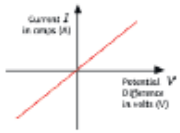
**voltage (V) = current (A) × resistance (Ω)**

**V = IR**

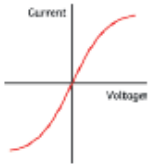



**Graphs of I-V Characteristics for Components in a Circuit**

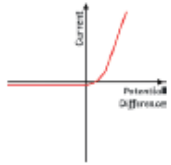
1. **Ohmic conductor**: the current is directly proportional to the potential difference - it is a straight line (at a constant temperature).



2. **Filament lamp**: as the current increases, so does the temperature. This makes it harder for the current to flow. The graph becomes less steep.




3. **Diode**: current only flows in one direction. The resistance is very high in the other direction which means no current can flow.




## Current and Circuit Symbols

**Current**: the flow of electrical charge.

**Potential difference (voltage)**: the push of electrical charge.

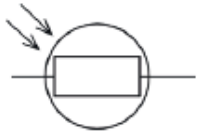
**Resistance**: slows down the flow of electricity.

| | | | | | |
|---|---|---|---|---|---|
| cell | | closed switch | | fuse | |
| resistor | | ammeter | A | LDR | |
| battery | | voltmeter | V | LED | |
| variable resistor | | bulb | | thermistor | |
| open switch | | diode | | | |

# Electricity – Foundation and Higher

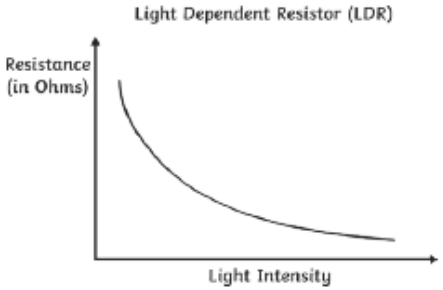
## Circuit Devices

**LDR – Light Dependent Resistor**



An LDR is dependent on light intensity. In bright light the resistance falls and at night the resistance is higher.

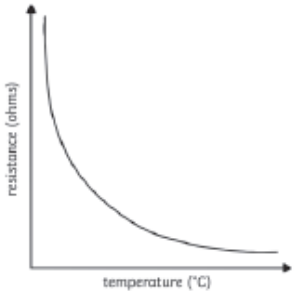
Uses of LDRs: outdoor night lights, burglar detectors.




**Thermistor**

A thermistor is a temperature dependent resistor. If it is hot, then the resistance is less. If it becomes cold, then the resistance increases.

Uses of thermistors: temperature detectors.




## Series and Parallel Circuits

### Series Circuits

Once one of the components is broken then all the components will stop working.

**Potential difference** – the total p.d. of the supply is shared between all the components.

$V_{total} = V_1 + V_2$

**Current** – wherever the ammeter is placed in a series circuit the reading is the same.

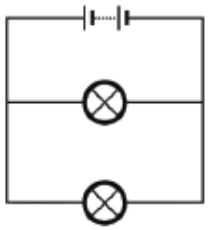
$I_1 = I_2 = I_3$

**Resistance** – In a series circuit, the resistance will add up to make the total resistance.

$R_{total} = R_1 + R_2$

### Parallel Circuits

They are much more common - if one component stops working, it will not affect the others. This means they are more useful.



**Potential Difference** – this is the same for all components.

$V_1 = V_2$

**Current** – the total current is the total of all the currents through all the components.

$I_{total} = I_1 + I_2 + I_3$

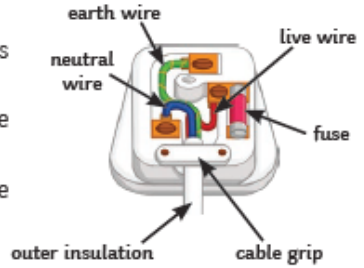
**Resistance** – adding resistance reduces the total resistance.

## Electricity in the Home

**AC** – alternating current. Constantly changing direction - UK mains supply is 230V and has a frequency of 50 hertz (Hz).

**DC** – direct current. Supplied by batteries and only flows in one direction.

**Cables** – most have three wires: live, neutral and earth. They are covered in plastic insulation for safety.




**Live wire** – provides the potential difference from the mains.

**Neutral wire** – completes the circuit.

**Earth wire** – protection. Stops the appliance from becoming live. Carries a current if there is a fault.

Touching the live wire can cause the current to flow through your body. This causes an electric shock.

**Energy Transferred** – this depends on how long the appliance is on for and its power.

**energy transferred (J) = power (W) × time (s)** $E = Pt$

Energy is transferred around a circuit when the charge moves.

**energy transferred (J) = charge flow (C) × potential difference (V)** $E = QV$

**power (W) = potential difference (V) × current (A)** $P = VI$

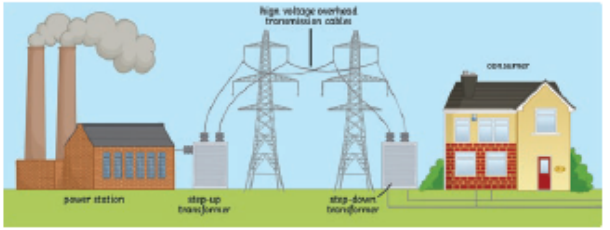
**power (W) = current² (A) × resistance (Ω)** $P = I^2R$

### The National Grid

The National Grid is a system of cables and transformers. They transfer electrical power from the power station to where it is needed. Power stations are able to change the amount of electricity that is produced to meet the demands. For example, more energy may be needed in the evenings when people come home from work or school. Electricity is transferred at a low current, but a high voltage so less energy is being lost as it travels through the cables.

**Step-up transformers** – increase the voltage as the electricity flows through the cables.

**Step-down transformers** – decrease the potential difference to make it safe.



PLYMPTON ACADEMY

# TERM FIVE & SIX

# HANDBOOK

# YEAR 10