Physics 1: Energy

Section 1: Energy stores and methods of transfer

1 Chemical store	Energy stored as chemicals waiting to **react.**
2 Kinetic store	Energy stored in objects that **move.**
3 Gravitational Potential store	Energy stored in objects raised up against the force of **gravity.**
4 Elastic Potential store	Energy stored in an object that have been **stretched.**
5 Internal store	Energy stored in the movement of particles. It is a combination of the **kinetic** energy of the particles and the **potential** energy of particles that are apart from each other. Can be modified by **heating** or **cooling**.
6 Nuclear store	Energy stored in the **nuclei** of atoms that can fuse (nuclear fusion) or split (nuclear fission).
7 Magnetic store	Energy stored in **magnets** that are **attracting** or **repelling.**
8 Electrostatic store	Energy stored in **electric charges** that are **attracting** or **repelling**.
9 Mechanical transfer	Energy transferred when a **force moves through a distance**.
10 Electrical transfer	Energy transferred when a **charge moves**.
11 Radiation transfer	Energy transferred by **electromagnetic radiation**.
12 Heat transfer	Energy transferred when an object is **heated.**

Section 2: Equations to learn

Calculation	Equation	Symbol equation	Units
13 Kinetic energy store	Kinetic energy = 0.5 x mass x velocity^2	$E_k = 0.5\ m\ v^2$	Energy – Joules (J) Mass – kilograms (kg) Velocity – metres per second (m/s)
14 Gravitational potential energy store	Gravitational potential energy = mass x gravitational field strength x height	$E_p = m\ g\ h$	Energy – Joules (J) Mass – kilograms (kg) Gravitational field strength – Newtons per kilogram (N/kg) Height – metres (m)
15 Power	Power =energy transferred ÷ time	$P = \frac{E}{t}$	Power – Watts (W) Energy transferred – Joules (J) Time – seconds (s)
16 Power	Power = work done ÷ time	$P = \frac{W}{t}$	Power – Watts (W) Work done – Joules (J) Time – seconds (s)
17 Efficiency	Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$		Energy – Joules (J)
18 Efficiency	Efficiency = $\frac{\text{useful power output}}{\text{total power input}}$		Power – Watts (W)

Section 3: Energy Resources

Resource	Renewable?	Uses	Advantages	Disadvantages
19 Fossil Fuels	Non-Renewable	Electricity, transport, heating	**Reliable** – electricity can be generated all of the time. Relatively **cheap** way of generating electricity.	Produces **carbon dioxide**, a greenhouse gas that causes **global warming.** Can produce **sulphur dioxide**, a gas that causes **acid rain**.
20 Nuclear Fuel	Non-Renewable	Electricity	Produces **no carbon dioxide** when generating electricity. **Reliable** – electricity can be generated all of the time.	Produces **nuclear waste** that remains **radioactive** for thousands of years. **Expensive** to build and **decommission** power stations.
21 Bio Fuel	Renewable	Heating, electricity	**Carbon neutral**. **Reliable** – electricity can be generated all of the time.	Production of fuel may damage ecosystems and create a **monoculture**.
22 Wind	Renewable	Electricity	**No CO_2** produced while generating electricity.	**Unreliable** – may not produce electricity during **low wind**. **Expensive** to construct.
23 Hydroelectricity	Renewable	Electricity	**No CO_2** produced while generating electricity.	Blocks rivers stopping **fish migration**. **Unreliable** – may not produce electricity during **droughts**.
24 Geothermal	Renewable	Electricity, heating	Does not damage **ecosystems**. **Reliable** source of electricity generation.	Fluids drawn from ground may contain **greenhouse gases** such as **CO_2** and **methane.** These contribute to **global warming**.
25 Tidal	Renewable	Electricity	**No CO_2** produced while generating electricity.	**Unreliable** – **tides vary**. May damage **tidal ecosystem** e.g. mudflats.
26 Waves	Renewable	Electricity	**No CO_2** produced while generating electricity.	**Unreliable** – may not produce electricity during **calm** seas.
27 Solar	Renewable	Electricity, heating	**No CO_2** produced while generating electricity.	**Unreliable** – does not produce electricity at **night**. Limited production on **cloudy** days. **Expensive** to construct.

Section 4: Key terms

28 Dissipation	Energy becoming **spread out** instead of in a concentrated store. “Wasted” energy.
29 Lubrication	A method of reducing unwanted energy transfers by application of a **lubricant** (e.g. **oil**) to **reduce friction**. Occurs in machines.
30 Insulation	A method of reducing energy transfers by the use of **insulators** (non-conductive material). Occurs in buildings.
31 Conservation of energy	The law that states that **energy cannot be created or destroyed**.
32 Specific heat capacity	The energy needed to raise **1kg** of a material by **1^{o}C**.

Section 3: Energy Resources

Resource	Renewable?	Uses	Advantages	Disadvantages
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20 Nuclear Fuel		Electricity		
22 Wind		Electricity	**No CO_2** produced while generating electricity.	
23 Hydroelectricity	Renewable	Electricity		Blocks rivers stopping **fish migration**. **Unreliable** – may not produce electricity during **droughts**.
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Section 2: Equations to learn

Calculation	Equation	Symbol equation
13 Kinetic energy store		
14 Gravitational potential energy store		
15 Power		

Section 3: Energy Resources

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Section 2: Equations to learn

Calculation	Equation	Symbol equation
13 Kinetic energy store		
14 Gravitational potential energy store		
15 Power		

Physics 2: Electricity

Section 1: Circuit Symbols

1  switch (open)

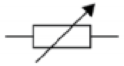
2  switch (closed)

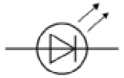
3  cell

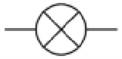
4  battery

5  diode

6  resistor

7  variable resistor

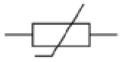
8  LED

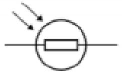
9  lamp

10  fuse

11  voltmeter

12  ammeter

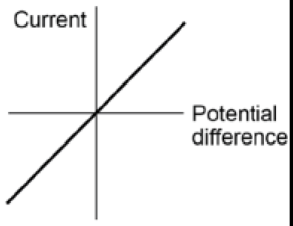
13  thermistor

14  LDR

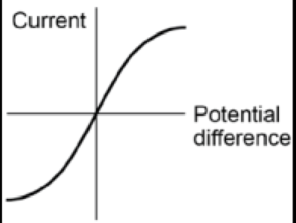
Section 4: V, I and R in Series and Parallel

	Components connected in…	Current	Potential Difference	Resistance
27	Series	The current is the **same** at every point in the circuit and in every component.	The total potential difference of the power supply is **shared** between the components.	The **more resistors, the greater the resistance**. The total resistance of two components is the sum of the resistance of each component. $R_{total} = R_1 + R_2$
28	Parallel	The **total current** through the whole circuit is the **sum of the currents through the separate components.**	The potential difference across each component is the **same.**	Adding **more resistors in parallel decreases resistance.** The **total resistance** of two resistors is **less than the resistance of the smallest individual resistor.**

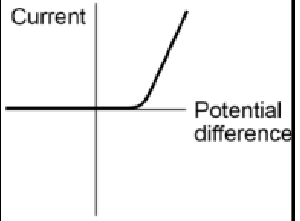
Section 5: IV Graphs



29 Fixed Resistor (Ohmic Conductor)
Current and potential difference are **directly proportional. Resistance is constant.**



30 Filament Lamp
Resistance of a filament lamp is **not constant**. As temperature increases, resistance increases. **Ions** within the lamp **vibrate more**, increasing **collisions** with **electrons.**



31 Diode/ LED
The **current** through a diode flows in **one direction only**. The diode has a **very high resistance in the reverse direction**.

Section 6: The Three Core Cable

32 Live	**Brown** colour. **Current flows** to the appliance. Potential difference between this and other wires should be **230V**.
33 Neutral	**Blue** colour. Current taken away from appliance. Potential difference should be **0V**.
34 Earth	**Yellow** and **green** colour. Potential difference of **0V**. Carries charge to Earth if live wire touches the metal casing of an appliance.

Section 2: Equations to learn

	Equation	Symbol equation	Units
15	Charge flow = current x time	$Q = I \times t$	Charge flow - coulomb (C) Current – amperes (A) Time – seconds (s)
16	Potential difference = current x resistance	$V = I \times R$	Potential difference – volts (V) Current – amperes (A) Resistance – ohms (Ω)
17	Power = potential difference x current	$P = V \times I$	Power – watt (W) Potential difference – volts (V) Current – amperes (A)
18	Power = current^2 x resistance	$P = I^2 \times R$	Power – watt (W) Current – amperes (A) Resistance – ohms (Ω)
19	Energy transferred = power x time	$E = P \times t$	Energy = joules (J) Power – watt (W) Time – seconds (s)
20	Energy transferred = charge flow x potential difference	$E = Q \times V$	Energy = joules (J) Charge flow - coulomb (C) Potential difference – volts (V)

Section 3: Key Terms

21 Electric current	The **flow** of **electric charge**.
22 Potential difference	The potential difference between two points in an electric circuit is the **work done when a coulomb of charge passes between the points.** Potential difference **causes charge to flow**
23 Resistance	Resistance is caused by anything that **opposes the flow of electric charge.**
24 Charge	Anything charged that is able to move within a circuit. **Electrons** or **ions**.
25 Series	A circuit with only **one route** for charge to take.
26 Parallel	A circuit with only **more than one route** for charge to take.

Section 7: Mains Electricity

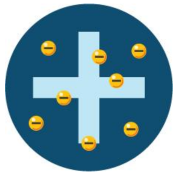
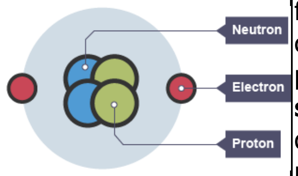
35 Alternating Current	The **current** regularly **changes direction e.g. mains electricity**
36 Direct Current	The **current** flows in **one direction only e.g. batteries.**
37 Mains Electricity	UK mains is an **alternating current** of **230V** and at a frequency of **50Hz**.
38 National Grid	A series of **cables** and **transformers** linking power stations to consumers.
39 Step-up Transformer	**Increases the potential difference** for **transmission** across power cables. This **reduces the current** and **therefore less heat is lost** from the cables. This makes the National Grid **efficient**.
40 Step-down Transformer	**Reduces the potential difference** from the cables to **230V** for use by consumers.

Physics 4: Atomic Structure

Section 1: Key Terms

1 Atom	The **smallest part of an element** that can exist. All substances are made of atoms. **No** overall **electrical charge. Very small**, radius of 0.1nm.
2 Element	An element **contains only one type of atom**. Found on the Periodic Table. There are about 100 elements.
3 Isotope	An atom of the **same element** with **different numbers of neutrons**.
4 Radioactive decay	When an **unstable nucleus changes** to **become more stable** and **gives out radiation. Random.**
5 Activity	The **rate at which decay occurs**. Measured in **becquerels (Bq).**
6 Count rate	**Number of decays** recorded **each second** by a Geiger-Muller tube.
7 Half life	The **time it takes** for the **number of nuclei of the isotope in a sample to halve** Or, The **time it takes for the count rate** (or activity) from a sample containing the isotope **to fall to half its initial level.**
8 Contamination	The **unwanted presence of materials containing radioactive atoms** e.g. within liquids, with the body/ on the skin.
9 Irradiation	When an object is **exposed to radiation**. The object does not become radioactive itself.
10 Ionisation	Radiation can ionize by **removing electrons from atoms to form ions**. If this happens in **DNA** it could lead to a **mutation that causes cancer**.
11 Peer review	The **checking of scientific results** by other **scientific experts**.

Section 2: Development of Atomic Model

12 Plum Pudding		The plum pudding model shows that the atom is a **ball of positive charge** with **negative electrons embedded** in it. Was **incorrect**.
13 Nuclear Model		Rutherford's scattering experiment found a central area of positive charge. The nuclear model has a **positive nucleus** and **electrons in shells**. Later, neutrons were discovered and included in the nucleus.

Section 3: Properties of Sub-Atomic Particles

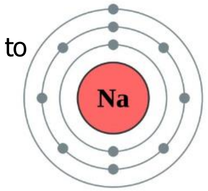
Sub-atomic particle	Mass	Charge	Position in Atom
14 Proton	1	+1	Nucleus
15 Neutron	1	0	Nucleus
16 Electron	Very small	-1	Orbiting in shells

17 **Mass number** – the total number of **protons** and **neutrons**

$$^{23}_{11}\mathrm{Na}$$

18 **Atomic number** – the **number of protons** (the number of electrons is the same in an atom)

19 **Energy levels:**
Absorption of radiation may lead to electrons moving further from the nucleus (higher energy level).
Emission of radiation may lead to electrons moving closer to the nucleus (lower energy level).



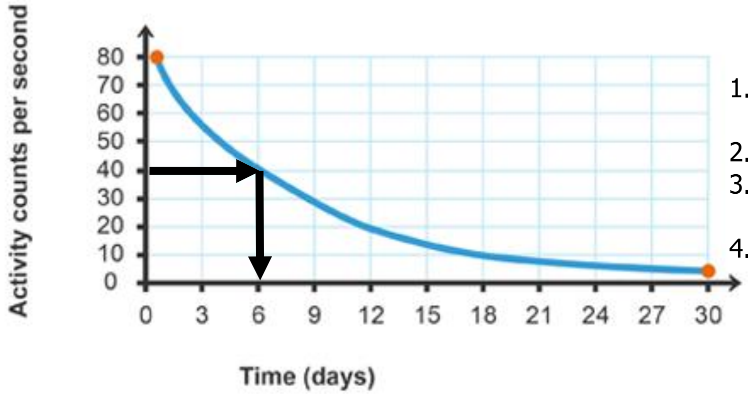
Section 4: Nuclear Radiation

Radiation	Range in air	Absorbed by	Ionizing Power	Product emitted when nuclei decays
20 Alpha	Short **– up to 5cm**	**Paper** and **skin**	**Very High**	**2 protons** and **2 neutrons**
21 Beta	Medium – **about 1m**	About 5mm of **aluminium.**	**Medium**	**Electron**
22 Gamma	**Unlimited –** spreads out in air from the source	**Several centimetres** of **lead.**	**Low**	**Electromagnetic wave**

Section 5: Nuclear Decay Equations

23 Alpha decay	$^{219}_{86}Rn \rightarrow {}^{215}_{84}Po + {}^{4}_{2}He$ In alpha decay a helium nucleus (2 protons and 2 neutrons) is emitted. The new element formed has: - A mass number that has decreased by 4. - An atomic number that has decreased by 2.
24 Beta decay	$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$ In beta decay a neutron turns into a proton. An electron is emitted. The new element formed has: - A mass number that stays the same. - An atomic number increases by 1.
25 Gamma ray	There are no changes to the nucleus when gamma rays are emitted.

Section 6: Finding Half Life

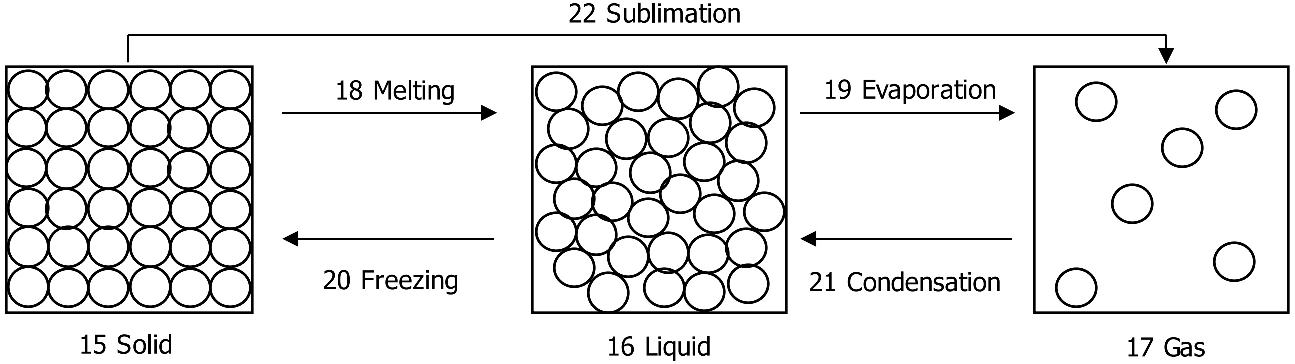


26

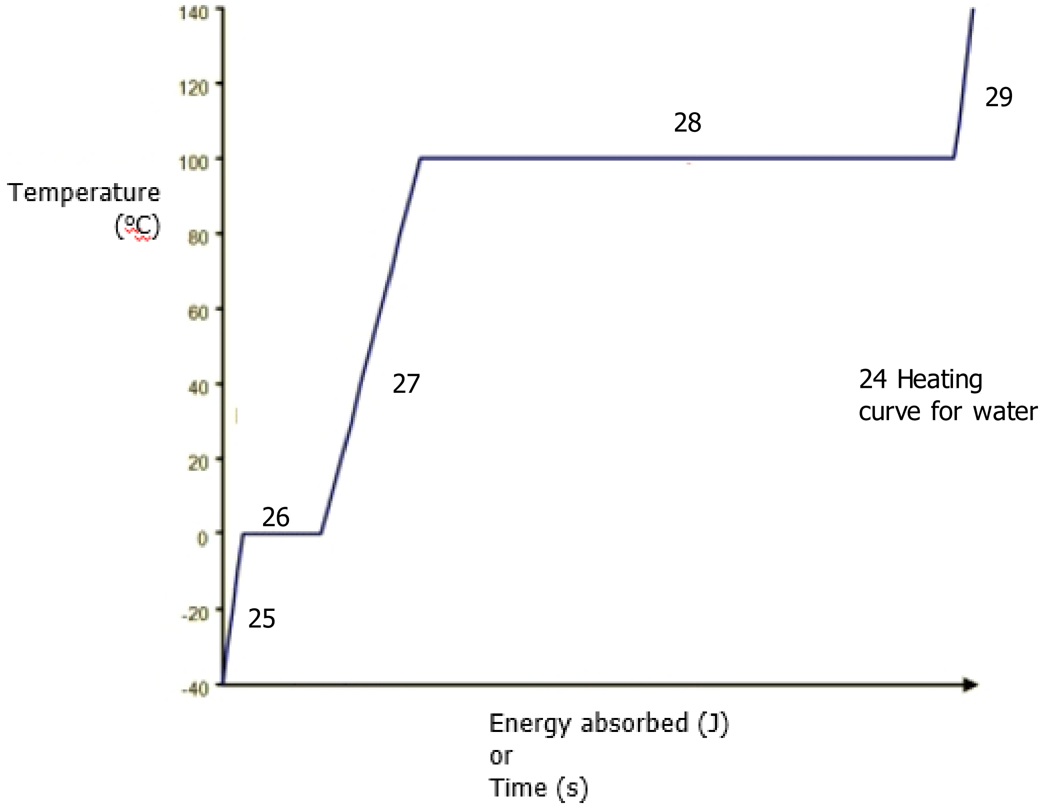
1. Find the initial count rate.
2. Half that value.
3. Draw a line across and then down.
4. This is the half life of the isotope.

Physics 3: Particle Model of Matter

Section 1: Key Terms	
1 Density	How much **mass** a substance contains **compared to its volume**. Solids are usually dense because the particles are closely packed.
2 State of matter	The way in which the **particles are arranged** – solid, liquid or gas.
3 Change of state	When a substance **changes from one state of matter** to another (e.g. melting is the change from a solid to a liquid). Energy changes the state, not the temperature.
4 Physical change	A change that can be **reversed** to recover the original material. **E.g. a change of state.**
5 Chemical change	A change that **creates new products**. It **cannot be revered.** E.g. a chemical reaction.
6 Internal energy	The **energy stored** inside a system **by the particles** (atoms and molecules) that make up the system. Internal energy is the **total kinetic energy and potential energy of all the particles.**
7 Kinetic energy	**Energy stored** within **moving objects** (e.g. particles).
8 Potential energy	**Energy stored** in **particles** because of their **position.** The **further apart** particles are, **the greater the potential energy.**
9 Specific heat capacity	The specific heat capacity of a substance is the **amount of energy** required to **raise the temperature of one kilogram** of the substance **by one degree Celsius**.
10 Temperature	The **average kinetic energy** of the **particles**.
11 Specific latent heat	The **amount of energy** required to **change the state of one kilogram** of the substance with **no change in temperature**.
12 Latent heat of fusion	**Energy required** to change state from **solid to liquid**.
13 Latent heat of vaporisation	**Energy required** to change state from **liquid to vapour**.
14 Gas Pressure	The **force** exerted by gases on surface as the **particles collide** with it. **As temperature increases, gas pressure increases** if the volume stays constant.



Section 2: Equations to learn			
Calculation	Equation	Symbol equation	Units
23 Density	Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{v}$	Density = kilograms / metre^3 (kg/m^3) Mass = kilograms (kg) Volume = metres^3 (m^3)



Section 3: Explaining a heating curve	
25 Solid	Particles are closely packed, fixed and arranged in regular layers. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
26 Melting	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
27 Liquid	Particles are touching but no longer arranged regularly. They are above to move. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
28 Evaporation	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
29 Gas	Particles move randomly. As more energy is absorbed the particles move more quickly and the temperature increases.

Chemistry 4: Chemical Changes

Section 1: Key Terms

1 Metal oxide	Metals react with oxides to produce metal oxides. This is an oxidation reaction.
2 Displacement reaction	A **more reactive metal** can **displace** a **less reactive metal** from a **compound**.
3 Oxidation	Two definitions: Chemicals are oxidised if they **gain oxygen** in a reaction. Chemicals are oxidised if they **lose electrons** in a reaction. (HT)
4 Reduction	Two definitions: Chemicals are oxidised if they **lose oxygen** in a reaction. Chemicals are oxidised if they **gain electrons** in a reaction. (HT)
5 Acid	A chemical that **dissolves in water** to produce **H^+ ions**.
6 Base	A chemical that **reacts with acids** and **neutralise** them. E.g. **metal oxides**, **metal hydroxides**, **metal carbonate**
7 Alkali	A **base** that **dissolves in water**. It produces **OH- ions** in solution.
8 Neutralisation	When a **neutral solution** is formed from reacting an **acid** and **alkali**. General equation: **$H^+ + OH^- \rightarrow H_2O$**
9 pH	A scale to **measure acidity/ alkalinity**. A **decrease of one pH** unit causes a **10x increase in H^+ ions**. (HT)
10 Strong acid (HT)	A strong acid is **completely ionised** in solution. E.g. **hydrochloric**, **nitric** and **sulfuric** acids.
11 Weak acid (HT)	A weak acid is **only partially ionised** in solution. E.g. **ethanoic**, **citric** and **carbonic** acids.

Section 2: Reactivity

Element	Reaction	Reactivity
12 Potassium	When potassium is added to **water**, the metal **melts** and floats. It moves around very quickly. The metal is also **set on fire**, with sparks and a **lilac flame**.	
13 Sodium	When sodium is added to **water**, it **melts** to form a ball that moves around on the surface. It **fizzes rapidly**.	
14 Lithium	When lithium is added to **water**, it floats. It **fizzes steadily** and becomes smaller.	
15 Calcium	**Fizzes quickly** with dilute **acid**.	
16 Magnesium	**Fizzes quickly** with dilute **acid**.	
17 (Carbon)		
18 Zinc	**Bubbles slowly** with dilute **acid**.	
19 Iron	**Very slow reaction** with dilute **acid**.	
20 (Hydrogen)		
21 Copper	**No reaction** with dilute **acid**.	

Section 4: Extracting Metals

22 Very unreactive metals	Found **naturally** in the ground. **Don't need extracting**.
23 Metals less reactive than carbon	Extracted by **reduction with carbon**.
24 Metals more reactive than carbon	Extracted by **electrolysis**.

Section 5: Reactions of Acids

25 With metal	Acid + Metal → Salt + Hydrogen
26 With alkali	Acid + Metal Hydroxide → Salt + Water (Neutralisation reaction)
27 With metal oxide	Acid + Metal Oxide → Salt + Water (Neutralisation reaction)
28 With carbonate	Acid + Metal Carbonate → Salt + Water + Carbon Dioxide (Neutralisation reaction)

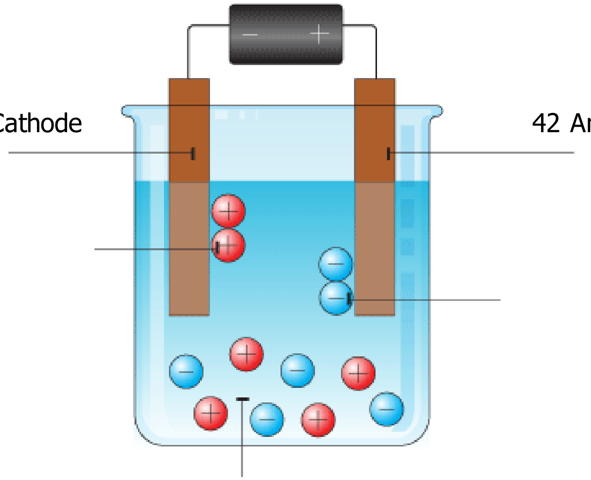
Section 6: Making a Soluble Salt

29	**Add solid** metal, metal carbonate, metal oxide or metal hydroxide **to an acid**.
30	Add solid **until no more reacts**.
31	**Filter** off excess solid.
32	**Evaporate** to remove some of the water.
33	Leave to **crystallise**.
34	Remove all water in a **desiccator/ oven**.

35 Acidic pH 0-6 | 36 Neutral pH 7 | 37 Neutral pH 8-14

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Chemistry 4: Chemical Changes



- **P**ositive
- **A**node
- **N**egative
- **I**s
- **C**athode

Section 7 Electrolysis key terms	
38 Electrolysis	The process of **splitting an ionic compound** by passing **electricity** through it.
39 Electrolyte	An **ionic compound** that is **molten** (melted) or **dissolved in water**. The **ions** are **free to move**.
40 Electrode	An **electrical conductor** that is placed in the **electrolyte** and connected to the **power supply**.
41 Cathode	The **electrode** attached to the **negative** terminal of the **power supply**.
42 Anode	The **electrode** attached to the **positive** terminal of the **power supply**.

Section 8: What is discharged in electrolysis?

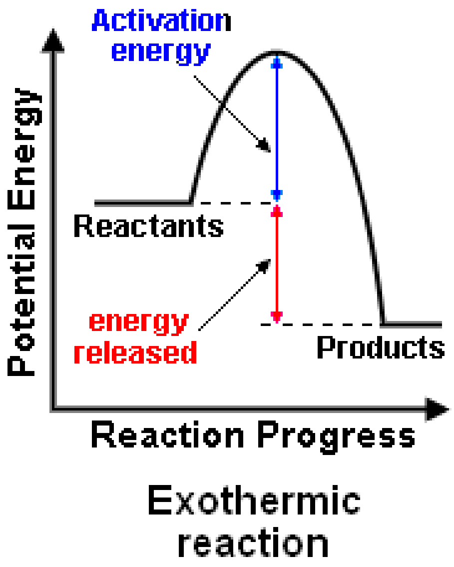
Electrolyte	Cathode	Anode
43 Molten Compound	Metal	Non-metal
44 Dissolved compound (aqueous solution)	The **metal** if the metal is **less reactive than hydrogen**. **Hydrogen** is produced if the **metal is more reactive than hydrogen**.	**Oxygen** is produced **unless the solution contains halide ions** (chloride, bromide, iodide) when the **halogen** (chlorine, bromine, iodine) is produced.

Section 9: Aluminium Electrolysis	
45 Cryolite	**Aluminium oxide** is **dissolved in cryolite** to **lower its melting point**. This **saves money on energy costs**.
46 Cathode	Positive **Al^{3+} ions move to the cathode**. Aluminium is produced. **$Al^{3+} + 3e^- \rightarrow Al$**
47 Anode	Negative **O^{2-} ions move to the anode**. Oxygen is made. **$2O^{2-} \rightarrow O_2 + 4e^-$** **Wears away** as the **carbon anode reacts with oxygen to form carbon dioxide**.

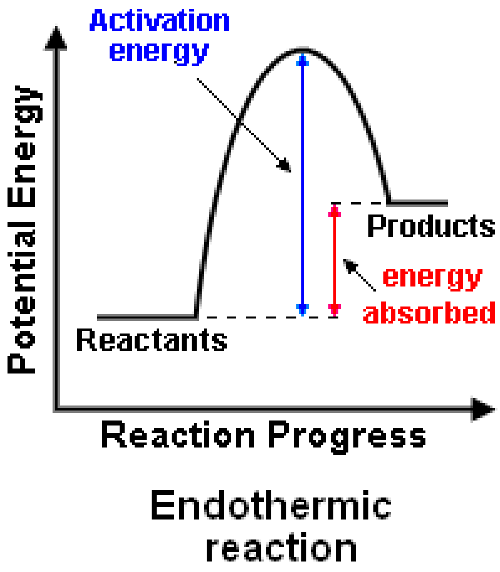
Chemistry 5: Energy Changes

Section 7 Energy Changes Key Terms	
1 Conservation of energy	Energy is **not created or destroyed**, only **transferred from one store to another**
2 Exothermic	A reaction that **transfers energy to the surroundings** so the **temperature of the surroundings increases**, e.g. **combustion** and **neutralisation** reactions. Used in **self-heating cans** and **hand warmers**.
3 Endothermic	A reaction that **takes in energy from the surroundings** so the **temperature of the surroundings decreases**, e.g. **thermal decomposition**. Used in **sports injury packs.**
4 Activation energy	The **energy needed** for **particles to successfully react**.
5 Breaking bonds	**Energy is needed** to break bonds.
6 Forming bonds	**Energy is released** when bonds are formed.

7 Exothermic Energy Profile



8 Endothermic Energy Profile



9 Energy released from forming bonds is **greater than** the energy needed to break bonds. (HT)

10 Energy released from forming bonds is **less than** the energy needed to break bonds. (HT)

Chemistry 3: Quantitative Chemistry

Section 1: Bonding Key Terms

1 Law of conservation of mass	**No atoms** are **lost** or **gained** during a **chemical reaction**. The mass of the products is the same as the mass of the reactants. Some reactions **appear to give a change in mass**, but this is because a **gas may have escaped** from the reaction container.
2 Relative atomic mass (A_r)	The **average mass** of an **atom of an element** compared to Carbon-12.
3 Relative formula mass (M_r)	The **sum** of **all the atomic masses** of the atoms in a **formula** (e.g. H_2O).
4 Uncertainty	The **interval** within which the **true value** can be **expected to lie**. E.g. 25°C ± 2°C – the true value lies between 23°C and 27°C.
5 Mole (HT)	A measurement for the amount of a chemical. It is the **mass** (in grams) of **6.02×10^{23}** (the Avogadro constant) **atoms of an element**. Symbol: mol.
6 Balanced equation (HT)	Balanced symbol equations show **the number of moles that react**. e.g. $Mg + 2HCl \rightarrow MgCl_2 + H_2$ Shows one mole of magnesium reacting with two moles of hydrochloric acid to form one mole of magnesium chloride and one mole of hydrogen.
7 Limiting reactant (HT)	The **reactant** that is **completely used up** in a chemical reaction. It **limits the amount of product** formed.
8 Excess reactant (HT)	The reactant that is **not completely used up** in a chemical reaction. There is some reactant left at the end.
9 Concentration	A measure of the **number of particles** of a chemical in a **volume**. Can be measured in **g/dm^3**.
10 Decimetre^3 (dm^3)	A **measurement of volume**. Contains **$1000cm^3$**.

Section 2: Calculations and Examples

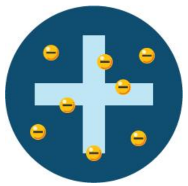
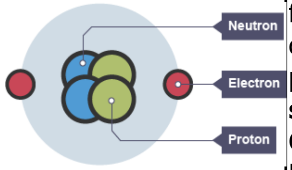
11 Calculating relative formula mass (M_r)	Add up all the atomic masses in a formula. e.g. H_2O. Mass of hydrogen = 1. Mass of oxygen = 16. (2x1) + 16 = 18
12 Percentage uncertainty	Percentage uncertainty = $\frac{\text{Uncertainty}}{\text{Quantity being measured}} \times 100$ e.g. What is the percentage uncertainty of a $50cm^3$ measuring cylinder accurate to $\pm 2cm^3$? Percentage uncertainty = $\frac{2}{50} \times 100 = 4\%$
13 Number of moles	Number of moles = $\frac{\text{Mass of chemical}}{\text{Relative formula mass}}$ e.g. How many moles of water are there in 36g of H_2O? Number of moles = $\frac{36}{18}$ = 2 moles
14 Volume in dm^3	Volume in dm^3 = $\frac{\text{volume of liquid}}{1000cm^3}$ e.g. What is the volume in dm^3 of $500cm^3$ of hydrochloric acid? Volume in dm^3 = $\frac{500}{1000} = 0.5dm^3$
15 Concentration of a solution	Concentration = $\frac{\text{Mass of solute}}{\text{Volume (in } dm^3)}$ e.g. What is the concentration of a solution of hydrochloric acid which contains 100g of hydrochloric acid in $500cm^3$? Concentration = $\frac{100}{0.5} = 200g/dm^3$

Chemistry 1: Atomic Structure and the Periodic Table

Section 1: Key Terms

1 Atom	The **smallest part of an element** that can exist. All substances are made of atoms. **No** overall **electrical charge**. **Very small**, radius of 0.1nm.
2 Element	An element **contains only one type of atom**. Found on the Periodic Table. There are about 100 elements.
3 Compound	**Two or more elements chemically bonded** with each other. Can only be separated into the elements through chemical reactions.
4 Mixture	**Contains two or more elements or compounds not chemically bonded**. Can be separated using physical methods e.g. by filtration, crystallisation, distillation and chromatography.
5 Filtration	A process that **separates** mixtures of **insoluble solids and liquids**.
6 Crystallisation	A process that **separates dissolved solids from liquids** by **evaporating** the liquid to leave crystals.
7 Distillation	A process that **separates a mixture of liquids** based on their **boiling points**.
8 Chromatography	A process that **separates mixtures** by **how quickly they move through a stationary phase** (e.g. paper)
9 Isotope	An atom of the **same element** with **different numbers of neutrons**.
10 Relative atomic mass	An **average value of mass** that takes account of the **abundance of the isotopes** of the element.

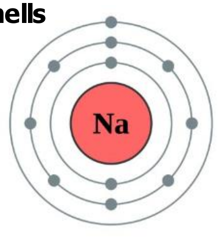
Section 2: Development of Atomic Model

11 Plum Pudding 	The plum pudding model shows that the atom is a **ball of positive charge** with **negative electrons embedded** in it. Was **incorrect**.
12 Nuclear Model 	**Rutherford's** scattering experiment found a central area of positive charge. The nuclear model has a **positive nucleus** and **electrons in shells**. **Chadwick** later discovered **neutrons**. **Bohr** discovered the arrangement of **electrons s in shells**.

16 **Mass number** – the total number of **protons** and **neutrons**

17 **Atomic number** – the **number of protons** (the number of electrons is the same in an atom)

18 **Electron configuration**– Electrons fill the first energy level (shell) first.
Maximum electrons:
2 in first shell
8 electrons in other shells



Section 3: Properties of Sub-Atomic Particles

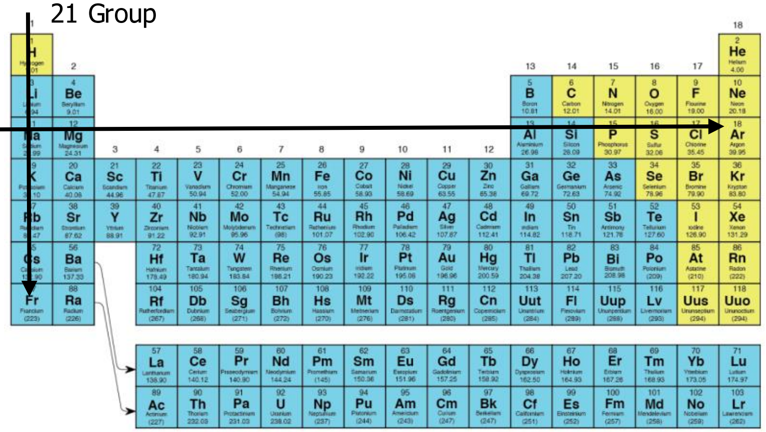
Sub-atomic particle	Mass	Charge	Position in Atom
13 Proton	1	+1	Nucleus
14 Neutron	1	0	Nucleus
15 Electron	Very small	-1	Orbiting in shells

Section 4: Periodic Table

16 Group	Elements in the **same vertical column** are in the same group. Elements in the same group have the **same number of electrons in their outer shell**, and therefore **similar properties.**
17 Period	Elements in the **same horizontal row.** The atomic number increases by one moving across the period.
18 Metal	Elements that react to form positive ions (except Hydrogen). Left and centre of periodic table
19 Non-Metal	Elements that react to form negative ions. Right of periodic table.
20 Mendeleev	Was able to make a relatively accurate periodic table by **leaving gaps for undiscovered elements** and **re-arranging some elements** (Mendeleev could only measure relative atomic mass, not atomic number).

21 Group

22 Period



23 Elements in the modern periodic table are **arranged by atomic (proton) number.**

Section 3: Groups of the Periodic Table

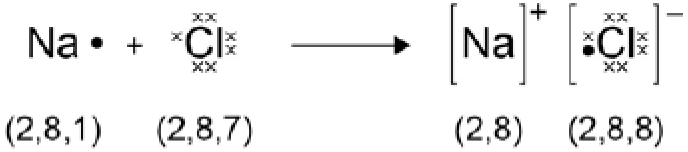
Sub-atomic particle	Properties	Trends	Reactions
24 Group 0 (Noble Gases)	**Unreactive** and **do not form molecules.**	**Boiling point increases** going **down the group.**	Very unreactive as they **have full outer shells.**
25 Group 1 (Alkali Metals)	**Reactive** because they can easily lose one electron.	**Reactivity increases** going **down the group.**	With water: Metal + water → Metal hydroxide and hydrogen With oxygen: Metal + oxygen → Metal oxide With chlorine: Metal + chlorine → Metal chloride
26 Group 7 (Halogens)	Non-metals **Form molecules**	**Reactivity decreases** going **down the group. Boiling point** and **melting point increase** going **down the group.**	A **more reactive halogen** can **displace** a **less reactive halogen** from a solution of its salt.

Chemistry 2: Bonding, Structure and the Properties of Matter

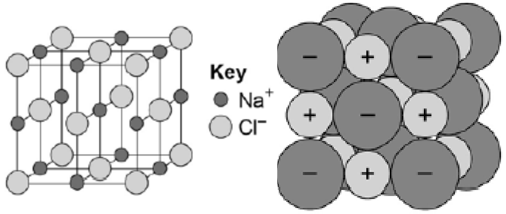
Section 1: Bonding Key Terms

1 Ion	An atom that is **charged** because of **gain** or **loss** of **electrons**.
2 Ionic bond	The **bond** between two **oppositely charged ions** (**metal** and **non-metal**). Occurs because of electrostatic attraction.
3 Electrostatic attraction	The **force** that **holds two oppositely charged ions** together. A **strong** force.
4 Metals	In ionic bonding, **metals lose electrons** to become **positively-charged** ions.
5 Non-metals	In ionic bonding, **non-metals gain electrons** to become **negatively-charged** ions.
6 Giant lattice	A **large 3D structure** that contains a **lot of bonds**.
7 Covalent bond	A bond formed when **non-metals share electrons**. A **strong** bond.
8 Molecule	A **small group of atoms** held together with **covalent bonds**. **Not charged**.
9 Polymer	**Very large covalent compounds** with **many repeating units**.
10 Metallic bonding	The **electrons** in the **outer shell** of metal atoms are **delocalised** and so are **free to move** through the whole structure. The **sharing of delocalised electrons** gives rise to **strong metallic bonds**.
11 Alloy	A mixture of **two or more elements**, **at least one of which is a metal**. E.g. steel

Section 2: Ionic Bonding



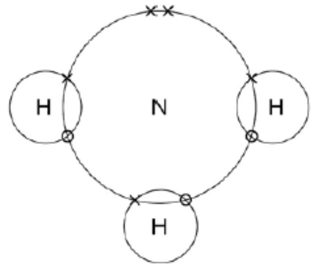
In ionic bonding, metals lose electrons to become positively-charged ions. Non-metals gain electrons to become negatively-charged ions.

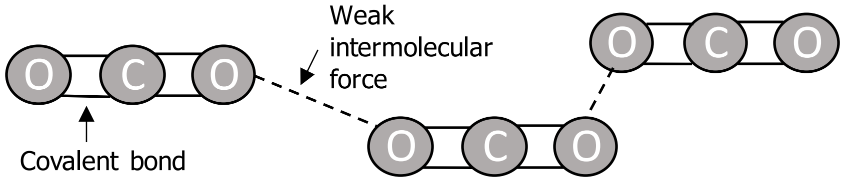


12 Two representations of a **giant ionic lattice**. The lines represent ionic bonds.

Property	Reason
13 High melting point	There is a **strong electrostatic force** between the **positive and negative ions** in the **giant lattice**. A **large amount of energy** is **needed to overcome this force**.
14 Conduct electricity when liquid/ molten	**Ions are able to move** so there is a **flow of charged ions** (current).
15 Do not conduct electricity when solid	**Ions are in fixed positions** so cannot flow**.**

Section 3: Simple Covalent Molecules

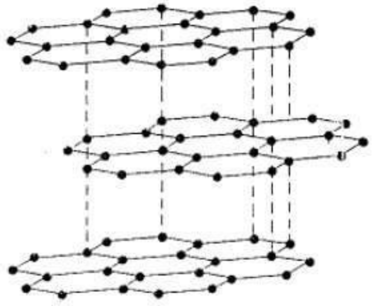




16 Covalent bonding in carbon dioxide

Property	Reason
17 Low melting and boiling points (usually gases or liquids)	There are only **weak intermolecular forces between the molecules**. **Not much energy** is needed to overcome these forces.
18 Do not conduct electricity	Covalent molecules are **not charged**.

Section 4: Giant Covalent Structures Made of Carbon

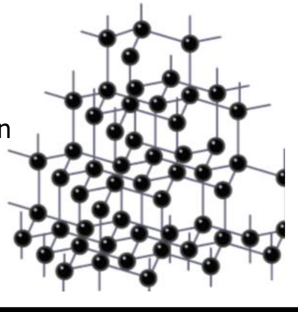


19 Graphite

Each **carbon** forms **3 bonds** to other carbon atoms. Arranged in **layers** with **weak intermolecular forces between layers**.

20 Diamond

Each **carbon** forms **4 bonds** to other carbon atoms.



Section 4a: Properties of Graphite

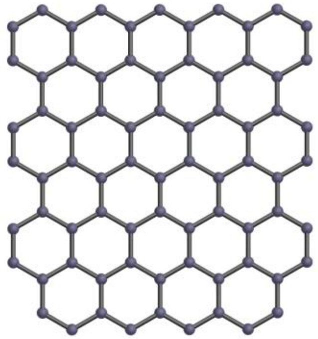
Property	Reason
21 Conducts electricity	Each carbon only **forms 3 bonds** so **one electron is delocalised**. These electrons are **free to move** and **carry charge** through the structure.
22 Soft and slippery	Only **weak intermolecular forces** exist **between layers**, so layers can easily be rubbed off.

Section 4b: Properties of Diamond

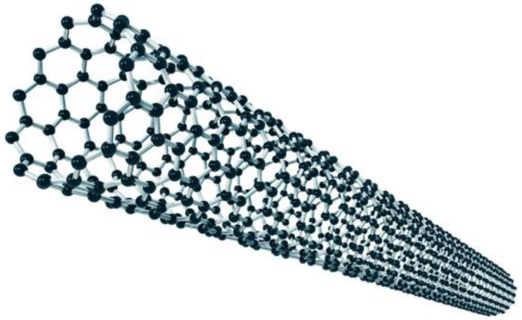
Property	Reason
23 Doesn't conduct electricity	Diamond **doesn't contain delocalised electrons or ions**.
24 Very hard	Each carbon bonds to **4 other carbon atoms** with **strong covalent bonds** to form a **lattice.**
25 High melting point	Each carbon bonds to 4 other carbon atoms with strong covalent bonds to form a lattice. A **large amount of energy** is needed to overcome all these bonds.

Section 5: Small Carbon-Based Structures

26 Fullerene



27 Graphene



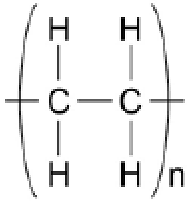
28 Carbon nanotube

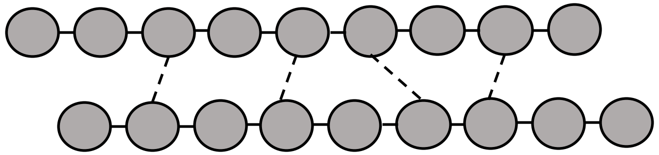
Section 1: Properties of Metals

	Structure	Properties	Uses
29 Fullerene	**Hollow-shaped**. Usually **hexagonal rings of carbon** atoms. E.g. Buckminsterfullerene (C_{60})	Very **strong**. Hollow so can contain other chemicals within it.	**Drug delivery, lubricants**.
30 Graphene	A **single layer of graphite**.	Very **strong**. **Has delocalised electrons** so it is able to **conduct electricity**.	**Electronics, composites.**
31 Carbon nanotube	**Cylindrical tubes** of carbon atoms that are **very long** compared to their diameter.	Very **strong, light** and **flexible**. Has **delocalised electrons** so it is able to **conduct electricity**.	**Nanotechnology, electronics, reinforcing (e.g. tennis rackets).**

Section 6: Polymers

32 A polymer. The lines show covalent bonds. 'n' is a large number.

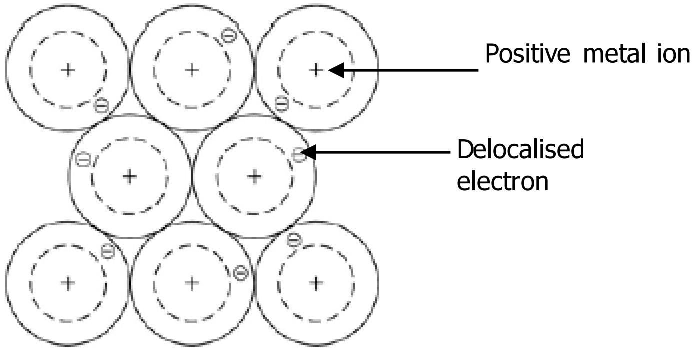




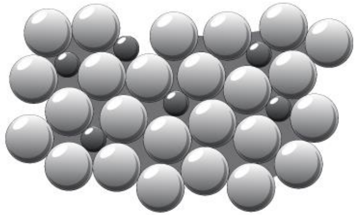
33 Polymer molecules are held together by intermolecular forces (dashed lines)

Property	Reason
34 Solid	Usually solid because the **intermolecular forces between polymer molecules** are **relatively strong**.

Section 7: Metallic Bonding



35 A pure metal. It consists of metal ions in layers with delocalised electrons.



36 An alloy. The layers have been distorted by the presence of other elements

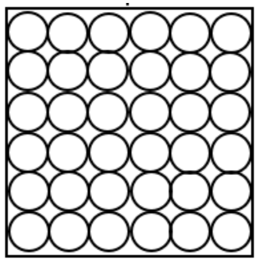
7a Properties of Pure Metals

Property	Reason
37 High melting points	**Strong electrostatic forces** between the **positive ions** and **delocalised electrons**. Requires a **large amount of energy** to overcome.
38 Conduct electricity	Metals have **delocalised electrons**. These electrons are **able to move** through the structure and carry charge.
39 Conduct heat	The **delocalised electrons** are able to **move and transfer thermal energy** through the structure.
40 Malleable	The **layers** are able to **slide over each other** so the metal can be bent and shaped. The attraction between the positive ions and delocalised electrons prevents the metal from shattering.

7b Properties of Alloys

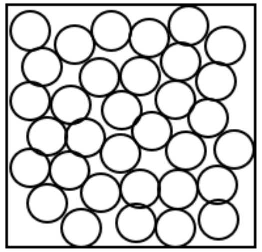
Property	Reason
41 Harder than metals	The **layers are distorted** by the presence of other elements. This **prevents the layers from being able to slide over each other**.

Section 8: States of Matter



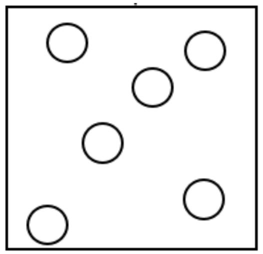
42 Solid

State symbol – (s)



43 Liquid

State symbol – (l)



44 Gas

State symbol – (g)

Biology 4: Bioenergetics

Section 1: Photosynthesis Equation

1 Carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen

2 $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Section 2: Key terms

3 Chloroplast	The plant **organelle** where **photosynthesis** takes place.
4 Chlorophyll	The **green pigment** that **absorbs energy from light**.
5 Endothermic	Photosynthesis **takes energy** in (in the form of **light**). It is an endothermic reaction.
6 Diffusion	**The spreading out of particles by random motion from where they are in high concentration to a low concentration. Occurs in gases and liquids.**

Section 3: Uses of Glucose

7 Used in **respiration** to provide **energy**.

8 Converted into **starch** for **storage**.

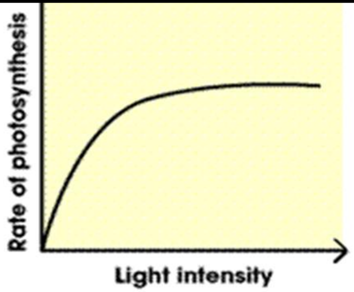
9 Converted into **fats** and **oils** for **storage**.

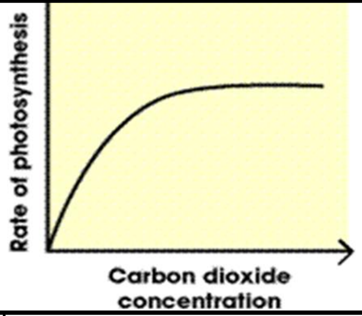
10 Produce **cellulose** to **strengthen** the **cell wall**.

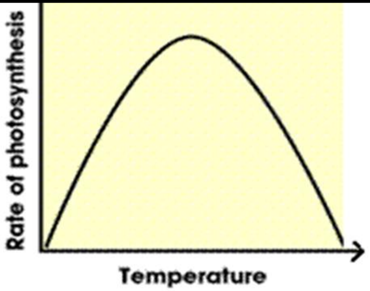
11 Produce **amino acids** to **make proteins** (also needs nitrate ions from the soil)

Section 4: Limiting Factors

12 Limiting Factor	The factor that stops the rate of photosynthesis from increasing; could be light intensity, CO_2 concentration, temperature or amount of chlorophyll.







13 Light Intensity
Initially light is the limiting factor. When the graph plateaus something else (e.g. CO_2 concentration, temperature) is limiting the rate.

14 CO_2 concentration
Initially CO_2 concentration is the limiting factor. When the graph plateaus something else (e.g. light intensity, temperature) is limiting the rate.

15 Temperature
As temperature increases, the rate of photosynthesis increases. Above the optimum there is a decrease in photosynthesis. Enzymes needed for photosynthesis become denatured.

Section 5: Respiration

16 Energy	Energy in organisms is needed for **chemical reactions to build larger molecules**, **movement** and **keeping warm**.
17 Aerobic Respiration	Aerobic respiration **provides energy**. It requires **oxygen**. It is an **exothermic** reaction (produces heat). In **mitochondria**. **Glucose + oxygen → carbon dioxide + water** **$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$**
18 Anaerobic Respiration (muscles)	**No oxygen** needed. Provides **less energy** than aerobic respiration as glucose **not fully oxidised**. Occurs during **intensive exercise**. In **cytoplasm**. **Glucose → lactic acid**
19 Lactic Acid	Produced in **anaerobic respiration in muscles**. **Build up** of lactic acid **causes fatigue**. Lactic acid must be **taken to the liver by the blood so** that it can be **oxidised back to glucose**.
20 Oxygen Debt	The **amount of extra oxygen** the body needs **after exercise** to **react with the lactic acid** and remove it.
21 Anaerobic Respiration (plant and yeast cells)	**No oxygen** needed. In yeast cells it is called **fermentation** – economically important for manufacture of **bread** and **alcoholic drinks**. In **cytoplasm**. **Glucose → ethanol + carbon dioxide**

Section 5: Response to Exercise

22 Increase in breathing rate	Increases rate at which **oxygen** is taken into the lungs.
23 Increase in heart rate	Oxygenated blood is pumped around the body at a faster rate. Carbon dioxide is removed at a faster rate.
24 Increase in breath volume	A **greater volume** of oxygen is taken in with each breath.

Section 6a: Metabolism

25 Metabolism	The **sum of all the reactions** in a **cell** or **body**. Some of these reactions **require the energy released from respiration**.

Section 6b: Metabolic Reactions

26 Conversion of glucose to starch, cellulose or glycogen.

27 Formation of lipids from glycerol and fatty acids

28 Use of glucose and nitrates to make amino acids (plants only)

29 Respiration

30 Breakdown of proteins to urea

Biology 3: Infection and Response

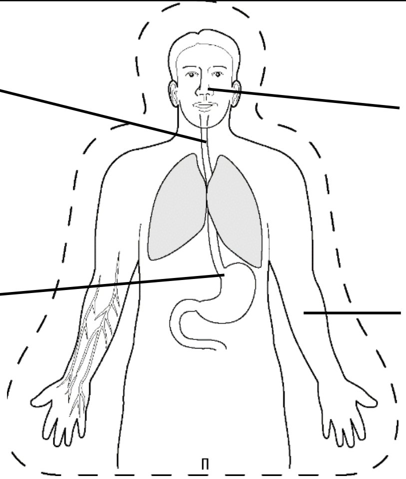
Section 1: Pathogens and Diseases

	Disease	Pathogen	How it is spread	Effect	Prevention/ Control
1	**Measles**	**Virus**	**Droplets** from sneezes and coughs	Can be **fatal**	**Vaccination** of children
2	**HIV**	**Virus**	**Sexual contact, needle exchange**	**Damages** some **white blood cells**	**Antiretroviral drugs** when infected
3	**Tobacco Mosaic Virus**	**Virus**	**Direct contact**	Mottling of leaves, **reduces photosynthesis**	
4	**Salmonella**	**Bacteria**	**Infected food**	**Fever, abdominal cramps, diarrhoea, vomiting**	**Vaccination** of poultry (chickens).
5	**Gonorrhoea**	**Bacteria**	**Sexual contact**	**Discharge** from **penis/ vagina, pain** when **urinating**	Controlled by **antibiotics**. Spread prevented by **condoms**.
6	**Rose Black Spot**	**Fungus**	**Spores** carried by **water** or **wind**	**Leaves** turn **yellow, fall early. Photosynthesis reduced.**	Treated by **fungicides** or **destroying affected leaves**.
7	**Malaria**	**Protist**	By a **vector – mosquito**	**Fever,** can be **fatal.**	**Preventing mosquitos from breeding**, using **mosquito nets**.

Section 2: Non-Specific Defences

8 Trachea and Bronchi
Produces **mucus** to **trap pathogens**. Contains **cilia** to **move mucus** for **swallowing**

10 Stomach
Contains **hydrochloric acid** to destroy pathogens.



9 Nose
Contains **hairs** and **mucus** to **trap pathogens**

11 Skin
A **physical barrier** to pathogens.

Section 3: Key terms

12 Pathogen	A **microorganis**m that **causes disease.**
13 Bacteria	A type of **pathogen** that **produces toxins that damage tissues**.
14 Viruses	A type of **pathogen** that **lives and replicates within cells** and causes **cell damage**. It is **difficult to kill viruses without damaging cells.**
15 Antibodies	Some white blood cells (lymphocytes) produce antibodies. These **bind to pathogens** and **destroy them** or **stick them together**.
16 Antitoxins	Some white blood cells (lymphocytes) produce antitoxins. Antitoxins **neutralise toxins**.
17 Antibiotics	Antibiotics **kill bacteria**. **Specific antibiotics** should be used for **specific bacteria**. **Some bacteria are resistant** to antibiotics. **Do not kill viruses**.
18 Painkillers	Painkillers **relieve symptoms** but **don't kill pathogens**.
19 Phagocytosis	Some white blood cells (phagocytes) **engulf pathogens.**

Section 4: Drugs

22 Aspirin	Originates from the **willow** tree.
23 Digitalis	A **heart drug.** Originates from **foxglove** plants.
24 Penicillin	Discovered by Alexander Fleming from the ***Penicillium* fungus.**
25 New drugs	Most new drugs are **synthesised by chemists in the pharmaceutical industry.** The **starting point** may be a **chemical extracted from a plant.**

20 Natural Immunity

- Pathogen enters body
- The correct white blood cell is found
- Antibodies are produced
- The white blood cells remain as memory cells
- If the pathogen returns, antibodies will be produced quickly

21 Vaccination

- Dead or weakened pathogen is injected
- The correct white blood cell is found
- Antibodies are produced
- The white blood cells remain as memory cells
- If the pathogen returns, antibodies will be produced quickly

Section 5: Clinical Trials

Trial	Stage	Purpose
26	1. **Preclinical – cells, animals**	Test for **toxicity** and **efficacy** before testing humans
27	2. **Healthy volunteers**	**Very low doses** to test for **toxicity.**
28	3. **Patients**	Larger groups. Test for **toxicity**, **efficacy** and **dose. Placebos** may be used in a **double-blind trial**.

Clinical Trial Key Terms

29	Placebo	A drug with **no active ingredients**, designed to **mimic a real drug**. Used to test if the effects of a drug on a patient are just **psychological**.
30	Double-blind trial	The volunteers do not know which group they are in, and neither do the researchers, until the end of the trial
31	Toxicity	How **harmful** the drug is. May have dangerous **side effects**.
32	Efficacy	How **effective** the drug is.
33	Dose	The **amount** of the drug given to the patient.

Biology 2: Organisation

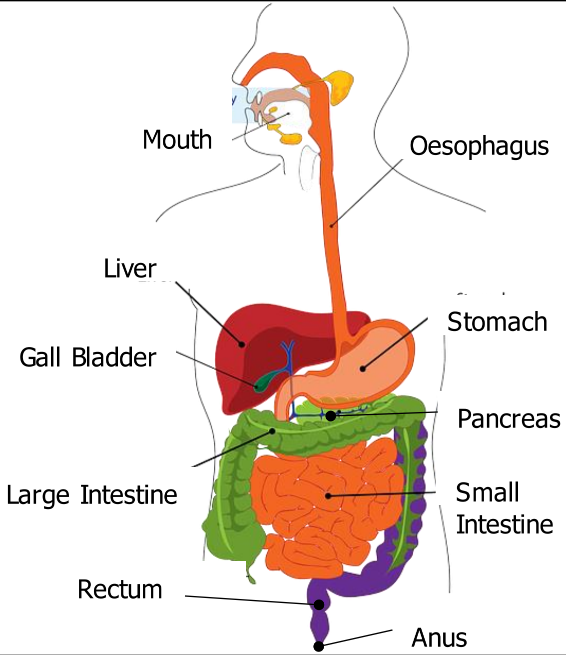
Section 1: Organisation

1 Tissue	A **group of cells** with a **similar structure and function** e.g. muscle tissue
2 Organ	A **group of tissues** performing a specific **function** e.g. heart, leaf
3 Organ System	A **group of organs** that perform a specific **function** e.g. digestive system.

Section 2: Human Digestive System

4 Order of movement of food through the digestive system:

Mouth	**M**any
Oesophagus	**O**rdinary
Stomach	**S**tudents
Small intestine	**S**truggle
Large intestine	**L**earning and
Rectum	**R**emembering
Anus	**A**nswers



Section 3: Enzymes Key Terms

5 Enzyme	A **biological catalyst** that can **speed up the rate of reaction** without being used itself. Made of a large **protein molecule**.
6 Substrate	The **chemical that fits into** the **active site** of an enzyme.
7 Lock and Key Model	Only **one type of substrate** can **fit into the active site** of an enzyme, like a key fits into a lock.
8 Denatured	When the **active site of an enzyme changes shape** and the **substrate can no longer fit in**. Can be caused by **pH** or **temperature**.

Section 4: Testing for Biological Molecules

Molecule	Chemical Test	Positive Result
9 Starch	Add orange/brown **iodine solution**.	Colour turns to **blue/black**.
10 Sugar	Add blue **Benedict's solution**. Place in a **boiling water bath for 5 minutes**.	Colour turns **green/ yellow/ orange/ brick red**.
11 Protein	Add blue **Biuret solution**.	Colour turns to **lilac/ purple**.
12 Lipid	Add **ethanol** and decant into **water**.	**Cloudy white emulsion**.

Section 5a: Human Digestive Enzymes

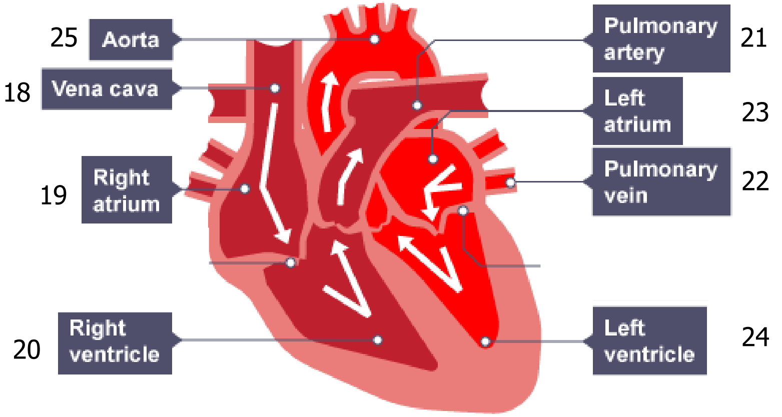
Enzyme	Function	Sites of production	Sites of action
13 Amylase	Breaks **starch** into **sugars.**	Salivary glands Pancreas Small intestine	Mouth Small intestine
14 Protease	Breaks **proteins** into **amino acids**.	Stomach Pancreas Small intestine	Stomach Small intestine
15 Lipase	Breaks **lipids (fats)** into **fatty acids and glycerol**.	Pancreas Small intestine	Small intestine

Section 5b: Other Chemicals

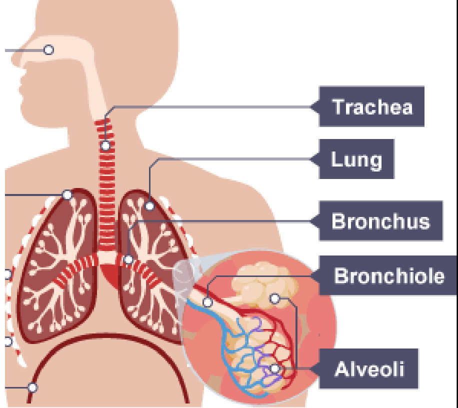
16 Hydrochloric Acid	Acid with pH of 2 produced by the stomach. **Unravels proteins**.
17 Bile	**Emulsifies fats** (turns them into droplets to give a greater surface area). It is **alkaline** so **neutralises acid from the stomach. Produced in liver, stored in gall bladder** and is **released into the small intestine**.

Section 6: Heart and Lungs

Orders of numbers is the way in which blood flows through the heart



26 – Lung structure



Section 6a: Structures in the Heart

27 Pacemaker	Group of cells in the **right atrium** that controls **resting heart rate.**
28 Right ventricle	Pumps **deoxygenated blood** to the **lungs** for **gas exchange.**
29 Left ventricle	Pumps **oxygenated blood** to the **body. Thick, muscular** wall.
30 Valve	Stops blood flowing the **wrong way** / leaking.

Section 6b: Structures in the Lungs

31 Alveoli	Small sacs where **gas exchange** occurs. **Surrounded by capillaries. Oxygen moves from the alveoli into the capillaries**, carbon dioxide moves from the capillaries into the alveoli
32 Trachea and Bronchi	Tubes through which gases move. **Lined with cartilage** so they don't collapse.

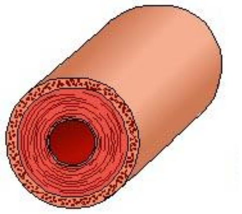
Biology 2: Organisation

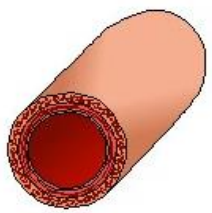
Section 7: Heart Disease

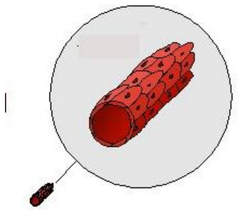
33 Coronary Heart Disease	Build up of **fatty material in coronary arteries**. Can lead to a **blood clot** and a **heart attack**.

Treatment	What it is	Advantage	Disadvantage
34 Stent	**Wire mesh** that **opens up** a **blocked artery**.	Keeps artery open. Low-risk surgery.	Fatty material can rebuild.
35 Statin	Drug that **reduces cholesterol**.	Reduces fat being deposited in arteries.	Side effects e.g. liver damage.
36 Heart transplant	**Replacement heart** from a donor.	Long-term.	Major surgery. Could be rejected.
37 Artificial heart	**Man-made heart** used while **waiting for a transplant**.	Not rejected. Keeps patient alive.	Short life-time. Battery has to be transported. Limited activity.
38 Mechanical heart valve	Mechanical replacement of faulty heart valve.	Can last a life-time.	Can damage red blood cells.
39 Biological heart valve	Biological replacement of faulty heart valve.	Don't damage red blood cells.	Valve hardens and may need replacing.

Section 8: Blood Vessels







	40 Artery	41 Vein	42 Capillary
Purpose	Takes blood **away from the heart.**	Takes **blood back to the heart.**	**Exchange of substances between blood and cells.**
Adaptations	**Thick wall** to **withstand high pressure**	Thin wall. **Valves to prevent backflow of blood**.	Wall is **one cell thick** to allow **quick diffusion** of substances.

Section 9: Components of the Blood

43 Plasma	**Liquid** part of the blood. Transports blood cells as well as **carbon dioxide**, **proteins**, **glucose**, **hormones** and **urea**.
44 Red Blood Cells	**Carries oxygen**. Packed with **haemoglobin**, a protein that binds to oxygen. **No nucleus** to create extra space for haemoglobin. **Biconcave shape** to give a **large surface area**.
45 White Blood Cells	**Destroy pathogens**. Some can produce **antibodies**.
46 Platelets	Cell fragments that help to **clot wounds**.

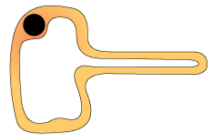
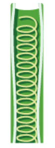
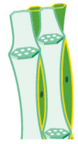
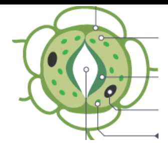
Section 10a: Movement within Plants

47 Transpiration	The **loss of water vapour** from the leaves by **evaporation from cells** and then out through the **stomata**.
48 Transpiration Stream	The **movement of water** from the **roots**, up the stem to the **leaves**.
49 Translocation	The **movement** of **dissolved sugars** around the plant.

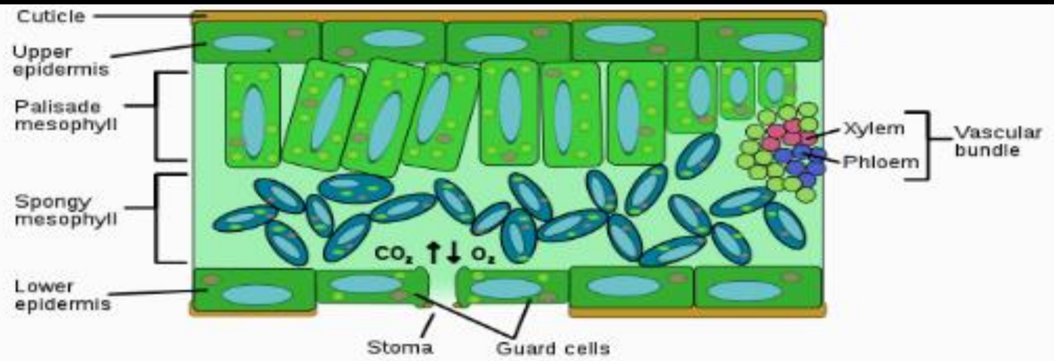
Section 10b: Factors Affecting Transpiration

50 Temperature	Increasing temperature **increases the transpiration rate** as water evaporates quickly.
51 Humidity	Increasing humidity **decreases the rate of transpiration** as water evaporates slowly.
52 Wind speed	Increasing wind speed **increases the transpiration rate** as water evaporates quickly.
53 Light	Increasing light **increases the rate of transpiration** as **stomata open**.

Section 11: Cell Adaptations for Movement Within Plants

			
54 Root hair cell **Extension** gives a **large surface area** to **absorb water and minerals**.	55 Xylem Vessels are **strengthened by lignin** to **withstand pressure.** Cell walls are **waterproof.**	56 Phloem End of cells **contain pores to allow dissolved sugars to move** between cells.	57 Guard Cells and Stoma Guard cells can **open** the stoma to allow **gas exchange** or **close** to **prevent water loss**.

Section 12: Leaf Structure and Plant Tissues



58 Epidermis	**Cover** the **surfaces** of the leaf; lets **light penetrate**.59
59 Xylem	**Carries water** and **minerals** from the roots around the plant.
60 Phloem	**Carries dissolved sugars** made through photosynthesis around the plant. 6
61 Palisade mesophyll	Where **most photosynthesis** takes place. Cells contain **many chloroplasts**. **Absorbs light**.
62 Spongy mesophyll	**Some photosynthesis**. Has **air spaces** for **diffusion** of CO_2 and O_2.
63 Guard cells	Cells that **open** and **close stomata**.
64 Stoma	**Opening** that allows **CO_2 and O_2** to **diffuse** in and out of the leaf.

Section 7: Heart Disease			
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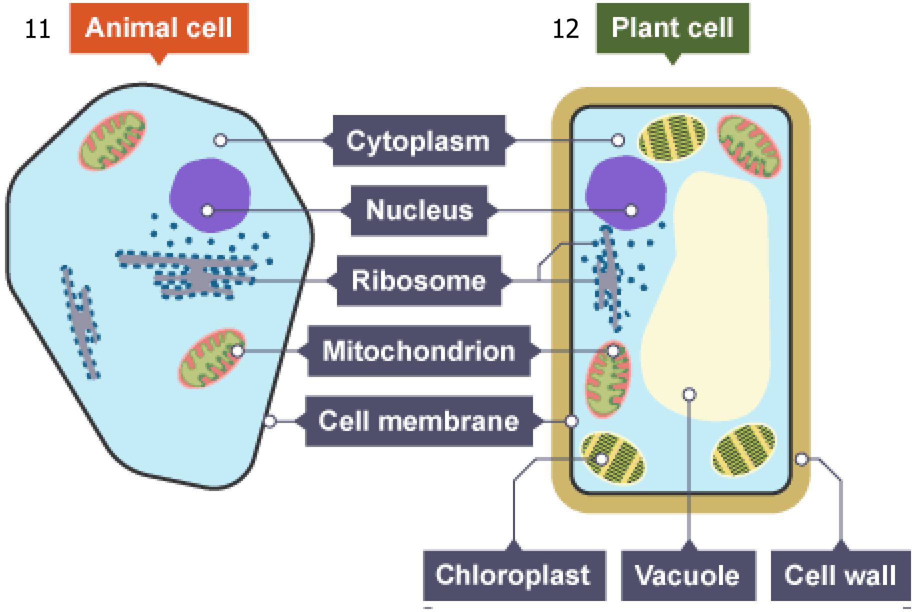
Biology 1: Cell Biology

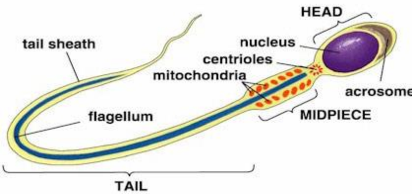
Section 1: Cell Structure

Cell Structure	Function	Eukaryotic: Animal Cells	Eukaryotic: Plant Cells	Prokaryotic: Bacterial Cells
1 Nucleus	Contains **genetic information** that **controls** the functions of the cell.	Y	Y	
2 Cell membrane	Controls what **enters** and **leaves** the cell.	Y	Y	Y
3 Cytoplasm	Where many **cell activities** and **chemical reactions** within the cell occur.	Y	Y	Y
4 Mitochondria	Provides **energy** from **aerobic respiration**.	Y	Y	
5 Ribosome	**Synthesises** (makes) **proteins**.	Y	Y	Y
6 Chloroplast	Where **photosynthesis** occurs.		Y	
7 Permanent vacuole	Used to **store** water and other chemicals as **cell sap**.		Y	
8 Cell wall	**Strengthens** and **supports** the cell. (Made of **cellulose** in plants.)		Y	Y
9 DNA loop	A loop of **DNA**, not enclosed within a nucleus.			Y
10 Plasmid	A **small circle of DNA**, may contain **genes** associated with antibiotic resistance.			Y

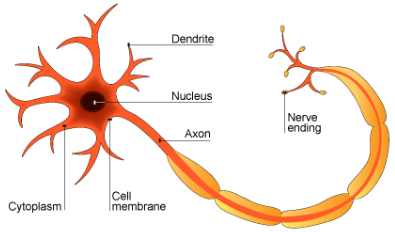


Section 2: Specialised Cells

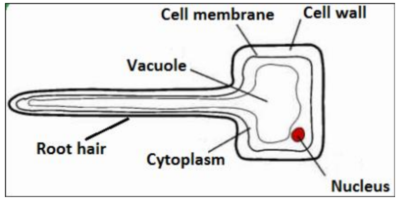
Specialised Cell	How structure relates to function
13 Sperm cell	**Acrosome** contains **enzyme** to break into egg; **tail** to swim; many **mitochondria** to provide **energy** to swim.
14 Nerve cell	**Long** to **transmit electrical impulses** over a distance.
15 Muscle cell	Contain **protein fibres** that can **contract** when energy is available, making the cells shorter.
16 Root hair cell	Long extension to **increase surface area** for water and mineral uptake; **thin cell wall**.
17 Xylem cell	**Waterproofed** cell wall; cells are **hollow** to allow water to move through.
18 Phloem cell	Some cells have lots of **mitochondria for active transport**; some cells have very little cytoplasm for sugars to move through easily.



19 – Sperm cell



20 – Nerve cell



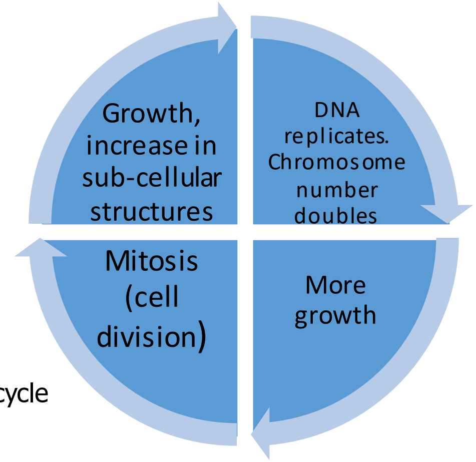
21 – Root hair cell

Section 3: Microscopy

22 Magnification	The degree by which an object is **enlarged**. **Magnification** = $\frac{\textbf{size of image}}{\textbf{size of real object}}$
23 Resolution	The ability of a microscope to **distinguish detail**.
24 Light microscope	Basic microscope with a maximum magnification of 1500x. **Low resolution.**
25 Electron microscope	Microscope with a much **higher magnification** (up to 500 000x) and resolving power than a light microscope. This means that it can be used to study cells in much finer detail.

Section 4: Orders of Magnitude

Unit Prefix	Size in metres	Standard Form
26 Centimetre (cm)	0.01m	10^{-2}m
27 Millimetre (mm)	0.001m	10^{-3}m
28 Micrometre (μm)	0.000001m	10^{-6}m
29 Nanometre (nm)	0.000000001m	10^{-9}m



30 – Cell cycle

Section 5: Mitosis and the Cell Cycle	
31	Number of **sub-cellular structures** (e.g. **ribosomes** and **mitochondria**) **increase**.
32	Number of **chromosomes double**.
33	One set of **chromosomes** is **pulled** to each end of the cell.
34	The **nucleus divides**.
35	**Cytoplasm** and **cell membranes divide** to form two **identical** cells

Section 6: Stem Cells		
Stem Cell	**Properties**	**Uses**
36 Embryonic stem cell	Can divide into **most types** of cell.	**Therapeutic cloning** – embryonic stem cells produced with same genes as patient. **No rejection**.
37 Adult stem cell	Can divide into a **limited number of cells** e.g. bone marrow stem cells can form various blood cells.	
38 Meristem	Found in plants. Can differentiate (divide) into **any type** of plant cell.	**Clone** rare species to **prevent extinction. Crops** with **special features** can be clones
Pros and Cons of Using Stem Cells		
39 Pros	**Treatment of diseases** such as diabetes, dementia and paralysis.	
40 Cons	**Ethical** and **religious** objections. Can **transfer viruses** held within cells.	

Section 7: Transport Across Membranes		
Cell Structure	**Definition**	**Uses**
41 Diffusion	**Spreading** out of the particles (gas/ solution) resulting in a **net movement** from an area of **higher concentration** to an area of **lower concentration.**	**Oxygen** and **carbon dioxide** in **gas exchange** (leaves and alveoli). **Urea** from **cells** into the **blood plasma** for excretion in the kidney.
42 Osmosis	The diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.	Movement of water into and out of cells.
43 Active Transport	The movement of substances from a more dilute solution to a more concentrated solution (against a concentration gradient). Requires energy from respiration.	**Absorption** of **mineral ions** (low concentration) from soil into **plant roots**. **Absorption** of **sugar molecules** from lower concentrations in the **gut** into the **blood** which has a higher sugar concentration.

Section 8: Factors Affecting Diffusion	
Factor	**Explanation**
44 Difference in concentrations (**concentration gradient**)	The greater the difference in concentrations, the faster the rate of diffusion.
45 **Temperature**	Particles move more quickly at higher temperatures, so rate of diffusion increases.
46 **Surface area** of membrane	The greater the surface area the quicker the rate of diffusion.

Section 9: Adaptations of Exchange Surfaces	
47	**Large surface area**
48	**Thin membrane** to provide a **short diffusion path**
49	**Ventilation** (in animals for gas exchange – maintains a concentration gradient)
50	**Efficient blood supply** (in animals – maintains a concentration gradient)