Year 10 Combined Science KO
Autumn Term 2026

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4 – 5	IV Relationships
6	Types of Bonding
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9 – 10	Principles of Waves
11 – 12	Velocity and Acceleration

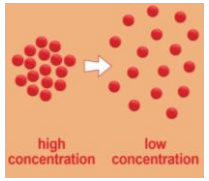
Year 10 Science Knowledge Organiser – BBL7 Digestion and Respiration

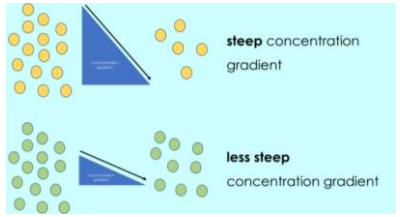
Lesson 1 – Diffusion

Key Terms

Rate - How quickly or slowly a particular process occurs.
Diffusion - the net movement of particles (atoms, molecules, or ions) from an area of higher concentration to an area of lower concentration
Concentration - the amount of a substance (solute) dissolved in a certain volume of a liquid (solvent)
Surface area - The surface area of a 3D shape is the total area of all the faces

- Rate of diffusion is a measure of how quickly particles diffuse from one area to another
- Rate of diffusion increases when:
  - Temperature is high
  - Concentration gradient is high/steep
  - Surface area is large





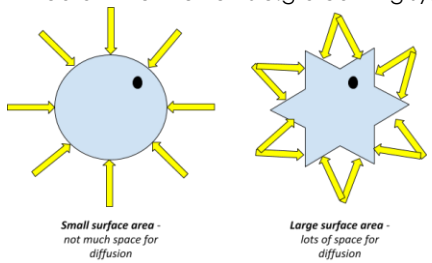
Lesson 2 – Surface Area and Diffusion

Key Terms

Specialised exchange surface - A part of a multicellular organism with a large surface area that allows them to exchange substances with the environment at a greater rate.

Volume - the amount of three-dimensional space occupied by an object or substance

- Organisms with a large surface area to volume ratio (SA:V) can rely on diffusion to obtain their nutrients e.g absorbing oxygen from surroundings
- Organisms with a small surface area to volume ratio (SA:V) cannot rely on diffusion alone as diffusion would be too slow. They need specialised exchange surfaces to obtain their nutrients e.g breathing system to get oxygen.



Calculating the SA:V of *E. coli*

Step 1: Identify the surface area (SA) and volume (V) of *E. coli*
Surface area (SA) of *E. coli*: 4.7 μm²
Volume (V) of *E. coli*: 0.29 μm³

Step 2: Write these figures as a ratio of SA to V
SA:V = 4.7 : 0.29

Step 3: Write this ratio in the form n:1
÷ 0.29 ÷ 0.29
SA:V = 16.2 : 1

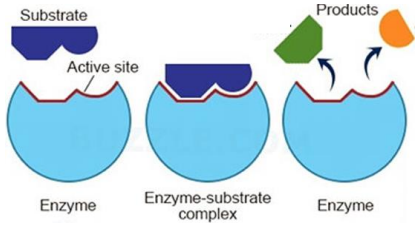
Lesson 4 – Enzymes structure and function

Key Terms

Active site - The active site is the part of an enzyme with a specific shape where a substrate binds. It is where the chemical reaction takes place.
Substrate - A substrate is the molecule that the enzyme acts on. It binds to the enzyme's active site, forming an enzyme-substrate complex.
Optimum - The optimum is the temperature or pH at which an enzyme works fastest, giving the highest rate of reaction.
Enzyme - Enzymes are **biological catalysts**. They speed up metabolic reactions (chemical reactions in the body) without being used up themselves

- Enzymes have an active site with a specific shape with where the substrate fits, forming an enzyme–substrate complex.
- Enzymes work fastest at an optimum temperature and pH
  - Low temperature: Enzyme activity is slow
  - High temperature: Enzyme activity stops as enzymes denature
  - Too high/low pH: Enzyme activity stops as enzymes denature

You can work out the rate of enzyme activity on a graph.
Rate = gradient, so work out the slope (rise ÷ run), often by drawing a tangent.



Lesson 5 – Type of enzymes and rate of action

Key Terms

Carbohydrase - A type of enzyme that breaks down carbohydrates
Protease - A type of enzyme that breaks down proteins.
Lipase - A type of enzyme that breaks down lipids (fats).
Bile - Bile is alkaline to neutralise hydrochloric acid from the stomach. It also emulsifies fat to form small droplets, which increases the surface area for lipase to act on.

- Specific enzymes are needed to break down food group substrates. For example, proteins are broken down by proteases to make amino acids.

Reactants	Enzyme	Products
Carbohydrates (e.g. sugar or starch)	carbohydrase	Simple sugars
Proteins	Proteases	Amino acids
Lipids	lipases	Fatty acid & glycerol

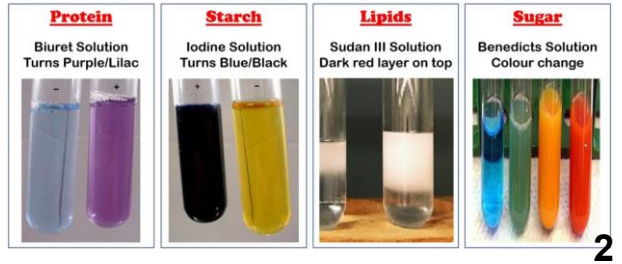
Lesson 3 – AQA RP4 Food tests

Key Terms

Iodine solution - A reagent used to test for the presence of starch
Biuret solution - A reagent used to test for the presence of protein
Benedict's solution - A reagent used to test for the presence of reducing sugar
Reducing sugar - A type of sugar that will turn Benedict's solution brick red when heated. (E.g. Glucose and fructose)

Chemical	Testing for	How to do the test	Results
Iodine	Starch	Add a drop of iodine to the food sample	Turns blue/black
Benedict	Glucose	Add a drop of Benedict's to the food sample. Heat the sample.	Turns yellow/green if there's less glucose Turns brick red if there's more glucose
Biuret	Protein	Add a drop of Biuret to the food sample	Turns purple
Ethanol	Lipid/Fat	Add the ethanol to the sample and shake. Add water.	Turns cloudy/milky

To summarise, each test and what a positive result looks like:



Year 10 Science Knowledge Organiser – BBL7 Digestion and Respiration

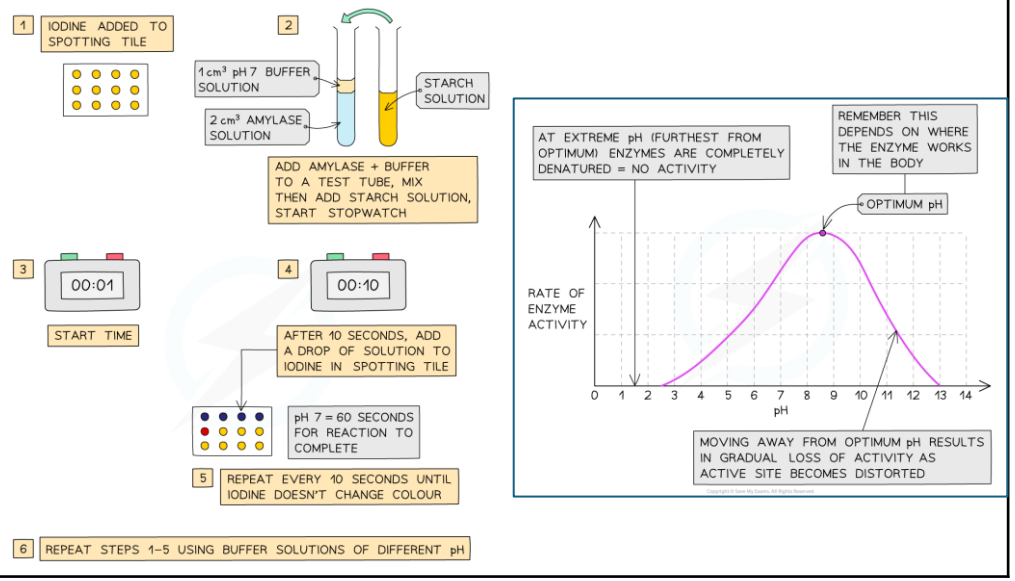
Lesson 6 – AQA RP5 pH and enzyme action

Key Terms

Plot - Mark on a graph using data given.

Give - Only a short answer is required, not an explanation or a description.

Explain - Students should make something clear or state the reasons for something happening.

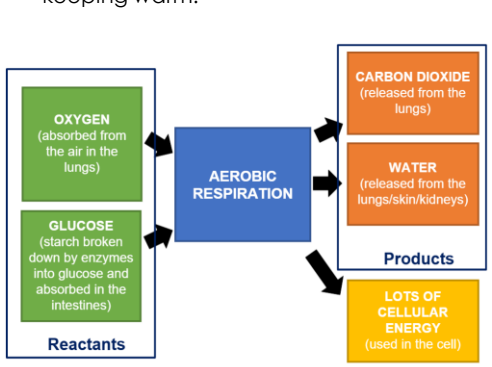


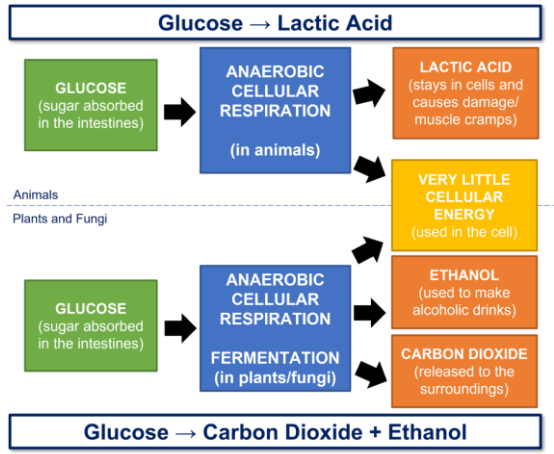
Lesson 7 – Cellular respiration

Key Terms

Respiration - Respiration is a chemical reaction that happens in all living cells to release energy from glucose
Aerobic - Aerobic respiration uses oxygen to break down glucose and release energy
Anaerobic - Anaerobic respiration only uses glucose to release energy
Exothermic – A chemical reaction that transfers energy to surroundings.

- Respiration is an exothermic reaction which means energy is released to surroundings
- Respiration takes place in the mitochondria of cells
- Respiration is important because energy is needed to build large molecules, movement and keeping warm.





Lesson 8 – Response to exercise (FOUNDATION)

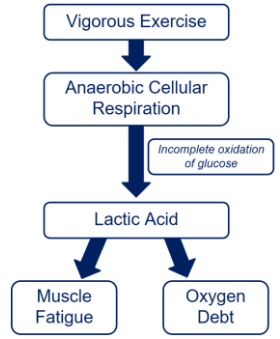
Key Terms

Breathing rate - Number of breaths taken per minute
Heart rate - Number of times the heart beats per minute (bmp)
Lactic acid - Toxic waste product produced in animal muscles during anaerobic respiration
Fatigue - Extreme physical and mental tiredness where the muscles no longer contracting efficiently
Oxygen debt - The amount of extra oxygen the body needs after vigorous exercise to recover from a period of anaerobic respiration.

Heart rate, breathing rate and temperature increases when exercise increases.

This is so that more blood and oxygen can be supplied to muscles/cells to increase respiration rate and release more energy.

If there is a lack of oxygen, the muscle will build up lactic acid.



Lesson 9 – Response to exercise (HIGHER)

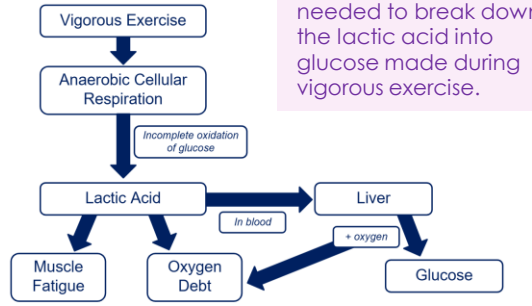
Key Terms

Same as above

Heart rate, breathing rate and temperature increases when exercise increases.

This is so that more blood and oxygen can be supplied to muscles/cells to increase respiration rate and release more energy.

If there is a lack of oxygen, the muscle will build up lactic acid.



HIGHER TIER: The liver is needed to break down the lactic acid into glucose made during vigorous exercise.

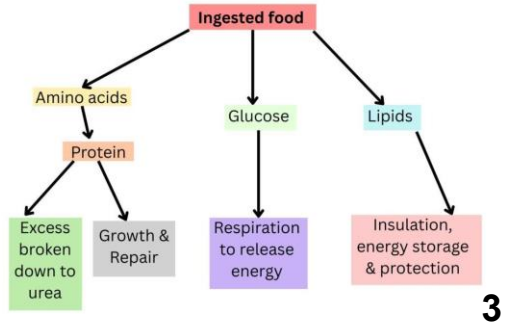
Lesson 10 – Metabolism

Key Terms

Metabolism - The sum of all the reaction in a cell or the body

Metabolic - A word used to describe a type of reaction that happens in the body.

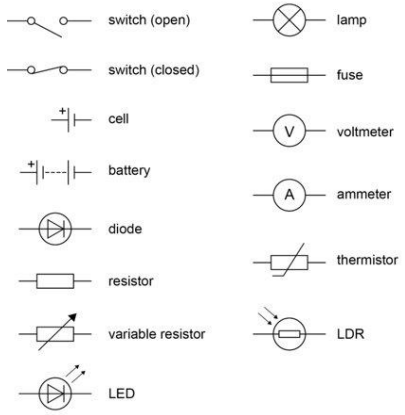
- metabolism is the sum of all the chemical reactions that occur in a cell or body.
- The formation of proteins, carbohydrates and lipids are examples of metabolic processes.
- Cellular respiration is an example of a metabolic process.



Year 10 Science Knowledge Organiser – OEOO12 IV Relationships

Lesson 1 – Common Circuit Symbols

Component –
a part of the circuit
Symbol –
a pictoral image of a component
Circuit –
a path of electric current



•**Switch (open/closed)** – A device that either completes or breaks the circuit, allowing or stopping the flow of current.
•**Battery** – Two or more cells connected to provide a greater potential difference and supply energy to the circuit.
•**Resistor** – A component that limits or controls the flow of electric current in a circuit.
•**Lamp** – A device that converts electrical energy into light energy when current passes through it.
•**Voltmeter** – A measuring device used to measure the potential difference (voltage) across a component; must be connected in parallel.
•**Ammeter** – A measuring device used to measure the electric current flowing through a circuit; must be connected in series.

Lesson 2 – Series Circuits

Key Terms

Series – an electrical pathway where all components are connected sequentially in a single loop. The electric current flows through each component one after another, meaning there is only one route for the electrons to travel.
Current – the rate at which electric charge flows through a conductor (such as a metal wire). It is driven by a voltage and is defined fundamentally by the equation.

The current is the same (equal the whole way around a series circuit.

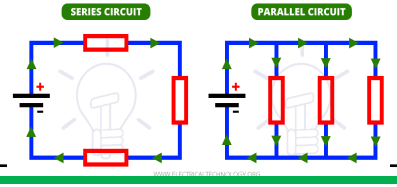
The total potential difference of the power supply is shared between the components.

The total resistance of each component is the sum resistance of each component.

Lesson 3 – Parallel Circuits

Key Terms

Parallel - an electrical circuit with multiple branches, providing more than one path for current to flow. If one component breaks, the other branches continue to work. It is the standard setup for household wiring.



The total current is sum of the current through each component or A total = A2 + A3

The potential difference across each component is the same or VTOTAL = V2 = V3..

The total resistance of two resistors in a parallel circuit is less than the resistance of the smallest individual resistor.

Lesson 4 – Qualitative Relationships

Key Terms

Potential difference – a measure of the energy transferred per unit of charge as it moves between two points in a circuit

Resistance – a measure of how much a component opposes the flow of electric current

The unit measure for energy is Joules, J
Changes in energy stores can be described.

Work done is the change energy stores due to a process or action taking place.
Chemical, gravitational, kinetic, thermal, and elastic are examples of stores.

There are 4 pathways: Heating by particles, Work (mechanical), electrical working and heating by radiation.

Lesson 5 – Quantitative Relationships

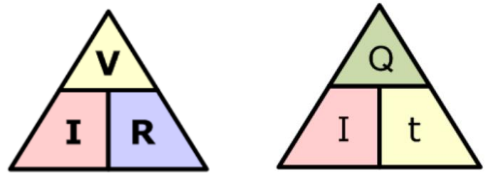
Key Terms

Determine – to firmly decide, establish, or ascertain facts after investigation, reasoning, or calculation

Calculate – to determine a numerical value, amount, or outcome by using mathematical, logical, or statistical processes

Potential difference (V) = current (A) x resistance (Ω)
V = I x R

Charge flow (C) = current (A) x time (s)
Q = I x t



Lesson 6 – IV Graphs

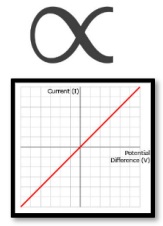
Key Terms

Ohmic – any electrical component or material that strictly obeys Ohm's Law, maintaining a constant resistance regardless of the voltage applied or current flowing through it

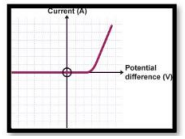
Resistance – The measure of an object's or material's opposition to the flow of an electric current.

Directly proportional – if when one changes, the other changes at the exact same relative rate. Line goes through the origin (0,0)

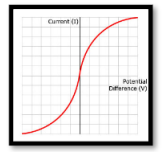
- This symbol means directly proportional



Diode – non ohmic conductor



Filament bulb – non ohmic conductor



←Resistor – ohmic conductor. Directly proportional

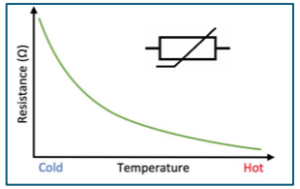
Year 10 Science Knowledge Organiser – OEOO12 IV Relationships

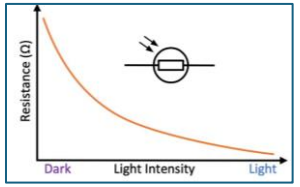
Lesson 7 – Specialist Resistors

Key Terms

Diode – a non-ohmic semiconductor component that allows electric current to flow in only one direction

Thermistor - a temperature-dependent resistor. Unlike a standard resistor, its resistance changes dramatically with temperature.





LDRs or light dependent resistors are a type of specialist resistor. As light intensity increases, the resistance decreases.

A thermistor is another specialist resistor. As temperature increases, the resistance decreases.

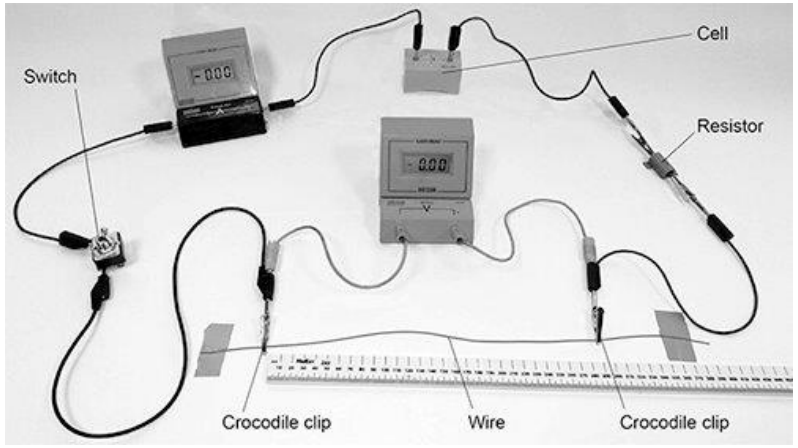
The graphs that are created by these resistors are in the key terms box.

Lesson 8 and 9 – Resistance in a Wire (RP)

Key Terms

Calculate – to determine an amount, number, or outcome using mathematical processes.

Determine - to firmly decide something or to discover the facts of a situation through investigation or calculation



1. A student set up the equipment as shown.
2. Measured the length of the wire between the crocodile clips
3. Measure the current with the ammeter
4. Measure the potential difference with the voltmeter
5. Calculate the resistance at each length
6. Using V = I x R
7. Repeat the readings
8. Calculate mean averages
9. Ensure the circuit is disconnected off for 30s between reading to ensure temperature remains
10. Keep the materials the wire is made from and the diameter of the wire the same

Year 10 Science Knowledge Organiser – BOM12 Types of Bonding

Lesson 1 – Introduction to Bonding

Key terms

Chemical bonding - the process by which atoms join together to form molecules and compounds, either by losing or gaining electrons.

Electrostatic Force- The force between oppositely charged particles

Element – A pure substance made of only one type of atom

- Atoms want a full outer shell of electrons so that they are stable.
- The first shell can hold a maximum of 2 electrons, every other shell can hold up to 8.
- Ionic bonds form between atoms of metals and non-metals
- Covalent bonds form between non-metal atoms
- Metallic bonds form between metals
- Electron configurations tell you how many electrons are in each shell (2,8,1) – 2 in first, 8 in second, 1 in third

Lesson 2 – Ionic Bonding

Key Terms

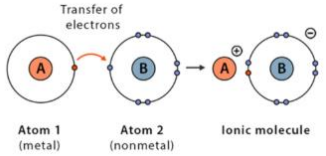
Ion – an atom with a charge

Ionic - The electrostatic force of attraction between oppositely charged ions

Cation – positively charged ion

Anion – negatively charged ion

- Ionic bonds are formed from the transfer of electrons between a metal and a non-metal.
- When atoms lose or gain electrons they become ions which have a positive/negative charge – and OPPOSITES ATTRACT.
- Metals always lose electrons forming positively charged cations.
- Non-metals always gain electrons forming negatively charged anions.



Lesson 3 – Ionic Compounds

Key Terms

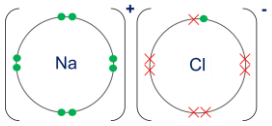
Lattice - A regular, repeating arrangement of particles

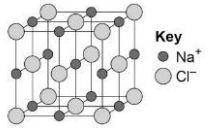
Compound – more than 1 type of element chemically bonded in fixed proportions

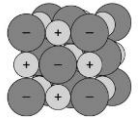
Evaluate - Consider strengths and weaknesses and come to a conclusion.

Empirical Formula - The simplest whole-number ratio of atoms or ions of each element in a compound

- Ionic compounds form a giant lattice structure of ions, held together by strong electrostatic forces of attraction between oppositely charged ions. These forces act in all directions within the lattice.
- Dot and cross, ball and stick, and 2D/3D diagrams







can be used to represent them.

Lesson 4 – Covalent Bonding

Key Terms

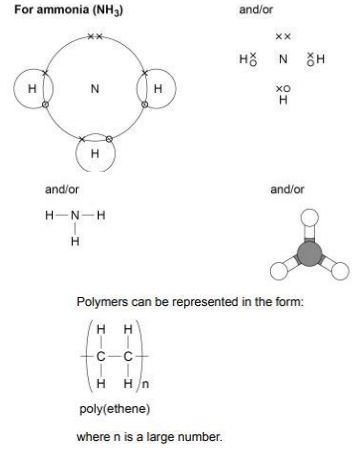
Covalent - The electrostatic attraction between a shared pair of outer electrons and the two positively charged nuclei of the bonded atoms

Simple molecule -A substance made of molecules with strong covalent bonds within the molecule and weak forces between molecules.

Giant covalent - A 3D network of atoms joined by covalent bonds.

Polymer - A very large molecule made by joining together many smaller repeating units called monomers.

- Covalent bonds are formed when non-metallic atoms share pairs of electrons.
- These bonds are very strong.
- Some covalent substances form simple molecules, such as oxygen (O_2)
- Some substances form very large polymer molecules.
- Some covalent substances form giant covalent structures, such as diamond and silicon dioxide (SO_2).
- There are several ways to represent covalent bonds:



Lesson 5 – Metallic Bonding

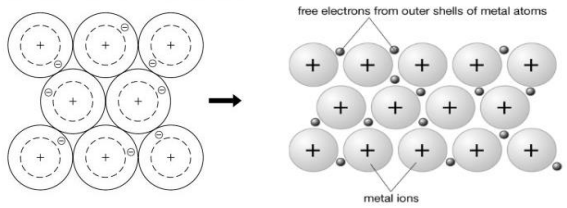
Key Terms

Metallic Bond- The electrostatic force of attraction between positive metal ions and delocalised electrons

Delocalised - Electrons that are free to move through a structure

Conductivity - Ability to allow charge to flow

- Metals consist of giant structures of atoms arranged in a regular pattern.
- The electrons in the outer shell of metals atoms are delocalised and move through the whole structure, allowing metals to conduct electricity.
- The sharing of these delocalised electrons forms strong metallic bonds.
- Bonding in metals is represented like this:



Year 10 Science Knowledge Organiser – BOM13 Quantitative chemistry

Lesson 1 – Chemical measurements and uncertainty

Key terms

Uncertainty - the range within which the true value is expected to lie.

Resolution - the smallest change in a quantity that an instrument can detect.

- The uncertainty of a measurement is the range within which the true value is likely to lie, and it is equal to ± half the smallest scale division.
- Repeats allow a mean to be calculated which produce more
- accurate data than using a single measurement.
- Using equipment with a greater resolution can reduce uncertainty.
- When we carry out multiple repeats during an experiment, we can also estimate the uncertainty in our repeated values. This shows how precise our measurements are – if the values vary a lot, precision is low; if they are close together, precision is high. To do this, we must calculate the range between our highest and lowest result.

Lesson 2 – Relative Formula Mass and % Composition

Key Terms

Relative atomic mass - is the average mass of its atoms, compared to 1/12th the mass of a carbon-12 atom

Relative formula mass – is the relative mass of the entire formula (the total of all of the relative atomic mass in the molecule or compound).

- Relative atomic mass (Ar) can be found on the Periodic Table. It is often a whole number because it has been rounded.
- The relative formula mass (Mr) of compounds using the sum of relative atomic masses.
- H_2SO_4 = (2 x 1) + (1 x 32) + (4 x 16) = 98
- In a reaction, mass is conserved. The mass of reactants = the mass of products.

$M_r: CH_4 = 16$ + $M_r: 2O_2 = 64$ $M_r: CO_2 = 44$ + $M_r: 2H_2O = 36$

Total Reactant M_r = 80 ***Total Product M_r = 80***

- Percentage composition tells us how much of a compound's total mass is made up of a specific element.

Lesson 3 – Measuring Changes of Mass

Key terms

Conservation of mass - The law of conservation of mass states that no atoms are lost or made in a chemical reaction. The mass of reactants = the mass of products.

- In a reaction, mass is conserved. The law of conservation of mass states that no atoms are lost or made in a chemical reaction. The mass of reactants = the mass of products.

$M_r: CH_4 = 16$ + $M_r: 2O_2 = 64$ $M_r: CO_2 = 44$ + $M_r: 2H_2O = 36$

Total Reactant M_r = 80 ***Total Product M_r = 80***

- Mass appears to change in a reaction where a gas is produced. The mass will go down because gas particles spread out and escape into the air, so their mass was no longer measured. The particles are far apart in a gas and can leave the flask easily, meaning measured mass decreases.
- You can measure the loss of mass of a reaction, by placing the reaction flask on a balance and monitoring the mass.

Lesson 4 – Concentration of Solutions

Key Terms

Solution - A solution forms when a solute dissolves in a solvent.

Concentration - measure how much solute is dissolved in a specific volume of solvent

- To convert cm^3 into dm^3: $cm^3 \div 1000 = dm^3$
- To convert dm^3 into cm^3: $dm^3 \times 1000 = cm^3$
- The units for concentration are g/dm^3.
- Mass is measured in g, using a balance. Volume is measured in cm^3 and then converted to dm^3.
- We are able to calculate concentration as the mass per unit volume.

$$\text{Concentration (g/dm}^3\text{)} = \frac{\text{mass (g)}}{\text{volume (dm}^3\text{)}}$$

- To calculate the mass of a solute in a given volume of solution, we rearrange the formula to give us:
- concentration (g/dm^3) x volume (dm^3) = mass (g)

- HT Volume of solution will affect the concentration. If we add more water (solvent) but keep the mass of the solute the same, the concentration decreases. This is called dilution. The solvent (water) could evaporate on a hot day. This would cause the concentration to increase because volume decreases.

- HT If the volume remains constant, adding more solute will increase the concentration of a solution.

Year 10 Science Knowledge Organiser – BOM13 Quantitative chemistry

Lesson 5 – Moles (HT only)

Key terms

Mole - the amount of a substance that contains the same number of particles as there are atoms in 12 grams of carbon-12.

Avagadro - Number of particles are in one mole (6.02×10^{23})

- Avogadro's Constant tells us how many particles are in
- one mole of a substance.
- The symbol for moles is mol.
- One mole of an element has a mass (in grams) equal to its relative atomic mass. Because one mole weighs the same (in grams) as the Ar, we can calculate moles
- using:

$$\text{number of moles (mol)} = \frac{\text{mass (g)}}{A_r}$$

- To calculate the number of particles, we use the following equation:

$$\text{no. of particles} = \text{no. of moles} \times \text{Avogadro's constant}$$

Lesson 6 – Reacting masses (HT only)

Key Terms

Actual yield – the amount of product actually obtained from a chemical reaction.

Predicted yield – The maximum calculated mass of a product that could possibly be formed, predicted using the balanced symbol equation and reacting masses.

Excess - the reactant that is not completely used up in a reaction.

- A reacting mass calculation is when we can use a known mass of any substance in a balanced equation to calculate the theoretical mass of any other substance involved – whether it's a reactant or a product.

- Some uses of reacting masses:
  1. To work out how much product we can make
  2. To scale up a reaction for industrial production
  3. To make sure no reactant is wasted
  4. To check if a reaction has gone to completion
  5. To compare actual vs predicted yield

- To calculate the theoretical mass of a product, we only need the mass of one reactant. This is because we assume all other reactants are in excess.

Lesson 7 – Limiting reactants

Key terms

Limiting reactant - the reactant that is completely used up first in a reaction, which limits the amount of product formed.

Excess - the reactant that is not completely used up in a reaction.

- We identify the limiting reactant by calculating available moles ÷ required moles. This tells us how many times each reactant could provide its needed amount.

- The reactant that can do it the fewest times is the limiting reactant, because it is used up first.

Lesson 8 – Balancing equations using moles

Key Terms

Transition metals – elements found in the centre of the periodic table

Mole - the amount of a substance that contains the same number of particles as there are atoms in 12 grams of carbon-12.

- Transition metals can form more than one possible compound with different ratios. For example, iron can form FeO, Fe_2O_3, or Fe_3O_4.

- It is important that we work out the ratio of transition metal to the other reactant in a reaction to determine the correct formula, rather than assuming.

- We use moles and ratios to determine formulae and balance equations.

Year 10 Science Knowledge Organiser – BOE15 Principles of Waves

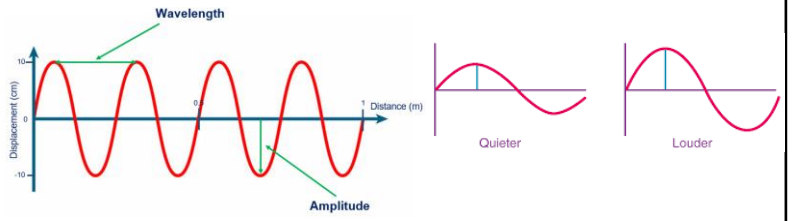
Lesson 1 – Graphing Waves

Key Terms

Wavelength - The distance from one point on one wave, to the equivalent point on the adjacent wave

Amplitude - The maximum displacement of a point on the wave away from its undisturbed position

Waveform - a visual representation of a wave



- A greater amplitude means a louder sound
- Microphones can be plugged into an amplifier, to amplify the sound – to make the sound louder.

Lesson 2 – Transverse vs longitudinal

Key Terms

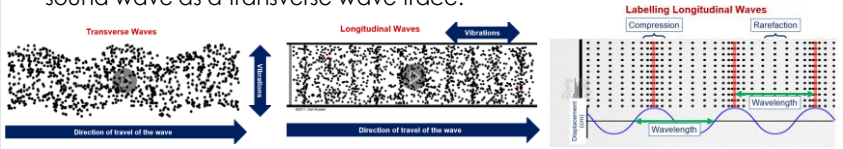
Transverse wave - The vibrations of the particles are perpendicular to the direction of travel of the wave.

Longitudinal wave - The vibrations of the particles are parallel to the direction of travel of the wave.

Vacuum - A space where there is no matter or particles

- All waves transfer energy, but not matter
- Water waves and electromagnetic waves (e.g. light) are examples of transverse waves
- Transverse waves can travel through a vacuum

- Longitudinal waves cannot travel through a vacuum
- Sound waves are an example of a longitudinal wave
- An oscilloscope is a piece of equipment that can be used to represent a sound wave as a transverse wave trace.

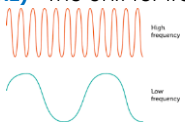


Lesson 3 – Frequency and periods

Key Terms

Frequency - The number of waves passing a point each second.

Hertz (Hz) - The unit for frequency



Period - The time taken for one complete wave cycle (oscillation) to pass a specific point.

$$\text{frequency (Hz)} = \frac{\text{number of waves}}{\text{time (s)}}$$

A buoy in the sea moves up and down as waves pass it. **200 waves** pass the buoy in **40 seconds.** Calculate the frequency of the waves.

$$\text{frequency (Hz)} = \frac{200}{40}$$

$$\text{frequency (Hz)} = 5 \text{ Hz}$$

$$\text{Period} = \frac{1}{\text{Frequency}}$$

↓ frequency = ↑ period
↑ frequency = ↓ period

A sound wave has a frequency of 250 Hz. **Calculate** its period.

$$Period = \frac{1}{250}$$

$$Period = 0.004\ s$$

Lesson 4 – Wave speed

Key Terms

Oscilloscope - used to record the waveform of a sound wave.

Frequency - The number of waves passing a point each second.

Wavelength - The distance from one point on one wave, to the equivalent point on the adjacent wave

- Light travels significantly faster than sound.
- The speed of sound can be determined by getting two students to stand a set, measured distance apart. Person A raises their hand and fires a pistol and then lowers their hands. Person B starts the stopwatch when they see the hand lower and stop the stopwatch when they hear the bang. They record the data, repeat and calculate the mean. Calculate speed: ***Speed (m/s) = distance (m) / time (s).***

$$\text{wave speed} = \text{frequency} \times \text{wavelength} \textbf{ or } v = f\,\lambda$$

A water wave has a frequency of 3 Hz and a wavelength of 5 m.

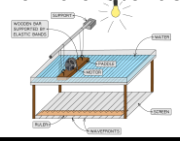
$$\text{wave speed (m/s)} = \text{frequency (Hz)} \times \text{wavelength (m)}$$
$$\text{wave speed (m/s)} = 3\ (Hz) \times 5h\ (m)$$
$$\text{wave speed} = 15 \text{ m/s}$$

- An oscilloscope trace is to be used to determine the frequency.

Lesson 5 – RP8 (RP20) – Ripple Tank

Key Terms

Ripple tank - a shallow, transparent glass-bottomed tray of water with a light shining down through it onto a white card below to clearly see the motion of the ripples created on the water's surface



1. Set up the ripple tank as shown in the diagram.
2. Pour water to a depth of about 5mm into the tank.
3. Switch on the overhead lamp and electric motor
4. Adjust the speed of the motor to produce low frequency water waves.
5. Adjust the height of the lamp so that the pattern of the waves can be clearly seen on the white card below.
6. Place a meter rules at right angles to the waves shown in the pattern on the card. Measure across as many waves as you can. Then, divide that length by the number of waves. This gives the wavelength of the waves.
7. Count the number of waves passing a point in the pattern over a given time (e.g. 10 seconds). Divide the number of wavs counted by 10. This gives the frequency of the waves.
8. Calculate the speed of the waves using the equation: $v = f\lambda$

Lesson 6 – Properties of EMS

Key Terms

Electromagnetic wave - Transverse waves that transfer energy from the source of the waves to an absorber
Reflection - When a wave bounces at the boundary between two different materials
Refraction -When a wave changed direction at the boundary between two different materials, due to a change in wave speed
Normal - A line drawn perpendicularly to the boundary between materials.
Incident Ray - The incoming ray of light or wave that travels toward and hits a surface, boundary, or medium

- All electromagnetic waves travel at the same velocity in a vacuum (space) or air.
- They have different wavelengths and frequencies.
- These form the electromagnetic spectrum.



- Our eyes only detect **visible light**, so we can only see a small part of the electromagnetic spectrum.
- In reflection, the angle of incidence = angle of reflection



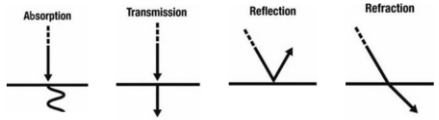
Year 10 Science Knowledge Organiser – BOE15 Principles of Waves

Lesson 7 – The interaction of waves (FT)

Key Terms

Absorbed: the wave's energy is taken in by the material.
Transmitted: The wave passes through the material. (Seeing through glass – light can pass through)
Reflected: The wave bounces off the surface. (Looking in the mirror – light is reflected)
Refracted: The wave changes direction as it passes from one substance to another.
Emission - The process of an object giving out energy
Matt - A surface that is microscopically textured so that the reflected light reflects over a wide area.

- When a wave meets a boundary, it can be absorbed, transmitted, reflected or refracted.



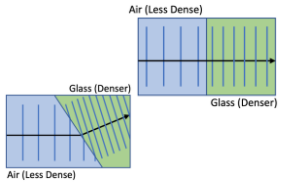
- The darker and more matt the surface is, the greater the absorption and emission of infrared waves.
- The lighter and shinier the surface is, the poorer the absorption and emission of infrared waves, they reflect the radiation.



Lesson 7 – The interaction of waves (HT)

Key Terms

Explain - Say why something has happened or is the way it is



- EM waves have different wavelengths and therefore behave differently at boundaries depending on the material that boundary is made from.
- Visible light has a longer wavelength than ultraviolet waves. Much of the UV waves that hit glass are absorbed, while the visible light is transmitted.
- Metal object reflect most EM waves like visible waves and radio waves. However, it absorbs microwaves strongly.
- If a wave hits a boundary at right angles (perpendicular), there is no change in direction, and no refraction takes place.
- Waves will travel at different velocities in different media (Eg: Light slows down as it enters glass)
- If the wave front hits a denser medium at an angle, that part of the wave front will slow down first. This causes refraction of the wave.

Lesson 8 – RP10 (RP21) – Radiation

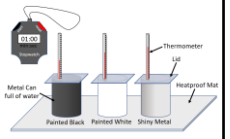
Key Terms

Leslie cube - A hollow metal cube with different surfaces on each side.

Matt - A surface that is microscopically textured so that the reflected light reflects over a wide area.

- A matt black container will cool down the quickest, as it will emit the most Infrared radiation
- A silver container will cool down the slowest, as it will emit the least Infrared radiation

Investigating the amount of infrared radiation radiated from different surfaces



- Set up at least 3 different flasks/cans like the diagram.
- Ensure that there is adequate insulation to place on top of the cans.
- Fill the first can with 50cm^3 of water from a kettle that has just boiled.
- Record the initial temperature and start the stopwatch.
- Record the temperature of the can every 20s for a total of 3 minutes.
- Repeat with each can in turn, ensuring the starting temperature of the water is the same for each can.

Investigating the amount of infrared radiation radiated from different surfaces



- Use a Leslie cube (or cans with different surfaces) and an infrared detector.
- Measure the amount of the infrared radiation emitted from each surface.
- Compare the amount of infrared radiation emitted from the difference surfaces.

Lesson 9 – Uses of EMS

Key Terms

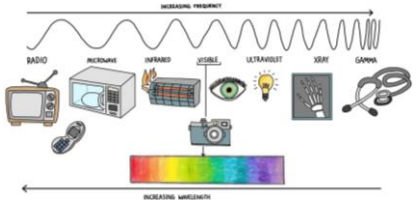
Ultraviolet - Waves that have a shorter wavelength than visible like but longer wavelength than x-rays

Infrared - Waves that have a longer wavelength than visible light but shorter than microwaves

X-ray - Waves that have a shorter wavelength than ultraviolet but a longer wavelength than gamma

Gamma Ray - Waves that have a shorter wavelength than x-rays

- **Radio waves** are used for communication (TV and Radio)
- **Microwave**s are used for satellite communication and for cooking food
- **Infra red** is used for thermal imaging, IR cameras, electrical heaters and also used for cooking
- **Visible light** is used for fibre optic communication.
- **Ultraviolet light** is used for tanning and some energy efficient lamps.
- **X-rays** are used for medical imaging.
- **Gamma rays** can be used to treat cancer.



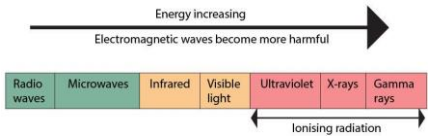
Lesson 10 – EMS and Ionising Radiation

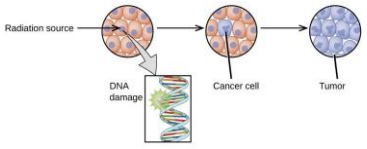
Key Terms

Describe - To recall some facts, events or process in an accurate way.
Compare - List the similarities and differences
Ionising Radiation - Radiation with enough energy to remove electrons from atoms or molecules, turning them into ions.
Radiation dose - A measure of the risk of harm from exposure to ionising radiation, measured in sieverts (Sv)
Sievert (sv) - The unit used for the biological effect of ionising radiation.

- All electromagnetic waves travel at the same speed in a vacuum — but they differ in frequency and energy.
- As we move from left to right across the spectrum, the frequency and energy increase.
- The waves at the lower-energy end, like radio and infrared, can make particles vibrate or heat up — but they don't have enough energy to remove electrons. These are called **non-ionising.**
- In Ultraviolet, X-rays, and gamma rays, the energy is high enough to remove electrons from atoms. These are what we call **ionising radiation.**

- UV radiation can penetrate the skin and damage the DNA inside skin cells, causing the skin to age more quickly (wrinkles, sunspots) and, in some cases, mutations that can lead to skin cancer.
- Ionising radiation has enough energy to damage or change the structure of DNA. Most of the time, the body repairs this damage but if the DNA is copied before it's repaired, it can cause a mutation. A mutation in the DNA of a cell can make that cell divide uncontrollably. That's how cancer can form.





- Ionising radiation can be very useful in medicine — for example, in treating tumours — but it also has potential risks, depending on the type of radiation and the dose absorbed.

Year 10 Science Knowledge Organiser – OEOO13 Velocity and Acceleration

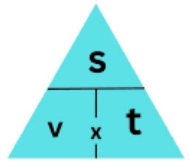
Lesson 1 – Speed

Key Terms

- **Uncertainty**: The interval or range of possible values within which the true value of a measurement lies
- **Speed**: A scalar quantity that is the rate of change of distance with time. It does not involve direction.
- **Velocity**: A vector quantity that is speed in a given direction.
- **Determine**: Use the information given (often through practical work or data) to work out the answer

- Uniform motion means that speed is constant
- Linear motion is the motion path being straight
- Typical walking speed is 1.5m/s
- Typical running speed is 3m/s
- Typical cycling is 6m/s
- Typical speed of sound is 330m/s

Distance travelled,s = Speed,v x time,t
(m) (m/s) (s)



$s = v \times t$

$t = \frac{s}{v}$

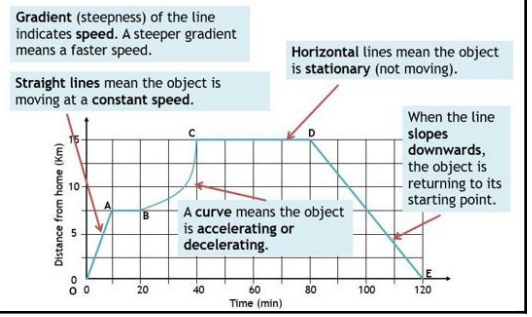
$v = \frac{s}{t}$

Lesson 2 – Distance time graphs

Key Terms

- **Proportional:** as one variable increases, the other increases at a constant rate. straight-line relationship, not necessarily through the origin
- **Distance-time graph:** A graph that shows how distance travelled changes with time; the gradient represents speed.

- Speed can be calculated from a distance time graph by calculating the gradient.
- Steeper gradient means faster speed
- (HT) a tangent can be drawn to the curve at a specific point to calculate speed at a specific time

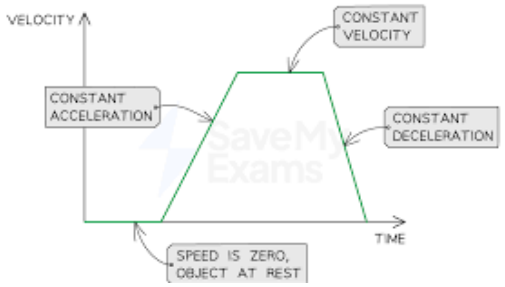


Lesson 3 – Velocity

Key Terms

Velocity: A vector quantity that is speed in a given direction.

- Distance is a scalar quantity showing how far an object moves
- Displacement is a vector quantity including both the distance an object moves, (measured in a straight line from the start point to the finish point) and the direction of that straight line
- Acceleration = rate of change of velocity
- Steeper the gradient of a velocity time graph, the greater the rate of change



Lesson 4 – Acceleration and Velocity time graphs

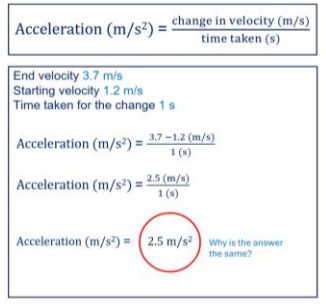
Key Terms

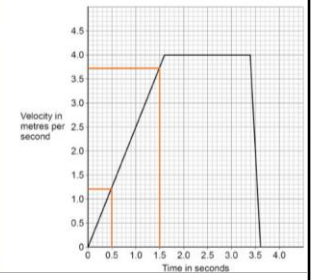
Acceleration: The rate of change of velocity with respect to time

Velocity-time graph: A graph that shows how velocity changes with time.

Terminal velocity: The constant speed reached by a falling object when the force of gravity is balanced by the resistive forces (such as air resistance)

- Acceleration can be calculated from the gradient on a velocity-time graph
- The area under the velocity-time graph represents distance travelled.
- Acceleration is a vector quantity
- Acceleration is measured in m/s^2





- Linear acceleration is shown by a straight line
- Non-linear acceleration is shown by a curve

Lesson 5 – Area under the graph (HT)

Key Terms

- **Distance**: a scalar quantity showing how far an object moves
- **Displacement**: a vector quantity including both the distance an object moves, (measured in a straight line from the start point to the finish point) and the direction of that straight line

- Displacement (m) = Velocity (m/s) x time (s)
- The area under a velocity time graph can determine the distance/displacement of an object
- The total distance travelled is equal to the total area, negative values are ignored
- The displacement is equal to the sum of total area in sections A and B, taking into account the negative values

Lesson 6 – Acceleration in context

Key Terms

Acceleration: The rate of change of velocity with respect to time

Estimate: Use approximate values or reasoning to make an approximate but sensible answer.

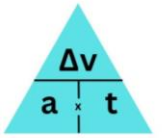
- The symbol Δ mean 'change'.
- Δv = final velocity – initial velocity

$$a = \frac{v-u}{t}$$

v = final velocity in metres per second
u = initial velocity in metres per second

- An object that is slowing down is decelerating.

Acceleration,a (m/s²) = Change in velocity, Δv (m/s) / time,t (s)



$a = \frac{\Delta v}{t}$

$\Delta v = a \times t$

$t = \frac{\Delta v}{a}$

Year 10 Science Knowledge Organiser – OEOO13 Velocity and Acceleration

Lesson 7 – Uniform Acceleration

Key Terms

Uniform acceleration: When an object's velocity is changing by the same amount during each equal time interval.

Calculate: Use numbers given in the question to work out the answer, showing steps where appropriate.

- This equation is used to calculate quantities such as initial or final speed, acceleration, or distance travelled in cases where the time taken is not known

Final Velocity^2 (m/s) - Initial Velocity^2 (m/s) = 2 x acceleration (m/s^2) x distance (m)

$$v^2 - u^2 = 2as$$

Final velocity = v

Initial velocity = u

Acceleration = a

Distance = s

$$a = \frac{v^2 - u^2}{2s} \qquad s = \frac{v^2 - u^2}{2a}$$

$$u = \sqrt{v^2 - 2as} \qquad v = \sqrt{u^2 + 2as}$$

Lesson 10 – Elastic potential energy

Key Terms

Elastic potential energy: The energy stored in a stretched or compressed object, such as a spring or rubber band

Work Done: The amount of energy transferred when a force moves an object over a distance

- Elastic potential energy can be calculated by:

Elastic potential (E_e) = 0.5 x spring constant (k) x extension^2

- E_e is measured in Joules (J)
- k is measured in Newtons per metre, (N/m)
- e is measured in meters (m)

A spring has a hanging mass placed on it. It extends by 0.2m

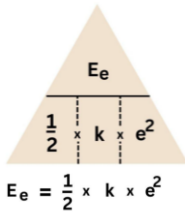
The spring constant for the spring is 150 N/m

Calculate the change in elastic potential energy stored in the spring.

Step 1 $Elastic\ potential\ energy = 0.5\ x\ spring\ constant\ x\ extension^2$

Step 2 $Elastic\ potential\ energy = 0.5\ x\ 150\ x\ 0.22$

Step 3 $Elastic\ potential\ energy = 3J$



$$E_e = \frac{1}{2} \times k \times e^2$$

$$k = \frac{2 \times E_e}{e^2}$$

$$e = \sqrt{\frac{2 \times E_e}{k}}$$

Lesson 8 – Acceleration in Fluids

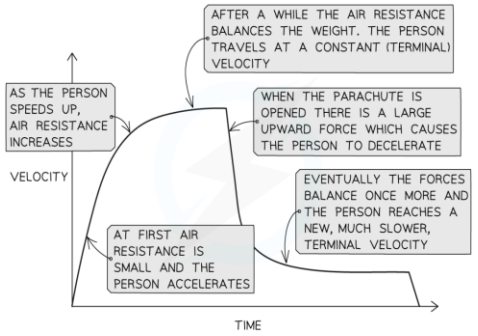
Key Terms

Viscosity: Viscosity is a measure of a fluid's resistance to flow

Terminal velocity: The constant speed reached by a falling object when the force of gravity is balanced by the resistive forces (such as air resistance)

- Near the Earths surface, any object falling freely under gravity has an acceleration of **9.81 m/s/s**
- The pull of gravity will remain the same during a falling object, the resistant forces will change.
- When resistant forces and gravitational pull equal when an object is falling, the object has reached terminal velocity.
- Terminal velocity is affected by **mass** and **surface area** of the object falling.
- A parachute will increase the surface area of a falling object and slow it down.
- An object falling through a fluid, initially accelerated due to the force of gravity.
- If a fluid is more **viscous**, object will fall slower through them.
- Faster an object decelerates, the quicker terminology velocity is a reached.



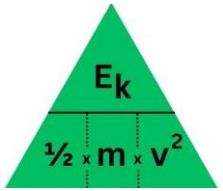


Lesson 9 – Kinetic energy

Key Terms

Kinetic energy: The amount of energy a moving object has in its kinetic store as a result of its mass and speed

- Kinetic energy increases when the objects are moving quicker
- Kinetic energy can be calculated by using: **Kinetic energy (E_k) = 0.5 x mass (m) x speed^2 (v)**
- Kinetic energy is measured in joules (J)
- Mass is measured in kilograms (kg)
- Speed is measured in meters per second (m/s)
- Objects moving at the same speed can have different stores of kinetic energy if they have different masses.



$$E_k = \tfrac{1}{2}mv^2$$

$$m = \frac{2 \times E_k}{v^2}$$

$$v = \sqrt{\frac{2 \times E_k}{m}}$$

800kg  30 m/s

Step 1 $Kinetic\ energy = 0.5 \times mass \times speed^2$

Step 2 $Kinetic\ energy = 0.5 \times 800 \times 30^2$

Step 3 $Kinetic\ energy = 360\,000\ J$