SL IB Biology

Your notes

Tool 1: Experimental Techniques

Contents

Safety, Ethical & Environmental Issues in Biology (HL)

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Safety, Ethical & Environmental Issues in Biology

- Throughout the course you will perform a variety of different practical investigations
- You need to be aware of **ethical issues** that may arise, as well as any **safety considerations**, and be able to suggest ways to **minimise** these issues during practical work

Safety

- The **hazards** and **risks** of any proposed experimental procedure should be considered
- A **hazard** relates to a feature of a procedure that may have **inherently harmful** properties, e.g.
  - A chemical substance might be an irritant to the skin
  - A rocky shore environment is likely to have slippery rocks
  - A Bunsen burner may cause burns
- The **risk** is the **level of danger** posed by the hazard
  - Factors that contribute to the dangers of a hazard include
    - The **likelihood** of the hazard causing harm
    - The **severity** of the harm, should it occur
- A risk assessment during any practical work should **identify** possible hazards, **assess** the level of risk, and make alterations to the procedure to **minimise** the risk
  - E.g. for a rocky shore quadrat practical we might:
    - Identify slippery rocks on the rocky shore as a hazard,
    - Assess that the risk of slipping and falling is quite likely, and could lead to injuries such as bruises or twisted ankles
    - Alter the practical procedure to state that footwear must have a good grip, students should avoid stepping onto rocks covered with seaweed, and that students should walk slowly and with care

Use of chemicals

- Some practical investigations may involve the use of chemical substances that have associated hazards and risks, e.g.
  - Stains used when viewing cells
  - Chemicals involved in measuring rates of reaction for enzymes
  - Solvents used in chromatography
- The safety of a chemical can be assessed by looking at the **hazard warning symbols** allocated to a substance
  - These are standardised symbols used on labels and safety data sheets to communicate the hazards associated with a chemical
  - There are nine hazard warning symbols, each representing a different type of hazard
  - These symbols are usually depicted inside a red diamond with a white background

Common hazard symbols table

Hazard Symbol	Meaning	
	Health hazard	includes warning on skin rashes, eye damage and ingestion
	Corrosive	can cause skin burns and permanent eye damage
	Flammable	can catch fire if heated or comes into contact with a flame
	Acute toxicity	can cause life-threatening effects, even in small quantities

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	Hazardous to the environment	substances that are a threat to aquatic life and the environment
	Oxidising	oxidising agents that can cause fire or explosions

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Exam Tip

When you are planning a practical procedure for internal assessment and you are suggesting a safety precaution you need to say more than just 'wear a lab coat and goggles', as this is standard practice in any laboratory.

You need to identify what the hazard is, and to justify the safety precaution taken, e.g. 'iodine is an irritant; the risk of harm can be reduced by wearing safety goggles and by immediately washing any skin with which it comes into contact.'

Ethical considerations

- Biology investigations often involve **living organisms**, and so ethical considerations are important
- The IB policy on animals in schools states that investigations should only involve animals where no alternative options are available, and that any investigations that must involve animals should **not be cruel**, and should include **measures that remove potential causes of animal distress**
- This may mean:
  - Choosing an experiment that does not involve animals
  - Ensuring that potential harm to animals is minimised by, e.g. keeping experiments short, handling animals as little as possible, releasing animals to their natural environment at the end of an

experiment

- Any experiment that involves humans, e.g. using a spirometer to measure breathing rate, should have the **fully informed consent** of the individual involved

Environmental considerations

- You need to consider the potential **environmental** impact of your investigation
- For laboratory experiments this may involve making sure that any **waste is disposed of correctly**, e.g.
  - Not disposing of toxic chemical waste down the laboratory sink
  - Ensuring that sharp equipment is disposed of using a sharps bin
  - Ensuring that biological waste, such as petri dishes with bacteria or dissected organs, are disposed of correctly
- For a field experiment this may involve **minimising environmental impact**, e.g.
  - Not working in very large groups
  - Avoiding sensitive environments
  - Taking equipment and litter away

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Measuring Variables in Biology

Measuring Variables in Biology

- When measuring a variable in an experiment, it is important to use the most appropriate instrument and measuring technique to achieve the most accurate value for that measurement to an appropriate level of precise

Measuring mass

- Mass is measured using a digital balance which normally gives readings to two decimal places
- Balances must be tared (set to zero) before use, this indicates that the container or balance is empty before taking the measurement
- The standard unit of mass is **kilograms (kg)** but in chemistry, **grams (g)** are most often used
  - 1 kilogram = 1000 grams

Measuring volume of liquids

- The most common units of measurement for volumes are **cm^3, dm^3 or ml (millilitres) or l (litres)**
- The volume of a liquid can be determined using several types of apparatus, depending on the level of accuracy needed
- For **approximate** volumes where high accuracy is not an important factor, measuring (or graduated) cylinders are used
  - These are graduated (have a scale so can be used to measure) and are available typically in a range of sizes from 10 cm^3 to 1 litre (1 dm^3)
- Volumetric pipettes are the most **accurate** way of measuring a **fixed** volume of liquid, usually 10 cm^3 or 25 cm^3
  - They have a scratch mark on the neck which is matched to the bottom of the **meniscus** to make the measurement
- Burettes are the most **accurate** way of measuring a **variable** volume of liquid between 0 cm^3 and 50 cm^3 (e.g. in a titration)
  - The tricky thing with burettes is to remember to read the scale from top to bottom as 0.00 cm^3 is at the top of the column
- Whichever apparatus you use, you may see markings in **ml (millilitre)** which is the same as a cm^3

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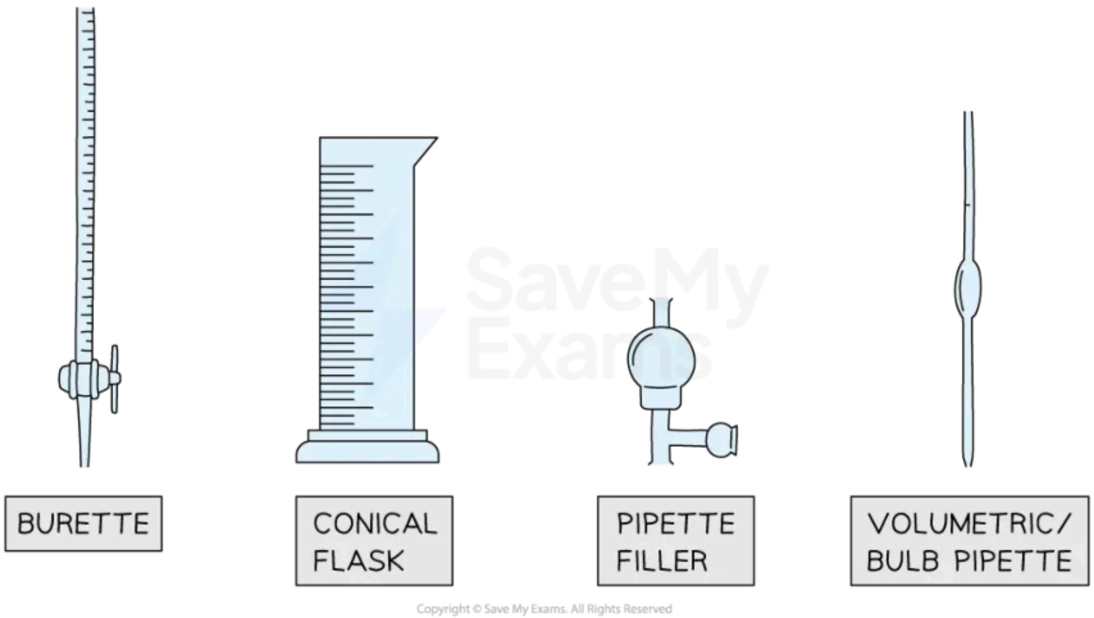
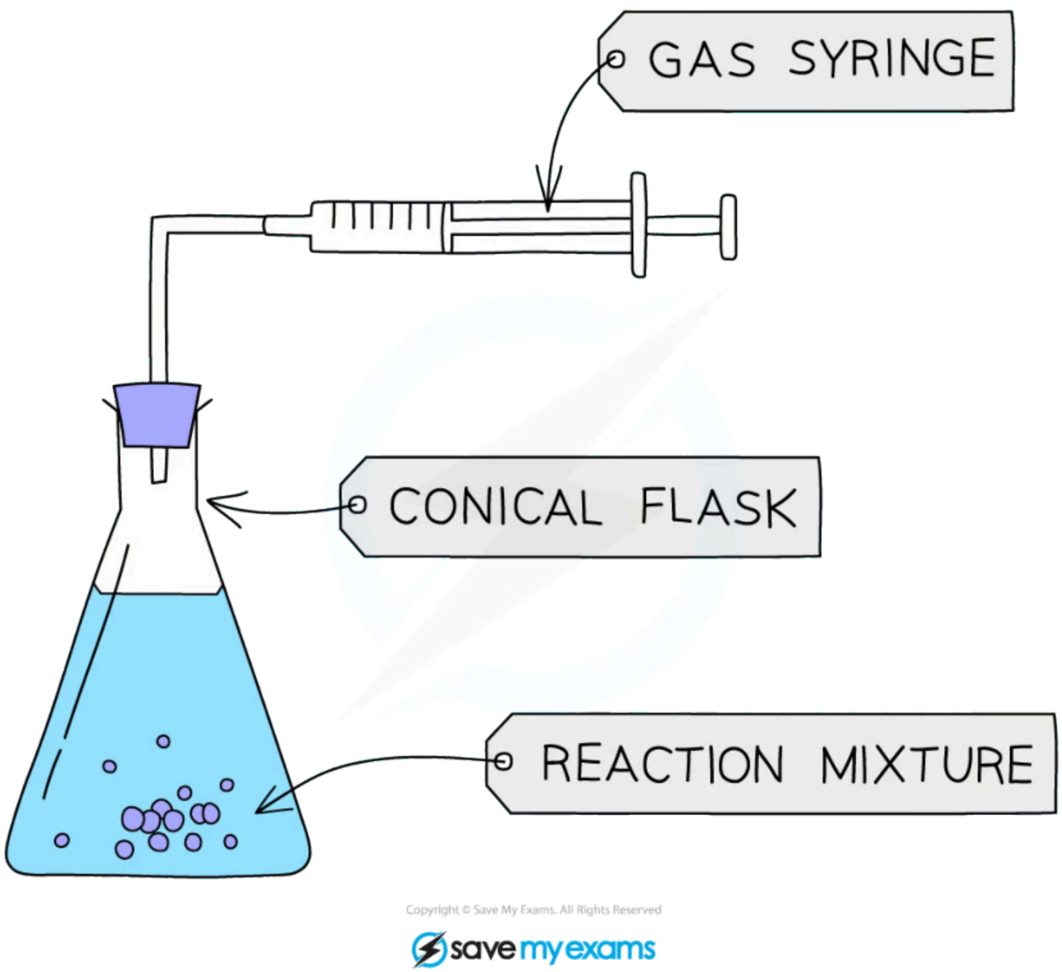


Burettes, measuring cylinders, pipette fillers and volumetric pipettes can be used to measure the volume of liquids

Measuring the volume of gases

- The volume of a gas sometimes needs to be measured and is done by collecting it in a graduated measuring apparatus
- A **gas syringe** is usually the apparatus used
- A graduated measuring cylinder or burette inverted in water may also be used, provided the gas is not water-soluble
- If the gas happens to be heavier than air and is coloured, the cylinder can be used upright



Gas syringes can be used to measure the volume of gas produced in a reaction

Measuring time

- Time can be measured using a **stopwatch or stop-clock** which are usually accurate to one or two decimal places
- The units of time normally used are **seconds** or **minutes** although other units may be used for extremely slow reactions (e.g. rusting)
  - 1 minute = 60 seconds
- An important factor when measuring time intervals is human reaction time
  - This can have a significant impact on measurements when the measurements involved are very short (less than a second)

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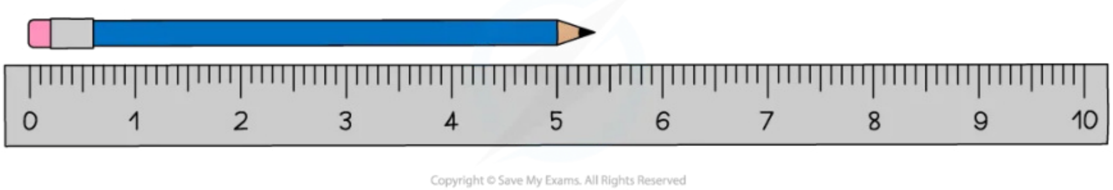
Measuring temperature

- Temperature is measured with a **thermometer or digital probe**
- Laboratory thermometers usually have a precision of a half or one degree
- Digital temperature probes are available which are more precise than traditional thermometers and can often read to 0.1 °C
- Traditional thermometers rely upon the uniform expansion and contraction of a liquid substance with temperature; digital temperature probes can be just as, if not, more accurate than traditional thermometers
- The units of temperature are **degrees Celsius (°C)**

Measuring length

- Rulers can be used to measure small distances of a few **centimetres (cm)**.
  - They are able to measure to the nearest **millimetre (mm)**
- The standard unit of length is **metres (m)**
- Larger distances can be measured using a tape measure
- Many distances in chemistry are on a much smaller scale, for example, a typical atomic radius is around 1×10^{-10} m, so cannot be measured in this way
- When measuring length it is important to take note of the units that are being measured
  - 1 cm is 10 mm
  - 100 cm is 1 m



A ruler can measure distances to the nearest mm

Making counts

- This often involves **taking counts of cells**, by counting the cells in a known volume of a culture, the **concentration can be assessed**
  - **Direct counting methods** of cells include microscopic counts using a hemocytometer or a counting chamber
    - A hemocytometer works by creating a volumetric grid divided into differently sized cubes for accurately counting the number of particles in a cube and calculating the concentration of the entire sample
  - Counting the number of cells in a culture can also be carried by a method known as a streak plate, this involves **plating a known volume of the cell culture onto a petri dish** with a growth medium

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    - Direct counting methods do not require highly specialised equipment sp are easy to perform but they can be quite time consuming
- Much of **ecology involves counting organisms**
    - Counting here can be difficult as many of organisms involved ma move, or are inconspicuous
    - Accurate counts are rare and so **population sampling** is carried out
    - Most counts are associated with errors due to the sizes of the populations or mistakes being made in detecting individuals or direct errors in counting such as large groups miscounted or individuals misidentified

Drawing annotated diagrams from observation

- To record the observations seen under the microscope (or from photomicrographs taken) a labelled biological drawing is often made
- **Biological drawings** are line pictures that show specific features that have been observed when the specimen was viewed
- There are a number of rules/conventions that are followed when making a biological drawing
- You can read in more detail the about drawing annotated diagrams from observations here

Making appropriate qualitative observations

- Classifying organisms is an example of making qualitative observations
- In qualitative classification, data can be classified based on attributes such as sex, colour of fur, number of limbs
- The attribute being observed cannot be measured so it is classed as qualitative data

Applying Techniques in Biology

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Applying Techniques in Biology

- There are a large number of **scientific techniques** that can be used to make **observations** of a range of objects from biological molecules to living organisms
- Use the links below to find details relating to these required techniques which are covered throughout the Biology course:
  - Paper or thin layer chromatography
  - Colorimetry and serial dilutions
  - Physical and digital molecular modelling
  - A light microscope and eye piece graticule
  - Preparation of temporary mounts
  - Identifying and classifying organisms
  - Using a variety of sampling techniques/using random and systematic sampling
  - Karyotyping and karyograms
  - Cladogram analysis
- For each of these you need to be able to **describe their purpose** and **explain** how to carry out the techniques