Criteria B MAIN STUFF

Criteria B

A full Criterion B contains the following:

- Research Question
- Hypothesis
- Variables
- Materials
- Method

Note: In your E Assessment, you could be asked to complete some or all of these steps in a given question. Read the question carefully to determine what is required of you. Don't write a full method if the question only says "describe how you will collect the data" and don't write a full variables section if the question says "state the variables", etc. Just do as asked!

Research Question:

The research question should describe the problem being tested and should be written as a question.
d
Pattern: how does the independent variable (range of IV and units) affect the dependant variable (units and how it is measured)while keeping the control variables the same.

Things that must be included: IV, DV, CV (at least 3), units, how everything is measured, range of IV (at least 5).

The independent variable is the that you change.
The dependent variable is the one that you measure how it changes in response to the independent variable.
The control variables are those that are kept.

EXAMPLES**:**
L 3-4 RQ: How does the temperature affect the solubility of a substance?
L 7-8 RQ: How does changing the temperature of a solvent, measured in ºC using a thermometer, for a range of 20, 25, 30, 35 and 40 ºC, affect the solubility of a solvent, measured as the mass of solute dissolved per mL of solvent (g/mL) that can be dissolved in a beaker of water while keeping the type of solvent, volume of solvent and rate of stirring the same throughout?

Hypothesis:

This is an **Educated Guess/Prediction** of the possible outcome, reason or relationship being investigated.

If the (*independent variable*) increases/ decreaes then the (*dependent variable*) will increase/decrease, because (*give a scientific explanation*).

give some quantitative reasoning: directly proportional; as one variables doubles - the other will double; inversely proportional - as one variable doubles, the other variable will halve

EXAMPLES**:**
L 3-4 Hypothesis: If the temperature of the solvent increases **then** the solubility will also increase **because** the water contains more energy to break down and dissolve more of the salt.
L 7-8 Hypothesis: If the temperature of the water increases **then** the solubility, measured as mass of salt dissolved per mL, will also increase **because** water molecules at a higher temperature contain more kinetic energy. This increases the energy of the collisions between water molecules and the salt particles and also causes an increased number of collisions which allows more of the salt to be dissolved. The energy provided is also used to break down the bonds between the Sodium and Chloride ions within the salt molecule allowing them to form bonds with the water molecules.

Variables

Independent Variable – The factor that you will decide how it changes.

Dependent Variable – This is what you measure or record how it changes in response to the independent variable.

Controlled Variable – These are the variables that you will keep the same throughout the experiment.

You must explain how you are going to **manipulate** the independent variable, **measure** the dependent variable and **control** all of the control variables.

You must explain how you are going to **manipulate** the independent variable. Include the following details.

- Equipment used
- The range of the IV - **you should have 5 increments** and they should increase in steady amounts where possible.
- The IV should have **as broad a range as possible** so that you can be confident in the reliability of any trend shown by the data, ie. that the relationship is true for a broad range of values rather than just in that one narrow range you have used.
- The unit of measurement
- Details about how you will change the IV during the investigation.
- You could also state whether the IV is a continuous or discontinuous variable. This will help you decide what type of graph to make later – ie. continous variables should be plotted on a line graph using a scatter plot and line of best fit.

You must explain how you are going to **measure** the dependent variable. Include the following details:

- Information about any equipment used.
- The unit of measurement
- Whether the variable is continuous or discontinuous
- Give an outline of how the variable is measured throughout the experiment using the equipment identified.
- Mention that 3 trials of data for the DV will be collected and that an average will be calculated.

You must explain how you are going to **control** the control variables :

- control variable (atleast three)
- why it is being controlled
- how it is being controlled

Materials

Think about your variables and the equipment you will use to change the IV, measure the DV and control your CVs as any other materials you will need to carry out your method.

- **Equipment**
- **quantity**
- **what will it be used for**

Method

Read the question carefully. Does it say to "Describe how sufficient data will be collected" or does it say to "Design an investigation". These are all different questions and require different levels of detail in the answers.

If the question asks you to "Design an investigation" it will usually ask you to do some other element of a Criterion B like writing a RQ or Hypothesis and then write a method for conducting the investigation, including how to collect sufficient data.

- detailed step-by-step
- logical order
- information about safety
- **detailed** enough so that someone who has never done the experiment could repeat it using your instructions.
- **include all steps required to collect sufficient data** and it should **ensure reliability of any data collected**.

If it asks you to "Describe how to collect sufficient data" this is a shorter response.

- Your method should include steps on how the IV is changed, the range of the IV, how the DV is measured and how control variables are managed during the investigation.
- Mention **5 values for IV** with **steady increments** and giving as **broad a range** as possible.
- **3 trials for the DV** should be measured and an **average is calculated** for the DV.

Safety

- State a specific hazard, eg. acid is corrosive, oil is flammable, hot water may cause burns, broken glassware may cause lacerations, etc.
- Outline the harmful effect, eg. Corrosive substances can burn the skin or cause blindness if in contact with the eyes, lacerations may lead to bleeding or infection, etc.
- Describe how this hazard will be managed. Mention specific equipment such as goggles or safety gloves, or specific steps taken to minimize risk.

Precision/Accuracy

- how precise we are. Eg use more precise equipment, or smaller different between values

Reliability

- how much the results can be trusted, eg. repeating things, improving tools, average

Validity

- Does the method prove what it should be proving? Does it have the correct variables? Do the tools used provide valid data?

Criteria C

Collecting Data:

- The IV must be changed at least 5 times
- The IV should increase by the same amount each time
- 3 trials of data so that an average value of the DV can be calculated.

Results table

Independent Variable (unit)	Dependant Variable (unit)			Mean (dependant variable unit)
	Trial 1	Trial 2	Trial 3	

Notes: Consider and eliminate anomalous results while calculating mean values

Any calculations / data processing that was carried out on the recorded data should be clearly shown.

One example calculation should be included for any formula used or data processing used.

Graph

Results should also be displayed in a suitable graph. This could be a bar graph or line graph (most probably).

Continuous data - a line graph
Discontinuous data (involving groups or categories) - bar graph or pie chart

Your graph must include: title, axis labels, line of best fit and units for each axis label.

For a line graph, it could be a straight line or a curve depending on the data. You need to look at the data (or associated formula) to decide the most suitable line of best fit.

Describing Results

Comment on the type of relationship shown between the independent and dependent variables.

- If the y variable increases as the x variable increases the relationship is positive.
- If the y variable decreases as the x variable increases the relationship is negative.
- If the graph shows a straight line it is a linear relationship.
- If the graph shows a straight line which also passes through the origin it is a directly proportional relationship.
- If it is not a straight line or it does not pass through the origin then it is not directly proportional.

Directly Proportional relationships (k=mx) : A directly proportional relationship is a type of positive relationship where both variables increase or decrease at the same rate, if you double one variable, you double the other, if you halve one variable you halve the other.

Invesely Proportional relationships (k=m/x): An inversely proportional relationship is a type of negative relationship, where as one variables increase the other variable decreases at the same rate, ie. if you double one variable, you halve the other and vice versa.

Gradient : (Y2-Y1)/(X2-X1)

Conclusion

- State what your results show. (The results and graph show that as the length of wire increased the current decreased.)
- Describe the shape of the graph (if you have one) (The graph shows a decreasing trend line. As the length of wire increased the current decreased. The line of best fit is linear)
- Use numbers to describe the trend/pattern. Give examples from the graph. As we can see at 10cm the current was 12.35A however with a length of 50cm the current was 4.25A.
- Mention Anomalies (We can see that the data point for 40cm does not fit on the line of best fit. This is an anomaly. I believe this unusual result happened because the measurement of the length of wire was inaccurate. There was a parallax error when reading the length from the ruler.)
- Compare your results to your hypothesis. My data supports my hypothesis as we can see there is a decrease in current when the length of wire increases. My data does not support my hypothesis as I had predicted that as the length of wire increased the current would also increase.
- Explain your results with scientific knowledge. As the length of wire increased the current decreased. This is because as the length of increases the resistance of the wire increases this is an increase in the resistance of the flow of electrons in the circuit and so the current was decreased.

Evaluation

There are 4 parts to an Evaluation:

1. Discussing strengths
2. Discussing limitations
3. Suggesting and explaining improvements
4. Suggesting extensions

First, look at the data on the graphs as well as the steps in the method to find strengths and limitations.
Strengths are anything in the method that improve the reliability of the investigation. Limitations reduce reliability. State the strength or limitation and explain the effect it had on the investigation if asked to explain. Here are some common examples of strengths in a method.

Strength	Explanation
Broad range of values for IV	Increases reliability of conclusions. Gives evidence for the relationship over a wider range.

Steady / regular increments of IV	Increaes reliability of conclusions. Gives better evidence of the observed trend. Pevents gaps in the data where confidence in the trend may not be justified.
Repeated trials for DV and average value calcualted	Reduces the effect of random error on the investigation Improves reliability of data Makes it easier to spot outliers.
CVs were kept constant (state specific examples)	Ensures that observed trend was caused by a change in the IV and not some other variable. Improves reliability of conclusions by inreasing confidence in the trend.

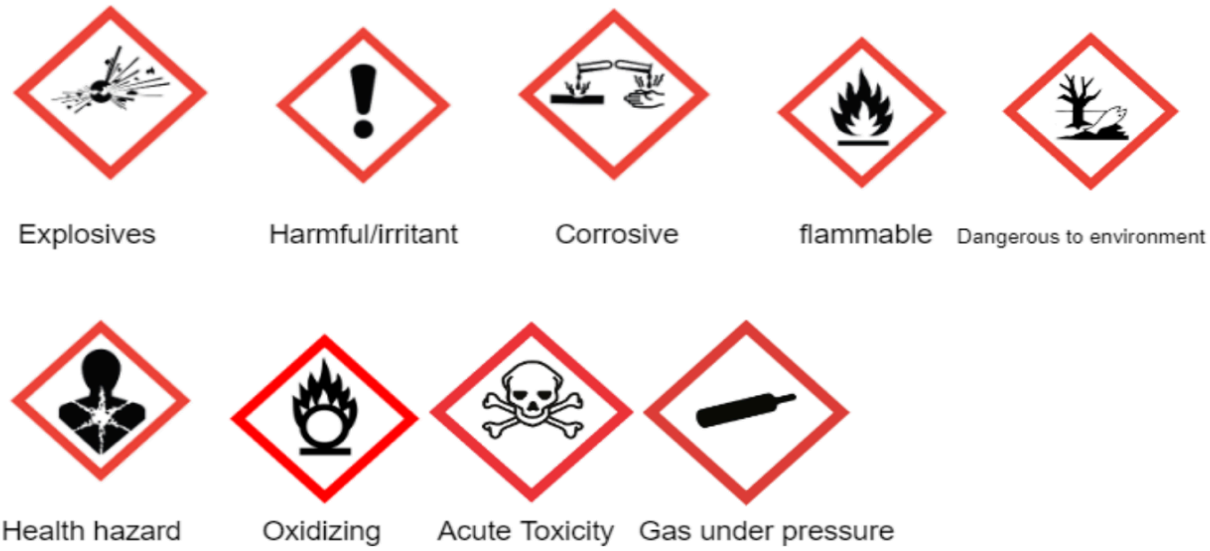
Identify strenghts and limitations from the data

- If all the data points lie directly on the line of best fit, this indicates high precision, decreased effect of random errors and increases confidence in the trend. If the points are scattered either side of the trend line, this indicates low precision, **random errors** have affected the investigation and there is decreased confidence in the trend.
- If you expect a relationship to be directly proportional and the graph does produce a straight line, but that line does not go through the origin, this would suggest a "zero error" in one of your measured variables, ie. a **systematic error** caused by the fact that the measuring device was not zeroed before use. This reduces the reliability of your investigation by negatively affecting the accuracy of your measurements. All values will be off by the same amount.
- Look for outliers or anomalies in the data. These are points on the graph or data measurements in the table that fall far outside the trend compared with other data points. This would indicate that something went wrong with this measurement, most probably a **random error** affected the measurement, or the device was not zeroed or calibrated correctly on this trial (**systematic error**). You would need to think of possible causes for this and look at the method for possible errors in how the measurement was taken.

Identify strengths and limitations from the equipment

- Measurement devices which allow for small changes in variables **improve the precision of that measurement** (strength), ie. large numbers of decimal places for digital devices or small increments on the scale of measurement for analogue devices. Eg. a ruler with increments of 1 mm is more precise than a ruler with increments to the nearest 0.5 cm. Another example would be using a measuring cylinder instead of a beaker to measure volume
- If a measurement is taken on an unstable surface or the instrument is prone to random movement or changes, then this will increase the effect of random errors and reduce precision. Steps that are taken to prevent such effects can be seen as strengths, eg. clamping a ruler in place so that it cannot move, allowing water to settle in a measuring cylinder before measuring the volume etc.
- Measurements not taken at eye level cause a specific type of error called **"parallax error".** This means the value taken will not be the true value (**ie. it is not accurate**). If all measurements were taken from the same position, the parallax error will be the same for all measurements (**ie. systematic error**), but if the position was different for each measurement (more likely) this would cause a different error for each measurement, thereby also affecting the precision (**ie. random error**).

Safety Hazard Signs (Chemistry)



Common Lab Apparatus (Chemistry)

Apparatus	Notes
Round Bottomed Flask 	They are used to uniformly heat or boil the contents of the flask. They have a curved bottom, which means that no substances can get stuck or accumulate in one area, hence the word uniform. Can be used to measure only 250 cm3 of liquid. Denoted by a ring along the neck.
Flat Bottomed Flask 	Same purpose as the round bottomed flask. The key difference is that they can stand on their own and not have to be clamped, unlike round bottomed flask.
Conical Flask 	Conical flasks are commonly used in reactions in which the flask may need to be closed with a **rubber bung** in order to prevent any product from escaping or to measure the volume of gas produced. They are also used when the flask has to be swirled, as the edges prevent spilling. They consist of measurements with regular intervals. Used in titrations.
Measuring Cylinder/ Graduated Cylinder 	They are used for measuring the volume of liquids **accurately and quickly.** More accurate than flasks and beakers. Normally used to dispense a known amount of liquid. They are not as precise as pipettes/ volumetric flasks in terms of measuring the volume of a liquid.
Volumetric Flask 	They are used for measuring a known quantity of liquid. Similar to the flat bottomed and round bottom flask, they contain a ring which denotes the volume of liquid present.
Beaker 	A beaker is a container used for mixing, stirring or heating up liquids. They have spouts for pouring.
Pipette	A pipette is used to transfer a small amount of liquid.

	
Burette 	Burettes are also used for measuring the volume of a liquid. They are commonly used in titrations, and the main distinction is the fact that you can control the volume of the liquid with the tap.
Evaporating Basin 	An evaporating dish is used for the evaporation of solutions.
Distillation Flask 	A distillation flask is used in simple distillation.
Condenser 	Used in distillation. Cold water flows through the outer part of the condenser, cooling the inner tube. This allows for the gas that is collected in this tube to condense and form a liquid.

Water bath and gas syringe

1. **Clamp the gas syringe vertically** to a stand before starting, with the plunger set at **0 cm^3**.
2. **Ensure all connections are airtight** between the gas syringe, tubing, and the bung in the reaction flask.
3. **Do not insert the syringe plunger too tightly** — it should slide freely but not fall out or leak.
4. **Add the reactants to the flask** (e.g. yeast + glucose or acid + carbonate) quickly and **seal the bung immediately**.
5. **Start the stopwatch** the moment you seal the flask.
6. **Watch the plunger move outward** as gas collects — this shows the volume of CO_2 being produced.
7. **Record the volume at fixed time intervals**, such as every 30 seconds or 1 minute.
8. **Do not allow gas to escape** — once the reaction starts, never remove the bung or loosen the tubing until the experiment is over.
9. **Use the same volume of reactants and same setup** for all trials to ensure fair comparison.
10. **After the reaction, clean the syringe and tubing thoroughly**, especially if sticky or acidic substances were used.
11. **Check calibration markings** on the gas syringe to ensure accuracy (e.g. if it shows cm^3 or mL).
12. **Avoid exceeding the maximum volume** of the syringe. If your reaction may produce too much gas, use a larger syringe or collect gas in portions.

How to Use a Thermostatic Water Bath

1. **Place the water bath on a flat, stable surface near a power outlet.**
2. **Fill the stainless steel tank with distilled water to the marked level (usually about halfway to three-quarters full).**
3. **Plug in the water bath and switch it on using the main power button.**
4. **Set the desired temperature using the digital controls or dial (e.g. 37°C for enzyme or yeast experiments).**
5. **Wait for the water to reach the target temperature — most units display the current temperature and may beep or indicate when ready.**
6. **Use a thermometer to double-check the temperature, especially if precise accuracy is needed.**

7. **Insert your test tube or flask into one of the circular openings using a clamp or test tube rack to keep it steady.**

8. **Keep the metal lid or ring in place to minimize evaporation and maintain constant temperature.**

9. **Start timing your experiment once the sample is submerged and at the correct temperature.**

10. **Do not let the water level drop too low — top up with distilled water if needed.**

11. **Turn off and unplug the unit when finished. Allow it to cool down before emptying or moving.**

12. **Dry the tank and wipe down the exterior after use to prevent corrosion or residue buildup.**

ERRORS

ERRORS

📌 Summary Table

Error Type	Definition	Example	Prevention Method
Human Error	Mistake made by the person	Late stopwatch start	Practice, focus, automation
Systematic Error	Consistent skew in one direction	Uncalibrated balance	Calibrate, replace instruments
Random Error	Unpredictable fluctuations	Stopwatch reaction time	Multiple trials, average values
Zero Error	Instrument not starting at zero	Scale shows 0.2 g when empty	Tare/zero instruments before use
Calibration Error	Incorrect reference points	Thermometer reads 5°C in ice	Use known standards to calibrate
Instrumental Error	Limit of precision	Ruler not accurate beyond mm	Use more precise instruments
Parallax Error	Misread due to viewing angle	Reading ammeter from the side	Eye-level reading, use digital displays

Safety precautions

Safety precautions

Having go-to safety precautions ready for any experiment is super useful, especially for writing Criterion B and C in MYP Science

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🧬 Common Safety Precautions – Biology

1. **Wear gloves and lab coat to avoid contact with biological materials.**
2. **Use goggles when working with chemicals, stains, or sharp instruments.**
3. **Disinfect work surfaces before and after experiments to reduce contamination.**
4. **Wash hands thoroughly before and after the experiment.**
5. **Dispose of biological waste properly, using biohazard bins where needed.**
6. **Avoid eating or drinking in the lab.**
7. **Label all petri dishes and samples clearly to avoid mix-ups.**
8. **Handle living organisms ethically, and return them safely if required.**
9. **Use pipettes and droppers carefully to avoid cross-contamination.**
10. **Follow aseptic technique when culturing microorganisms.**

⚙️ Common Safety Precautions – Physics

1. **Wear safety goggles when working with projectiles, electricity, or light sources.**
2. **Keep electrical equipment dry and away from water or wet hands.**
3. **Check that wires and plugs are not frayed or damaged.**
4. **Turn off equipment before making adjustments.**
5. **Use low voltages in circuit experiments whenever possible.**
6. **Clamp heavy apparatus securely to prevent it from falling.**
7. **Avoid looking directly into laser beams or bright light sources.**
8. **Keep bags and stools tucked away to avoid tripping in apparatus-heavy setups.**
9. **Use heat-resistant gloves when handling hot equipment (like lamps or heaters).**
10. **Ensure weights or moving objects are stable and don't pose a falling hazard.**

⚗️ Common Safety Precautions – Chemistry

1. **Wear safety goggles and a lab coat at all times.**
2. **Never touch or smell chemicals directly. Waft vapors if needed.**
3. **Label all reagents clearly and check before use.**
4. **Use a fume hood when handling volatile, flammable, or toxic substances.**
5. **Neutralize acid/base spills immediately using appropriate neutralizers.**
6. **Dispose of chemicals properly, not down the sink unless instructed.**
7. **Add acid to water, not the other way around.**
8. **Keep flammable substances away from open flames or heat.**
9. **Wear gloves when handling corrosive or staining substances.**
10. **Tie back long hair and secure loose clothing.**

EQUIPMENTS

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Evaporating Basin 	An evaporating dish is used for the evaporation of solutions.
Distillation Flask	A distillation flask is used in simple distillation.

	
Condenser 	Used in distillation. Cold water flows through the outer part of the condenser, cooling the inner tube. This allows for the gas that is collected in this tube to condense and form a liquid.

⚙️ Physics Lab Equipment Master List by Quantity

🟡 1. Mass (kg, g, mg)

Purpose	Equipment	When to Use
Measure	Electronic balance	Common for small/medium values (mg–kg)
Measure	Triple beam balance	Manual alternative for <500 g
Control	Mass sets / Standard weights	For consistent added mass
Manipulate	Add/remove weights	Change independent variable in motion or force experiments

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🟠 2. Length / Distance (m, cm, mm, μm)

Purpose	Equipment	Use For
Measure	Ruler / Meter stick	cm to m range
Measure	Vernier caliper	mm precision (±0.1 mm)
Measure	Micrometer screw gauge	Sub-mm values (±0.01 mm)
Control	Use fixed intervals on a ramp or rail	Repeated distances in setups
Manipulate	Change ramp height or gap	Affects speed, force, etc.

🟢 3. Time (s, ms)

Purpose	Equipment	Use For
Measure	Stopwatch (manual)	General timing (±0.2 s)

Measure	Light gates / Photogates	High accuracy motion/timing
Control	Use timers / software control	Repeated time intervals
Manipulate	Vary time intervals manually	To test reaction time, duration

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🔵 4. Temperature (°C, K)

Purpose	Equipment	Use For
Measure	Thermometer (alcohol/digital)	Liquids or environments
Measure	Data logger with thermoprobe	Continuous temperature recording
Manipulate	Bunsen burner, hot plate	Heating to change temperature
Control	Water bath, thermostat	Maintaining constant temperature

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🔴 5. Force (N)

Purpose	Equipment	Use For
Measure	Newton spring balance	Measuring applied force
Measure	Force sensor / data logger	Precise force measurement
Manipulate	Apply different weights	To change force in Newton's Law exp.
Control	Use same weight each trial	Keep force constant

🟣 6. Speed / Velocity / Acceleration (m/s, m/s²)

Purpose	Equipment	Use For
Measure	Light gates / Photogates	Timing object at two points
Measure	Motion sensor / ticker tape	Instantaneous/average speed
Control	Same initial height or push	Ensures constant starting condition
Manipulate	Vary angle, force, or mass	To change velocity/acceleration

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🟤 7. Voltage (V) and Current (A)

Purpose	Equipment	Use For
Measure	Voltmeter / Ammeter	Measuring electrical quantities
Manipulate	Variable power supply	To change voltage (independent)
Control	Resistor or fixed battery	To keep current or voltage constant

⚫ 8. Resistance (Ω)

Purpose	Equipment	Use For
Measure	Ohmmeter / Multimeter	Direct resistance measurement
Manipulate	Use variable resistor (rheostat)	Change resistance value
Control	Fixed resistor	To maintain constant resistance

⚪ 9. Energy / Work / Power (J, W)

Purpose	Equipment	Use For
Measure	Calculated from other data (e.g. using W=F×dW = F \times d)	Indirectly measured
Manipulate	Vary applied force or distance	To change energy/work done
Control	Use fixed height, force, or time	Keep power constant

🟤 10. Pressure (Pa)

Purpose	Equipment	Use For
Measure	Barometer / Manometer	Air or fluid pressure
Manipulate	Syringe / compressed gas	Change pressure in a system
Control	Sealed container	Maintain constant pressure

🟡 11. Light / Optics

Purpose	Equipment	Use For
Measure	Light sensor / Lux meter	Measure intensity
Manipulate	Change angle, lens, or filter	Alter light path or intensity
Control	Fixed lamp setup, constant distance	Ensure identical lighting conditions

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Here is a **comprehensive Chemistry Lab Equipment List** organized by:

- **Quantity/Property being measured, manipulated, or controlled**
- **Use in experiments** (measuring, changing, or holding variables)
- **Specific tools for different value ranges** (small vs large)

🧪 Chemistry Lab Equipment List

(Organized by Quantity and Use: Measure | Manipulate | Control)

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1. Mass (mg, g, kg)

Use	Equipment	Notes
Measure	Electronic balance	High precision (±0.01 g), good for solids
Measure	Analytical balance	Higher accuracy for microquantities (±0.0001 g)
Control	Fixed mass weights	Used for repeated trials

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2. Volume (µL, mL, L)

Use	Equipment	Notes
Measure	Graduated cylinder	Moderate precision, e.g., 1–500 mL
Measure	Volumetric flask	High-accuracy fixed volume (e.g., 100 mL)
Measure	Burette (50 mL)	High precision dispensing, ideal for titration
Measure	Pipette (1–25 mL) + filler	Accurate small-volume measurement
Measure	Micropipette (0.1 µL–1 mL)	Very small volumes, ideal for biochemical work
Manipulate	Adjust volume added by burette	Used in titration
Control	Fixed volume in flask/pipette	Ensures consistent input

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3. Temperature (°C, K)

Use	Equipment	Notes

Measure	Alcohol thermometer	Standard lab thermometer
Measure	Digital thermometer	Quick readings, ±0.1 °C accuracy
Control	Water bath	Maintains stable temperature
Control	Ice bath / boiling bath	Sets fixed temperature points
Manipulate	Bunsen burner / hot plate	Heats reagents to desired temp

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4. Concentration / pH

Use	Equipment	Notes
Measure	pH probe / pH meter	High precision, suitable for titrations
Measure	pH paper / Universal indicator	Quick pH estimate
Manipulate	Add acid/base solutions	Adjusts solution concentration
Control	Use buffer solution	Maintains pH during reactions

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5. Color / Light Absorbance

Use	Equipment	Notes
Measure	Colorimeter	Measures absorbance or transmittance
Control	Cuvette (1 cm path)	Ensures consistent sample thickness
Manipulate	Add colored compounds	Changes absorption characteristics

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6. Electrical Conductivity

Use	Equipment	Notes
Measure	Conductivity meter	Used in ionic solution analysis
Control	Use distilled water / same molarity	Ensures consistent ion concentration

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7. Gas Volume / Pressure

Use	Equipment	Notes
Measure	Gas syringe (100 mL, 250 mL)	Measures volume of gas evolved
Measure	Manometer / Pressure sensor	Measures gas pressure
Control	Sealed flask + valve setup	Controls escape of gas
Manipulate	Add more reactant or heat	Produces more gas

8. Reaction Rate / Time

Use	Equipment	Notes
Measure	Stopwatch / timer	Measures time to endpoint
Measure	Visual indicator (e.g., color change)	Monitors completion
Control	Same temperature/concentration	Ensures consistent conditions

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9. Heating and Separation

Use	Equipment	Notes
Heating	Bunsen burner	Direct flame heating
Heating	Hot plate with stirrer	Safer, gradual heating
Separation	Filter paper + funnel	Removes solids from liquids
Separation	Distillation setup	Separates liquids by boiling point
Condensing	Liebig condenser	Used in distillation
Evaporation	Evaporating dish	Removes solvent from solution

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10. Observation and Safety

Use	Equipment	Notes
Observation	Test tube + rack	Holds small liquid samples
Observation	Spotting tile	Small-scale reactions
Support	Clamp and stand	Supports burette, condenser, etc.
Safety	Goggles, gloves, lab coat	Standard lab safety
Holding	Beaker (100–500 mL)	Used for mixing, not precise measurement
Stirring	Stirring rod / magnetic stirrer	Ensures even mixing

📏 Tool Choice Based on Value Size

Quantity	Small Values	Large Values
Mass	**Digital balance (mg–g)**	**Spring balance, manual scale (g–kg)**
Time	**Data logger, light gate (ms)**	**Stopwatch (s–min)**

Distance	**Micrometer / Vernier caliper (μm–mm)**	**Meter stick, trundle wheel (m)**
Voltage	**Millivoltmeter**	**Digital voltmeter**
Force	**Force sensor, sensitive spring**	**Heavy-duty spring balance**
Pressure	**Manometer**	**Pressure gauge / barometer**

ASSUMPTIONS

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⚗️ Chemistry – Common Assumptions

Assumption	Why it's assumed
The reaction goes to completion	Many reactions are reversible or slow
All reactants are pure	Impurities can alter reaction yield or rate
There is no loss of product during transfer or filtration	Spills or sticking to glassware can reduce measured mass
The temperature remains constant during the reaction	Exothermic or endothermic reactions may change temp and rate
All of the limiting reactant reacts	Some of it may remain unreacted if mixing is poor
The gas collected is dry and at room temperature and pressure (RTP)	Gases can be moist or at different conditions affecting volume
The equipment is calibrated correctly	Faulty balances, burettes, or thermometers affect accuracy
Indicators change color sharply at the exact equivalence point (in titrations)	Some indicators have gradual transitions

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⚙️ Physics – Common Assumptions

Assumption	Why it's assumed
Air resistance is negligible	For simplified motion calculations (e.g., free fall)
Surfaces are frictionless	Makes force and energy calculations simpler
Objects are point masses or rigid bodies	Ignoring deformation or shape variation
Measurements have perfect timing	Stopwatch reaction time or sensor delays can affect accuracy
Electrical components behave ideally (e.g., resistors have no heating)	Real components heat up and change resistance
Lenses are thin and free of aberrations	Real lenses have imperfections
The system is closed/no energy loss (e.g., pendulums)	In reality, energy is lost to air resistance or friction
Springs obey Hooke's Law perfectly	Real springs have elastic limits and may deform

🧬 Biology – Common Assumptions

Assumption	Why it's assumed
Living organisms behave uniformly	Biological variation is natural, but hard to control
All environmental conditions are identical for each trial	Light, temperature, humidity may vary subtly
Enzymes/substrates are not denatured during the experiment	Heat, pH, or time may affect enzyme activity
Diffusion/osmosis occurs only due to concentration gradient	Other factors like membrane permeability can affect rate
The sample size is representative of the whole population	Small samples may not reflect overall trends
No contamination occurred	Microbial contamination can affect growth or measurement
The instrument (e.g., colorimeter) is calibrated properly	Any drift or error in sensors affects data

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🧠 How to Use These in Evaluations (Criterion C):

- **"It was assumed that ___; however, this may not be valid because ___."**
- **"One key assumption was ___, which could affect the accuracy/reliability of the results."**
- **"To improve, this assumption could be tested by ___ or minimized by ___."**

COMMON EXPERIMENTS

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1. Absorption Spectra Experiment

Equipment Needed (with Specific Values)

- **Light source: White light (e.g., halogen lamp or tungsten bulb)**
- **Slit and collimator: 1 mm slit to produce a narrow beam**
- **Sample cuvette: Glass or quartz cuvette (1 cm path length)**
- **Colored solution: Copper(II) sulfate, 0.1 M**
- **Spectrometer or diffraction grating and screen: 1000 lines/mm diffraction grating**
- **Dark box or black enclosure to reduce ambient light**
- **Ruler or angle scale for measuring angular shift**
- **Data logger or manual observation sheet**

8-Step Procedure

1. **Set up the white light source behind a 1 mm slit to create a narrow beam.**
2. **Pass the beam through a collimating lens to make it parallel.**
3. **Place the cuvette containing 0.1 M copper(II) sulfate in the beam's path.**
4. **Position a diffraction grating (1000 lines/mm) in front of a screen or spectrometer to separate the light.**
5. **Observe the spectrum produced by the light passing through the solution.**
6. **Identify dark absorption lines where specific wavelengths are absorbed by the solution.**
7. **Measure the angles or wavelengths at which these lines appear.**
8. **Repeat the procedure with different concentrations of the solution (e.g., 0.05 M and 0.2 M) and record changes in absorption intensity.**

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2. Emission Spectra Experiment

Equipment Needed (with Specific Values)

- **Gas discharge tube: Hydrogen, helium, or neon**
- **Power supply: High-voltage unit (5,000–10,000 V rated for discharge tubes)**
- **Diffraction grating: 1000 lines/mm**

- **Spectroscope or white projection screen**
- **Dark room or black hooded area to block light**
- **Meter stick for measuring distances**
- **Protractor or angular scale for angle measurements**
- **Spectral reference chart (optional, for comparison)**

8-Step Procedure

1. **Connect the discharge tube to the high-voltage power supply.**
2. **Turn off room lights or place the tube in a darkened area.**
3. **Switch on the power supply until the gas begins to glow visibly.**
4. **Set up the diffraction grating approximately 30 cm from the discharge tube.**
5. **View the emitted light through a spectroscope or project it onto a screen.**
6. **Observe the bright emission lines unique to the gas in the tube.**
7. **Measure the angle or wavelength of each visible emission line using a meter stick and protractor.**
8. **Repeat the experiment using a different gas discharge tube and compare the resulting spectra.**

BIO NAMING THING

complete master guide to all the **major biological classification acronyms — FARMB**, **PECAAMEN**, **King Philip**, and the **Plant Groups mnemonic** — with **full explanations for each letter and concept**.

🌍 MASTER LIST OF BIOLOGICAL CLASSIFICATION ACRONYMS

🧬 1. Taxonomic Hierarchy (Classification of All Life)

🔤 Mnemonic:

✅ **"Dear King Philip Came Over For Good Soup"**

This helps you remember the order of taxonomic ranks from broadest to most specific.

Level	Meaning	Describes
Domain	Eukarya, Bacteria, Archaea	Cell type, complexity (nucleus or not)
Kingdom	Animalia, Plantae, Fungi, Protista, Monera	Nutrition, body type
Phylum	Chordata, Arthropoda, etc.	Basic body plan (e.g. backbone, segmentation)
Class	Mammalia, Insecta, Aves, etc.	Traits like warm-bloodedness, feathers, hair
Order	Primates, Carnivora, etc.	Broad lifestyle traits (diet, locomotion)
Family	Hominidae, Felidae	Closely related genera
Genus	*Homo*, *Panthera*	Very similar organisms
Species	*sapiens*, *leo*	Individual group that can breed and produce fertile offspring

🧠 **Example**: Humans
Domain: Eukarya → *Kingdom*: Animalia → *Phylum*: Chordata → *Class*: Mammalia → *Order*: Primates → *Family*: Hominidae → *Genus*: Homo → *Species*: sapiens

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🐾 2. FARMB – Vertebrate Classification

🔤 Mnemonic:

✅ **"FARMB" = Fish, Amphibians, Reptiles, Mammals, Birds**

Letter	Group	Key Traits
F	**Fish**	Cold-blooded, gills, fins, aquatic
A	**Amphibians**	Cold-blooded, metamorphosis (gills → lungs), moist skin
R	**Reptiles**	Cold-blooded, dry scaly skin, lay leathery eggs
M	**Mammals**	Warm-blooded, hair/fur, give birth, feed young with milk
B	**Birds**	Warm-blooded, feathers, lay hard-shelled eggs, wings

🧠 Vertebrates are **animals with backbones**. Each group has distinct features related to **reproduction**, **temperature regulation**, and **body covering**.

🐛 3. PECAAMEN – Invertebrate Phyla

🔤 Mnemonic:

✅ **"Please Excuse Creepy And Amazing Arthropods Making Excellent Nests"**
(*You can rearrange based on learning level, but this covers all eight major invertebrate phyla.*)

Letter	Phylum	Examples	Key Traits
P	**Porifera**	Sponges	No organs, porous body, filter feeders
E	**Echinodermata**	Starfish, urchins	Marine, radial symmetry, tube feet
C	**Cnidaria**	Jellyfish, corals	Tentacles, stinging cells (nematocysts)
A	**Annelida**	Earthworms	Segmented body, true coelom
A	**Arthropoda**	Insects, crabs, spiders	Exoskeleton, jointed limbs, largest group
M	**Mollusca**	Snails, octopuses	Soft body, many with shells
E	**Platyhelminthes**	Tapeworms	Flatworms, one opening for digestion
N	**Nematoda**	Roundworms	Cylindrical, complete digestive system

🧠 Invertebrates = **no backbone**. These phyla are grouped based on body symmetry, segmentation, and body cavities.

🌿 4. Plant Classification Mnemonic

🔤 Mnemonic:

✅ **"My Friendly Cactus Flowers"**
(*Used to remember evolutionary order from simple to complex*)

Letter	Group	Key Traits
M	**Mosses**	No vascular tissue, reproduce by spores, live in damp areas
F	**Ferns**	Vascular tissue, reproduce by spores, have fronds
C	**Conifers**	Vascular tissue, reproduce by seeds in cones, needle-like leaves
F	**Flowering Plants**	Vascular tissue, flowers, seeds in fruit, wide leaves

🧠 Plants are classified based on **vascular tissues**, **reproduction methods (spores or seeds)**, and **presence of flowers or cones**.

🧾 SUMMARY CHART

Acronym	What It Covers	Used For
Dear King Philip...	Domain → Species	Full scientific taxonomy of all living things
FARMB	Fish, Amphibians, Reptiles, Mammals, Birds	Vertebrate classes
PECAAMEN	Porifera to Nematoda	Major invertebrate phyla
My Friendly Cactus Flowers	Mosses → Flowering Plants	Plant classification by structure & reproduction

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READ FOR BIO

🧬 1. DNA Replication

Purpose: To **copy DNA** so that each new cell gets a full set during cell division.

🔁 Steps:

1. **Unwinding the DNA**
    - **Helicase** enzyme unzips the DNA double helix, breaking hydrogen bonds between bases.
2. **Complementary Base Pairing**
    - **DNA polymerase** adds new complementary nucleotides to each template strand:
        - A pairs with T
        - C pairs with G
3. **Formation of Two New Strands**
    - Each new DNA molecule has one original (old) strand and one new strand → called **semi-conservative replication**.
4. **Proofreading**
    - DNA polymerase checks for errors and corrects them to ensure accuracy.

✅ **End Result**: Two identical DNA molecules.

🗒️ 2. Transcription (DNA → mRNA)

Purpose: To make an **mRNA copy** of a gene so it can be translated into a protein.

✏️ Steps:

1. **DNA Unzips**
    - Only the gene that needs to be expressed is unzipped by RNA polymerase.
2. **mRNA is Synthesized**
    - **RNA polymerase** builds a strand of **mRNA** by pairing RNA nucleotides with the DNA template strand:
        - A → U (RNA uses uracil instead of thymine)
        - T → A

- C → G
- G → C

3. **mRNA Detaches and Leaves Nucleus**
    - The completed mRNA strand exits the nucleus via a **nuclear pore** and enters the cytoplasm.

✅ **End Result**: A **single-stranded mRNA molecule** ready for translation.

🔤 3. Translation (mRNA → Protein)

Purpose: To **read the mRNA code** and build a specific **protein**.

🗒️ Steps:

1. **mRNA Binds to Ribosome**
    - Ribosome "reads" the mRNA in **codons** (3-base sequences).
2. **tRNA Brings Amino Acids**
    - **tRNA** molecules carry **specific amino acids** and have **anticodons** that match mRNA codons.
3. **Codon-Anticodon Pairing**
    - The tRNA anticodon binds to its complementary mRNA codon, placing the correct amino acid in sequence.
4. **Peptide Bonds Form**
    - The ribosome joins amino acids with **peptide bonds** to form a **polypeptide chain**.
5. **Stop Codon**
    - When a **stop codon** is reached, translation ends. The completed **protein** is released.

✅ **End Result**: A **folded protein** made of a specific sequence of amino acids.

📌 Quick Summary Chart

Process	Input	Output	Location	Key Enzymes/Structures
Replication	DNA	Identical DNA	Nucleus	DNA helicase, DNA polymerase
Transcription	DNA	mRNA	Nucleus	RNA polymerase

Translation	mRNA, tRNA	Protein	Cytoplasm (ribosome)	Ribosome, tRNA

Would you like a visual flowchart of all three steps together for revision?

READ FOR CHEM

Reaction Type	Equation Example	Notes
Ammonia + Water	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$	Makes alkaline solution
Ammonia + Acid → Ammonium Salt	$NH_3 + HCl \rightarrow NH_4Cl$	No water, just a salt
Heating ammonium salts	$NH_4Cl \rightarrow NH_3 + HCl$	Reversible reaction
Ammonium salt + alkali	$NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$	Used in tests