iBLaurel

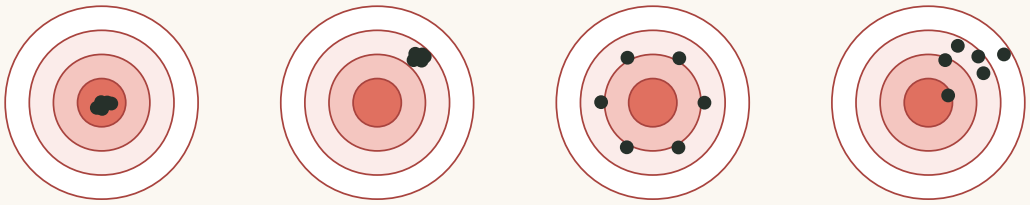
Specialist one-to-one Science, Maths & Economics tuition

AQA GCSE BIOLOGY · PRACTICAL SKILLS + REQUIRED PRACTICALS

Practical Skills

Complete revision & exam preparation guide — key points to memorise, clear diagrams, practice questions and full answers

Key-point notes | Memory hooks | All 10 required practicals | Data skills | Exam questions + answers



Prepared by iBLaurel · Specialist one-to-one Science, Maths & Economics tuition
Suitable for Foundation and Higher tier · Combined Science (Trilogy) and Separate Biology

START HERE

Contents and how to use this guide

P.1 Measuring substances
P.2 Heating
P.3 Safety, risk and ethics
P.4 Potometers and microscopes
P.5 Planning: hypotheses and variables
P.6 Accuracy, precision and errors
P.7 Sampling
P.8 Processing data
P.9 Graphs, conclusions and evaluation
P.10 All 10 required practicals at a glance
★ One-page memory sheet
✎ Summary questions
✓ Answers and mark scheme

How to use this guide

1. **Read** one section. Study the diagram and say the labels out loud.
2. **Learn the gold "Remember it" box** — short hooks that make facts stick.
3. **Cover and recall:** cover the page, write the key points and **equations** from memory, then check and correct in a different colour.
4. **Read the green "Exam tip" and red "Common mistake" boxes** — they show where marks are won and lost.
5. Finish with the **summary questions** (no notes), then mark them with the **answers**. Re-test the ones you got wrong 2–3 days later.

WHY PRACTICAL SKILLS MATTER

At least **15%** of the marks in AQA GCSE Biology exams test **practical skills** — using apparatus, planning fair tests, handling data and evaluating methods. You won't sit a practical exam; instead you are asked about the **required practicals** in the written papers. This booklet covers the skills **and** gives every required practical on one page.

Key boxes in this guide

Box	What it means
Remember it	Memory hook, rhyme or shortcut to memorise
Exam tip	How to write the answer to get the marks
Common mistake	Errors examiners see every year
Maths skill	Calculations and graph skills you must be able to do
RP	AQA Required Practical — can be asked in the written exam
BIOLOGY ONLY	Only for Separate (Triple) Biology, not Combined Science
HIGHER TIER	Only examined on the Higher tier paper

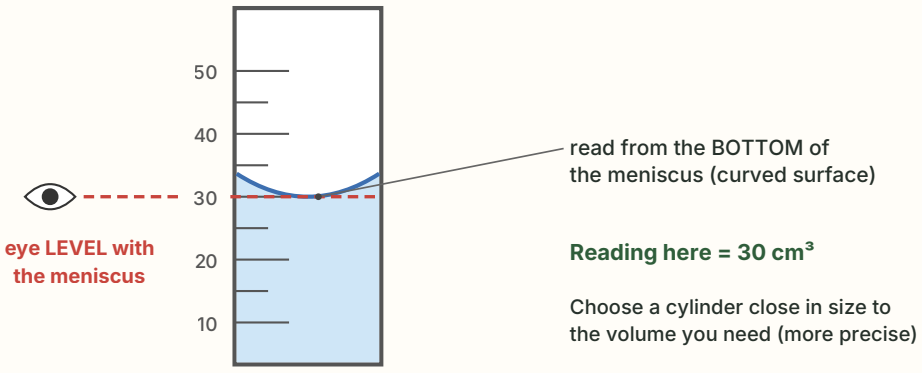
PART A

Using Apparatus Safely

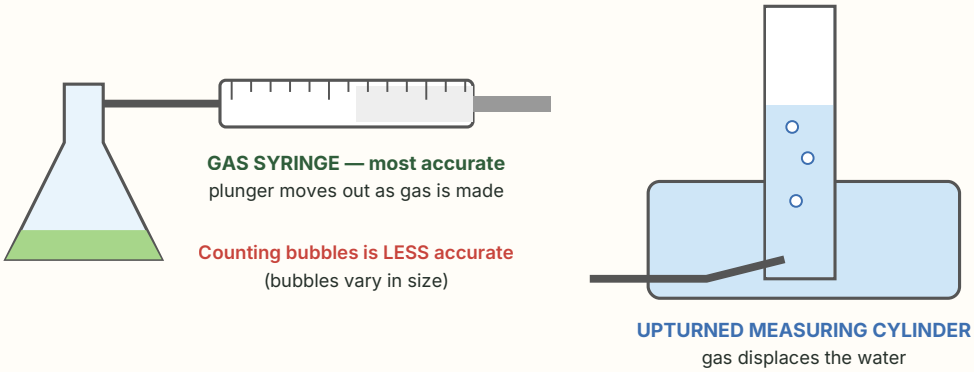
P.1 Measuring substances

Apparatus and techniques

Quantity	Apparatus	How to measure it well
Mass	Balance	Put the empty container on the balance, set it to **zero** (tare), then add the substance
Temperature	Thermometer	Make sure the **bulb is completely submerged**; wait for the reading to **stabilise**; read at **eye level**
Volume of a liquid	Measuring cylinder, pipette, dropping pipette, graduated pipette	Read from the **bottom of the meniscus** at eye level. Choose a cylinder close in size to the volume (a 1 dm^3 cylinder for 2 cm^3 gives big errors). **Graduated pipettes** with a **pipette filler** transfer accurate volumes; **dropping pipettes** transfer single drops
Volume of a gas	Gas syringe or upturned measuring cylinder filled with water	Gas syringe is the **most accurate**. Make sure the apparatus is **airtight** so no gas escapes. Counting bubbles or measuring a bubble's length is **less accurate** but fine for comparing results
pH	Indicator, universal indicator, indicator paper, pH meter	**Universal indicator** changes colour gradually → estimate pH. **Indicator (litmus) paper** — blue turns red in acid, red turns blue in alkali; damp paper can test a gas. A **pH meter** gives an accurate digital value



Reading the volume of a liquid



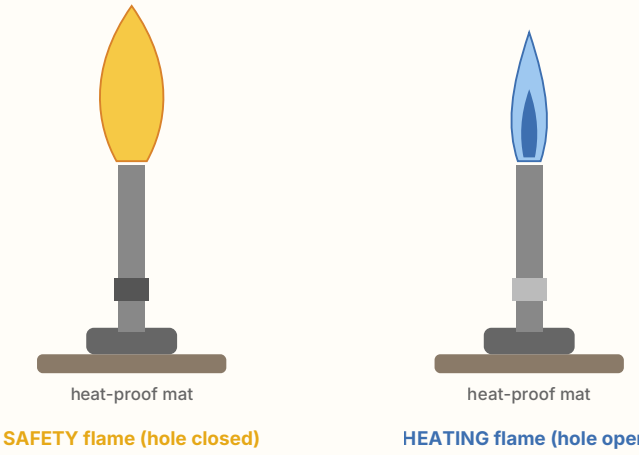
Two ways to measure the volume of a gas

REMEMBER IT

"Bottom, Eye, Zero" → read the **bottom** of the meniscus, at **eye** level, and **zero** the balance first. When reading a scale, write down the value of the **graduation it is closest to**.

P.2 Heating

Apparatus and techniques



- Always on a heat-proof mat
- Yellow flame when not in use — easy to see
- Blue flame to heat; hold vessel at the top of the flame with tongs
- Point openings AWAY from people
- Beaker: tripod + gauze

Using a Bunsen burner safely

Method	Notes
Bunsen burner	Heats things **quickly**, but has a naked flame. Close the hole when not heating (yellow flame is easy to see)
Simple water bath	A beaker of water heated over a Bunsen and monitored with a thermometer — it is hard to keep the temperature **constant**
Electric water bath	Monitors and **adjusts the temperature** for you. Put the tube in once the water is at temperature; the water level should be just above the substance. Heating is **very even**
Electric heater (hot plate)	Set to a temperature; heats only from below, so you usually need to **stir** to heat evenly

EXAM TIP

An **electric water bath** is the best way to keep a **constant temperature** — a common answer to "how could you control the temperature?" in enzyme, decay and photosynthesis practicals.

P.3 Safety, risk and ethics

Working safely

- Before you start, know the **safety precautions** for the method and the **chemicals** — some may be flammable, irritants or harmful.
- Wear sensible clothing: a **lab coat**, **safety goggles** and sometimes **gloves**. No open shoes.
- Keep flammable things away from Bunsen flames; don't touch hot equipment; handle glassware carefully.

Hazard	Risk	Precaution
Bunsen flame	Burns; setting things alight	Heat-proof mat; safety flame when not in use; tie hair back
Hot water / hot glassware	Scalds and burns	Use tongs or test-tube holders; let it cool
Chemicals (e.g. biuret, iodine)	Irritation of skin and eyes	Wear goggles; wash hands; clean spills
Bacteria (microbiology)	Growing harmful pathogens	Aseptic technique; tape lid; incubate at 25 °C max
Sharp tools (scalpel, cork borer)	Cuts	Cut away from your body on a tile

Ethics

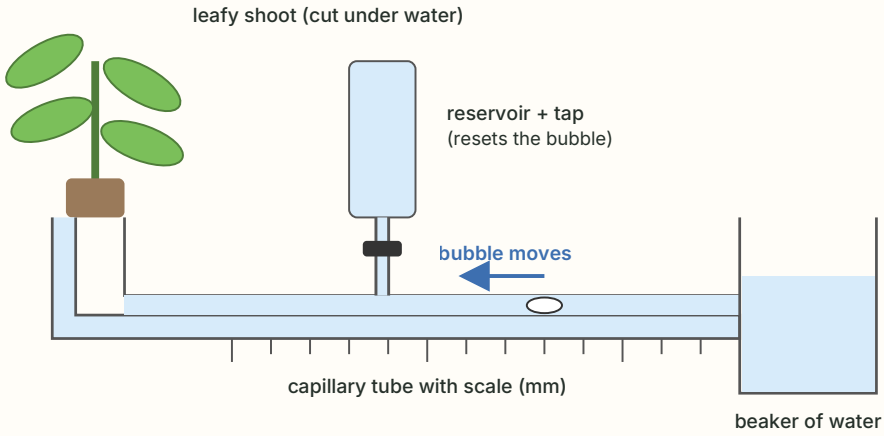
- All organisms should be treated **safely and ethically**.
- Animals must be handled **carefully**; wild animals studied in fieldwork should be **returned to their habitat**.
- Animals kept in the lab should be cared for **humanely**, e.g. not kept in overcrowded conditions.
- People taking part (e.g. a caffeine reaction-time test) must **volunteer** — they shouldn't be pressured.

REMEMBER IT

Safety = **"HRP"**: name the **H**azard, the **R**isk it causes, and the **P**recaution to reduce it.

P.4 Potometers and microscopes

Apparatus and techniques



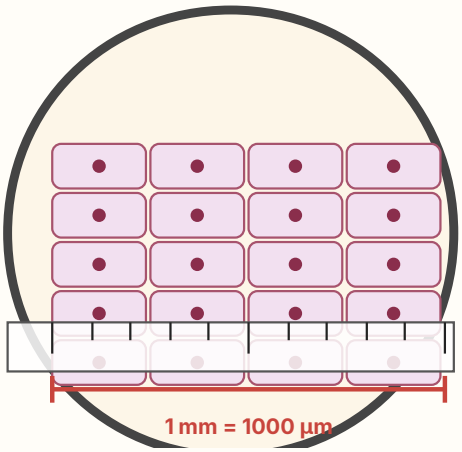
A potometer

Setting up a potometer (estimates the rate of transpiration by measuring water uptake):

1. **Cut a shoot underwater** (at a slant) — this stops air entering the xylem and increases the surface area for water uptake.
2. Assemble the potometer **underwater** and insert the shoot, so no air can enter.

3. Remove from the water but keep the end of the capillary tube **submerged** in a beaker of water.
4. Check the apparatus is **watertight and airtight**. Dry the leaves; let the shoot **acclimatise**; shut the tap.
5. Remove the end of the capillary tube from the water until **one air bubble** forms, then put it back.
6. Record how far the bubble moves in a set time → rate of water uptake.

Measuring a single cell



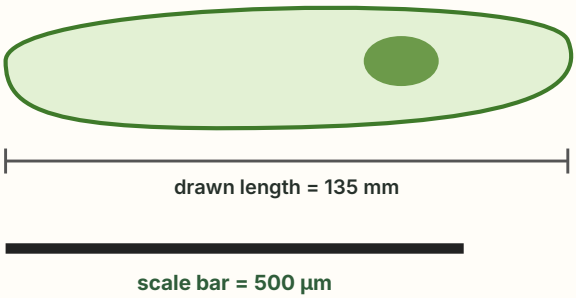
Measuring the size of one cell

1. Put a clear plastic ruler on the slide; clip both onto the stage
2. Use the ×10 objective (total ×100)
3. Focus to get a clear image
4. Line the cells up along 1 mm; count how many fit
5. Cell length = 1000 µm ÷ number

4 cells in 1 mm → 1000 ÷ 4 = 250 µm

Measuring cells with a clear ruler

Drawing a scale bar



Real cell length = 615 µm

Scale bar length (µm) = drawn length × 500 ÷ real length

= 135 000 µm × 500 ÷ 615
≈ 110 000 µm = 110 mm

Using the real size of a cell to draw a 500 µm scale bar

FORMULA

Scale bar length (µm) = drawn length of cell (µm) × 500 ÷ actual length of cell (µm). Convert the answer back to mm to draw it (1 mm = 1000 µm).

PART B

Working Scientifically

P.5 Planning: hypotheses and variables

Working scientifically

Word	Meaning	Example (enzyme practical)
Hypothesis	A possible **explanation** for an observation, based on scientific ideas	pH affects the shape of amylase's active site
Prediction	What you think will happen, often "as X increases, Y will..."	Amylase will work fastest at pH 7
Independent variable	The one you **change**	pH
Dependent variable	The one you **measure**	Time for starch to be broken down
Control variables	All the others, kept the **same** so it is a **fair test**	Temperature, volume and concentration of amylase and starch
Control experiment	Set up the same but **without** the factor being tested, to show the effect is due to it	Starch + buffer + water instead of amylase

REMEMBER IT

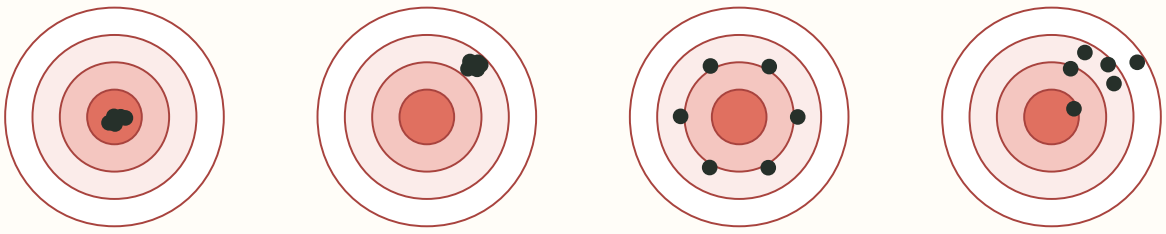
Independent = **I** change it. **D**ependent = **D**ata I collect. **C**ontrol = **C**onstant.
On a graph: independent on the **x-axis**, dependent on the **y-axis** — "**DRY MIX**": **D**ependent/**R**esponding on **Y**; **M**anipulated/**I**ndependent on **X**.

EXAM TIP

When asked for a control variable, give one that would **actually affect** the result — not "use the same equipment" or "same person". Say **how** you would control it (e.g. "use an electric water bath at 30 °C").

P.6 Accuracy, precision and errors

Working scientifically



Accurate + precise | **Precise, NOT accurate** | **Accurate, NOT precise** | **Neither**

Accuracy and precision, shown as darts on a target

Word	Meaning
Accurate	Close to the **true value**
Precise	Repeat results are **close together** (little spread around the mean)
Repeatable	The **same person** using the same method gets similar results
Reproducible	**Someone else**, or a different method or equipment, gets similar results
Resolution	The **smallest change** an instrument can detect (a thermometer reading to 0.1 °C has a higher resolution than one to 1 °C)
Valid	The method answers the question and is a **fair test**

Error	What it is	How to reduce it
Random error	Unpredictable differences each time (e.g. reaction time when starting a stopwatch)	**Repeat** and calculate a **mean**
Systematic error	Results are wrong by the **same amount** each time (e.g. a faulty balance)	Check and calibrate equipment; repeats do **not** help
Zero error	A type of systematic error: the instrument doesn't read zero when it should	Zero the instrument, or subtract the error from every reading
Anomalous result	A result that doesn't fit the pattern	Repeat it; **ignore it** when calculating the mean (if there's a reason)

MATHS SKILL — UNCERTAINTY

Uncertainty = range ÷ 2 (range = largest − smallest).
Repeats: 22, 24, 26 s → mean = 24 s, range = 4 s → result = **24 ± 2 s**.

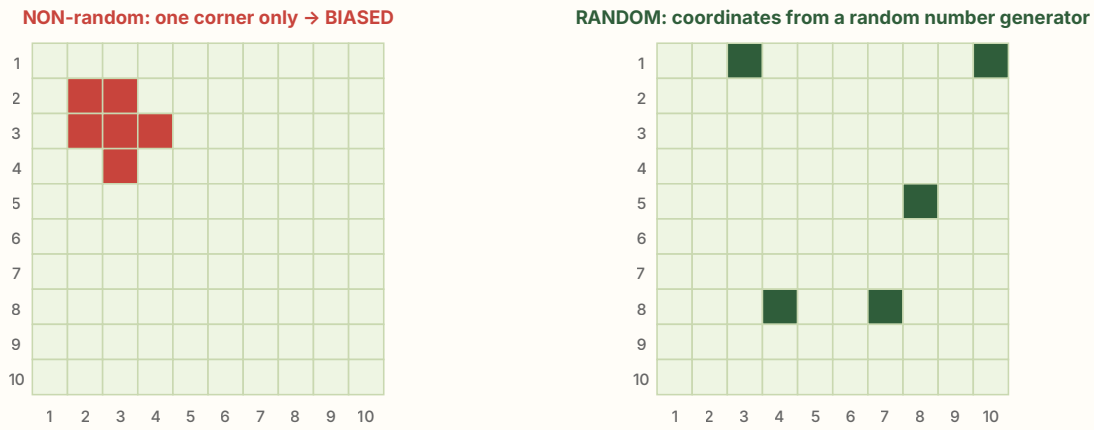
REMEMBER IT

Accurate = hits the **Answer**. **Precise** = **Packed** together.
Repeatable = same pe**R**son; **Reproducible** = s**O**meone else.

P.7 Sampling

Working scientifically

- It is usually **impossible** to study every organism, so we take a **sample** that **represents** the whole population.
- The sample must be **random** — otherwise it is **biased** and the conclusions may be wrong.



Choosing quadrat sites in a field

1. **Divide** the field into a grid.
2. **Label** the grid along the bottom and up the side with numbers.
3. Use a **random number generator** (on a computer or calculator) to choose coordinates, e.g. (2, 6).
4. Take your samples at these coordinates.

Health data should also be taken from **randomly selected people**. E.g. to estimate how many people with type 2 diabetes also have heart disease: identify all 270 196 people with type 2 diabetes from hospital records, give each a number, use a random number generator to choose a sample, then use the **proportion** in the sample to estimate the total.

> **REMEMBER IT**
> Random sampling: **"Grid, Number, Generate, Sample"**. Non-random = **biased**.

P.8 Processing data

Working scientifically

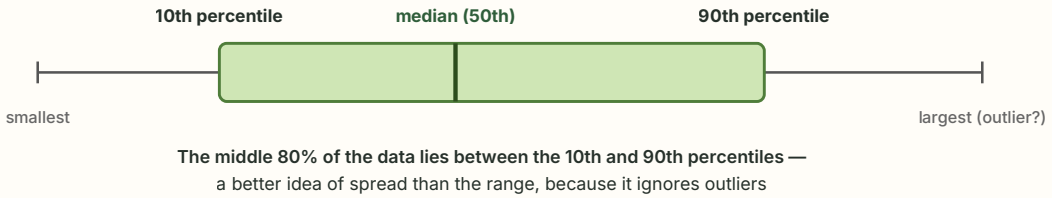
Calculation	How	Example
Mean	Add up the values ÷ number of values (ignore anomalies)	12, 14, 16 → 42 ÷ 3 = **14**
Range	Largest − smallest	16 − 12 = **4**
Median	The **middle** value when in order	3, 5, **7**, 8, 9
Mode	The **most common** value	2, 4, **4**, 6 → 4
Percentage change	(final − original) ÷ original × 100	7.5 g → 8.7 g: 1.2 ÷ 7.5 × 100 = **+16%**
Rate	Amount ÷ time, or 1000 ÷ time	36 cm^3 in 60 s = **0.6 cm^3/s**

> **WHY USE PERCENTAGE CHANGE?**
> It lets you **compare** results that didn't start at the same value — e.g. potato cylinders with different starting masses. Example: cylinder 1, 7.5 g → 8.7 g = **+16%**; cylinder 2, 8.0 g → 6.8 g = **−15%**. A negative answer means the value **decreased**.

Percentiles

- To find a percentile, **rank** your data from smallest to largest, then divide it into **100 equal chunks**. Each chunk is one percentile.

- A value at the **90th percentile** is larger than **90%** of the data. The **median** is the 50th percentile.



Using the 10th and 90th percentiles to describe spread

Significant figures: give your answer to the same number of s.f. as the data with the **fewest** s.f. Always include **units**.

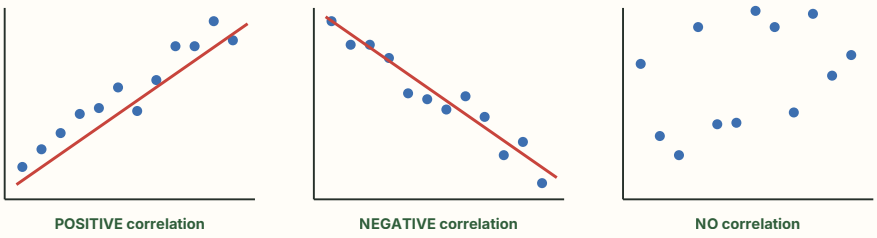
> **REMEMBER IT**
> % change = **"New minus Old, over Old, times 100"**.

P.9 Graphs, conclusions and evaluation

Working scientifically

Type of data	Graph to use
Categoric independent variable (e.g. blood group, type of food)	**Bar chart** (bars don't touch)
Continuous independent variable (e.g. temperature, time)	**Line graph** or **scatter graph** with a line (or curve) of best fit
Grouped continuous data (e.g. height ranges)	**Histogram** (bars touch)

- Plot points accurately with a sharp pencil; label both **axes with units**; use more than half the grid.
- The **gradient** of a line graph shows the **rate** (change in y ÷ change in x).



Three types of correlation

- A **correlation** is a relationship between two variables. It does **not prove** that one causes the other — there may be a **third factor**, or it may be **chance**.

Writing a conclusion: (1) describe the **pattern**, (2) quote **data** from your results, (3) **explain** it using science, and (4) say whether it supports the **hypothesis**. Only conclude about the range of values you tested.

Evaluating: comment on the **method** (was it a fair test?), the **quality of the data** (anomalies, spread, repeatability) and suggest **improvements** (more repeats, smaller intervals, better apparatus such as a gas syringe, colorimeter, pH probe or electric water bath).

> **REMEMBER IT**
> Conclusion = **"PDE"** → **P**attern, **D**ata, **E**xplain. Correlation ≠ causation.

PART C

All 10 Required Practicals at a Glance

#	Practical	Topic / course	Aim	Key method points to remember
1	**Microscopy**	Topic 1 **Both**	Prepare a slide (e.g. onion + iodine); view with a light microscope; draw and label; calculate magnification	Thin sample, stain, cover slip at an angle; low power first, coarse then fine focus; magnification = image ÷ real
2	**Microbiology**	Topic 1 **Bio only**	Effect of antiseptics or antibiotics on bacterial growth	Aseptic technique; discs on a lawn of bacteria; incubate at 25 °C; measure clear zone → area = πr^2
3	**Osmosis**	Topic 1 **Both**	Effect of sugar/salt concentration on the mass of potato	Equal cylinders; blot dry; % change in mass; where line crosses 0 = concentration of cell sap
4	**Food tests**	Topic 2 **Both**	Test foods for sugars, starch, protein and lipids	Benedict's (heat, brick-red), iodine (blue-black), biuret (purple), Sudan III (red layer)
5	**Enzymes**	Topic 2 **Both**	Effect of pH on the rate of amylase activity	Water bath 35 °C; buffers; iodine on spotting tile every 30 s; rate = 1000 ÷ time
6	**Photosynthesis**	Topic 4 **Both**	Effect of light intensity on the rate of photosynthesis (pondweed)	Vary lamp distance; count bubbles / gas volume per min; control temperature + CO_2; light $\propto 1/d^2$
7	**Reaction time**	Topic 5 **Both**	Effect of a factor (e.g. caffeine) on reaction time	Ruler drop or computer test; same person, same hand; repeat, mean
8	**Plant responses**	Topic 5 **Bio only**	Effect of light or gravity on seedling growth	Cress seeds; light from above, side, dark; same water, temperature, seed number
9	**Field investigations**	Topic 7 **Both**	Population size and distribution using quadrats and transects	Random coordinates; mean × area; transect with quadrats at intervals; % cover
10	**Decay**	Topic 7 **Bio only**	Effect of temperature on the rate of decay of milk	Milk + sodium carbonate + phenolphthalein (pink) + lipase; time to go colourless; rate = 1000 ÷ time

EXAM TIP — REQUIRED PRACTICAL QUESTIONS

You may be asked to: **describe the method** (often 6 marks — write it in numbered steps), name the **variables**, suggest a **safety precaution**, explain an **improvement**, or process **results** (mean, rate, % change, graph). The full method for each practical is in the topic booklet listed in the table.

REMEMBER IT

Combined Science students do **7** of these (all except 2, 8 and 10). Separate Biology students do all **10**.

★ LAST-MINUTE

One-page memory sheet

Topic	Must-know facts
Measuring	Zero the balance; thermometer bulb submerged, wait to stabilise; read the bottom of the meniscus at eye level; right-sized cylinder; gas syringe most accurate, airtight; universal indicator, litmus paper, pH meter.
Heating	Bunsen on a heat-proof mat; safety (yellow) flame when idle; blue flame to heat. Electric water bath = constant, even temperature. Electric heater → stir.
Safety + ethics	Hazard → risk → precaution. Lab coat, goggles. Treat organisms ethically; return animals; volunteers only.
Potometer	Cut shoot underwater at a slant; assemble underwater; airtight; one air bubble; measure distance moved in a set time.
Cell size	Clear ruler on slide; ×100; count cells in 1 mm; length = 1000 µm ÷ number. Scale bar = drawn length × 500 ÷ actual length.
Variables	Independent (change, x-axis), dependent (measure, y-axis), control (keep same). Control experiment. Hypothesis vs prediction.
Data quality	Accurate (near true), precise (close together), repeatable (same person), reproducible (others), resolution. Random error → repeat + mean. Systematic/zero error → calibrate. Uncertainty = range ÷ 2.
Sampling	Random to avoid bias: grid + random number generator. Health data: random selection from records.
Processing	Mean, median, mode, range; % change = (new − old) ÷ old × 100; rate; percentiles (10th–90th = middle 80%); s.f. + units.
Graphs + conclusions	Bar chart for categoric, line/scatter for continuous. Gradient = rate. Correlation ≠ causation. Conclusion: pattern, data, explain. Evaluate method, data, improvements.
Required practicals	1 Microscopy · 2 Microbiology (Bio) · 3 Osmosis · 4 Food tests · 5 Enzymes · 6 Photosynthesis · 7 Reaction time · 8 Plant responses (Bio) · 9 Field investigations · 10 Decay (Bio).

PRACTICE

Summary questions

Try every question **without notes**. Tick each one you get fully right; redo the rest in 2–3 days. Answers are in the next section.

Section A — Quick recall (1–2 marks each)

1. Why should you set a balance to zero before weighing?
2. Give two things to do when using a thermometer to get an accurate reading.
3. Where should you read the volume of a liquid in a measuring cylinder?
4. Why should you use a 10 cm^3 measuring cylinder rather than a 1 dm^3 one to measure 2 cm^3?
5. What is the most accurate way to measure the volume of a gas?
6. Give a method of measuring pH that gives an accurate numerical value.
7. What colour does blue litmus paper turn in acid?
8. Why should a Bunsen burner be left on a yellow flame when not in use?
9. Give one advantage of an electric water bath over a beaker of water heated by a Bunsen.
10. Give two pieces of safety equipment to wear in the lab.
11. What should happen to animals captured during fieldwork?
12. Why must a potometer shoot be cut underwater?
13. How do you calculate the length of one cell if 5 cells fit in 1 mm?
14. What is a hypothesis?
15. What is the independent variable?
16. What is the dependent variable?
17. Why are control variables kept the same?
18. What does ‘accurate’ mean?
19. What does ‘precise’ mean?
20. What is the difference between repeatable and reproducible?
21. What is resolution?
22. How can the effect of random errors be reduced?
23. What is a systematic error?
24. What is an anomalous result?
25. Why should samples be chosen randomly?
26. What does the 90th percentile mean?
27. Which type of graph should be used for categoric data?
28. What does the gradient of a line graph show?
29. Does a correlation prove that one variable causes another?
30. Which three required practicals are for Separate Biology only?

Section B — Exam-style questions

31. A student wants to find the effect of temperature on the rate of an enzyme reaction. Identify the independent, dependent and two control variables. [4 marks]
32. Describe how to set up a potometer so that it gives valid results. [4 marks]
33. Explain the difference between accuracy and precision. Use an example. [3 marks]
34. A student's balance always reads 0.2 g with nothing on it. Name this type of error and explain how to correct the results. [2 marks]
35. Explain why repeating readings and calculating a mean improves the results of an experiment. [2 marks]
36. Describe how a student could choose random positions for quadrats in a field. [3 marks]
37. A student found a positive correlation between hours of sunlight and plant growth. Explain why she cannot be sure that sunlight caused the growth. [2 marks]
38. Suggest two ways a student could improve the pondweed photosynthesis practical. [2 marks]
39. Describe how to measure the length of a single plant cell using a light microscope and a ruler. [4 marks]
40. Explain why a student would use percentage change, rather than change in mass, in the osmosis practical. [2 marks]
41. A student wants to test the effect of caffeine on reaction time using classmates. Describe one ethical issue and one safety issue. [2 marks]

Section C — Maths and data skills

42. Calculate the mean of 23, 25, 21 and 27 s. [1 mark]
43. Repeat readings were 4.2, 4.6 and 4.4 cm^3. Give the mean and the uncertainty. [2 marks]
44. A potato cylinder went from 8.0 g to 6.8 g. Calculate the percentage change. [2 marks]
45. 4 cells fit along 1 mm. What is the length of one cell in µm? [1 mark]
46. A cell is 250 µm long. Its drawing is 50 mm long. How long should a 500 µm scale bar be? [2 marks]
47. Starch was fully broken down in 125 s. Calculate the rate using 1000 ÷ time. [1 mark]
48. Give 0.004572 to 2 significant figures in standard form. [1 mark]
49. Find the median of 7, 3, 9, 5, 8. [1 mark]

ANSWERS

Answers and mark scheme

Section A — Quick recall

1. **Why should you set a balance to zero before weighing?**
   So that only the mass of the substance is measured, not the container.
2. **Give two things to do when using a thermometer to get an accurate reading.**
   Make sure the bulb is fully submerged; wait for the reading to stabilise; read at eye level (any two).
3. **Where should you read the volume of a liquid in a measuring cylinder?**
   From the bottom of the meniscus, at eye level.
4. **Why should you use a 10 cm^3 measuring cylinder rather than a 1 dm^3 one to measure 2 cm^3?**
   The graduations are smaller, so it is more precise / less error.
5. **What is the most accurate way to measure the volume of a gas?**
   A gas syringe.
6. **Give a method of measuring pH that gives an accurate numerical value.**
   A pH meter.
7. **What colour does blue litmus paper turn in acid?**
   Red.
8. **Why should a Bunsen burner be left on a yellow flame when not in use?**
   It is easy to see, so people won't touch it by accident.
9. **Give one advantage of an electric water bath over a beaker of water heated by a Bunsen.**
   Keeps the temperature constant automatically / heats evenly.
10. **Give two pieces of safety equipment to wear in the lab.**
    Lab coat, safety goggles, gloves (any two).
11. **What should happen to animals captured during fieldwork?**
    They should be returned to their original habitat.
12. **Why must a potometer shoot be cut underwater?**
    To stop air entering the xylem.
13. **How do you calculate the length of one cell if 5 cells fit in 1 mm?**
    1000 µm ÷ 5 = 200 µm.
14. **What is a hypothesis?**
    A possible explanation for an observation, based on scientific ideas.
15. **What is the independent variable?**
    The variable you change.
16. **What is the dependent variable?**
    The variable you measure.
17. **Why are control variables kept the same?**
    So it is a fair test and only the independent variable affects the result.
18. **What does 'accurate' mean?**
    Close to the true value.
19. **What does 'precise' mean?**
    Repeat results are close together / little spread.

20. **What is the difference between repeatable and reproducible?**
    Repeatable: same person and method gets similar results. Reproducible: someone else or a different method gets similar results.
21. **What is resolution?**
    The smallest change an instrument can detect.
22. **How can the effect of random errors be reduced?**
    Repeat the readings and calculate a mean.
23. **What is a systematic error?**
    An error that makes readings wrong by the same amount each time (e.g. faulty or uncalibrated equipment).
24. **What is an anomalous result?**
    A result that doesn't fit the pattern of the other results.
25. **Why should samples be chosen randomly?**
    To avoid bias, so the sample represents the whole population.
26. **What does the 90th percentile mean?**
    The value is larger than 90% of the data.
27. **Which type of graph should be used for categoric data?**
    A bar chart.
28. **What does the gradient of a line graph show?**
    The rate of change.
29. **Does a correlation prove that one variable causes another?**
    No — there may be another factor or it may be chance.
30. **Which three required practicals are for Separate Biology only?**
    Microbiology, plant responses, decay.

Section B — Exam-style questions

31. **A student wants to find the effect of temperature on the rate of an enzyme reaction. Identify the independent, dependent and two control variables.** [4]
    - Independent: temperature (1)
    - Dependent: rate of reaction / time taken (1)
    - Any two controls (2): pH, enzyme concentration/volume, substrate concentration/volume
32. **Describe how to set up a potometer so that it gives valid results.** [4]
    - Cut the shoot underwater at a slant (1) to stop air entering the xylem
    - Assemble the potometer underwater and insert the shoot (1)
    - Make sure it is airtight and watertight (1)
    - Introduce one air bubble and allow the shoot to acclimatise; keep conditions constant (1)
33. **Explain the difference between accuracy and precision. Use an example.** [3]
    - Accurate results are close to the true value (1)
    - Precise results are close together / small spread (1)
    - Example: three repeats of 24.0, 24.1, 24.0 °C are precise but not accurate if the true value is 25 °C (1)
34. **A student's balance always reads 0.2 g with nothing on it. Name this type of error and explain how to correct the results.** [2]
    - Zero error / systematic error (1)
    - Subtract 0.2 g from every reading (or zero the balance first) (1)

35. **Explain why repeating readings and calculating a mean improves the results of an experiment.** [2]
    - It reduces the effect of random errors (1)
    - Anomalous results can be spotted and ignored, so the mean is closer to the true value (1)
36. **Describe how a student could choose random positions for quadrats in a field.** [3]
    - Divide the field into a grid (1)
    - Label the axes with numbers (1)
    - Use a random number generator to pick coordinates and place quadrats there (1)
37. **A student found a positive correlation between hours of sunlight and plant growth. Explain why she cannot be sure that sunlight caused the growth.** [2]
    - Correlation does not show causation (1)
    - Another factor, e.g. temperature, also rises with sunlight and could cause growth (1)
38. **Suggest two ways a student could improve the pondweed photosynthesis practical.** [2]
    - Measure the volume of oxygen with a gas syringe instead of counting bubbles (1)
    - Use an LED lamp or a heat shield so temperature stays constant; more repeats (1)
39. **Describe how to measure the length of a single plant cell using a light microscope and a ruler.** [4]
    - Place a clear ruler on top of the slide; clip onto the stage (1)
    - Use a ×100 total magnification and focus (1)
    - Line the cells up along 1 mm and count how many fit (1)
    - Divide 1000 µm by the number of cells (1)
40. **Explain why a student would use percentage change, rather than change in mass, in the osmosis practical.** [2]
    - The potato cylinders may have different starting masses (1)
    - Percentage change allows results to be compared fairly (1)
41. **A student wants to test the effect of caffeine on reaction time using classmates. Describe one ethical issue and one safety issue.** [2]
    - Ethical: participants must volunteer / give consent / not be pressured (1)
    - Safety: too much caffeine may cause side effects (fast heart rate); don't use people with heart conditions (1)

Section C — Maths and data skills

42. **Calculate the mean of 23, 25, 21 and 27 s.** [1]
    96 ÷ 4 = **24 s**
43. **Repeat readings were 4.2, 4.6 and 4.4 cm³. Give the mean and the uncertainty.** [2]
    Mean = 13.2 ÷ 3 = 4.4 cm³ (1); range = 0.4 → uncertainty ± 0.2 → **4.4 ± 0.2 cm³** (1)
44. **A potato cylinder went from 8.0 g to 6.8 g. Calculate the percentage change.** [2]
    (6.8 − 8.0) ÷ 8.0 × 100 (1) = **−15%** (1)
45. **4 cells fit along 1 mm. What is the length of one cell in µm?** [1]
    1000 ÷ 4 = **250 µm**
46. **A cell is 250 µm long. Its drawing is 50 mm long. How long should a 500 µm scale bar be?** [2]
    50 mm = 50 000 µm → 50 000 × 500 ÷ 250 (1) = 100 000 µm = **100 mm** (1)
47. **Starch was fully broken down in 125 s. Calculate the rate using 1000 ÷ time.** [1]
    1000 ÷ 125 = **8 s^{-1}**
48. **Give 0.004572 to 2 significant figures in standard form.** [1]
    4.6×10^{-3}

49. **Find the median of 7, 3, 9, 5, 8.** [1]
Ordered: 3, 5, 7, 8, 9 → median = **7**

FINAL EXAM ADVICE

Use the **key words** examiners look for: *independent, dependent, control variable, fair test, hypothesis, accurate, precise, repeatable, reproducible, resolution, random error, systematic error, anomalous, uncertainty, mean, range, percentage change, random sampling, bias, correlation*. For any method question, write **numbered steps**, give **quantities** and **apparatus**, and mention **repeats** and **control variables**.

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