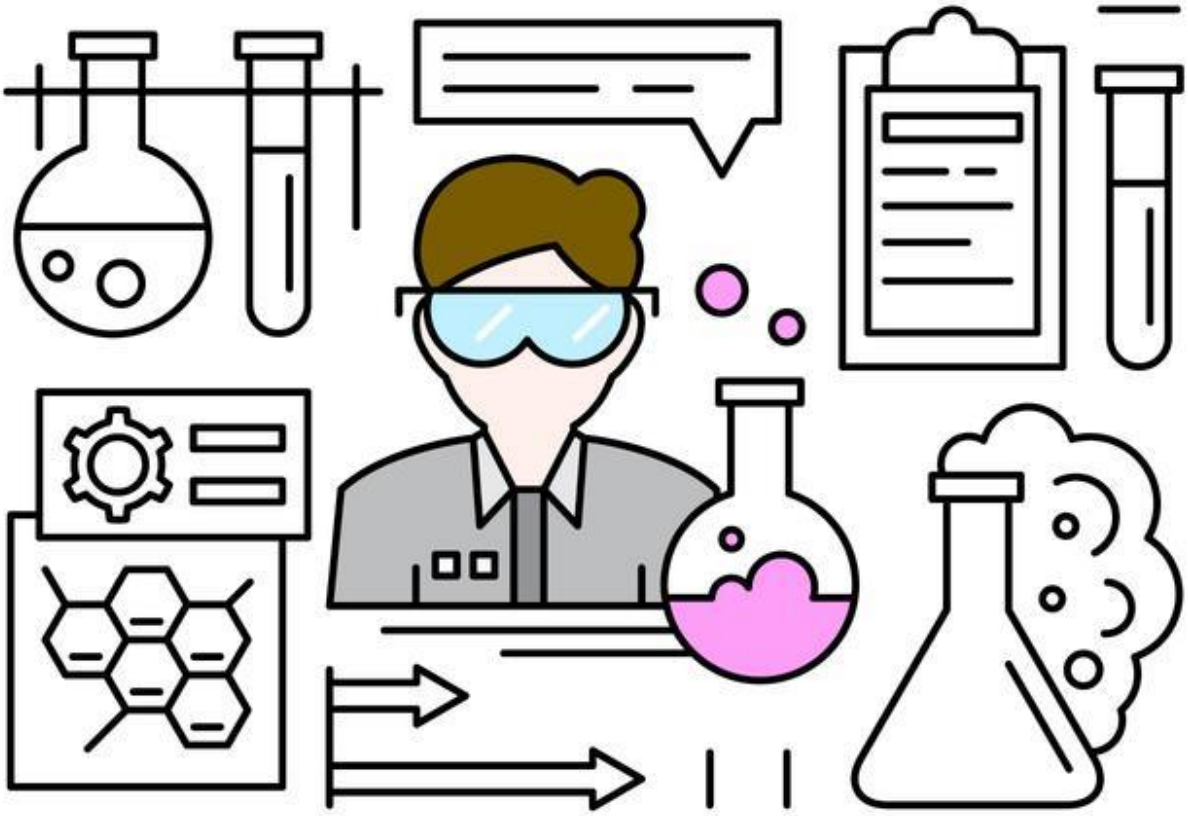
BEATTY SECONDARY SCHOOL

A Distinguished Institution of Thinkers, Learners, Contributors



Pure Biology (6093/03)

Practical Notes

Name:

Class:

Date:

Pure Biology Practical Assessment

Scientific subjects are, by their nature, experimental. It is therefore important that an assessment of your knowledge and understanding of Science should include a component relating to practical work and experimental skills.

This assessment is provided in Paper 3 as a formal practical test:

Total: 40 marks, 20% of examination

Duration: 1 h 50 min

Although the questions are different on each Paper 3, the number of marks assigned to each skill is always the same. This is shown in the table below.

Skill	Description	Weighting
Planning **(P)**	• Identify key variables for a given question • Outline an experimental procedure to investigate the question • Describe how the data should be used to reach a conclusion • Identify the risks of the experiment and state the precautions that should be taken to keep risks to a minimum	15%
Manipulation, measurement and observation **(MMO)**	• Set up apparatus correctly by following written instructions or diagrams • Use common laboratory apparatus and techniques to collect data and make observations • Describe and explain how apparatus and techniques are used correctly • Make and record accurate observations with good details and measurements to an appropriate degree of precision • Make appropriate decisions about measurements or observations	25%
Presentation of data and observations **(PDO)**	• Present all information in and appropriate form • Manipulate measurements effectively for analysis • Present all quantitative data to an appropriate number of decimal places/significant figures	25%
Analysis, conclusions and evaluation **(ACE)**	• Analyse and interpret data or observations appropriately in relation to the task • Draw conclusion(s) from the interpretation of experimental data or observations and underlying principles • Make predictions based on their data and conclusions • Identify significant sources of errors and explain how they affect the results • State and explain how significant errors may be overcome or reduced, as appropriate, including how experimental procedures may be improved.	35%

1. Biological Drawing

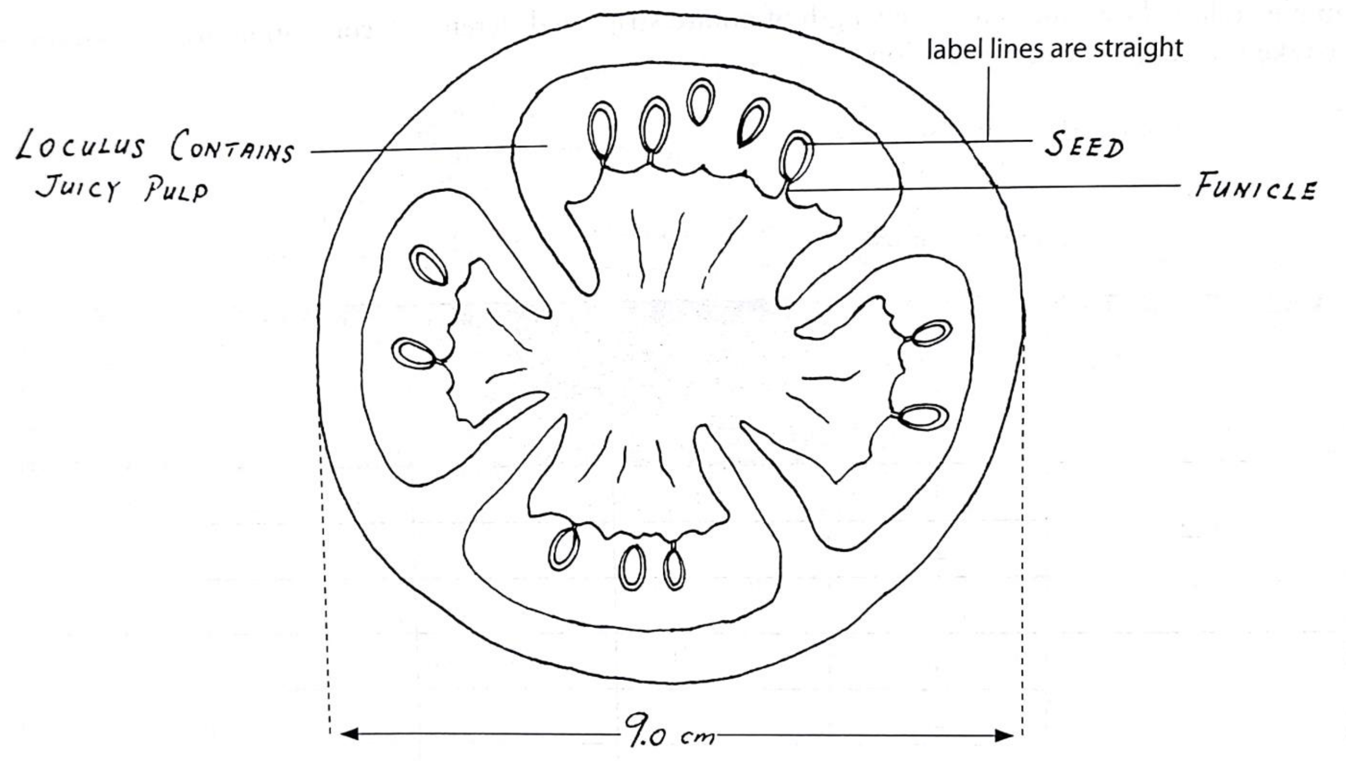
Here, we are training your observational skills. You should learn to look very closely at a specimen, and use sound Biology knowledge to choose the structures to include or omit in your drawing.

A good biological drawing should…

- Be drawn using a sharp 2B pencil
- Cover at least 2/3 of space given
- Have a clean, clear and sharp outline
- Have **straight labeling lines** drawn using ruler
  (Ideally, labels should all be on one side of the drawing. Label lines also should not cross or obscure the drawing.)
- Have labels for all features of the drawing
- Have an explanatory title that is underlined
- Have accurate relative sizes of the structures drawn
- Indicate the magnification at the bottom of the diagram

Here is an example of a good biological drawing.

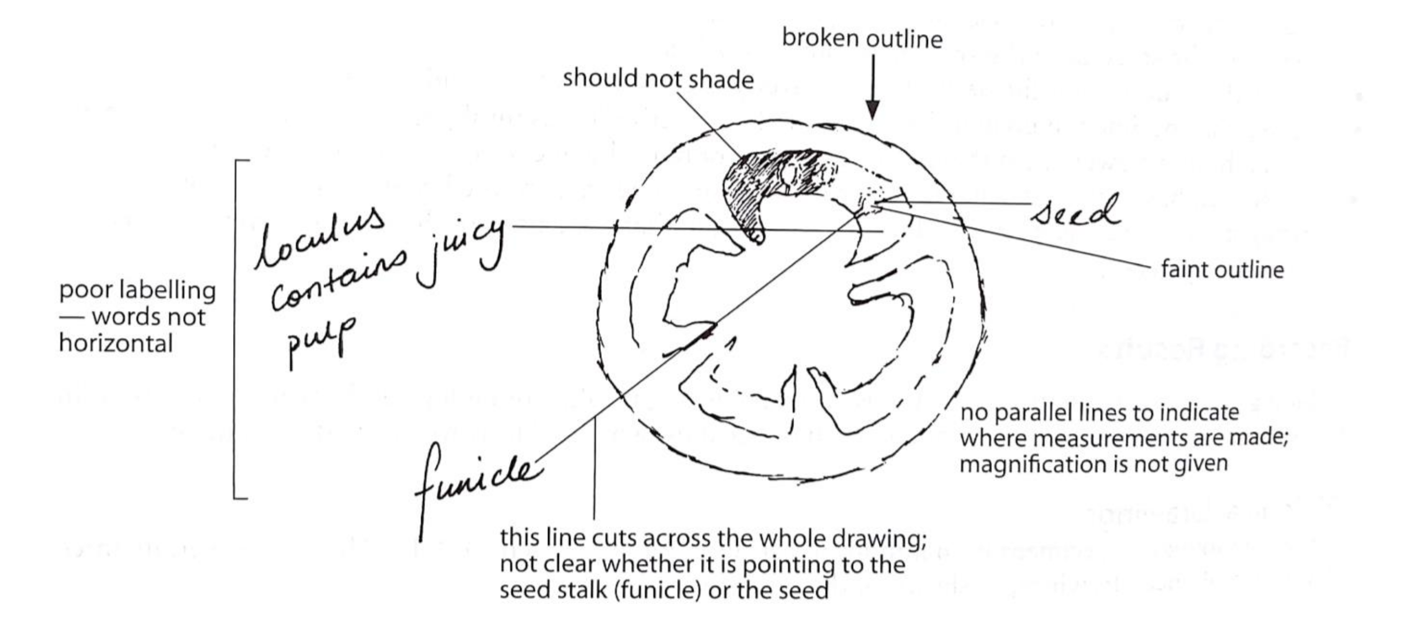
Transverse Section of a Tomato Fruit



Magnification = size of drawing (cm) / actual size (cm) x
= 9.0 / 4.5
= 2.0 x (to 1 d.p.)

(Pic: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2007). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

Here is an example of a poor biological drawing.



(Pic: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2007). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

How to calculate the magnification of scientific drawing?

$$\text{magnification} = \frac{\text{size of drawing (cm)}}{\text{actual size (cm)}} \quad \text{x}$$

In summary, have you gotten STAMP'D for approval?

- **S**ize – at least 2/3 of space provide
- **T**itle of drawing
- **A**ccuracy – showing all details
- **M**agnification
- **P**roportion
- **D**rawing – sharp, clear lines

2. Tabulating Data

When carrying out experiments, you will have to take down raw data – both qualitative and quantitative. It is therefore important for you present your data in a clear and logical manner.

Quantitative data: It is a good practice to draw a table **before** you begin an experiment then enter the data straight into the table on collection.

A good table should…

- Have independent variable in the extreme left column
- Have dependent variables or qualitative observations in the following columns
- Clear headings with units
- **Not** have units in the body of the table
- Group measurements together if experiment is repeated
  (So that an average of the measurement can be later calculated)

Here is an example of a good table.

The independent variable is always recorded in the first column of the table.

The dependent variables will be recorded in subsequent columns.

Units are put only in the header row. Do not put the units in the body of the table, i.e. do not put units for every value that you record.

Concentration of salt solution/ mol/dm^3	Potato strip	Initial length of potato strip/cm	Final length of potato strip/cm	Change in length of potato strip/cm	Average change in length/cm
0.2	1				
	2				
	3				
0.4	1				
	2				
	3				
0.6	1				
	2				
	3				

(Table: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2007). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

What are the three types of variables?

The things that are changing in an experiment are called **variables**. There are three types of variables:

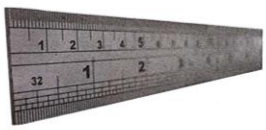
- **Independent** variable is the factor that is ____________________________.
- **Dependent** variable is the factor that ____________________________due to the varied factor.
- **Constant** variables: parts of the experiment that are kept the ______________ in each test.

Degree of accuracy

You should use the correct number of significant figures when recording the results.

All data should be written in tables to the **same** number of decimal places. This number would be determined by the precision of the instrument used to measure the data.

The table shows some commonly used apparatus in the laboratory and the common accuracy values for each apparatus.

Instrument		Unit(s)	Smallest division	Data leave to…
	Weighing/mass balance	g	0.01 g	2 d.p.
			0.1 g	1 d.p.
	thermometer	^oC	1 ^oC	1 d.p.
	ruler	mm, cm	0.1 cm	1 d.p.
	Stop watch	s, min	0.01 s	2 d.p.
			0.1 s	1 d.p.
	Measuring cylinder	cm^3	1 cm^3	1 d.p.
	syringe	cm^3 [1 m*l* = 1 cm^3]	0.2 cm^3	1 d.p.

(Table: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2014). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

Degree of accuracy for calculations

The final answer for calculation should be left in the number of significant figure according to the raw data that is the **least** accurate.

Example:
Calculate the size of an object if the drawing is measured to be 24.6 cm and has a magnification of x25.

3 s.f.

2 s.f.

size of real object = size of image / magnification
size of real object = 24.6 / 25
= 9.84
≈ **9.8 cm**

Answer left to 2 s.f.
because in the raw data,
the least number of s.f. is 2

Qualitative data: It is presented in a descriptive format. It is good practice to use simple language that everyone can understand.

Here are some examples of good qualitative data.

Not so good observations	Good observations
(Universal indicator) The solution turned red.	The solution turned from green to red.
(Benedict's test) The solution turned brick-red.	Brick-red ppt was formed.
(Limewater test) The solution turned milky / chalky.	White ppt was formed.
(Photosynthesis) Some parts of the leaf turned blue-black.	The parts of the leaf that were originally green were stained blue-black. The parts of the leaf that were originally white were stained brown.
(Iodine test) No change.	Iodine solution remained brown.

(Table: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2014). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

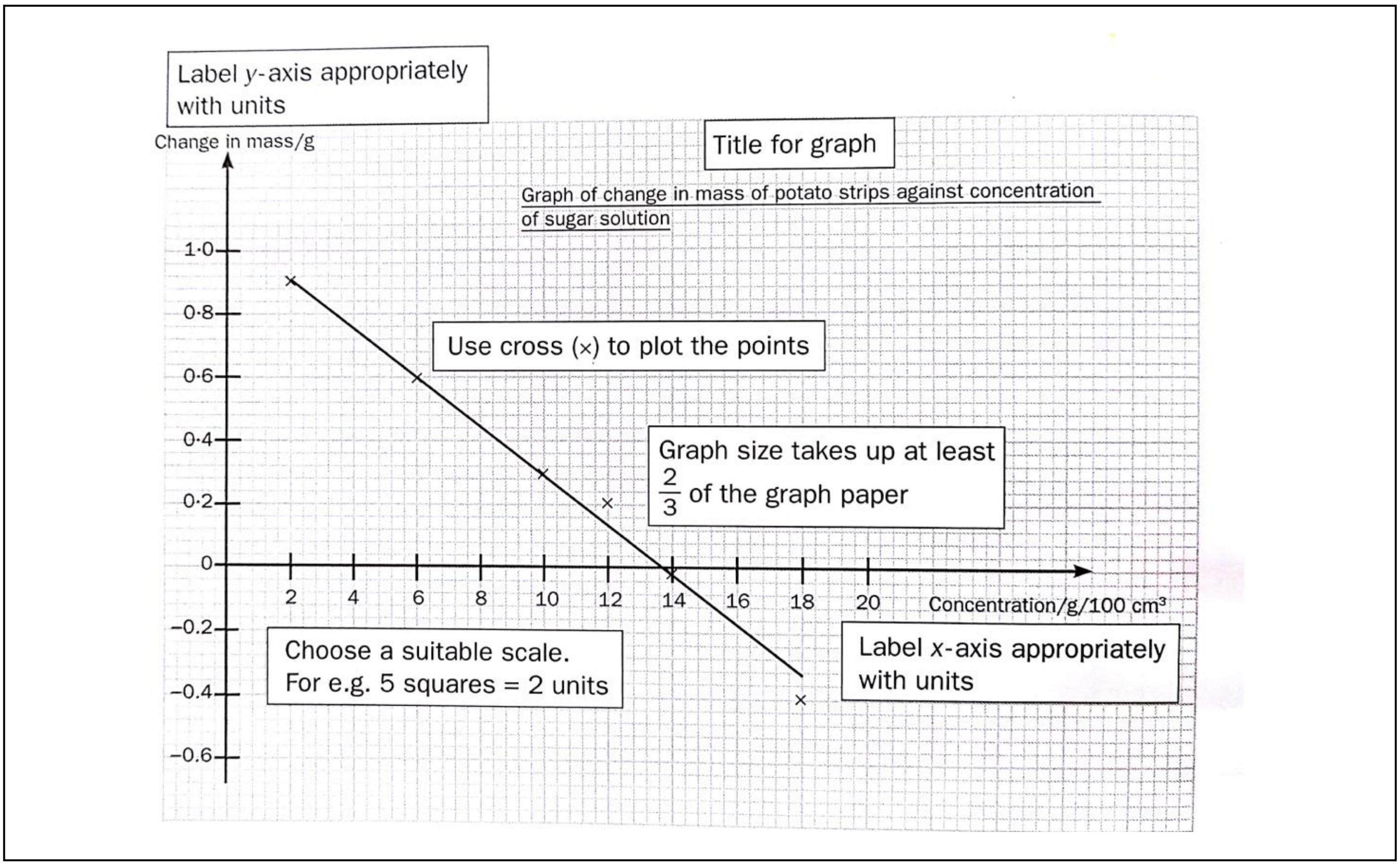
3.Plotting Graphs

Graphing skills can be assessed both in O-Level written papers and practical assessment.

A good graph should…

- Have both axes clearly labelled with the quantity measured and units
- Have independent variable on the x-axis and dependent variable on the y-axis
- Have a suitable scale
- Cover at least 2/3 of the grids
- Use crosses (x) to plot the data clearly
- Use a smooth best-fit line or curve to join up the points
- **Not** have the line extending beyond the first and last points (No extrapolation)

Here is an example of a good graph.



(Table: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2014). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)

How to choose a suitable scale?

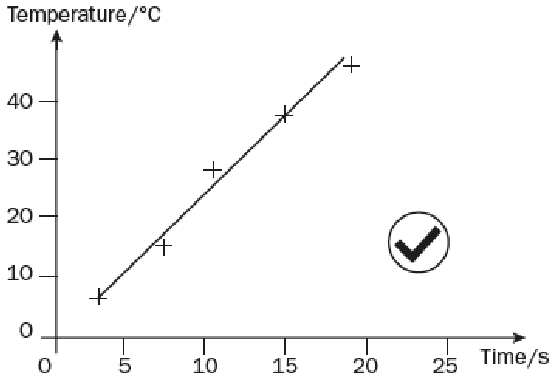
You should consider the following before marking the scales:

- the maximum and minimum values of each variable
- the size of the graph paper
- whether 0.0 should be included as a data point
- do not use a difficult scale (e.g. multiples of 3, 7, 11 etc)

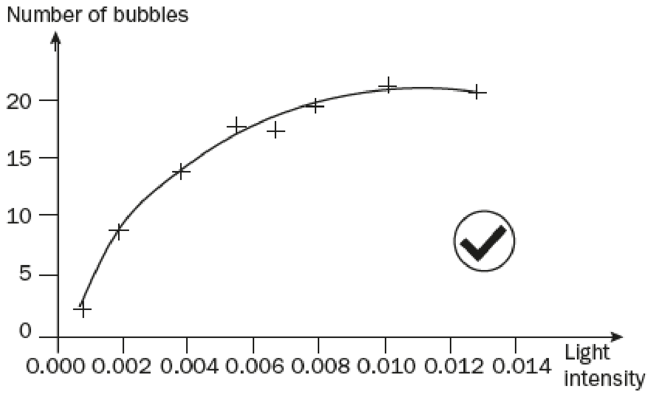
How to decide on a best-fit line or curve?

There is no definitive way of determining where a line of best fit should be drawn. A good rule of thumb is to make sure that there are **as many points above and below the line**. Often the line should pass through, or very close to, the majority of plotted points.

Figures 17 and 18 show examples of desirable graphs.

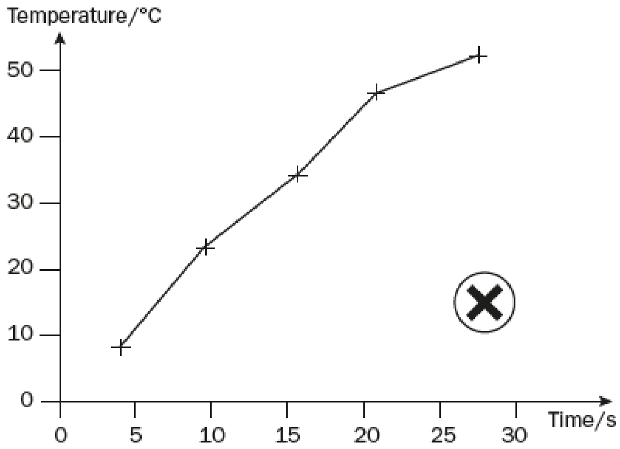


▲ **Figure 17**

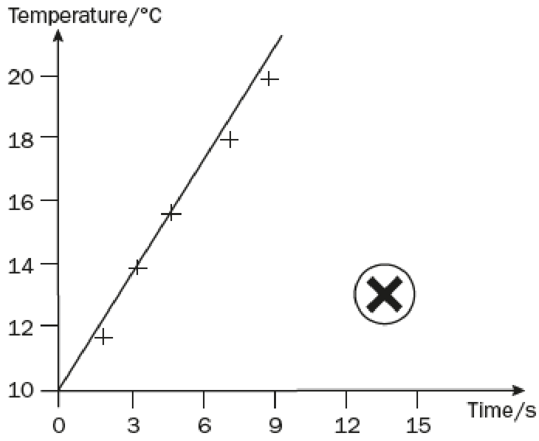


▲ **Figure 18**

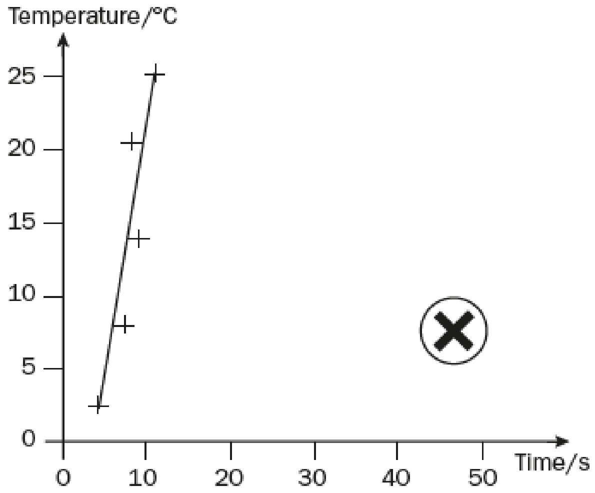
Figures 19 to 23 show examples of undesirable graphs.



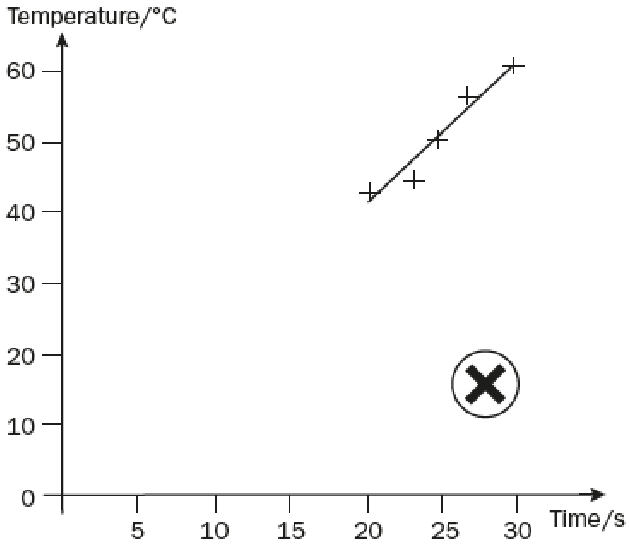
▲ **Figure 19** The points are joined from point to point.



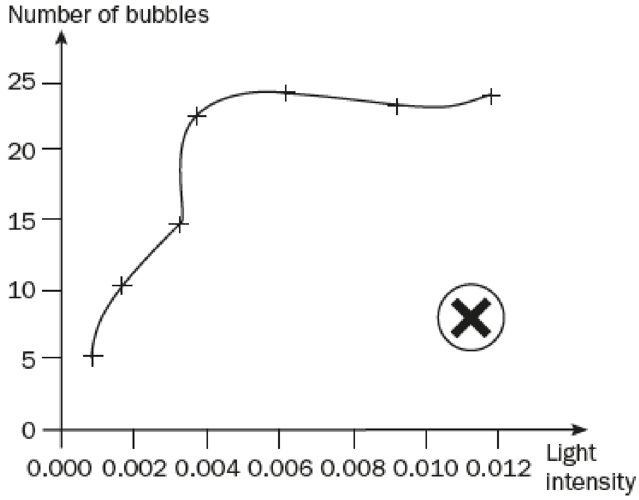
▲ **Figure 20** The scale for the *x*-axis is awkward, and there is an unequal number of points on either side of the line. The line should not be drawn beyond the plotted points.



▲ **Figure 21** The scale for the *x*-axis is not appropriate, resulting in a small graph.



▲ **Figure 22** The points are crowded at one corner of the graph paper due to inappropriate scale used for the *x*-axis.



▲ **Figure 23** The points are joined up without drawing a smooth curve.

In summary, make sure you aim for the ALPS in graphing!

- **A**xes – have labels with units
- **L**ine – smooth best-fit line or curve
- **P**lotting – points plotted clearly using crosses (x)
- **S**cale – easy to read and covers at least 2/3 of the grids

4. Simple Chemical Tests

Food tests

Test for Starch – Iodine Test

Procedures:

1. Add a drop of ____________________ to a drop of solution from the food sample on a white tile.

Results:

- If starch is **present**, ________________ solution turns ________________.
- If starch is **absent**, solution remains ________________.

Test for Reducing Sugars – Benedict's Test

Procedures:

1. Add 2 cm^3 ________________________________to 2 cm^3 of food sample.
2. Shake well.
3. Heat in a beaker of ________________water for 3 - 5 minutes.

Results:

- If **large** amount of reducing sugar is present, ________________________ is observed.
- If **moderate** amount of reducing sugar is present, ________________________ is observed.
- If **small** amount of reducing sugar is present, ________________________ is observed.
- If reducing sugar is absent, solution remains ________________________.

Test for Proteins – Biuret Test

Procedures:

1. Add 2 cm^3 of ________________________ to 2 cm^3 of food sample.
2. Shake well.
3. Add ________________________ drop by drop. Shake after each drop.

Results:

- If proteins are **present**, __________________ solution turns __________________.
- If proteins are **absent**, solution remains __________________.

Test for Fats – Ethanol Emulsion Test

Procedures:

1. Add 2 cm^3 of __________________l to 2 cm^3 of food sample.
2. Shake well.
3. Add 2 cm^3 of __________________. Shake well.

Results:

- If fats are present, a ____________________________________is observed.
- If fats are absent, solution remains __________________.

Universal indicator

This indicator is used to show pH of solution. The table shows the colour of indicator at different pH.

pH	**1**	**3**	**5**	**7**	**9**	**11**	**13**
Colour	Red	Orange	Yellow	Green	Blue	Indigo	Violet

Limewater test

This is used to show the presence of carbon dioxide in an experiment.

Condition	Observation
Carbon dioxide absent	Limewater remains clear
Carbon dioxide present	White ppt observed

Hydrogencarbonate indicator

This indicator is used to show carbon dioxide concentration in solution. The table shows the colour of indicator at different levels of carbon dioxide concentration.

Concentration of carbon dioxide	Indicator turns
Highest	Yellow
Higher	Orange
Atmospheric level	Red
Low	Magenta
Lowest	Purple

Cobalt chloride paper

This indicator is used to show the presence of water, or humidity, in the environment. Cobalt paper is initially blue in colour.

Condition	Observation
Water absent	Paper remains blue
Water present	Paper turns from blue to pink

5. Planning an Experiment

As a Science student, you should be able to make use of your knowledge and practice to plan investigations to solve problems.

A good plan should include…

- Independent, dependent, and constant variables
- A step-by-step description of the procedure
- Describe how variables are kept constant and/or changed
- Describe how the data collected can be used to reach a conclusion
- Identify risks of the experiment and state the precautions that should be taken to keep risks to a minimum

Here is an example.

Describe how variables are kept constant / changed.

Number your steps. Be very clear and precise.

Procedures:

1. Remove a green leaf from a plant that has been exposed to sunlight for 1 hour and another that is kept in a dark room for 1 hour.
2. Put the 2 leaves in boiling water for 2 min.
3. Put the boiled leaves in a boiling tube containing some ethanol. Place the boiling tube in a beaker of hot water. The Bunsen flame should be turned off before putting the tube in hot water.
4. Gently remove the leaves and put them into the hot water.
5. Remove the leaves and spread them evenly on a white tile.
6. Add a few drops of iodine solution to the leaves.

Conclusion:

1. If iodine solution remains brown, starch is not present. Plant has not carried out photosynthesis.
2. If iodine solution turns blue-black, starch is present. Plant has carried out photosynthesis.

Write down how you can interpret the results.

(Experiment adapted from: Lam, P. K.& Lam, E. Y. (2014). G.C.E. O Level Biology matters. Singapore: Marshall Cavendish Education.)

6. Sources of Error

Experimental errors

Errors are **uncontrolled variables** that could affect your results.

Experimental errors may arise due to:
- Inconsistencies of biological specimens
- Limitation of instrument used, resulting in a lack of precision
- Influence of environmental condition, such as wind, temperature, humidity, on the experimental set-up

Suggesting improvements

You may be asked to suggest how the investigation you have done could be improved. Your improvements should be aimed at getting more valid or reliable results to the question the investigation was trying to answer.

The improvements you could suggest are:
- Do several repeats in the experiment and calculate a mean
- Using a more precise instrument
- How to control variables that were not controlled previously

Here are some examples of sources of errors.

Source of error	Effect on results	Improvement to experiment
Specimens provided may come from different potato plants.	Different amount of catalase may be present in cells, resulting in higher or lower production of oxygen. Hence, the number of bubbles produced **may** be **higher or lower than expected**.	Use the same potato tuber for each concentration of solution.
Potato slices were trapped in the froth.	As potato slices take up space and volume, the height of froth measured **may** be **higher than expected**.	Use one slice of potato and repeat the experiment for the second slice. Calculate the average change in height of froth.
Potato slices tend to stick to each other.	As surface area exposed to hydrogen peroxide decreases, less oxygen **may** be produced, resulting in **lesser number of bubbles counted than expected**.	Use one slice of potato and repeat the experiment for the second slice. Calculate the average number of bubbles produced.
Water could have evaporated from the sucrose solution. This could increase the concentration of sucrose solution surrounding the stalk.	There is an increase in net movement of water molecules out of the plant tissue, causing it to curve outwards by a lesser extent. Hence, the length of the stalk **may** be **shorter than expected**.	Cover the petri dish containing the sucrose solution and stalk to prevent evapouration of water.

Number of oxygen bubbles produced is too fast to accurately count them	Fewer than expected bubbles may be counted and recorded.	Repeat the experiment a few times and calculate the average number of bubbles produced to increase the reliability of the experiment.
Size of bubbles produced may vary	Height of froth measured may be higher or lower than expected.	Repeat the experiment a few times and calculate the average height of froth to increase the reliability of the experiment.
A wide range of temperature, pH or concentration is used in the experiment.	Relationship between variables cannot be accurately observed.	Use a narrower range of temperatures, pH or concentration/ carry out experiment at more frequent intervals
The instrument used is not precise enough to measure small volumes.	The measurement recorded may be **higher or lower than expected**.	Use a more accurate instrument of measurement such as a burette.
Colour perception/ difficult to detect colour changes	The time taken for the colour to change may be **faster or slower than expected**.	Use a colorimeter/ colour chart

(Table: Lam, P. K., Lam, E. Y., & Lee, C. Y. (2014). G.C.E. O Level Biology Matters Practical Book. Singapore: Marshall Cavendish Education.)