CATHOLIC HIGH SCHOOL
DEPARTMENT OF SCIENCE

PRACTICAL ASSESSMENT

REVISION KIT FOR BIOLOGY 2022

CONTENTS

This revision kit only serves as a supplement to the practical file containing the weekly practical tasks.

Revise the practical file prior to assessment.

PRACTICAL ASSESSMENT

Paper 3 (1 h 50 min, 40 marks)

This paper will comprise two or three compulsory practical questions, based mainly on experimental skills and investigations.

- Planning (P)
- Manipulation, measurement and observation (MMO)
- Presentation of data and observations (PDO)
- Analysis, conclusions and evaluation (ACE)

One or more of the questions may incorporate assessment of Planning (P) and require candidates to apply and integrate knowledge and understanding from different sections of the syllabus. The assessment of PDO and ACE may include questions on data-analysis which do not require practical equipment and apparatus.

The assessment of Planning (P) will have a weighting of 15%. The assessment of skill areas MMO, PDO and ACE will have a weighting of 85%. This accounts for **20%** of the total weighting in the subject for the GCE O-Level assessment.

Candidates are not allowed to refer to notebooks, textbooks or any other information during the assessment.

COMPETENCY LIST

(A) Planning (P)

Candidates should be able to
(A1) identify key variables for a given question/problem
(A2) outline an experimental procedure to investigate the question/problem
(A3) describe how the data should be used in order to reach a conclusion
(A4) identify the risks of the experiment and state precautions that should be taken to keep risks to a minimum

(B) Manipulation, measurement and observation (MMO)

Candidates should be able to
(B1) set up apparatus correctly by following written instructions or diagrams
(B2) use common laboratory apparatus and techniques to collect data and make observations
(B3) describe and explain how apparatus and techniques are used correctly
(B4) make and record accurate observations with good details and measurements to an appropriate degree of precision
(B5) make appropriate decisions about measurements or observations

(C) Presentation of data and observations (PDO)

Candidates should be able to
(C1) present all information in an appropriate form
(C2) manipulate measurements effectively for analysis
(C3) present all quantitative data to an appropriate number of decimal places/ significant figures

(D) Analysis, conclusions and evaluation (ACE)

Candidates should be able to
(D1) analyse and interpret data or observations appropriately in relation to the task
(D2) draw conclusion(s) from the interpretation of experimental data or observations and underlying principles
(D3) make predictions based on their data and conclusions
(D4) identify significant sources of errors and explain how they affect the results
(D5) state and explain how significant errors may be overcome or reduced, as appropriate, including how experimental procedures may be improved.

Candidates may be asked to carry out exercises comprising:

1. simple physiological experiments, involving tests for food substances, enzyme reactions, hydrogencarbonate indicator solution, cobalt(II) chloride paper and so on;

2. simple physiological experiments, involving the use of sharp instruments on plant or animal materials (accurate observations of these specimens will need a hand lens of not less than ×6 magnification for each candidate);

3. manipulative skills in assembling apparatus, in using chemical reagents and in using such instruments as mounted needles, scalpels and razor blades, forceps and scissors;

4. measurements using appropriate instruments (e.g. thermometer, syringe, measuring cylinder, ruler and so on) and simple arithmetical calculations;

5. familiar and unfamiliar techniques to record observations and make deductions from them;

6. recognition and observation of features of familiar and unfamiliar biological specimens, recording observations and making deductions about functions of whole specimens or their parts; and

7. clear line drawings of the specimens provided, indicating magnification and labelling familiar structures.

This is not intended to be an exhaustive list. Candidates are expected to be familiar with the use of data-loggers. Assessment of Skill P may include the appropriate use of data-loggers.

NOTES ON COMPETENCIES SKILLS

COMPETENCIES	Page(s)
Planning (P)	
identify key variables for a given question/problem	6-7
outline an experimental procedure to investigate the question/problem	
describe how the data should be used in order to reach a conclusion	
identify the risks of the experiment and state precautions that should be taken to keep risks to a minimum	8
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	9
describe and explain how apparatus and techniques are used correctly	10
make and record accurate observations with good details and measurements to an appropriate degree of precision	10-17
make appropriate decisions about measurements or observations	
Presentation of data and observations (PDO)	
present all information in an appropriate form	18-27
manipulate measurements effectively for analysis	28-30
present all quantitative data to an appropriate number of decimal places/ significant figures	
Analysis, conclusions and evaluation (ACE)	
analyse and interpret data or observations appropriately in relation to the task	30-34
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	35-38
state and explain how significant errors may be overcome or reduced, as appropriate, including how experimental procedures may be improved	

(A) Planning (P)

(A1) Identify key variables for a given question/problem

- What variables should I change, measure and keep constant?

Name of variable	Meaning
Independent	This is the variable that you deliberately **change** to observe what effect it has.
Dependent	This is the variable that you **measure**. It is the variable that you think will change because you have changed the independent variable.
Controlled	This is a variable or variables that you should keep **constant**, so that any test you do is a fair test.

(A2) Outline an experimental procedure to investigate the question/problem

- What is the **control** setup, if required?
- What techniques should I use?
- How should the **variables** be **manipulated** e.g. measured/ varied/ kept constant?
- What are the **instruments** I need?
- How many **repeats** should I do? (To take average)
- What is a suitable **range** and **interval**?

(A3) Describe how the data should be used in order to reach a conclusion

- How should I interpret the **data**?
- Are there any **calculations** I need to make?
- What is the best way to present my findings?

Worked example:

Describe an investigation you could carry out to determine the concentration of salt solution that would cause fresh onion epidermal cells to become like the cell in Fig. 1. (P) **[4]**

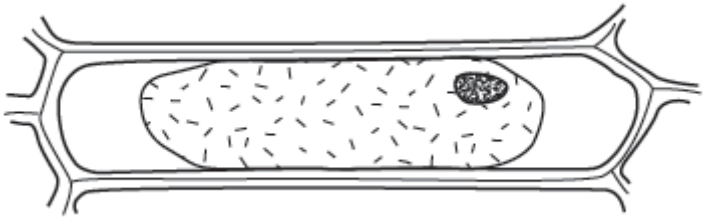

Fig. 1

Answer	Remark
use a range of different concentrations of salt solutions [1]	identify independent variable
extra detail, e.g. stated concentrations / minimum of 5 concentrations [1]	identify suitable range and interval
same onion / same time / same temperature / same sized piece of epidermis [1]	identify variables to be kept constant
microscope [1]	identify instrument needed
recording approach – number / presence of plasmolysed cells [1]	identify dependent variable
handling of data to determine salt concentration (using plotted graph of number of plasmolysed cells and concentration) [1]	identify interpretation and calculation approaches

EXERCISE 1:

Describe an investigation you could carry out using a test to compare the amount of reducing sugar in an unripe, immature fruit with a ripe, mature fruit. (P) **[4]**

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(A4) Identify the risks of the experiment and state precautions that should be taken to keep risks to a minimum

Equipment, Materials & Processes	Possible hazards	Measures to reduce risk posed by the hazards
Ethanol	Flammable	Place ethanol away from ignition sources. Water bath is used in the heating of alcohol.
Hydrogen peroxide	Corrosive	When in contact with skin, rinse sufficiently under running water.
Chemicals (e.g. Iodine solution, acids, alkalis)	Irritant	Wear safety googles.
Hot water bath	Danger of scalding	Wear safety googles for heating experiments.
Glassware	Cuts because of breakage	Exercise caution when using glasswares.
Sharp objects: Scalpel, penknife, glass slides, cover slips, etc.	Possibility of cuts	Exercise caution when using scalpel/penknife.

**This is not intended to be an exhaustive list.*

EXERCISE 2:

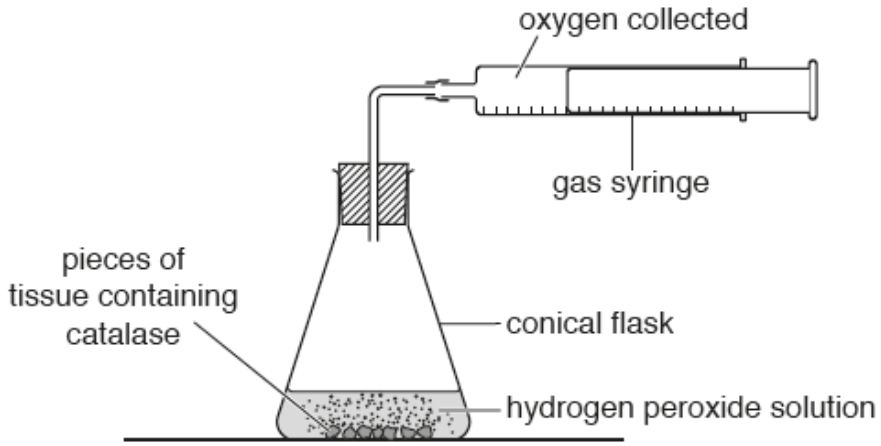

Fig. 2

(a) Giving full experimental details, describe how you could use the apparatus shown in Fig. 2 to investigate the effect of temperature on the activity of catalase. (P) **[5]**

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(b) State **one** safety precaution you would take when you carry out this experiment. Explain why this precaution is needed. (P) **[2]**

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(B) Manipulation, measurement and observation (MMO)

(B2) Use common laboratory apparatus and techniques to collect data and make observations

Common apparatus

- Sharp instruments (forceps, mounted needles, scalpels/ razor blades and
- scissors)
- Appropriate measuring equipment to measure volume, temperature, length, time and mass

No	Apparatus	Smallest Division	Uncertainty	Examples of recording
1	Burette	0.1 cm^3	0.05 cm^3	25.0 cm^3 25.00 cm^3, 25.05 cm^3
2	Electronic balance	0.1g	0.1 g	120.0 g, 121.1 g
		0.01 g	0.01 g	121.00 g, 121.10 g
3	Ruler	0.1 cm	0.1 cm	12.0 cm, 12.1 cm
4	Measuring cylinder (100 cm^3)	1 cm^3	0.5 cm^3	18.0 cm^3, 18.5 cm^3
5	Stopwatch (analogue)	0.1 s	0.1 s	36.0 s, 36.1 s
6	Stopwatch (digital)	0.1 s	0.1 s	28.1 s
		0.01 s	0.01 s	28.00 s, 28.11 s
7	Thermometer (–10 °C to 110 °C)	1 °C	0.5 °C	23.0 °C, 23.5 °C
8	Syringe (5m/)	0.2 m/	0.1m/	2.6 m/, 4.5 m/

EXERCISE 3:

Select the appropriate measuring equipment to measure volume, temperature, length, time, and mass

Task	Apparatus provided	Smallest division of instrument	Put a tick beside the apparatus which is most appropriate	Support your choice of instrument with a reason
1. Measuring 3.0 cm^3 of protease for an enzyme experiment	3 cm^3 dropper	0.5 cm^3		
	5 cm^3 syringe	0.2 cm^3		
2. Measuring 8 cm^3 of distilled water	100 cm^3 beaker	20 cm^3		
	10 cm^3 measuring cylinder	0.2 cm^3		
	1 cm^3 Syringe	0.1 cm^3		
3. Timing 2 minute intervals for 10 minutes.	Stopwatch	0.01 s		
	Clock	1 min		

(Modified from CPDD Science Unit, 2016)

- Microscopes and magnifying glass to view specimens (Appendix A)
- Data-loggers
- Syringe (Appendix B)

Common experimental techniques

- Food tests (Appendix C)
- Preparing slides of temporary mounts (Appendix D)
- Preparing specimen for drawing by cutting longitudinal or transverse sections (Appendix E)
- Prepare leaf for starch test (Appendix F)
- Hydrogen carbonate indicator and cobalt chloride paper (Appendix G)

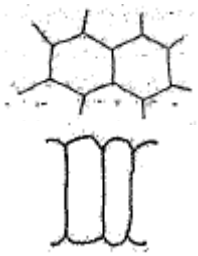
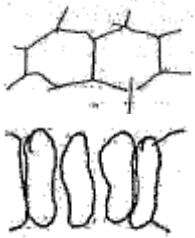
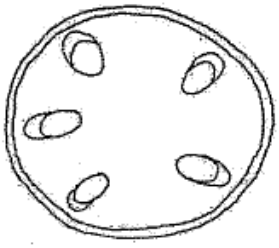
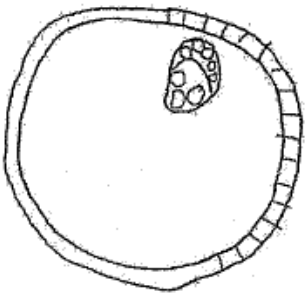
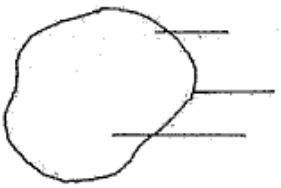
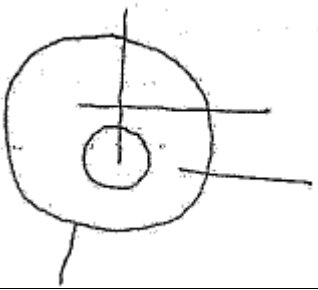
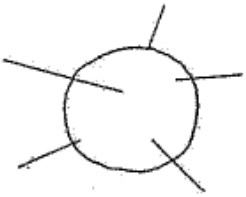
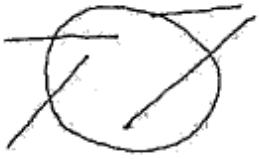
(B3) Describe and explain how apparatus and techniques are used correctly

This involves understanding the purpose behind steps in a procedure and the selection and use of instruments. Refer to Appendix H for a practice activity.

(B4) Make and record accurate observations with good details and measurements to an appropriate degree of precision

Biological drawing

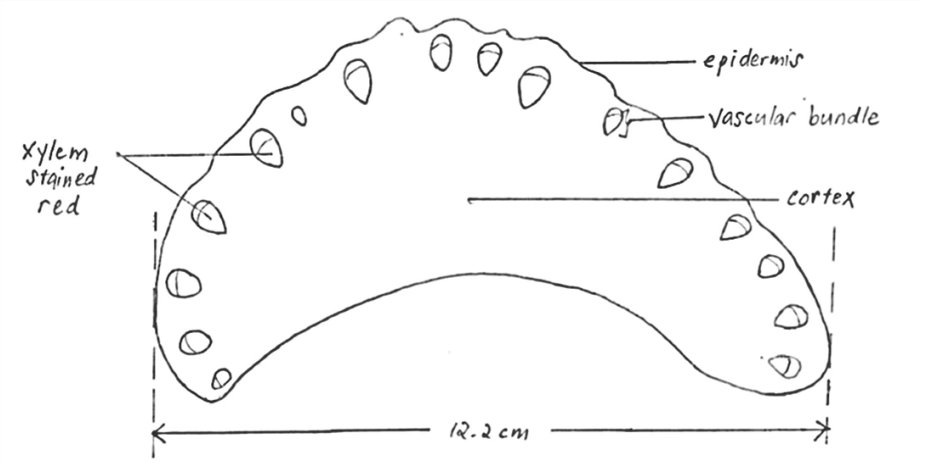
- Drawn in **pencil** for ease of erasing
- Resembles actual specimen in terms of its size, shape and proportion
- **Label lines ruled**, neat and **do not intersect each other**
- Occupies **more than half** of the space given
- Include **title**
- **Magnification** calculated and shown as 'drawing length / actual length = __ x'.

Right!	Wrong!
Smooth and continuous lines 	Sketched 
Lines should always meet exactly, e.g. plant cells animal cells 	
Nuclei are granular (consisting of dots), not shaded 	
Low-power diagrams show areas only, never cells, e.g. TS plant stem 	
Arrowheads are not necessary. Cut across as little of the drawing as possible. Label lines should never cross. 	
Keep label lines parallel (if possible) or evenly radial (if possible). 	

Refer to Appendix I for common biological diagrams

Worked example:

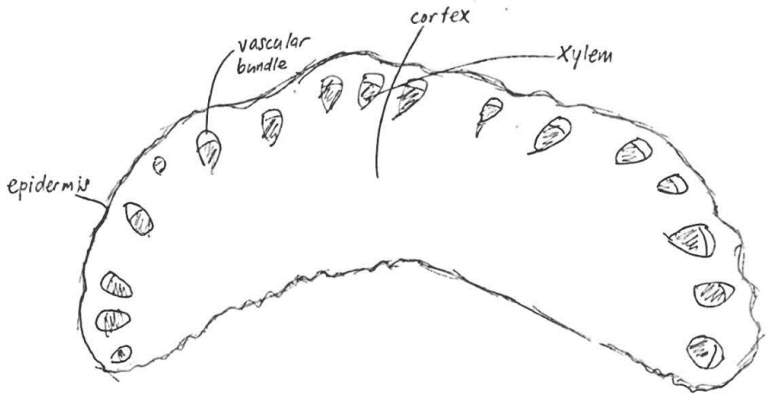
Good example



Transverse section of a celery stalk stained with red dye

Actual size = 2.5 cm
Length of drawing = 12.2 cm
Magnification = 12.2/2.5
= 5.0 x

Poor example



3 mistakes observed:

1. label lines cross each other and are not ruled. Where possible, label lines should be consistently vertical or horizontal ;
2. magnification is not shown ;
3. use of broken lines with shading.

(CPDD Science Unit, 2016)

EXERCISE 4:

Fig. 4 shows a transverse section of a marrow fruit.

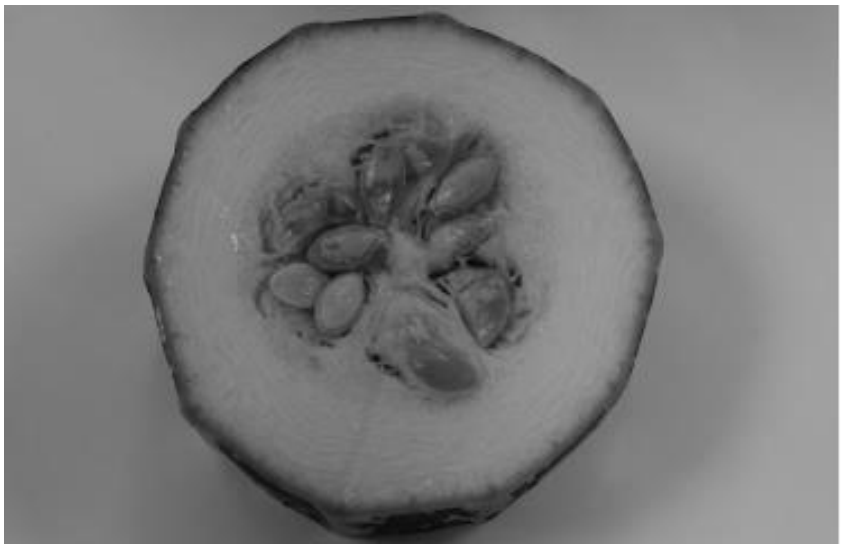


Fig. 4

Make a large, labelled drawing of the section through the fruit to show the arrangement of the seeds and fruit wall. (MMO) **[5]**

EXERCISE 5:

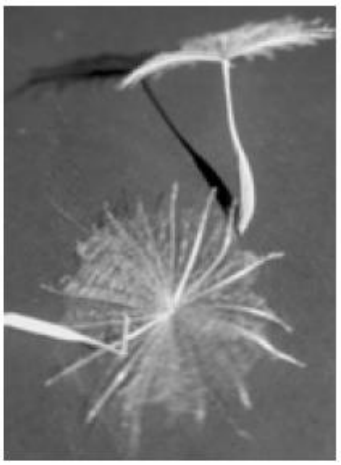


Fig. 5a x 1.5

Fig. 5b x 2

(a)(i) In the space below, make a large drawing of the lower part of the fruit shown in Fig. 5a which contains the seed. Labels are **not** required. **[4]** (MMO)

(ii) Measure the length of your drawing and the length of the same part of Fig. 5a. Mark clearly on Fig. 5a the part of the fruit which you have drawn and measured.

Length of drawing .....

Length on Fig. 5a .....

Use these measurements to calculate the magnification of your drawing compared with the actual size of the fruit. Show your working. (MMO, PDO)

Magnification .....

[2]

(b) State two ways in which the dispersal structures of the two fruits can be seen to be different. (ACE)

1. .....

.....

2. .....

.....

[2]

Describing qualitative observations

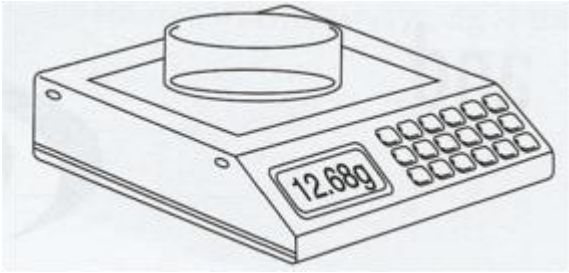
Observation	Description
Colour	• State the colour of the contents of the test tube **before** and **after** the reaction and also during the reaction if appropriate
State or texture of products	• State (solid, liquid or gas) • Texture (powdery, gelatinous, viscous, etc.)
Appearance	• Flaccid or turgid • Decrease or increase in size (length, thickness) of tissue
Clarity or turbidity	• Clear (transparent), turbid or opaque
Presence of gases, froth or effervescence	• Colour and odour of gas produced • Thickness of froth or foam
Temperature changes	• Decrease (heat absorbed) or increase (heat released)

Recording measurements to an appropriate degree of precision

- Refer to page 9 for the table of common laboratory apparatus
- Follow instruction from question (e.g. to nearest second or nearest mm) for degree of precision **if given.**

EXERCISE 6:

Electronic balance

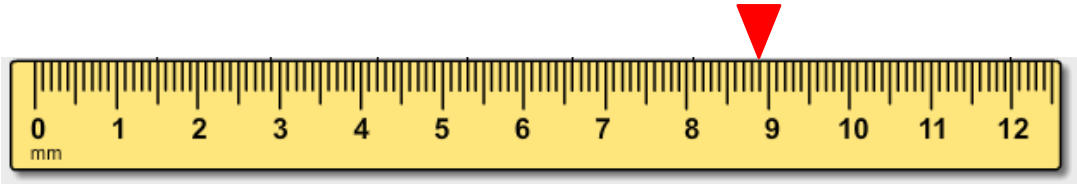


Smallest division: …….

Uncertainty: …….

Recorded reading: …….

Ruler



Smallest division: …….

Uncertainty: …….

Recorded reading: …….

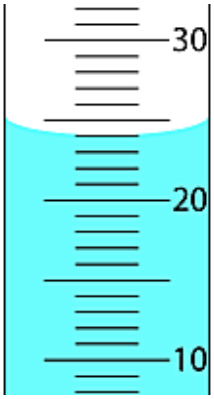
Syringe (5ml)

Smallest division: …….

Uncertainty: …….

Recorded reading: …….

Measuring cylinder

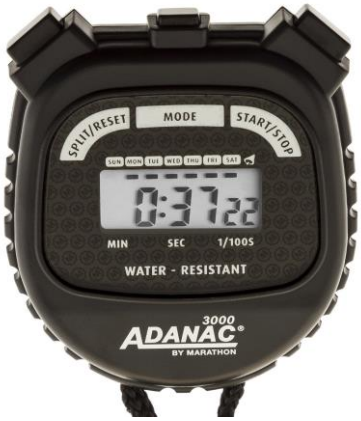


Smallest division: …….

Uncertainty: …….

Recorded reading: …….

Stopwatch (digital)

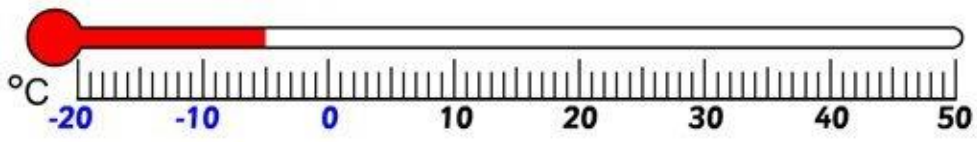


Smallest division: …….

Uncertainty: …….

Recorded reading: …….

Thermometer



Smallest division: …….

Uncertainty: …….

Recorded reading: …….

(C) Presentation of data and observations (PDO)

(C1) Present all information in an appropriate form

Table

Independent variable

Dependent variable

Units in headings

concentration of sugar solution (mol)	length of potato at start (mm)	length of potato after 24 hours (mm)		mean length (mm)	mean change in length (mm)	% change in length (%)
		piece 1	piece 2			
0	60	60	64	62.0	+2.0	+3.3
0.2	60	58	59	58.5	-1.5	-2.5
0.4	60	55	55	55.0	-5.0	-8.3
0.6	60	54	54	54.0	-6.0	-10.0
0.8	60	53	54			
1.0	60	52	53	52.5	-7.5	-12.5

Consistent d.p in readings in a column

Answers:
- 53.5 (mean length), -6.5 (mean change), -10.8 (% change)

Worked examples:

Give reasons how each of the following tables can be improved.

1.

Number of potato slices	4	8	12	16
Height of froth / cm	5.0	8.5	10.1	11.5

Preferably, headings with units should be in top row instead of first column.

2.

Number of potato slices	Height of froth
16	11.5 cm
12	10.1 cm
8	8.5 cm
4	5.0 cm

Units should be included with headings and not with the values in the table.

3.

Number of potato slices	Height of froth (cm)	
4	4.8	5.0
8	8.3	8.5
12	9.8	10.1
16	11.2	11.5

Average (mean) should be calculated and included in the table as a new column.

4.

Number of potato slices	Trials		Mean
4	4.8	5.0	4.9
8	8.3	8.5	8.4
12	9.8	10.1	9.95
16	11.2	11.5	11.35

What is the physical quantity that is measured as the dependent variable? Replace trials and mean with height of froth (cm) and mean height of froth (cm) respectively.

EXERCISE 7:

Some students investigated the effect of different concentrations of sucrose solution on potato tissue. One 4 cm potato strip was placed in each of four sucrose solutions of different concentrations for 30 minutes. The length of each strip was then measured and recorded as 4.3 cm, 4.1 cm, 3.8 cm and 3.6cm for sucrose concentration of 0.2 M, 0.4 M, 0.6 M and 0.8 M respectively.

Present the recorded readings in a table and calculate the change in length for each potato strip in the space provided below. **[4]**

Types pf Graphs

a) Line Graph

Axes

- X and Y axes **labelled with units**; **independent variable** on x-axis, **dependent variable** on y-axis
- Need not start from zero at both axes
- Include a suitable **title**

Size/scale

- Ensure that size of graph is **at least 50% of the graph paper** along both axes of graph paper (Fig. 6)
- Use sensible ratio for scale, e.g., 2 cm on the graph paper representing 1 or 2 or 5 units of the variable (or 10, 20 or 50 etc.)

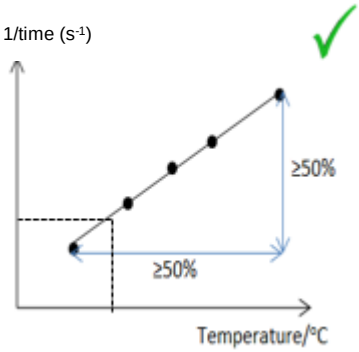


Fig. 6

Plotting

- All points **plotted correctly and clearly** with a 'x', '●' or 'o'
- Each data point should be plotted to an accuracy within one half of the smallest square on the grid
- Identify and circle anomalous points (shouldn't have more than 1)

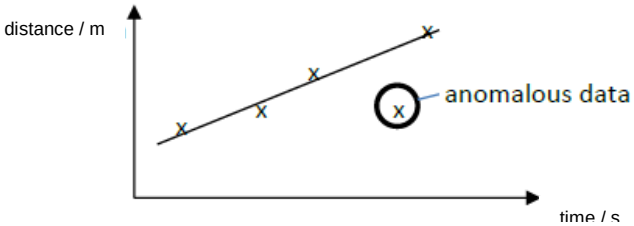


Fig. 7

Line

- Best fit line to reflect a certain trend:
  1. **not to be drawn from point to point** (Fig. 8a); equal number of points above and below the line with points being approximately equal distances to the line
  2. **can be a curve** (bended line) rather than a straight line depending on plotted points (Fig. 8b)
  3. no extrapolation/ extension of the line **beyond 2 extreme plotted points** (Fig. 8c)
  4. if more than one line is drawn on a graph paper:
     i. use **different plotting points** for different lines (i.e. 'x', '●' or 'o')
     ii. label the lines or use a legend
  5. should have about **equal number of points on either side** of the line over its entire length

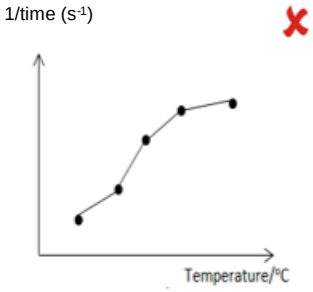


Fig. 8a

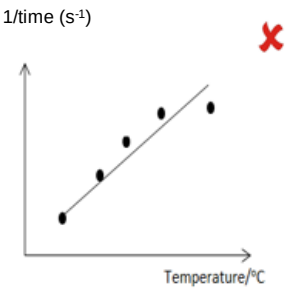


Fig. 8b

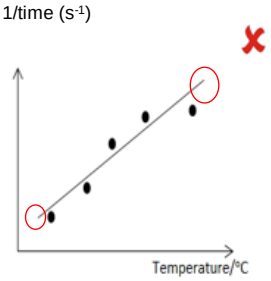
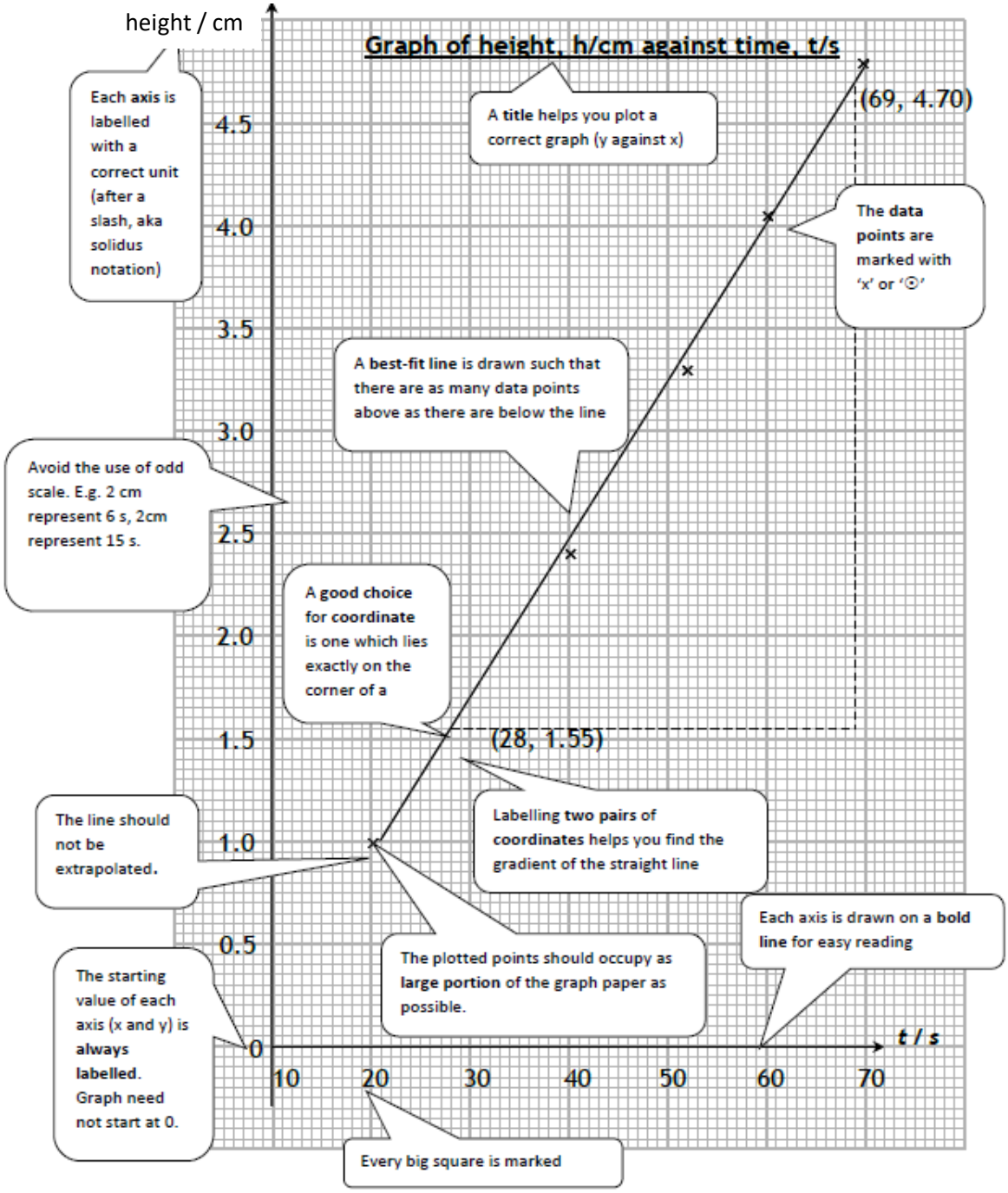


Fig. 8c

Worked example:

Important pointers in a plotted graph

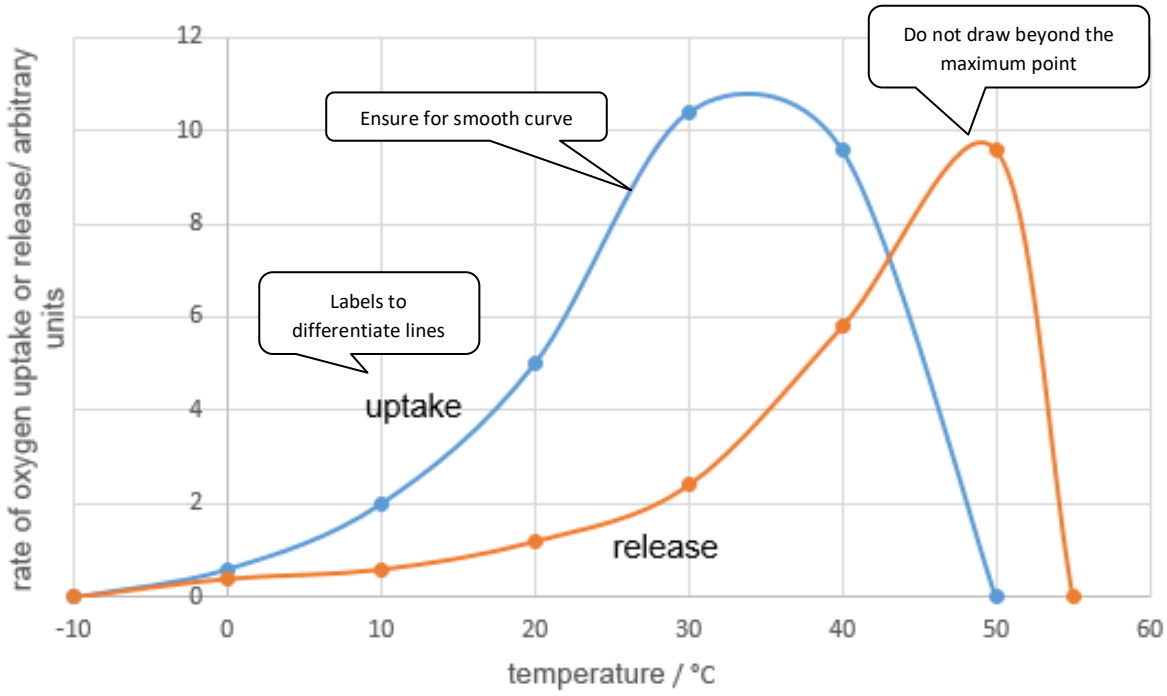


(CPDD Science Unit, 2016)

Worked example:

<u>Important pointers in a plotted graph</u>

Graph of rate of oxygen uptake or release against temperature

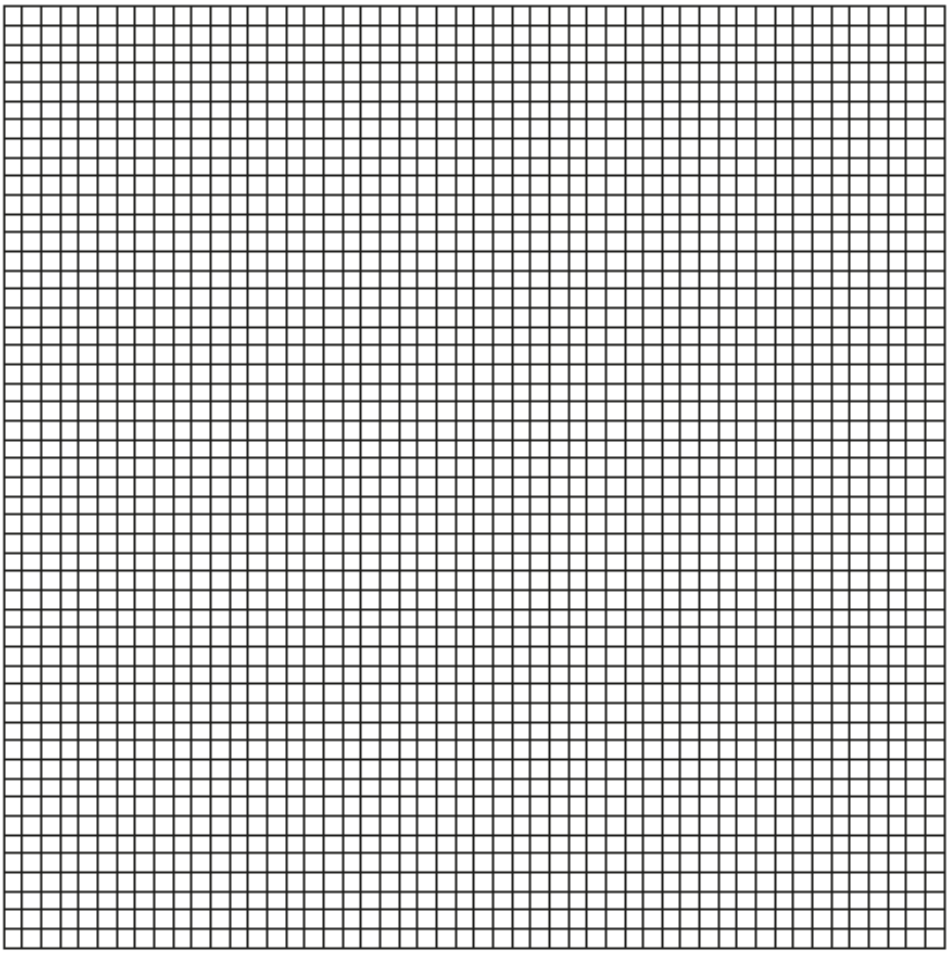


EXERCISE 8:

Using the data in Table 1, plot a line graph to show the effect of pH on the activity of catalase. **[4]**

Table 1

pH	volume of oxygen produced / cm^3
5.0	12
6.0	45
7.0	88
8.0	57
9.0	8

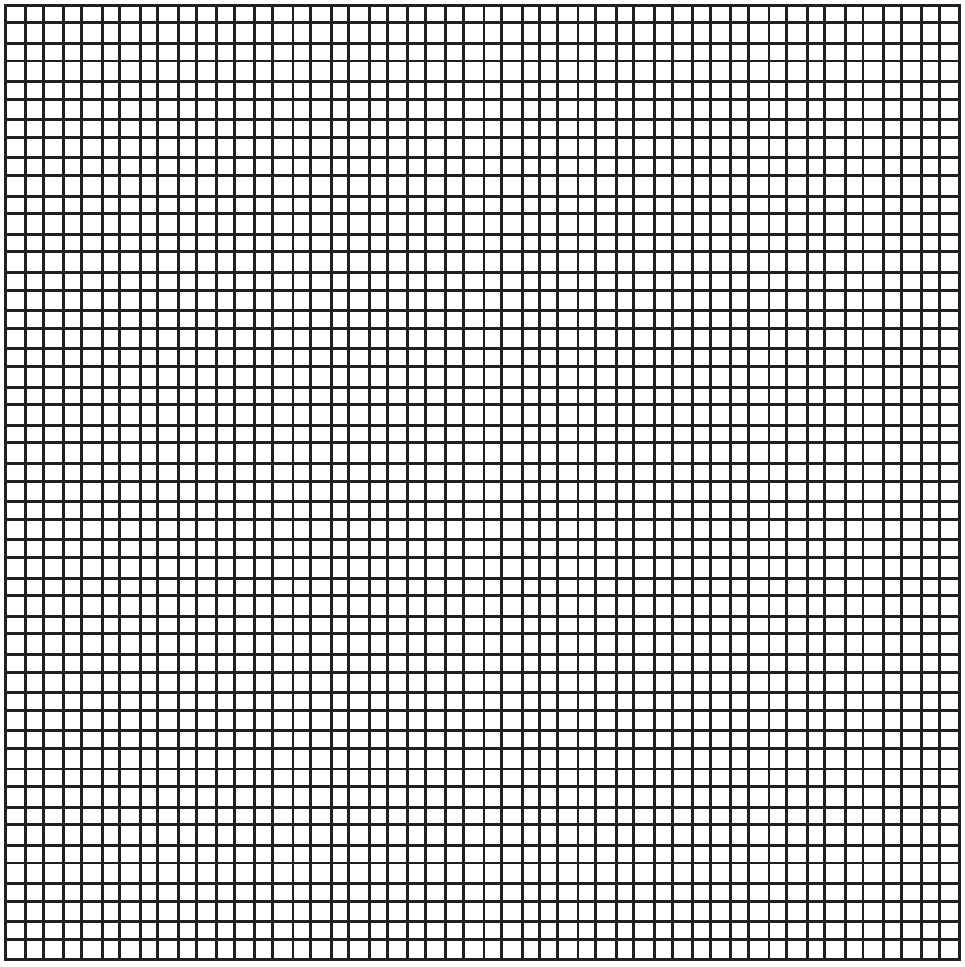


EXERCISE 9:

Using the data in Table 2, plot a line graph to show the change in alcohol concentration with time. **[4]**

Table 2

time / hr	alcohol concentration / g per dm^3
0	0.0
5	4.0
10	5.2
15	6.8
20	7.0
25	7.8



(2) Histogram

- Both axes involve variables that lie on a **numbered scale**
- Independent variable has been grouped into ranges; **blocks touch the next**

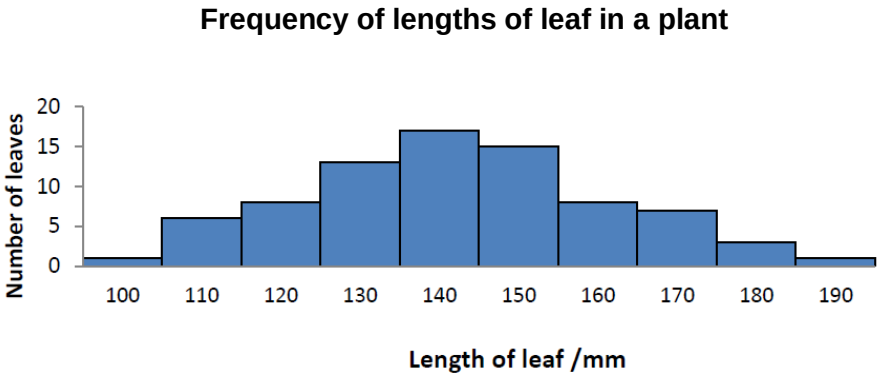


Fig. 9

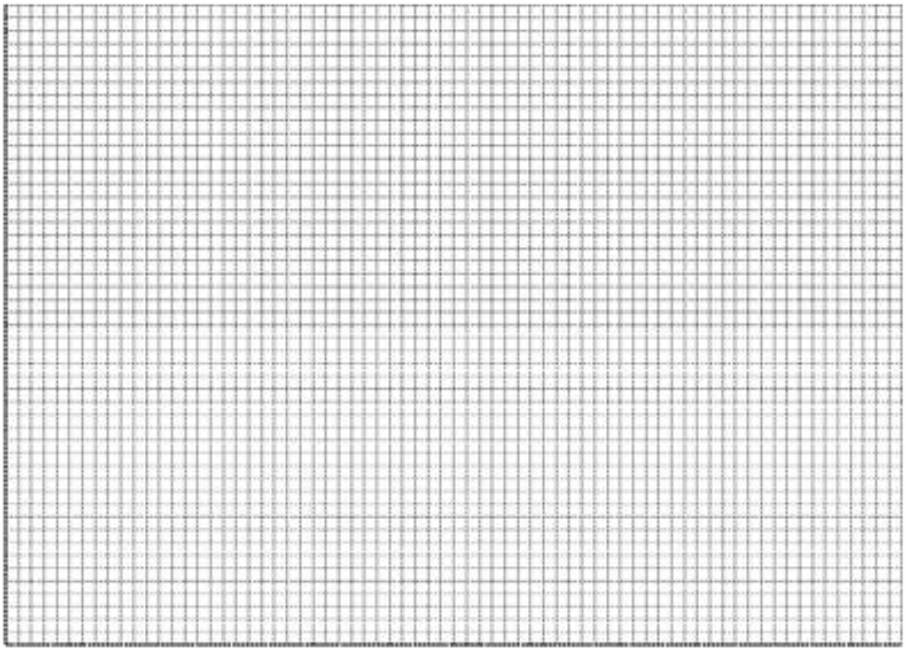
EXERCISE 10:

The weight of forty primary school children was measured and recorded in Table 3.

Table 3

weight / kg	number of children
24.0 – 27.9	2
28.0 – 31.9	5
32.0 – 35.9	7
36.0 – 39.9	16
40.0 – 43.9	6
44.0 – 47.0	4

Construct a histogram of the number in each group of weights. **[4]**



(3) Bar chart

- Independent variable is grouped in **distinct categories** (e.g. types of surfaces)
- Blocks of **equal width** separated by a space
- Dependent variable is continuous

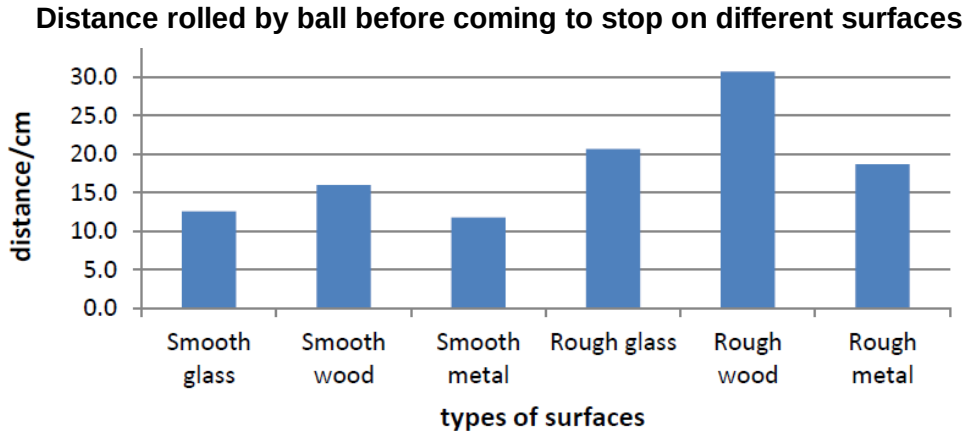


Fig. 10

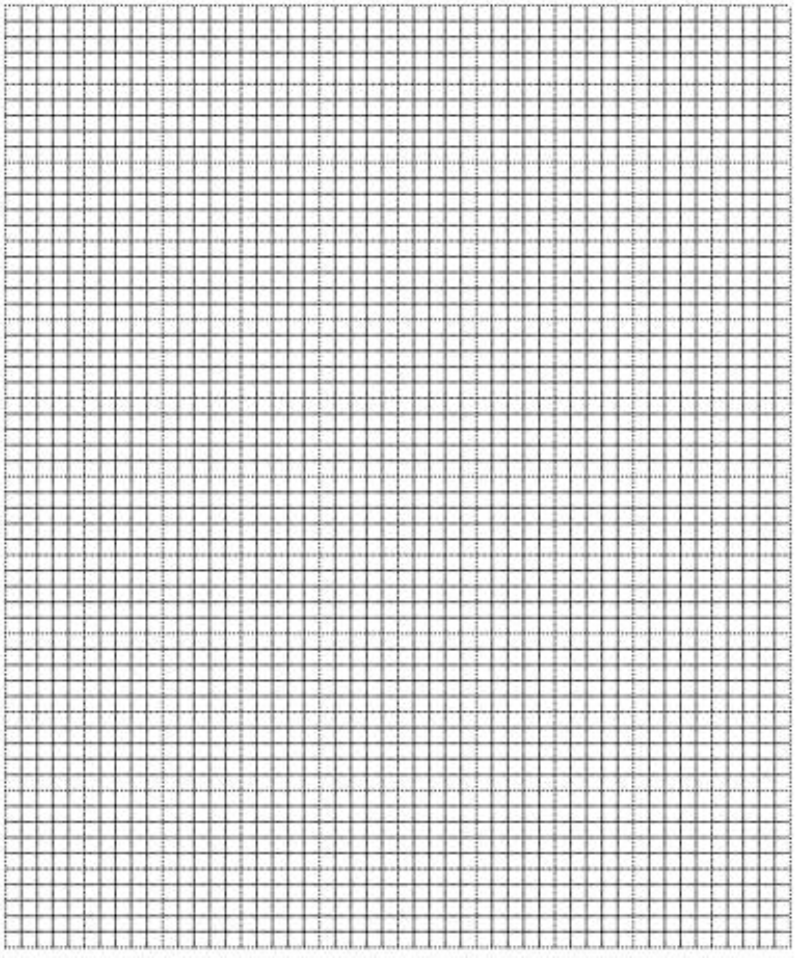
EXERCISE 11:

Table 4 shows the plant fibres that were tested and the masses needed to break each one.

Table 4

plant fibre	mass needed to break one fibre / g
banana	980
celery	450
jute	2900
nettle	600
Phormium	830

Construct a bar chart of the data in Table 4. **[4]**



(C2) Manipulate measurements effectively for analysis

- Examples of common calculations:
  - Mean / average
  - Difference between initial and final readings
  - Percentages
  - Reciprocal of a certain value e.g. 1/ t
- Workings must be shown
- Use **negative values** to indicate a decrease in the physical quantity measured so that graph plotting is correct (e.g. change in length will be tabulated as -3cm if the length of potato strip shrinks by 3cm)
- **Draw a triangle** of good size and show coordinates on graph when finding gradient

(C3) Present all quantitative data to an appropriate number of decimal places/ significant figures

- Calculated values should not be more accurate than the data used to obtain it
- Calculated data are **consistent in decimal places**

EXERCISE 12:

Some students wanted to investigate the effect of concentrated fruit juice on potato tissue. Fruit juice contains a lot of sugar.

Five different solutions **A**, **B**, **C**, **D**, and **E** were prepared from concentrated fruit juice and water as shown in Table 5.

(a) Complete Table 5 by inserting the volumes of fruit juice and water required to prepare solution **B**.

Table 5

solution	volume of fruit juice used / cm^3	volume of water used / cm^3	fruit juice concentration / %
A	0	100	0
B			25
C	50	50	50
D	75	25	75
E	100	0	100

[1]

Five pieces of fresh potato were cut to 70 mm in length. One piece was placed in each of the five solutions so that each piece was fully submerged. They were left for 40 minutes and then removed.

Fig. 11 shows the appearance of these five pieces of potato after 40 minutes.

solution	pieces of potato in side view
A	
B	
C	
D	
E	

Fig. 11

(b)(i) Measure the length of each piece of potato in Fig. 11 and record your measurements in Table 6.

Table 6

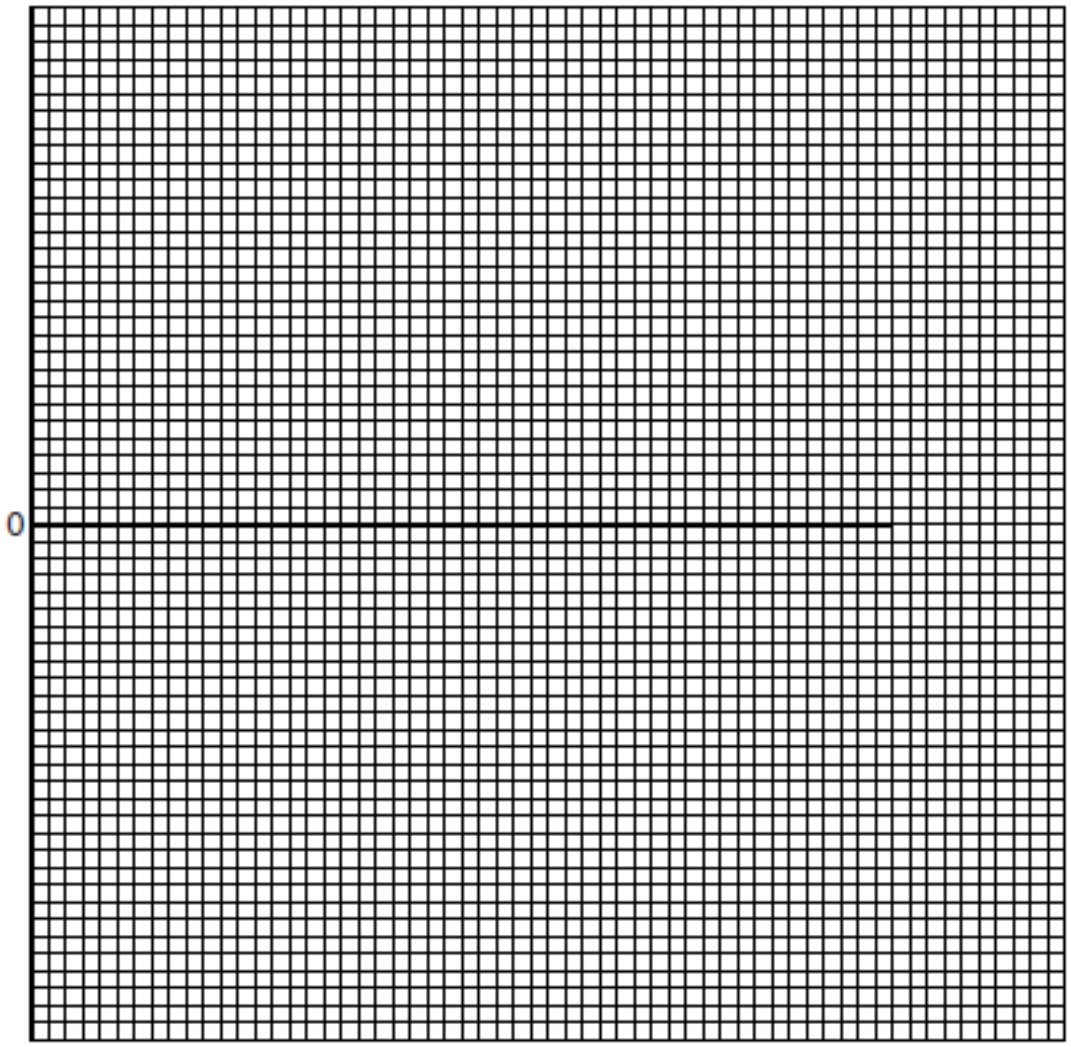
solution	fruit juice concentration/%	final length of potato piece/mm	change in length of potato piece/mm
A	0		
B	25		
C	50		
D	75		
E	100		

[2]

(ii) Complete the last column in Table 6 by recording the change in length of each piece of potato. **[2]**

(iii) Construct a graph to show the effect of fruit juice concentration on change in length of potato pieces.

Complete the labelling of the axes.



[5]

(D) Analysis, conclusions and evaluation (ACE)

(D1) Analyse and interpret data or observations appropriately in relation to the task

- Looking for **patterns and trends**
- Calculations – e.g. finding gradients to determine rate of reaction / x-intercept to find water potential of a tissue
- Draw **dotted line** on graph when finding corresponding value
- All data values, including the coordinates on the line drawn and the intercept, should also be read to an accuracy within one half of the smallest squares on the grid

- Describing processed results
- Explain the findings by relating to what that is learnt in theory
- Suggest how the findings (to what extent) support the hypothesis or address the aim of the investigation

<u>(D2) Draw conclusion(s) from the interpretation of experimental data or observations and underlying principles</u>

- Describe the trend observed from data obtained or graph drawn
- Express your conclusion as a generalisation (**claim**) based on the trend of your results (**evidence**)
- Give an explanation (**reason**) of the trend based on known scientific theories

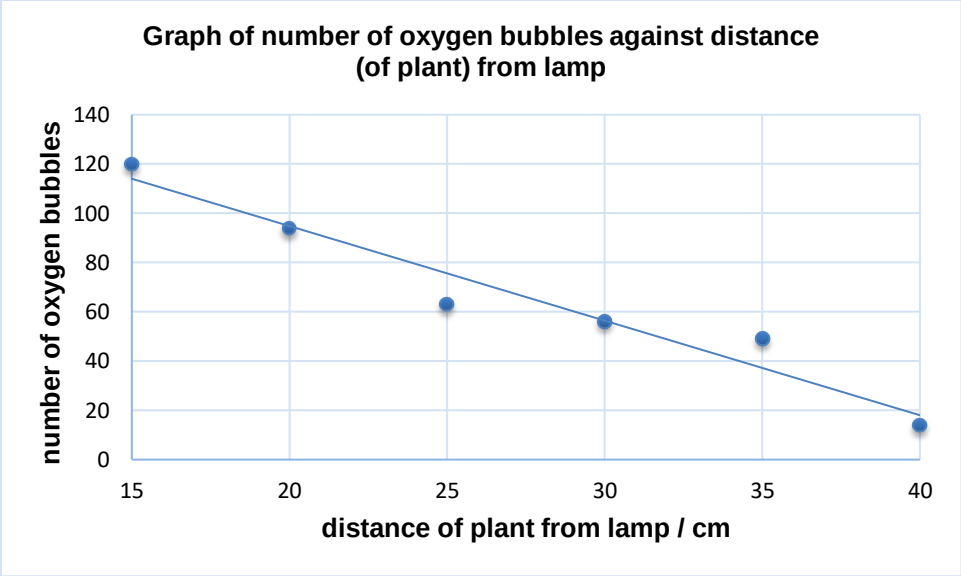


Fig. 12

E.g.

- Rate of photosynthesis decreases when light intensity decreases. (**claim**)
- As distance of plant from lamp increases, number of oxygen bubbles decreases. (**evidence**)
- Oxygen is a by-product of photosynthesis and lesser oxygen bubbles is a result of a decrease in rate of photosynthesis. (**reason**)

Worked example:

Some students carried out a similar investigation to find the effect of pH on the production of apple juice using this enzyme.

Fig. 13 shows a graph of their results.

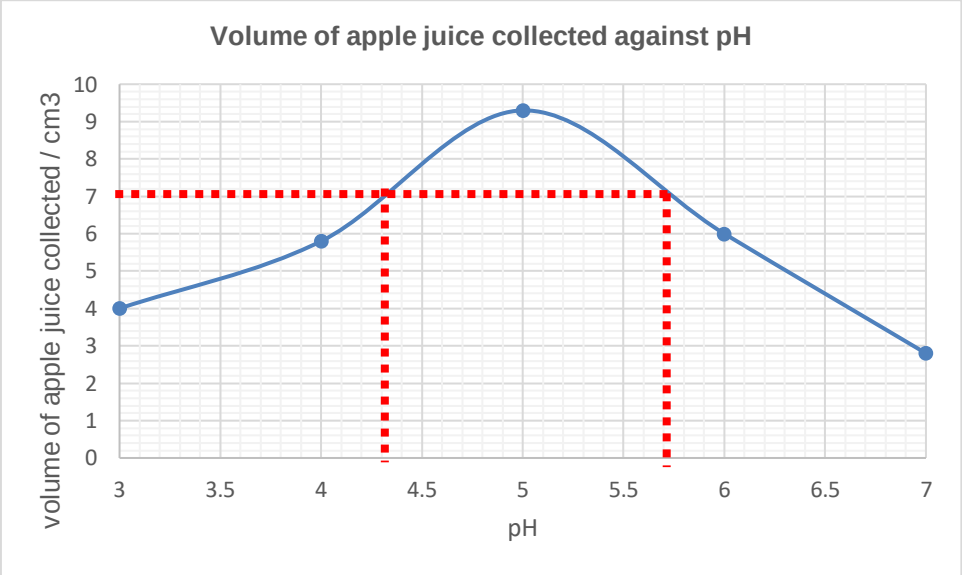


Fig. 13

(a) State the optimum pH for the action of this enzyme.

pH 5

(b) State the pH values when 7 cm^3 of apple juice is collected.

pH 4.3 and pH 5.7 (dotted lines drawn)

(c) Describe and explain the effect of pH on the production of apple juice, using this enzyme.

As pH increases from 3 to 5, volume of apple juice collected increases from 4 cm^3 to 9.2 cm^3. As pH increases beyond 5 to 7, volume decreases to 3 cm^3. **[trend + evidence]**

At pH away from the optimum pH, more enzymes are denatured. Active site shape changes and substrates can no longer bind to form E-S complex. **[reason]**

EXERCISE 13:

Flies lay eggs which hatch into maggots. An investigation was carried out to find out the effect of temperature on the respiration rate of maggots.

Fig. 14 shows some living maggots in a large test-tube.

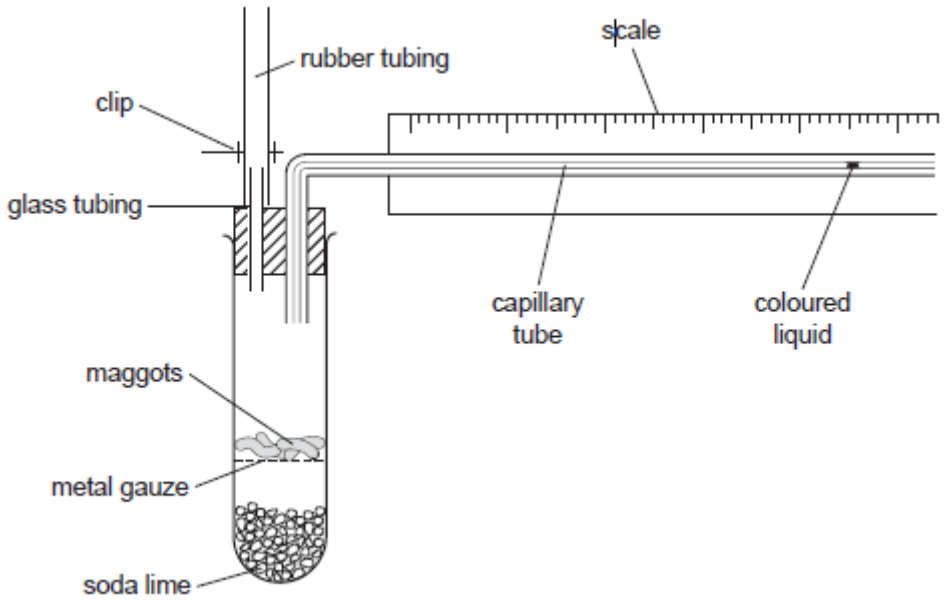


Fig. 14

Soda lime absorbs carbon dioxide. During the investigation, the drop of coloured liquid moved along the capillary tube **towards** the test-tube.

Fig. 15 shows the results of the investigation.

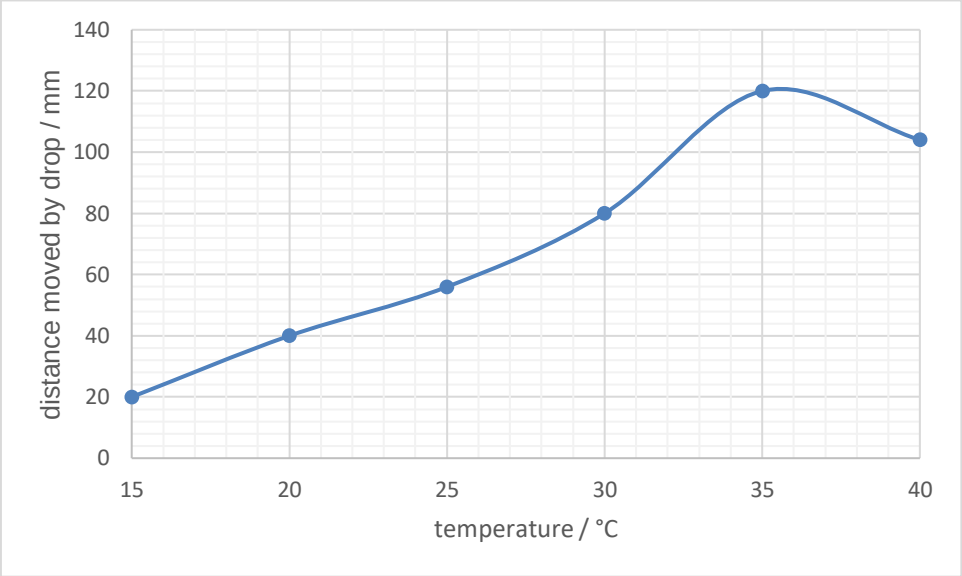


Fig. 15

(a) State the temperature when the rate of respiration of maggots is the fastest.

.....

[1]

(b) State the distance moved by the drop at 28 °C.

.....

[1]

(c) Describe and explain the difference between the results at 20 °C and 30 °C.

.....

.....

.....

.....

.....

[5]

(D4) Identify significant sources of errors and explain how they affect the results

- Error refers to the difference between measured value and 'true' value
- Source of error refers to what causes this difference and some examples include:
  - Lack of precision in the equipment
  - Problems in experimental procedure
  - Inconsistencies of biological specimens
  - Interference from external environmental factors (e.g. wind, humidity, temperature)
- Not a precaution/ incompetence in practical skills/ carelessness (e.g. parallax error or solutions are not fresh); usually cannot be eliminated by repeating the experiment
- Avoid writing results as being inaccurate for the effect when it can be more specific (e.g. evaporation of water in sucrose solution➔ lower water potential➔ faster rate of osmosis ➔ water level drops faster)
- Explain on inaccuracy even when effect cannot be predicted or specified (e.g. subjectivity in colour judgment➔ inaccurate results)

(D5) State and explain how significant errors may be overcome or reduced, as appropriate, including how experimental procedures may be improved

- For a measured value to be accurate, it should be very close to the true value
- For a set of measured values to be reliable, the variation within the values must be small
- Overcome or reduce source of error with the following strategies:
  - Use a more precise measuring equipment to improve on accuracy (i.e. Vernier Caliper to measure length over ruler)
  - Improve experimental procedure (i.e. find average from repeats/ replicates to increase reliability of results)
  - Use same biological specimen to eliminate biological variability
  - Maintain a constant external environmental conditions as far as possible (i.e. conducting experiment indoors such as a greenhouse)

EXERCISE 14

Some students measured respiration in yeast using a culture of active yeast. Yeast produces a gas during respiration. Two syringes were filled with 20 cm3 of the active yeast culture and each syringe was placed into a large test-tube containing water at 35 °C. Both were placed in a water-bath at 35 °C as shown in Fig. 16.

The volume of gas in each syringe was measured every 5 minutes for 25 minutes.

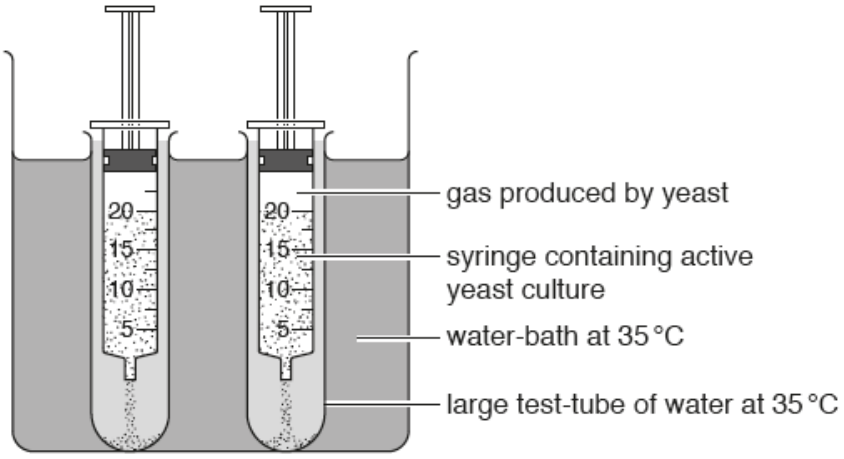


Fig. 16

(a) State **two** variables that have been kept constant in this method. (MMO)

1. ……..

2. …….. **[2]**

(b) Identify **one** source of error in this method and suggest an improvement. (ACE)

error ……..

improvement ……....

…….....

……..... **[2]**

EXERCISE 15

A student was provided with five Petri dishes labelled S1 to S5. Each contained a different concentration of sucrose solution. They were also provided with 10 potato strips, each exactly 50 mm long. Two strips of potato were placed in each solution and left for thirty minutes. Then the strips were removed and blotted carefully. Their lengths were re-measured and recorded.

State two ways in which this experiment could be improved to make the results more reliable. (ACE)

1. ……..

   ……..

2. ……..

   …… **[2]**

EXERCISE 16

Fig.17 shows a simple apparatus to investigate the rate of photosynthesis by counting the bubbles that are given off by a piece of pond weed.

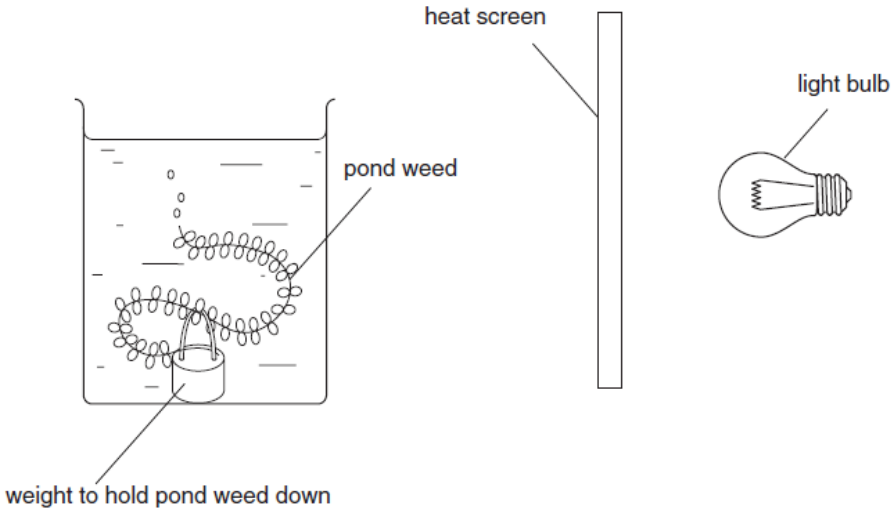


Fig. 17

- the bubbles given off in one minute were counted
- the light intensity was then changed
- after waiting 5 minutes the new rate was counted, and so on

(a) Explain why it is necessary to have the heat screen in the apparatus. (MMO)

……

……

…… **[2]**

(b) State why there was a waiting time of 5 minutes before a new reading was taken. (MMO)

…… **[1]**

(c) Suggest two ways by which the light intensity could be increased in the experiment. (MMO)

1. ……

2. …… **[2]**

(d) Suggest 4 ways in which the experiment could be made more accurate and reliable. (ACE)

1. ……

2. ……

3. ……

4. …… **[4]**

- end of notes on competencies skills –

SOLUTIONS:

EXERCISE 1

Answer	Remark
Benedict's test [1]	food test needed
use same mass / weight / volume of fruit sample [1]	variables to be kept constant
use same volume / concentration of Benedict's (reagent) [1]	variables to be kept constant
at same temperature [1]	variables to be kept constant
EITHER left for same time period [1]	dependent variable
OR time for colour to change measured / compared [1]	
EITHER colour change to yellow / orange / red indicates more reducing sugar / green less [1]	interpretation approach
OR faster colour change indicates more reducing sugar **ORA** [1]	

EXERCISE 2

(a) Answer	Remark
use same volume / concentration of hydrogen peroxide each time [1]	variables to be kept constant
idea of using same type / volume / mass / surface area of enzyme / tissue [1]	variables to be kept constant
fresh samples used (at each temperature) [1]	
different temperatures [1]	independent variable
range of suitable temperatures stated [1]	
method of maintaining temperature [1]	**A**: water bath, **R**: direct heating
leave time for flask and contents to come to temperature before measuring begins [1]	
measure volume of oxygen produced in (same) given time [1]	dependent variable

[Max 5]

(b) Answer	Remark
stated safety precaution [1]	
explanation [1]	explanation must be linked to safety precaution

EXERCISE 3

1. 5 cm^3 syringe [1]
   In enzyme experiments, the volume of enzymes needs to be accurate. 5 cm^3 syringe is most appropriate due to its more precise measurement.
2. 10 cm^3 measuring cylinder [1]
   The smallest division of the beaker is beyond the volume to be measured. Using a syringe, the volume should be measured 5 times. Hence, the measuring cylinder is the best instrument for this task.
3. Stopwatch [1] It is difficult to detect 2 minute intervals using a clock.

***EXERCISE* 4**

Drawing: complete section drawn at least 6 cm diameter with clear, clean lines and double line indicating outer layer [1]
proportion of seed area to fruit wall correct [1]
at least 5 seeds drawn in correct position [1]

Labels: seed [1]
fruit wall / pericarp / epicarp / mesocarp / endocarp [1]
vascular tissues [1]

***EXERCISE* 5**

(a)(i) At least 4cm, clean lines [1]
Central ridge indicated [1]
Lower half of fruit drawn, 1 side flat, other convex [1]

(ii) Clearly marked and accurately measured and recorded [1]
[to 1mm/0.1cm]
Expression: drawing over subject, statement of mag. [1]
[magnification 'x' or 'times' up to 2 dp. etc]
allowance for x1.5. [1]

Example:
drawing = 45mm on Fig. 4.1 = 15mm so: 45 ÷ 15 = 3
allowing for x 1.5: 3 x 1.5 = 4.5 mag. = x 4.5 etc.

(b) Umbrella v. linear arrangement of hairs [1]
Interlocking / branched v simple hairs [1]

EXERCISE 6

Electronic balance	
Smallest division:	0.01 g
Uncertainty:	0.01 g
Recorded reading:	12.68 g
Ruler	
Smallest division:	0.1 cm
Uncertainty:	0.1 cm
Recorded reading:	8.9 cm
Syringe (5ml)	
Smallest division:	0.2 m*l*
Uncertainty:	0.1 m*l*
Recorded reading:	4.8m*l*
Measuring cylinder (cm^3)	
Smallest division :	1 cm^3
Uncertainty:	0.5 cm^3
Recorded reading:	24.0 cm^3
Stopwatch (digital)	

Smallest division:	0.01 s
Uncertainty:	0.01 s
Recorded reading:	37.2 s (round up to 1 d.p due to reaction time)
Thermometer	
Smallest division:	1 °C
Uncertainty:	0.5 °C
Recorded reading:	-5.0 °C

EXERCISE 7

concentration of sucrose solution / M	length of potato strip at start / cm	length of potato strip after 30 min / cm	change in length / cm
0.2	4.0	4.3	+0.3
0.4	4.0	4.1	+0.1
0.6	4.0	3.8	-0.2
0.8	4.0	3.6	-0.4

- table has all headings and units [1]
- table must be ruled [1]
- correct calculation of change in length + signs [1]
- consistent d.p.in each column [1]

EXERCISE 8

- axes correct orientation and both axes labelled fully [1]
- linear scale for both axes [1]
- all 5 points visibly plotted correctly [1]
- plotted points joined with ruled lines and no extrapolation [1]

EXERCISE 9

- time on x-axis and concentration on y-axis, both axes fully labelled [1]
- linear scale starting at 0 with more than ½ grid used on both axes [1]
- all points plotted correctly [1]
- smooth curve through all plotted points [1]

EXERCISE 10

– label axes – x-axis: weight + y-axis: number of children[1]
– plots to fill half or more on both axes [1]
– plot / height of bars correct [1] **A**: accuracy to +/– 0.5 of grid square
– no gaps between columns [1]

EXERCISE 11

axes labelled with units [1]

y – mass /g ; x – plant + names centred to bar

A: rotation of axes through 90°

size to fill at least ½ of grid + linear scale on y-axis [1]

plot correct ± 1mm [1]

all columns drawn ruled and of equal width separated by a gap [1]

with zero or scale break

EXERCISE 12

(a) (fruit juice) 25 + (water) 75 [1]

(b)(i) A 82
B 74
C 68
D 64
E 60
(printed version may not follow same scale)

all correct: 2 marks
1 error: 1 mark
2 or more errors: 0 marks

(ii)

solution	concentration / %	change in length / mm
A	0	12
B	25	4
C	50	– 2
D	75	– 6
E	100	– 10

5 correct calculations: 2 marks
4 correct calculations: 1 mark
3 or fewer correct calculations: 0 marks

(iii) 1. x-axis labelled ‘concentration of fruit juice / %’ + ‘mm’ added on y-axis [1]

2. linear scales with numerical values + negative values on y-axis [1]

3. line / plots to use at least half grid on both axes [1]

4. 5 plots correct + visible [1]

5. plots joined with ruled lines / smooth curve through all plotted points [1]

EXERCISE 13

(a) 35 °C [1] **R:** no units

(b) 70 mm [1] **R:** no units

(c) distance moved by drop increases from 20 °C to 30 °C [1]

quote values of distance correctly [1]

maggots respire faster / AW [1]

activity of enzymes increases / faster rate [1]

ref. kinetic energy / rate of ES complex formation [1]

AVP e.g. for doubling rate for10°C rise in temperature [1]

[max 5]

EXERCISE 14

(a) time qualified e.g. time intervals for measurements / total time of measuring [1]

temperature [1]

(starting) volume of yeast [1]

same yeast culture [1]

[max 2]

(b) error:

loss of yeast from syringe (so less respiration / gas released) [1]

improvement:

idea of: sealed syringe / 3-way tap and collecting gas using gas syringe / AW [1]

error:

idea of taking up, air / froth, with the yeast [1]

improvement:

filling from below the level of the foam [1]

error:

samples of yeast may vary in concentration [1]

improvement:

mix / stir, the culture before removing samples [1]

error:

no method of maintaining temperature [1]

improvement:

use a thermostatically controlled water bath / Bunsen burner and thermometer / idea of insulation [1]

error:

syringe containing yeast not equilibrated before using [1]

improvement:

idea of leaving for a time to reach, correct temperature / 35 °C [1]

error:

syringe has an imprecise scale [1]

improvement:

use a syringe with more graduations [1]

EXERCISE 15

Two from:
keep s/a of chips the same [1]
use more chips; use longer chips [1]
all from same potato/to eliminate variation [1]
equal/constant temperature [1]
repeat/replicate; use other soln. concs [1]
measure mass/weight [1]
repeat measures to constant values [1]
cover to reduce evaporation (of solvent) [1]

EXERCISE 16

(a) light source generates heat [1]
affects rate of: reaction/photosyn./enzyme action [1] R: denatures
(b) time to settle/acclimatise [1]
(c) move lamp/apparatus closer [1]
use brighter/higher power bulb/more bulbs [1]
(d) replicate readings/take mean [1]
method of having uniform bubbles [1]
maintain constant temp/w.bath etc. [1]
collecting / measuring gas [1]
more weed / longer time [1] I: CO2/HCO3

- end of solutions –

PRACTICE QUESTIONS

Question	***Chapter***	***Page***	***Score***
1	Chapter 3: Movement of Substances	15	/ 14
2		17	/ 15
3		19	/ 12
4	Chapter 6: Nutrition in Humans	21	/ 14
5	Chapter 7: Nutrition in Plants	23	/ 18

Chapter 3: Movement of Substances

1. A student cut pieces of potato to the same length and placed them in boiling tubes containing a range of sugar solutions. Two pieces were placed into each boiling tube. Each piece was re-measured after 24 hours. The table below shows the results of the experiment.

concentration of sugar solution (mol)	length of potato at start (mm)	length of potato after 24 hours (mm)		mean length (mm)	mean change in length (mm)	% change in length (%)
		piece 1	piece 2			
0	60	60	64	62.0	+2.0	+3.3
0.2	60	58	59	58.5	-1.5	-2.5
0.4	60	55	55	55.0	-5.0	-8.3
0.6	60	54	54	54.0	-6.0	-10.0
0.8	60	53	54			
1.0	60	52	53	52.5	-7.5	-12.5

The percentage change in length was calculated using the equation shown below.

% change in length = $\frac{mean\ change\ in\ length}{original\ length}$ x 100

(a) Complete the table by calculating the mean length, the mean change in length and the percentage change in length for the potato pieces in 0.8 mol sugar solution. (PDO) **[1]**

(b) Plot a line graph of percentage change in length against concentration. (PDO) **[4]**

(c) Use your graph to predict in which sugar concentration there would be no change in length. (ACE) **[1]**

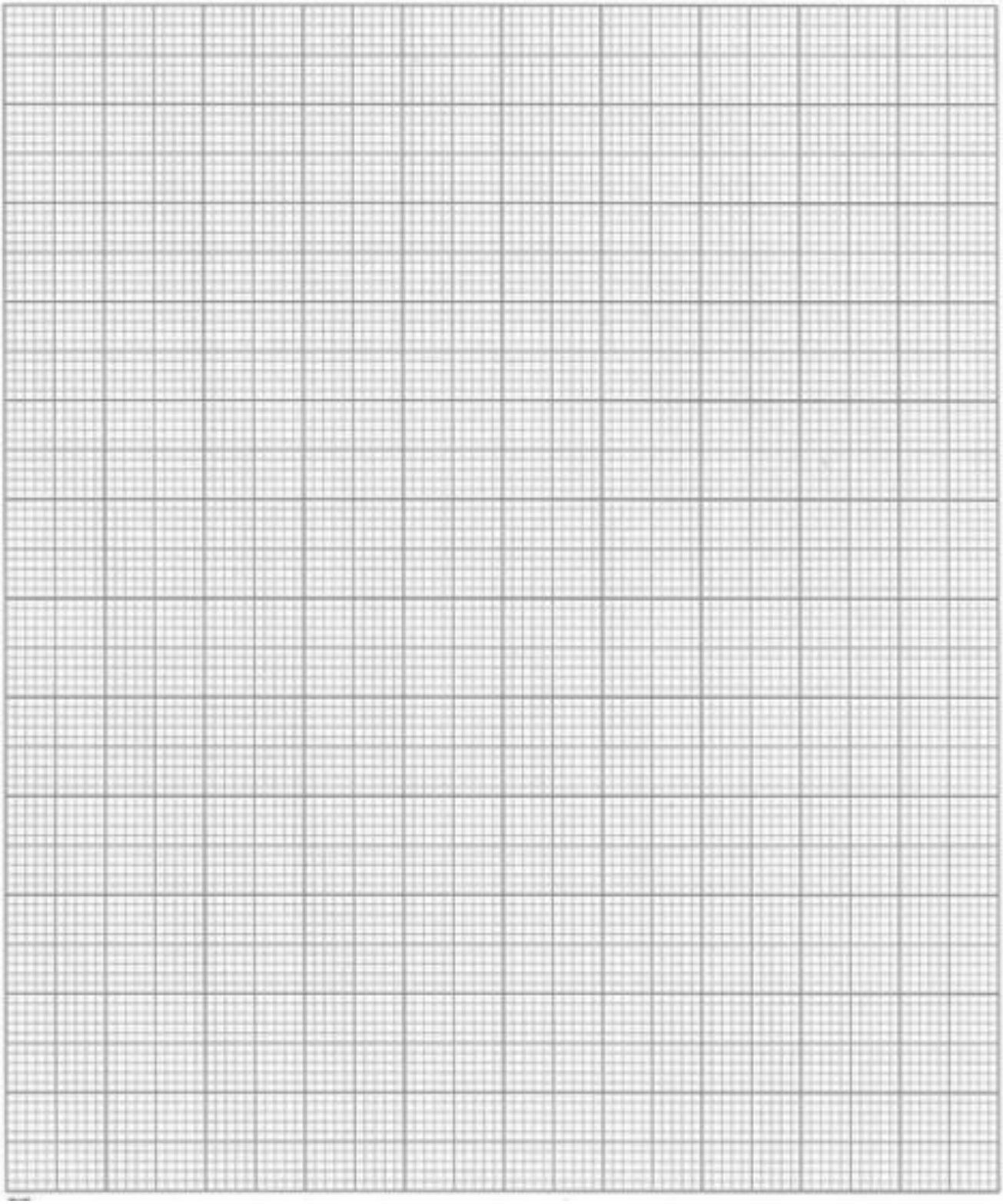
(d) Explain your answer shown in (c). (ACE) **[3]**

(e) State one assumption of the sugar solution during the experiment (over 24 hours) and suggest how it may affect the results. (ACE) **[2]**

(f) State one assumption of the potato strips used in the experiment and suggest how it may affect the results. (ACE) **[2]**

(g) Suggest how you could make this investigation as reliable as possible. (ACE)

[1]



Chapter 3: Movement of Substances

2. An experiment was carried out to investigate the effect of different concentrations of sugar solution on yam tissues. Ten cubes of yam tissue of the same dimensions were cut and weighed.

Two cubes were placed in pure water and two placed in each of four different concentrations of sugar solutions. The cubes were left for one hour. They were then removed from the solutions, dried carefully with blotting paper and reweighed.

The table below shows the results.

Concentration of sugar solution g/cm³	***Initial mass/ g***		***Mean initial mass/ g***	***Final mass/ g***		***Mean final mass/ g***	***Mean change in mass/ g***	***Mean percentage change in mass (2s.f.)***
	Cube 1	***Cube 2***		***Cube 1***	***Cube 2***			
0	2.22	2.24	2.23	2.41	2.43	2.42		
5	2.29	2.33	2.31	2.45	2.49	2.47		
10	2.19	2.17	2.18	2.31	2.29	2.30		
20	2.29	2.25	2.27	2.14	2.16	2.15		
40	2.38	2.40	2.39	2.17	2.23	2.20		

(a) Why were the cubes blotted dry before reweighing? (MMO) **[1]**

(b) Why were batches of two cubes used rather than single cube? (P) **[1]**

(c) Name one variable which is maintained constant for a fair comparison of results. (P) **[1]**

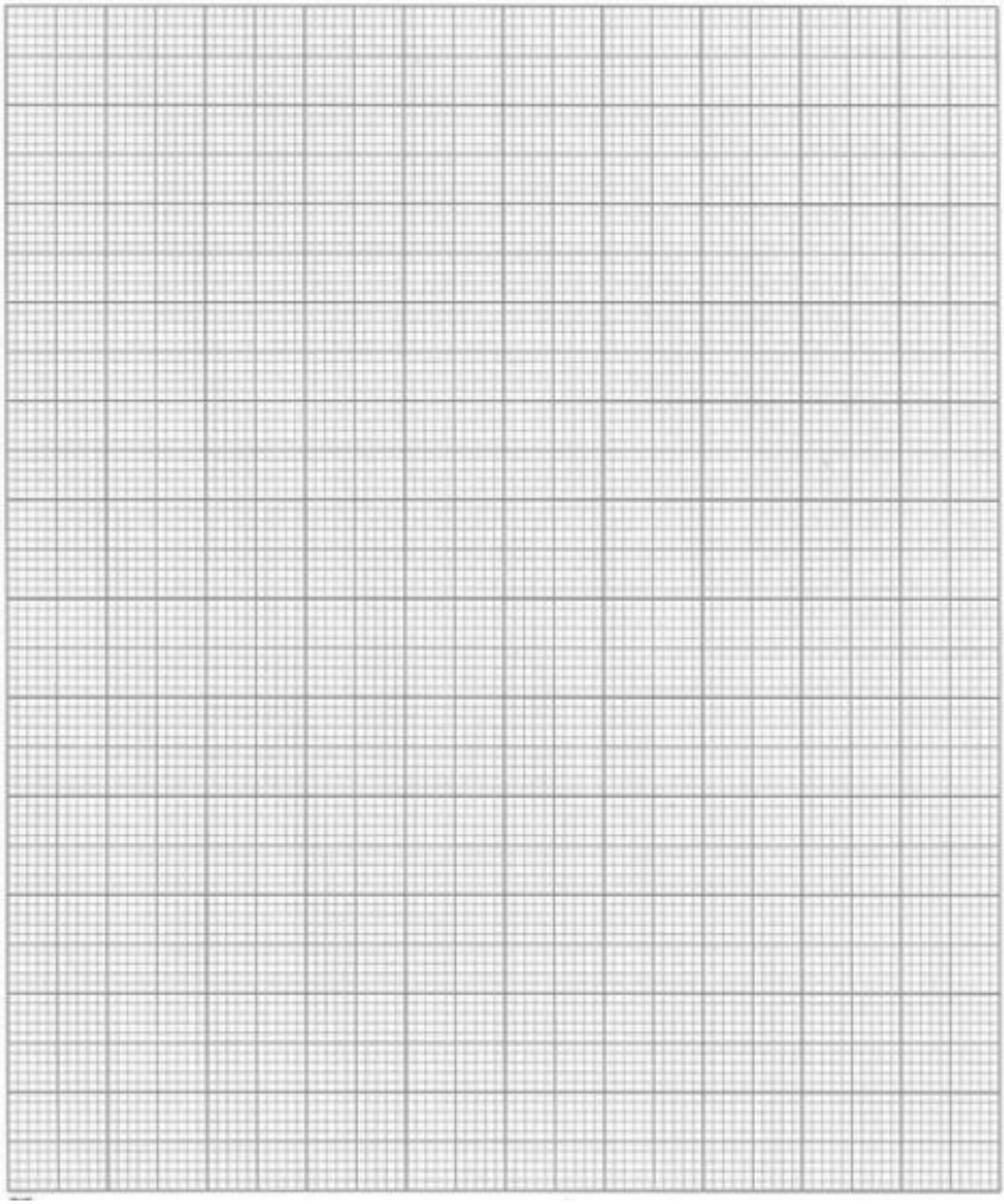
(d) Calculate and fill up the column for mean change in mass and mean percentage change in mass in the table. (PDO) **[2]**

(e) Plot the mean percentage change in mass against the concentration of sugar solution. (PDO) **[4]**

(f) Why does the graph record the mean percentage change in mass rather than the mean change in mass? (ACE) **[2]**

(g) Use the graph to find the sugar solution concentration which would cause no change in the mean change in mass. (ACE) **[1]**

(h) If the sugar solutions were not covered during the experiment, how could this affect the results? (ACE) **[3]**



Chapter 3: Movement of Substances

3. In an experiment, ten similar strips of onion tissue were placed in different concentrations of salt solution for half an hour. They were then observed under a light microscope and the percentage of plasmolysed cells was counted and the results were recorded in table below.

test tube number	***salt concentration / mol dm^{-3}***	***plasmolysed cells / %***
1	0.00	0
2	0.10	0
3	0.20	0
4	0.30	2
5	0.40	8
6	0.50	20
7	0.60	62
8	0.70	86
9	0.80	98
10	0.90	100
11	1.00	100

(a) Describe the process which leads to the observations in test tube **10**. (ACE) **[2]**

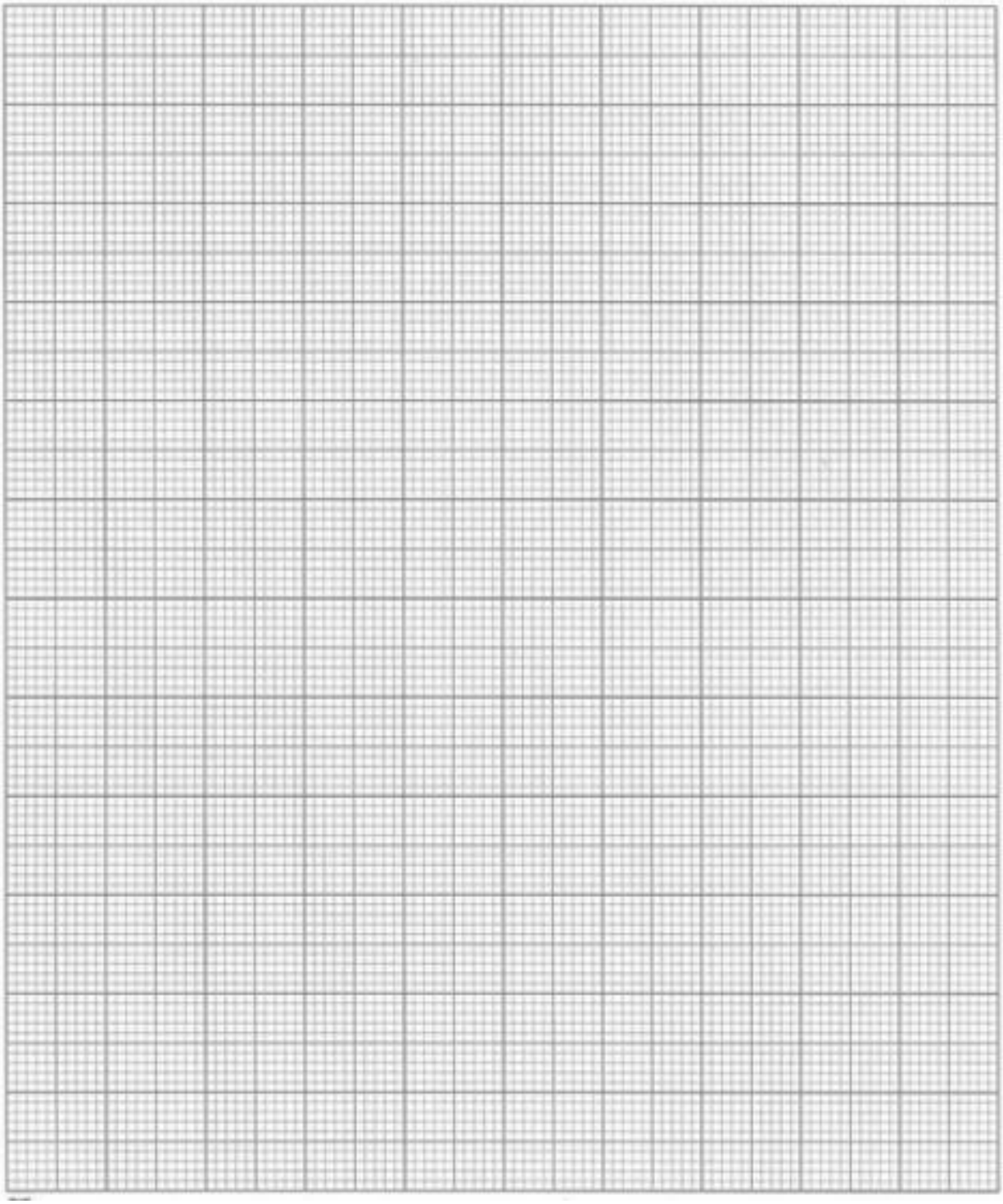
(b) Draw and label a cell you would see from test tube **10**, in the space below. (MMO) **[2]**

(c) Plot the percentage of plasmolysed cells against salt concentration on the grid provided below. (PDO) **[4]**

(d) From the graph, state the concentration of salt solution when 50% of onion cells in a strip is plasmolysed. (ACE) **[1]**

(e) Identify one key source of error and states how it affects the results. (ACE) **[1]**

(f) Predict and explain the change that can be observed regarding the percentage of plasmolysed cells if the onion tissues were placed in salt solution for 1 hour instead of 30 minutes. (ACE) **[2]**



Chapter 6: Nutrition in Humans

4. Lactose is the main sugar found in milk. Lactose is broken down by lactase, an enzyme which is made by cells lining the small intestine. The glucose and galactose molecules produced are then absorbed into the bloodstream.

$$Lactose \xrightarrow{\text{lactase}} glucose + galactose$$

A student carried out an investigation to compare the lactose contents of human milk and cow's milk. She set up a test tube containing human milk and lactase solution. Every 30 seconds, samples of the mixture were taken and the glucose concentration measured. Then, she repeated the procedure with cow's milk. Her results are shown in the table below.

Time (mins)	***Concentration of glucose (%)***	
	In human milk	In cow's milk
0	0	0
0.5	0.28	0.28
1.0	0.54	0.46
1.5	0.80	0.54
2.0	1.04	0.58
2.5	1.10	0.58
3.0	1.10	0.58

(a) One variable that must be kept constant in this investigation is pH. List three other variables which would have to be kept constant and how to do so. (P) **[3]**

(b) Plot the data on a graph paper. (PDO) **[4]**

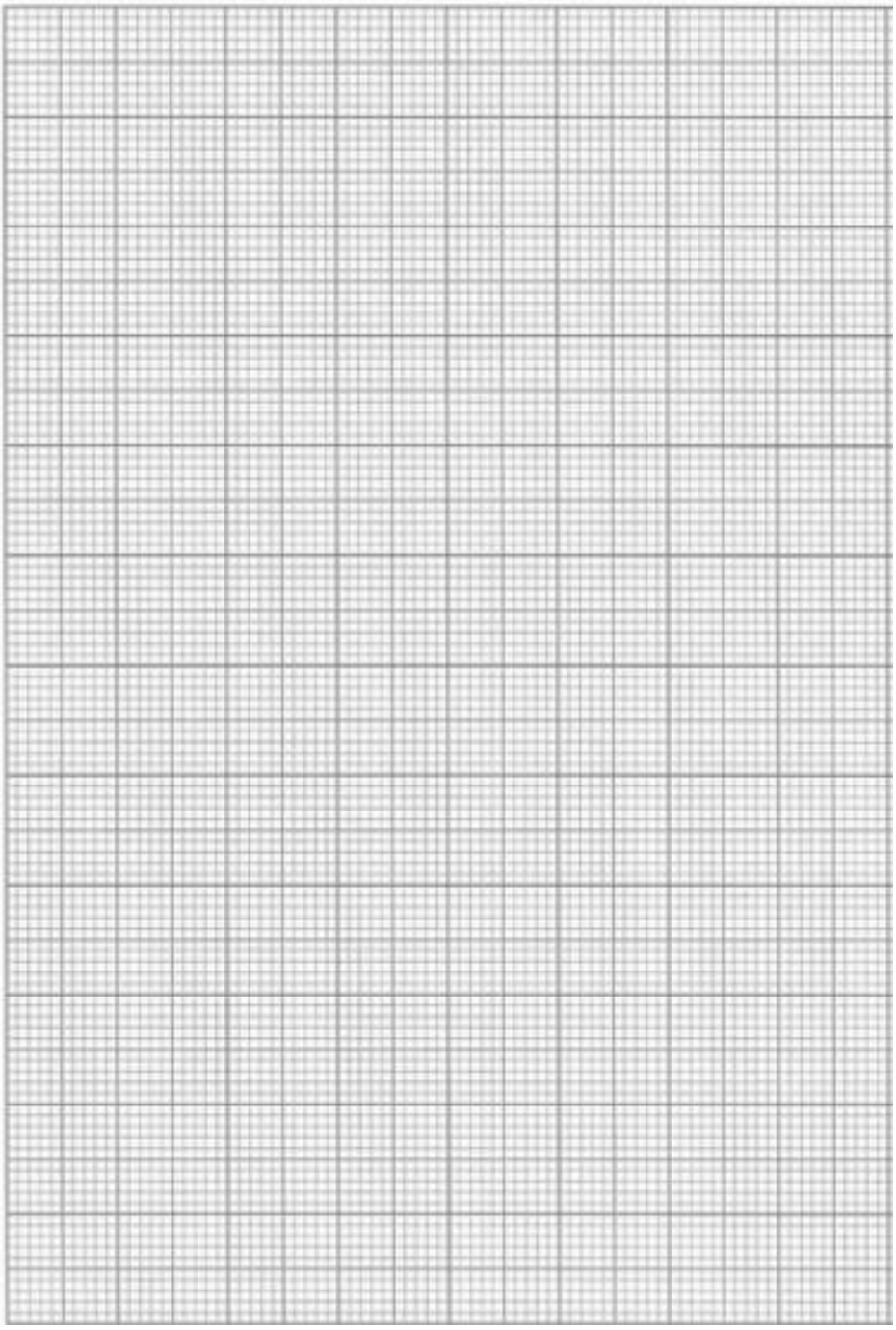
(c) Calculate the rate of lactose digestion in human and cow's milk at 1.0min on the graph paper. (ACE) **[2]**

(d) What conclusion can be drawn from this investigation? (ACE) **[1]**

(e) Suggest a reason why the rate of glucose production was not constant throughout the investigation. (ACE) **[2]**

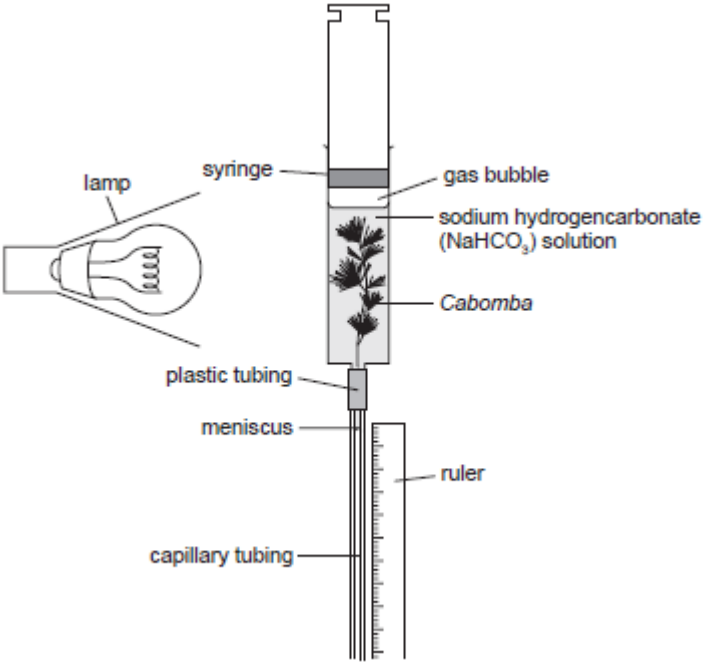
(f) How could the student improve the reliability of his results? (ACE) **[1]**

(g) Suggest a suitable control experiment. (ACE) **[1]**



Chapter 7: Nutrition in Plants

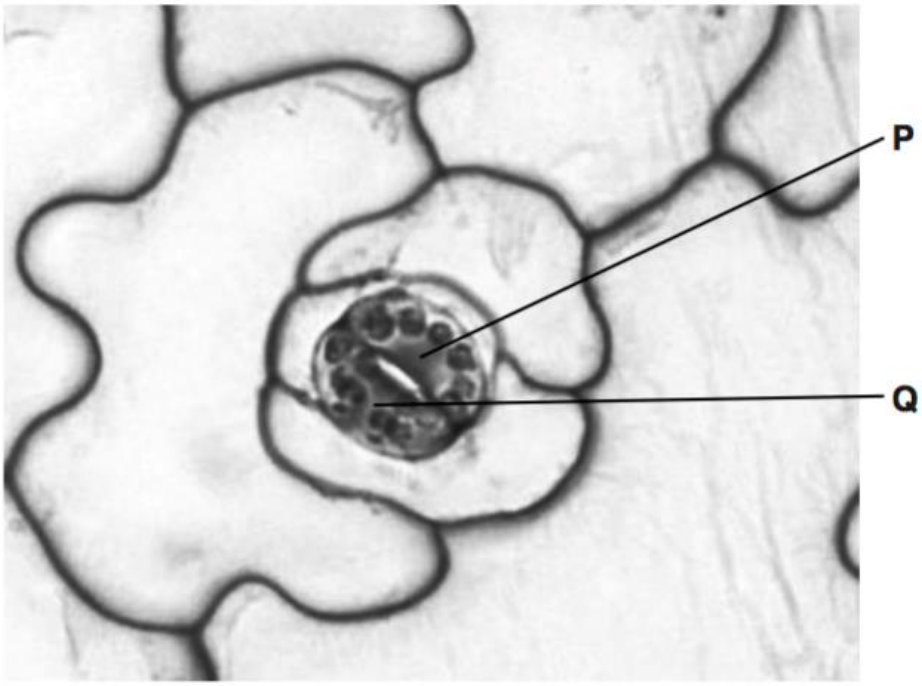
5. A student investigated the effect of increasing the concentration of carbon dioxide on the rate of photosynthesis of Cabomba, an aquatic plant. The figure below shows the apparatus that the student used.



The concentration of carbon dioxide in the water surrounding the plant was changed by adding different concentrations of sodium hydrogencarbonate solution to the water.
The student recorded the time taken for the meniscus to travel 50 mm down the tubing.
The rate of photosynthesis was calculated as:
rate of photosynthesis = 1000/t
where t = time taken in seconds for the meniscus to travel 50 mm.

The student's results are shown in the table below.

Concentration of sodium hydrogencarbonate solution/ mol per dm^3	***T, time taken for meniscus to travel 50 mm/s***	***Rate of photosynthesis (1000/t)/ s^{-1}***
0.00	4998	
0.01	2500	
0.02	1175	
0.05	350	
0.07	201	
0.10	199	



(a) The figure above shows part of the leaf surface, as seen using a microscope. Make an accurate drawing of the cells labelled **P** and **Q**. (MMO) **[3]**

(b) Calculate the rate of photosynthesis. Write your answer (in 1d.p) in the table. (PDO) **[1]**

(c) Using the data, plot the graph of the rate of photosynthesis against concentration of sodium hydrogencarbonate solution in a graph. (PDO) **[4]**

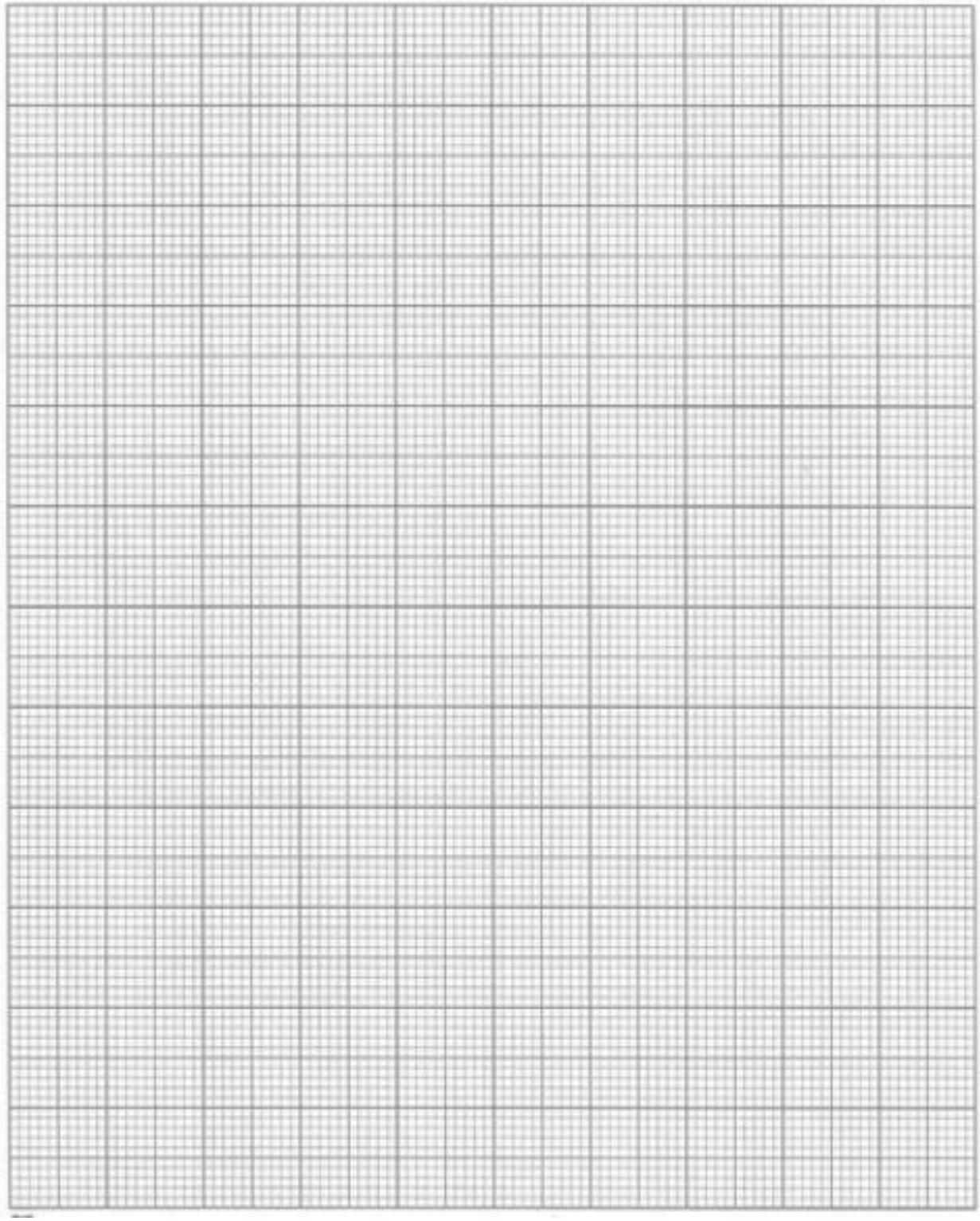
(d) Describe and explain the relationship between the concentration of sodium hydrogencarbonate solution and the time taken for meniscus to travel 50 mm. (ACE) **[4]**

(e) Suggest one source of error and its effect on the results. (ACE) **[1]**

(f) Predict the effect on the results if the plunger is not air-tight. (ACE) **[1]**

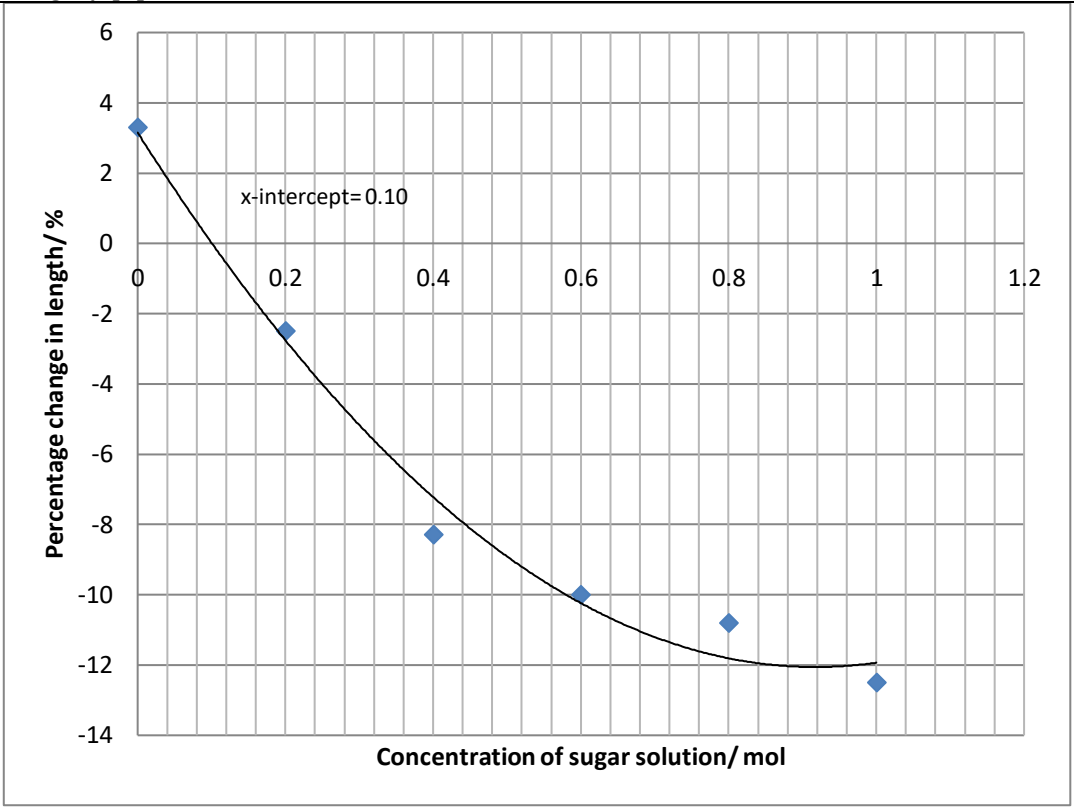
(g) Predict how the accidental shifting of the apparatus can affect the results. (ACE) **[1]**

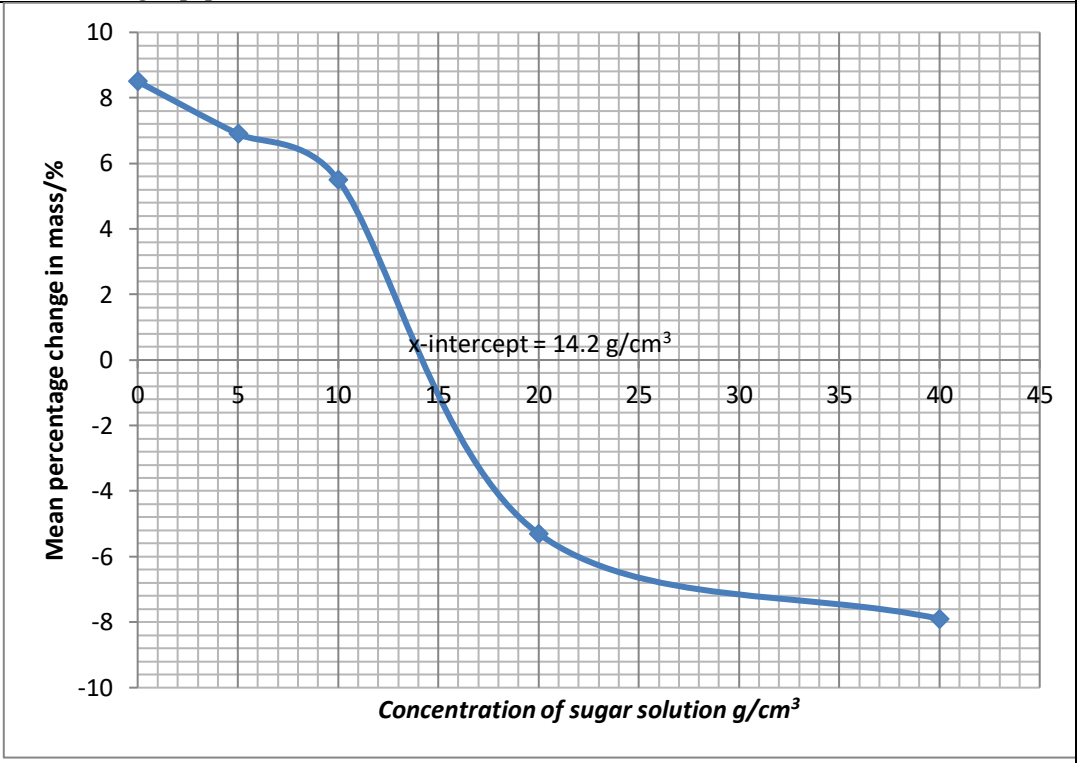
(h) Describe how you could use the apparatus in the set-up to carry out an investigation of the effect of different light intensity on the rate of photosynthesis. (P) **[5]**

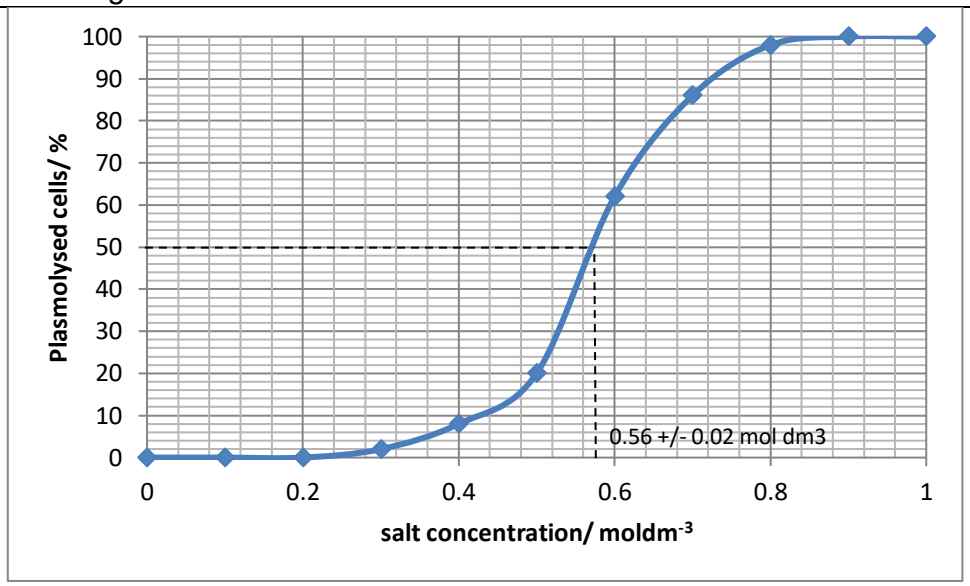


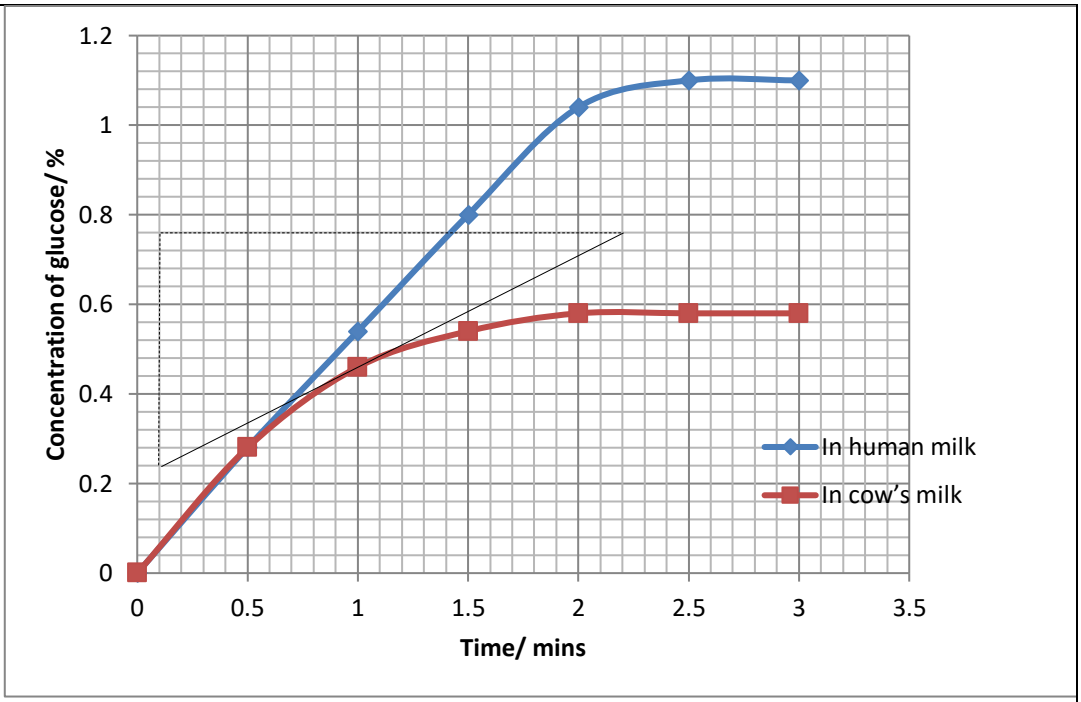
- end of practice questions –

MARK SCHEME

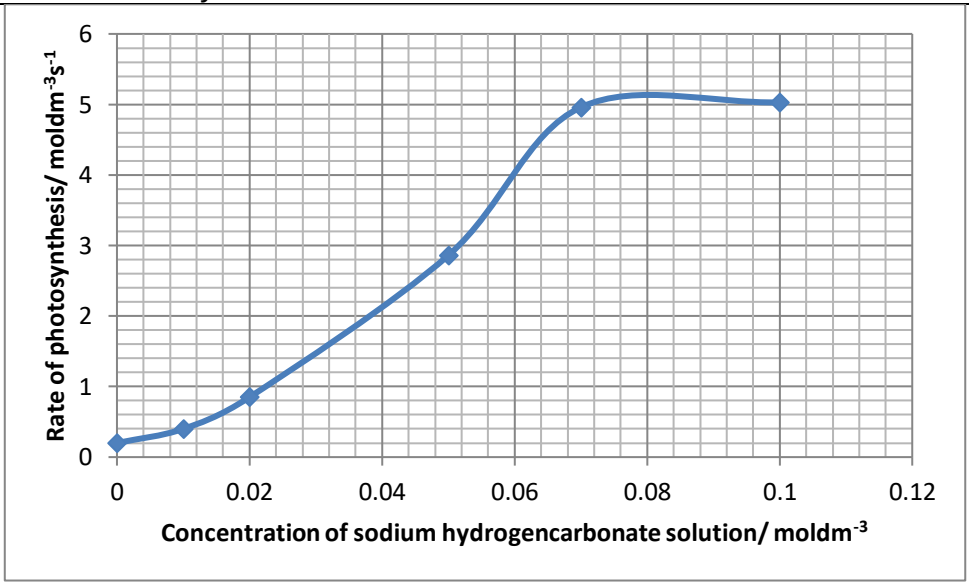
1.	
(a) PDO	53.5 (mean length) + -6.5 (mean change in length) + -10.8 (% change in length) [1]
(b) PDO	 **A** labelling of axes (x-axis concentration/mol + y-axis labelled percentage change in length/%) [1] R: if wrong orientation **S** scale (graph needs to be more than half of the graph paper) [1] [e.g. x = 20 units for 0.2, y = 10 units for 2] **P** all points plotted correctly [1] **L** line (a best-fit curve + no extrapolation) [1]
(c) ACE	0.10 or 0.11 <u>mol</u> [1] (mark according to the line on the graph)
(d) ACE	- water potential / concentration of sugar same between solution and potato strips [1] A: no water potential grapdient - no net movement of water / no osmosis [1] - no (percentage) change in length [1[
(e) ACE	Water did not evaporate/ water potential did not decrease [1] + greater decrease in length [1]
(f) ACE	- Potato strips originated from same parent plant [1] - precision of results affected by biological variabilities [1]
(g) ACE	Repeat + take average / mean [1]
2.	
(a) MMO	Remove excess water + add to weight of potato cubes [1]
(b) P	Mean change in mass will be more accurate + larger sample size [1]
(c)	Length of time cubes were placed in sugar solution [1]

P	
(d) PDO	<table><tr><th>Mean change in mass/ g</th><th>Mean percentage change in mass (2s.f.)</th></tr><tr><td>+0.19</td><td>+8.5</td></tr><tr><td>+0.16</td><td>+6.9</td></tr><tr><td>+0.12</td><td>+5.5</td></tr><tr><td>-0.12</td><td>-5.3</td></tr><tr><td>-0.19</td><td>-7.9</td></tr></table> correct calculation in 2s.f. [1] correct sign [1]
(e) PDO	 **A** labelling of axes (x-axis concentration/mol + y-axis labelled mean percentage change in mass/%) [1] R: if wrong orientation **S** scale (graph needs to be more than half of the graph paper) [1] [e.g. x = 20 units for 10, y = 10 units for 2] **P** all points plotted correctly [1] **L** line (a best-fit curve + no extrapolation) [1]
(f) ACE	All cubes do not weigh the same at the beginning of the experiement [1] Mean percentage change in mass account for the initial differences [1]
(g) ACE	14.2 or 14.3 g/cm^3 [1]
(h) ACE	- Evaporation of water [1] - decrease water potential of sugar solution [1] - smaller increase in mass (for 0, 5, 10g/cm^3) or greater decrease in mass (for 20, 40g/cm^3) [1]
3.	
(a) ACE	- Net movement of water molecules/ osmosis [1] - from cell sap (higher water potential) to salt solution (lower water potential) [1]

(b) MMO	Visible organelles: Nucleus, central vacuole, cytoplasm, plasma membrane (detaches from cell wall), cell wall R: cell sap, chloroplasts, ER, mitochondrion Any missing/extra label minus 0.5 m each Drawing mistakes minus 0.5 m each
(c) PDO	 **A** labelling of axes (x-axis salt concentration/moldm^{-3} + y-axis labelled plasmolysed cells/%) [1] R: if wrong orientation **S** scale (graph needs to be more than half of the graph paper) [1] [e.g. x = 10 units for 0.1, y = 10 units for 10] **P** all points plotted correctly [1] **L** line (a best-fit curve + no extrapolation) [1]
(d) ACE	0.56 +/- 0.02 mol dm3 (with dotted lines) [1]
(e) ACE	- Judging of plasmolysed cells is subjective, inaccurate counting - Water evaporates from salt solution, more cells plasmolysed - Onion tissue started with some plasmolysed cells, more cells plasmolysed [1] (any 1)
(f) ACE	- Percentage of plasmolysed cells increases [1] - (More time for) more water lost from onion tissues [1]
4.	
(a) P	Temperature / incubate reactants in water bath maintained at a constant temperature [1] Volume of milk used / measure with a measuring cylinder [1] Duration of experiment/ measure time with stopwatch [1]

<table>
<tr><td>(b)
PDO</td><td> 

A labelling of axes (x-axis time/mins + y-axis labelled Concentration of glucose/ %) [1] R: if wrong orientation
S scale (graph needs to be more than half of the graph paper) [1]
[e.g. x = 20 units for 1.0, y = 10 units for 0.1]
P all points plotted correctly [1]
L line (a best-fit curve + no extrapolation) [1]</td></tr>
<tr><td>(c)
ACE</td><td>Human's milk: 0.52%/min [1]
Cow's milk: (0.76-0.24)/(2.2-0.1) = 0.25%/min [1]
(without correct units -1)
(triangle must be drawn on graph to calculate gradient)</td></tr>
<tr><td>(d)
ACE</td><td>Human milk contains more lactose than cow's milk [1]</td></tr>
<tr><td>(e)
ACE</td><td>- Rate of lactose digestion decreases when lactose concentration decreases [1]
- frequency of lactose fitting into active site of lactase decreases [1]</td></tr>
<tr><td>(f)
ACE</td><td>Repeat the experiment twice to obtain more results [1]</td></tr>
<tr><td>(g)
ACE</td><td>Setup a test tube containing distilled water and lactase solution [1]</td></tr>
<tr><td></td><td></td></tr>
<tr><td>5.</td><td></td></tr>
<tr><td>(a)
MMO</td><td><table>
<tr><td>P and Q only drawn with clear, clean continuous lines and no shading [1]</td><td></td></tr>
<tr><td>cell walls indicated by double line [1]</td><td>either P or Q must show complete cell wall</td></tr>
<tr><td>indication of chloroplasts in cell [1]</td><td>not more than 8 chloroplasts in one cell</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>(b)
PDO</td><td>
<table>
<tr><th>Rate of photosynthesis (1000/t)/ s^{-1}</th></tr>
<tr><td>0.2</td></tr>
<tr><td>0.4</td></tr>
<tr><td>0.9</td></tr>
<tr><td>2.9</td></tr>
<tr><td>5.0</td></tr>
<tr><td>5.0</td></tr>
</table>
Award 1m only if all calculations are correct
</td></tr>
<tr><td>(c)
PDO</td><td>


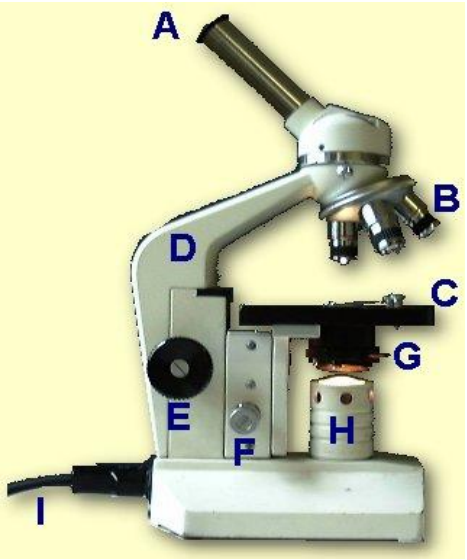
A labelling of axes (x-axis Light intensity/ arbitrary units + y-axis labelled Oxygen production in water plant/ arbitrary units) [1] R: if wrong orientation
S scale (graph needs to be more than half of the graph paper) [1]
[e.g. x = 20 units for 0.2, y = 20 units for 1]
P all points plotted correctly [1]
L line (a best-fit curve + no extrapolation) [1]
</td></tr>
<tr><td>(d)
ACE</td><td>- increase concentration of sodium hydrogencarbonate solution, shorter the time taken for meniscus to travel 50mm [1]
- increase [CO_2], increase rate of PS, rate of O_2 production increases, time taken for meniscus to travel 50mm decreases [1]
- beyond 0.07moldm^{-3} of sodium hydrogencarbonate solution, time taken remains almost constant [1]
- [CO_2] no longer the limiting factor [1]</td></tr>
<tr><td>(e)
ACE</td><td>Temperature increases due to proximity of the lamp, rate of PS increases [1]</td></tr>
<tr><td>(f)
ACE</td><td>Some gas escape, time taken for meniscus to travel 50mm increases, slower rate of PS [1]</td></tr>
<tr><td>(g)
ACE</td><td>Meniscus may shift in position and results will be inaccurate [1]</td></tr>
<tr><td>(h)
P</td><td>set lamp/bulb at measured distance [1]
leave to stabilise [1]
change in time taken for meniscus to travel 50mm measured [1]
move lamp/bulb [1]
repeat for reliability [1]</td></tr>
</table>

- end of answer scheme –

APPENDICES

Appendix A

Parts of a compound microscope



A – Eyepiece – where you look into
B – Objective lenses – provide increasing/decreasing power of magnification
C – Stage – where the slide is put
D – Arm – carried by user
E – Coarse focusing knob – moves the objective lens toward or away from the slide, allowing to make the image sharper
F – Fine focusing knob - fine-tunes the focus of the image
G – Diaphragm – changes the amount of light passing through the slide
H – Light source
I – Power cord

Steps to using a compound microscope

1. Carry the microscope with both hands. Hold the arm **(D)** with one hand and place the other hand under the base for support.
2. Set the revolving nosepiece so that the lowest power objective lens **(B)** is "clicked" into position.
3. Place the slide on the stage **(C)** and fasten it with the stage clips.
4. Using the coarse focusing knob **(E)**, lower the objective lens down as far as possible, without touching the slide.
5. Look through the eyepiece **(A)** and adjust the diaphragm **(G)** for the greatest amount of light.
6. Slowly turn the coarse focusing knob **(E)** so that the objective lens goes up. Continue until the image comes into focus. Use the fine focusing knob **(F)** for fine focusing.
7. When changing to the next objective lens, only use the fine focusing knob **(F)** to focus.
8. Immersion oil should be dropped over the slide coverslip when viewed under the 100x objective lens. Slowly move the stage up until the lens makes contact with the oil. Continue focusing with the coarse and fine focusing knobs.

Light microscope (low power) video - http://tinyurl.com/y8vn8sqj
Light microscope (high power) video - http://tinyurl.com/ycjyefxz

Source (video): http://www.tplhk.com.hk/

Appendix B

Taking reading on the plunger of a syringe

There are two points on the plunger of a syringe; take the reading off the second point as seen in the picture below.

1. Volume should be read off this point on the plunger of the syringe.

2. Students tend to take the reading off this point of the plunger, which is incorrect.

Appendix C

Food tests

Preparation of food sample for testing

Liquid food samples can be used directly for food tests. For solid food samples, cut / mesh into small pieces and use approximately **1 cm^3** for food tests.

Test for starch (Iodine Test)
1. Place 1 drop of unknown liquid or 1 cm^3 solid sample on white tile.
2. Place two drops of iodine solution onto the chopped food pieces.
3. Observe and record changes in the colour of the iodine solution.

Observation	Conclusion
Turned blue-black	Starch present
Remained brown	Starch absent

Test for reducing sugars (Benedict's Test)
For liquid sample:
1. Add about 2 cm^3 of unknown solution and an equal volume of Benedict's solution into a test tube.
2. Shake the mixture thoroughly and heat it by placing it in a boiling water bath for 5 minutes.
3. Remove tubes from the water bath.
4. Observe and record changes in the colour of the mixture, if any.

For solid sample:
1. Place one portion of the chopped food pieces (approximately 1 cm^3) into a clean test tube and label the tube appropriately.
2. Add in sufficient water (about 1 cm^3) to the tube to dissolve the reducing sugar in the sample. Shake thoroughly to mix.
3. Add in equal volume of Benedict's Solution to the solution containing the chopped sample. Shake thoroughly to mix.
4. Place tube in boiling water bath for 5 minutes.
5. Remove tubes from the water bath.
6. Observe and record changes in the colour of the mixture, if any.

Observation	Conclusion
Remained blue	No reducing sugar
Turned from blue to green precipitate	Traces of reducing sugar
Turned from blue to yellow or orange precipitate	Moderate amount of reducing sugar
Turned from blue to brick-red precipitate	Large amount of reducing sugar

Test for proteins (Biuret Test)
For liquid sample:
1. Add about 2 cm^3 of unknown solution and an equal volume of sodium hydroxide solution to the mixture. Shake thoroughly to mix.
2. Add in 1% copper sulphate solution drop by drop. Shake the test-tube after adding each drop.

3. Observe and record any colour changes, if any.

For solid sample:
1. Place one portion of the chopped food pieces (approximately 1 cm^3) into a clean test tube and label the tube appropriately.
2. Add in sufficient water (about 1 cm^3) to the tube to the chopped sample. Shake thoroughly to mix.
3. Add in equal volume sodium hydroxide solution to the mixture. Shake thoroughly to mix.
4. Add in 1% copper sulphate solution drop by drop. Shake the test-tube after adding each drop.
5. Observe and record any colour changes, if any.

Observation	**Conclusion**
Remained blue	Protein absent
Turned violet/purple	Protein present

<u>Test for fats (Ethanol emulsion Test)</u>
For liquid sample:
1. Add 1 small drop of oil into a dry test tube.
2. Add 3 cm^3 of alcohol to the test tube and shake the mixture thoroughly to mix.
3. Add an equal amount of water to the mixture in the test tube slowly.

For solid sample:
1. Place one portion of the chopped food pieces (approximately 1 cm^3) into a clean and dry test tube and label the tube appropriately.
2. Add 3 cm^3 of ethanol into the chopped food mixture. Shake thoroughly to mix.
3. Record changes in the solution.
4. Decant the mixture (allow the mixture to settle, pour the liquid part of the mixture into another dry test tube).
5. Add the same volume of water to the liquid portion. Observe and record formation of white emulsion, if any.

Observation	**Conclusion**
Remained clear	Fat absent
White emulsion formed	Fat present

Appendix D

Microscopy techniques

Steps to making a wet mount

1. Gather a thin piece of specimen and spread out evenly on the slide. Otherwise, the coverslip will wobble on top of the specimen and will not be viewable under High Power

2. Place one drop of water directly over the specimen.
3. Place the coverslip at an approximately 45-degree angle with one edge touching the water drop and then gently let go. Ensure that no bubbles are trapped under the coverslip.
4. Remove any excess solution that has spilled out of the cover slip with a piece of filter paper.

Temporary mount of plant tissue video - http://tinyurl.com/yd7a8kps

Staining a slide

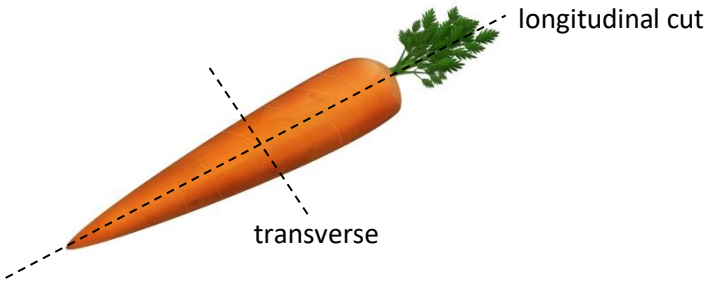
1. Place a drop of stain (i.e. iodine) on the edge of the coverslip.
2. Place the flat edge of a piece of filter paper on the opposite side of the coverslip. The cohesion of water will draw the stain under the slide, to the other side.
3. Remove excess stain on the slide with a filter paper.

Source (video): http://www.tplhk.com.hk/

Appendix E

Prepare a specimen for drawing by cutting longitudinal (LS), transverse (TS) or staining

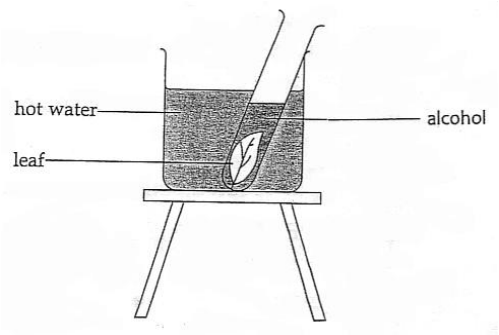
1. Blot specimen dry with paper towel if it is immersed in water
2. Always cut specimen on white tile
3. Longitudinal axis is defined by points at the opposite ends of an organism
4. Transverse axis is defined by points on the opposite sides of an organism



Appendix F

Prepare leaf to test for the presence of starch

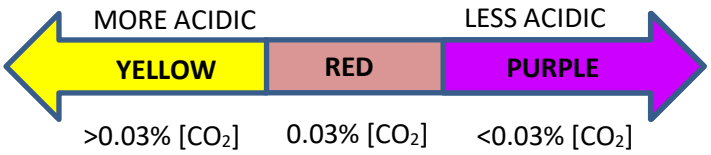
1. Half fill a beaker with water and heat. When the water boils, turn off the heat.
2. Put the green leaf into the hot water for 5 minute.
3. Put the boiled leaf in a boiling tube containing ethanol so that it is fully submerged. Use a glass rod to push the leaf into the ethanol.
4. Place the boiling tube in the beaker of hot water.
5. When the leaf turns pale yellow in colour or colourless, carefully remove the brittle leaf using the forceps. Then immerse it in warm water for a few seconds to soften it.
6. Remove the leaf from the warm water and place it on a white tile. Carefully spread out the leaf using the forceps.
7. Cover the leaf with iodine solution, leave for a while and then wash away the iodine solution.



Appendix G

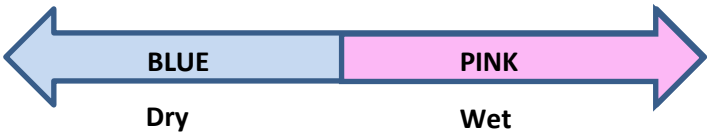
Hydrogen carbonate indicator

- pH indicator to show colour change as carbon dioxide concentration in an aqueous solution increases
- commonly used in photosynthesis and respiration experiments
- colour change scale:



Cobalt chloride paper

- test for the presence of water (moisture)
- dry cobalt chloride paper turns from blue to pink in the presence of water



Appendix H

Background:	Living organisms naturally produce hydrogen peroxide during metabolism. This chemical is toxic to cells if left to accumulate. While it can naturally break down into water and oxygen, this process is very slow. To prevent this toxic chemical from accumulating and causing harm to the organism, living cells produce an enzyme known as catalase. Catalase will speed up the decomposition of hydrogen peroxide into water and oxygen. $\mathbf{2\ H_2O_2 \rightarrow 2\ H_2O + O_2}$		
Inquiry Question:	How does increasing concentrations of catalase affect the decomposition of hydrogen peroxide?		
Apparatus:	5 cm^3 syringe	Graph paper	Safety goggles
	100 cm^3 measuring cylinder	Pen-knife	White tile
	1 piece of plasticine	Ruler	Gloves
Materials:	2.0 mol dm^{-3} hydrogen peroxide solution 4 potato cylinders (each about 3 cm in length)		
Safety Precautions:	Hydrogen peroxide is corrosive. Please wear gloves and safety goggles when handling it.		
Procedure:	**The procedure has been jumbled. Rearrange them and answer the questions that accompany the steps.**		

A) **Use a pen-knife and ruler to cut a potato cylinder into 2 cm in length.**	**G)** **Wait for 30 seconds and then count the number of bubble evolved in 1 minute. Record this count.** *Questions:* *- What do the bubbles contain?* *- Why do you need to wait for 30 seconds before counting the bubbles?* *- What does the number of bubbles in 1 minute represent?* Answers: - oxygen - allow time for reaction to start - rate of reaction

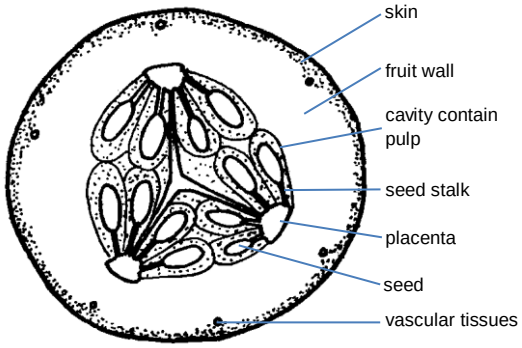
B) **Cut each potato cylinder into 10 slices (discs) of approximately equal thickness.** *Questions:* *- Why should the potato discs be of equal thickness?* *- Suggest how this step may affect the results of the experiment.* Answers: - Maintain a constant cross-sectional area to ensure for a fair test - Affects the rate of reaction by changing the exposed surface area of the enzyme and substrate	**H)** **Remove the plunger from the syringe and place two of the potato discs within the barrel of the syringe.**
C) **Discard the contents of the syringe and repeat the count one more time using fresh discs and hydrogen peroxide. Record your results in the table below.** Question: - Why do you need to obtain more than 1 reading? Answers: - Ensure for reliability of results	**I)** **Repeat steps 3 – 8 using 4, 6, and 8 potato slices.** *Question:* *- Read the procedure and identify the variables that you have changed and kept constant.* Answers: - changed number of potato slices - kept constant original length of potato cylinder, thickness, volume and concentration of hydrogen peroxide, duration of bubbles count
D) **Attach a piece of plasticine to the plunger of the syringe and drop the syringe into the measuring cylinder of water. The syringe should sink to the bottom of the measuring cylinder. If it does not happen, remove the syringe and add more plasticine to the plunger.**	**J)** **Replace the plunger, pushing it as far as possible without crushing the potato discs**
E) **Draw 5 cm^3 of the 2.0 mol dm^{-3} hydrogen peroxide solution into the syringe.** *Question:* *- Suggest why 5 cm^3 of hydrogen peroxide is used.* Answers: - ensure hydrogen peroxide is not limiting the reaction	**K)** **Fill a measuring cylinder with about 80 cm^3 of water.**
F) **Pull the plunger further to draw 1 cm^3 of air into the syringe.**	

Sequence: ……

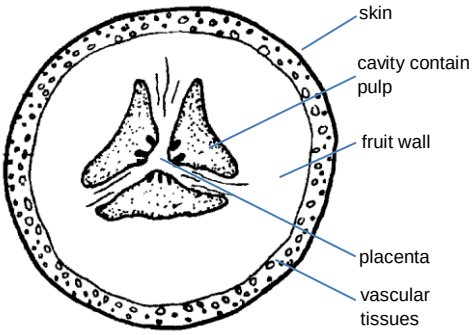
Answer: A, B, H, J, E, F, K, D, G, C, I

Appendix I

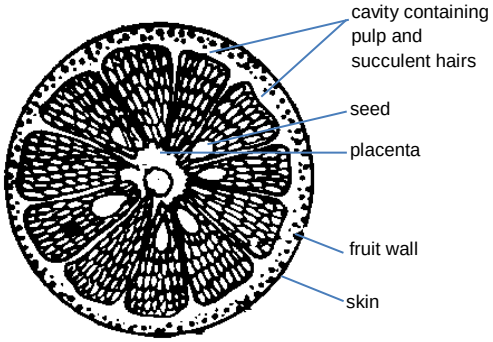
Common biological diagrams



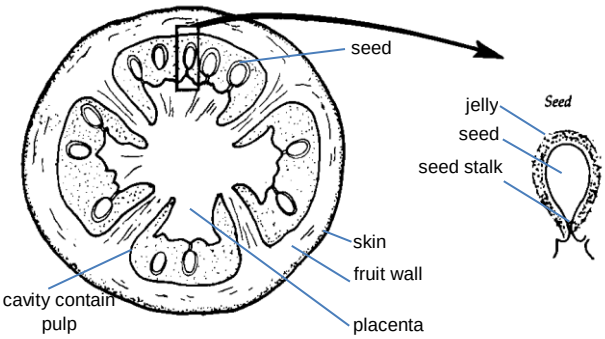
TS Cucumber



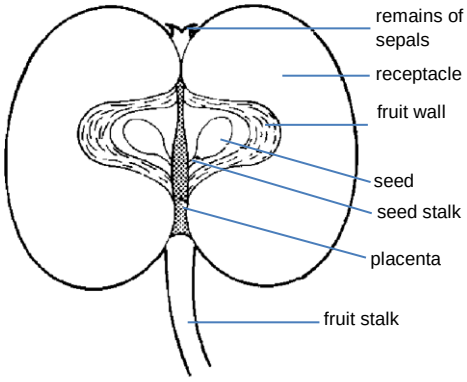
TS Banana



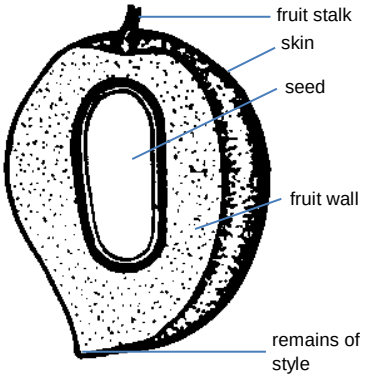
TS Orange



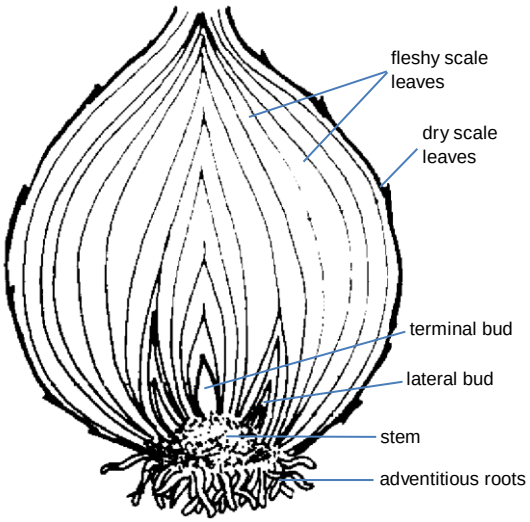
TS Tomato



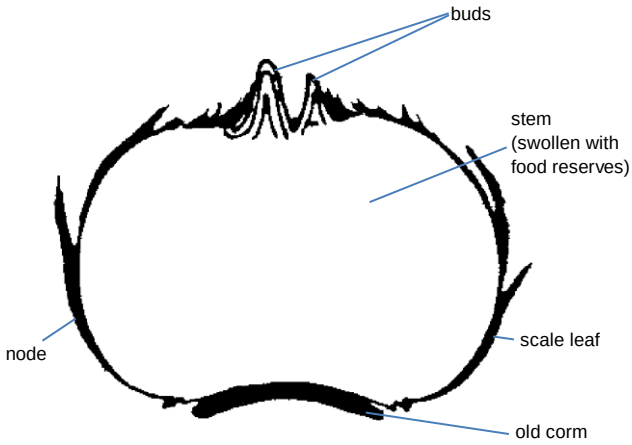
LS Apple



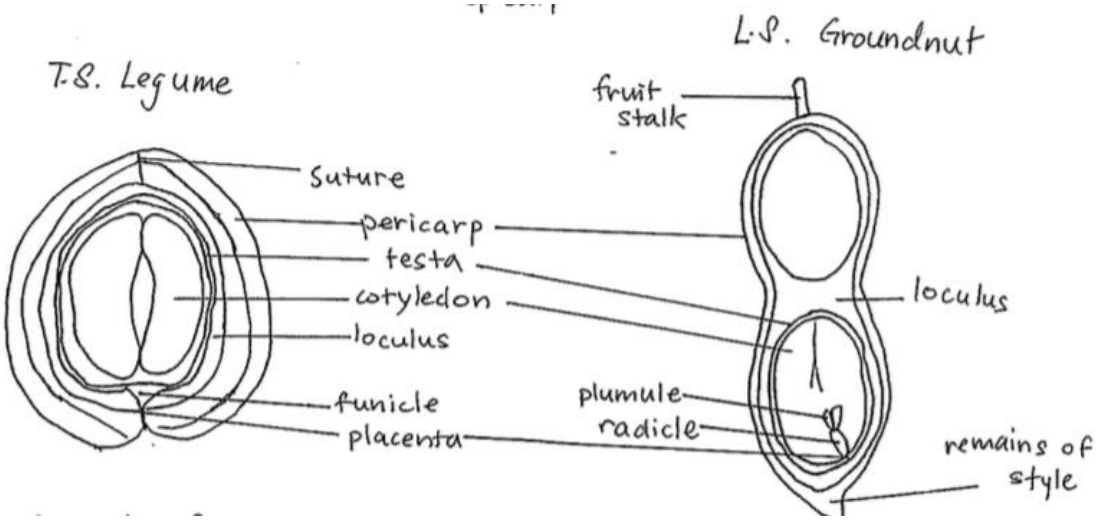
LS Mango



LS Onion



LS Water Chestnut



-- end of appendices –

Reference

CPDD Science Unit. (2016). Science Laboratory Practical Handbook, A Practitioner's Guide. Singapore: Curriculum Planning & Development Division.