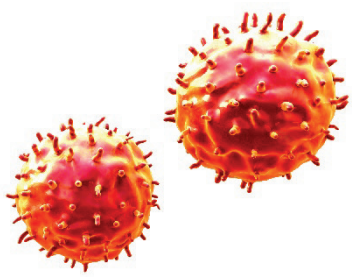
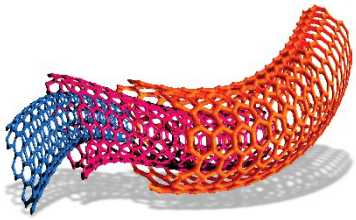
Cambridge Assessment International Education

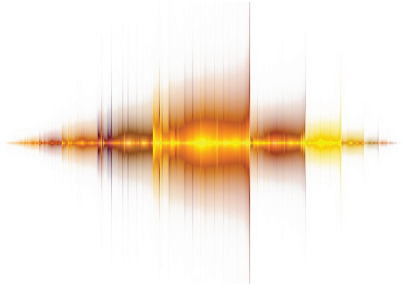
Skills for science
Observations, measurements and estimates

Cambridge IGCSE™
Biology 0610
Chemistry 0620
Physics 0625

The activities and worksheets used in this booklet are suitable for use with other IGCSE, IGCSE (9–1) and O Level science syllabuses.







Version 1.0

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Contents

About this document

This document has been designed to help you to develop your learners' observational, measurement and estimation skills as defined by assessment objective 3 (AO3) in the science syllabuses.

AO3 Experimental skills and investigations

Candidates should be able to:

- demonstrate knowledge of how to safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate)
- plan experiments and investigations
- **make and record observations, measurements and estimates**
- interpret and evaluate experimental observations and data
- evaluate methods and suggest possible improvements.

In AO3, learners are expected to be able to make accurate observations, measurements and estimations from experiments. In this document, we will use the term 'experiments', but all of the skills, information and activities also apply to investigations.

The document is divided into **three** main sections:

1. Introduction

This describes the importance of accurate observations and measurements within the context of our science syllabuses. It includes suggested questions that learners should ask themselves whilst planning and conducting experiments. Help with starting classroom discussions on observations, measurements and estimates in general terms are also provided.

2. Classroom activities

A set of generic worksheets are provided that can be used to increase learner confidence in observation and measurement skills.

3. Example responses

Questions from past papers and the associated mark schemes are provided along with example responses. There is one example for each of the three IGCSE science subjects (Biology, Chemistry and Physics). A middle-level response is annotated with what was done well, what could be improved, and useful terminology. An improved response to the question is then annotated for comparison.

Introduction

Candidates may be required to do the following in either Paper 5 or Paper 6:

- *Recall of familiar, and unfamiliar, techniques to record observations and make deductions from them.*
- *Record readings from diagrams of apparatus, including:*
  - *reading a scale with appropriate accuracy and precision*
  - *interpolating between scale divisions*
  - *taking repeated measurements, where appropriate, to obtain an average value.*

Observations and **measurements** in science need to be accurate and unbiased. Observations are things that can be seen as a result of an experiment, and can be either be qualitative (descriptive) or *quantitative* (counted or measured). Therefore, a measurement is simply a type of observation. An **estimate** is an approximation of a value. Estimations are used when a scientist is unable to gain reliable data for part of an experiment. They are also used to predict intermediate values from a graph or chart of previously gathered data.

Learners should be encouraged to:

- Draw a results table to record observations and measurements, using appropriate headings
- For quantitative observations, use the correct units of measurement
- For qualitative observations, written descriptions should be in the present tense, include key vocabulary and use impersonal language.

A well-planned experiment will enable learners to collect data easily. Learners should ask themselves the following questions before making observations and taking measurements.

- What data am I going to collect?
- Is the apparatus arranged in such a way that I can take accurate measurements?
- What units are my measurements recorded in?
- Will my equipment allow me to collect accurate data?
- How many measurements do I need to take?
- Do I have an appropriate way of recording the data that I collect (e.g. results table)?
- How will I use the data I collect to prove or disprove the hypothesis?
- How can I ensure that I can make observations safely?

Getting started

Before learners begin an experiment, encourage them to consider how they will make observations, take measurements or use estimates using the following activities.

Making observations and measurements

Discuss how to take accurate observations and measurements by asking learners:

- What are the different types of observations and measurements you might want to make in a science experiment?
- For each of the above, what different types of equipment could you use to take these measurements?
- What units of measurement do scientist use?
- When might it be appropriate to take repeat observations and measurements in an experiment?

Types of observation

For each of the following experiments, get the learners to decide:

- Which observations the experimenter will need to make?
- Which equipment will be used to make the observations?
- How will the observation be recorded (number or written description)?
- How will the observations be as accurate as possible?

The effect of temperature on enzyme activity
Four test-tubes containing starch and amylase were placed at fource different temperatures (0 °C, room temperature, 40 °C and 65 °C). A drop of iodine was added to each test-tube and the stopwatch started. The time taken for the blue-black colour to disappear at each temperature was measured.

Displacement reactions between metals and their salts
A few drops of copper sulfate, zinc nitrate, magnesium sulfate and lead nitrate were placed in adjacent wells in a spotting tile. A small piece of copper metal was added to each well and any reactions noted.

Extension of a spring
A spring was attached to a clamp stand and the length of the spring recorded. A 10 g mass was hung from the bottom of the spring and the new length of the spring was recorded. This was repeated, adding 10 g each time until the total mass hanging from the spring was 100 g.

Estimations

Estimate how many breaths you have taken since you were born. How would you go about doing this? Think about:

- How many breaths do you take in 1 minute?
- How many breaths in 1 hour? How many breaths in 1 day?
- How many breaths in 1 year?
- How old are you?

Classroom activities

The following worksheet activities can be used with your learners to help them improve their observational and measurement skills. These worksheets are generic and can be used to develop observational, measurement and estimation skills in general.

- **Worksheet 1:** Match the statements
- **Worksheet 2:** Reading from a scale
- **Worksheet 3:** Observation and inference
- **Worksheet 4:** Estimations
- **Worksheet 5:** Observation scenario – biology
- **Worksheet 6:** Observation scenario – biology
- **Worksheet 7:** Observation scenario – chemistry
- **Worksheet 8:** Observation scenario – chemistry
- **Worksheet 9:** Observation scenario – physics
- **Worksheet 10:** Observation scenario – physics

Worksheet 1: Match the statements

The list of statements in column **A** contains common measurements made in science experiments. Cut out the statements and stick them into column **A** on the second part of the worksheet.

The list of statements in column **B** are types of equipment used to make these measurements. Cut out the statements and stick them in column **B,** matching them to the type of measurement in column **A**.
NOTE: more than one statement could match with each of the column **A** statements.

The list of statements in column **C** contains units of measurement commonly used with the measurements in column **A**. Cut out the statements and stick them in column **C,** matching them to the type of measurement in column **A** and equipment in column **B**.
NOTE: more than one statement could match with each of the column **A** and column **B** statements.

A	**B**	**C**
volume	stopwatch	grams
mass	ammeter	centimetres
force	syringe	ohms
length	voltmeter	millilitres
time	measuring tape	cm^3
current	balance	seconds
voltage	thermometer	newtons
temperature	measuring cylinder	degrees Celsius
resistance	burette	volts
	balance	metres
	pipette	kilograms
	ruler	milliseconds
	newton meter	millimetres
	ammeter	minutes
		amperes

Worksheet 1: Match the statements, continued

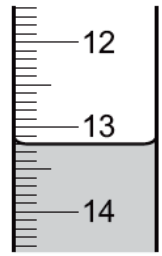
Put the types of measurement in column **A** then match the equipment used for that measurement in column **B** and the units of measurement in column **C**.

A	**B**	**C**

Worksheet 2: Reading from a scale

For each of the following diagrams, give the correct measurement from reading the scale. Include units of measurement wherever possible.

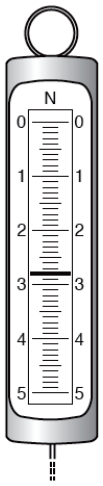
(1)



final reading

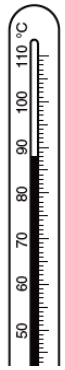
Reading: .....

(2)



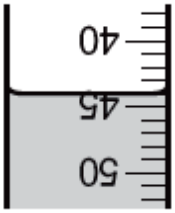
Reading: .....

(3)



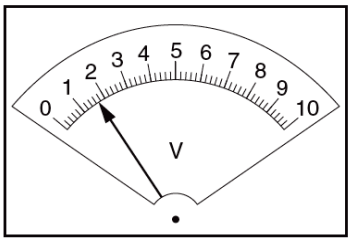
Reading: .....

(4)



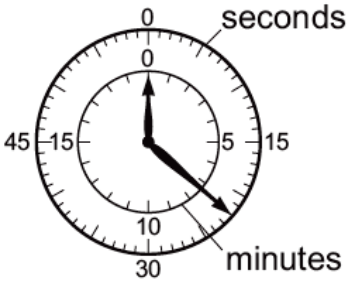
Reading: .....

(5)



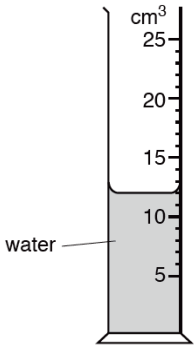
Reading: .....

(6)



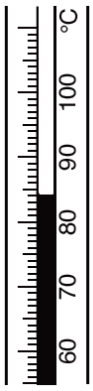
Reading: .....

(7)



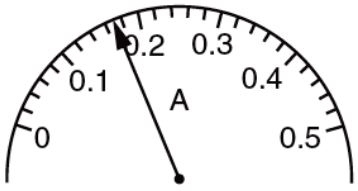
Reading: .....

(8)



Reading: .....

(9)



Reading: .....

Worksheet 3: Observation and inference

An **observation** is information gathered by looking, hearing, smelling and touching.
This can be quantitative (the amount of something, such as length or mass), or qualitative (colour, size, shape).

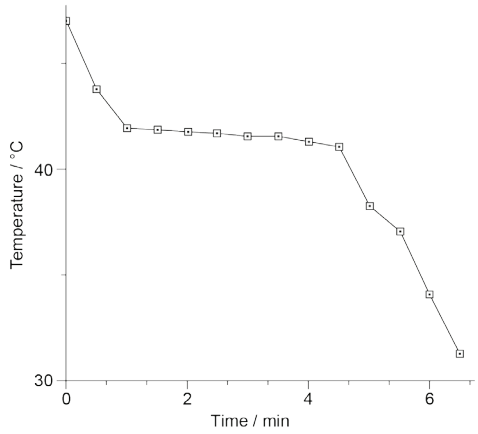
An **inference** is an explanation or interpretation of what is being observed.

For each of the following statements decide whether they are an observation or an inference.

	Observation or inference?
The mass of the block was 0.3 kg.	
The second ball bounced higher because it is made of rubber.	
28 bubbles were released by the *Elodea* plant in 5 minutes when the lamp was at a distance of 20 cm.	
The potato changed colour from brown to blue-black when iodine was added.	
The handle of a metal spoon got hotter than the handle of a wooden spoon when it was put in hot water.	
The potassium fizzed and burnt with a purple flame when it was dropped into water.	
The potato went blue-black when iodine was added because it contains starch.	
The temperature of the water was 75 °C.	
The handle of a metal spoon got hotter than the handle of a wooden spoon when it was put in hot water because metals are good conductors of heat.	
When a piece of magnesium was placed into copper sulfate solution the magnesium turns brown because magnesium is more reactive than copper.	

Worksheet 4: Estimations

(1) Stearic acid was heated in a boiling tube until it changed from a solid to a liquid. It was allowed to cool and the temperature taken every 30 s. The graph below shows the cooling of stearic acid.



Estimate from the graph:

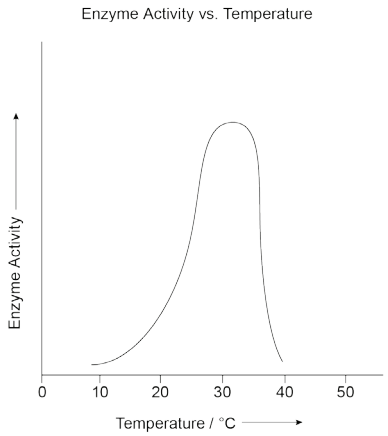
(a) the temperature at which stearic acid changes from a liquid to a solid

……..

(b) the time at which stearic acid changes from a liquid to a solid.

……..

(2) The graph below shows how the activity of an enzyme changes as the temperature increases.



Estimate from the graph:

(a) the optimum temperature for this enzyme

……..

(b) the temperature at which this enzyme is denatured.

……..

Worksheet 4: Estimations, continued

(3) The table below shows the boiling points of a range of organic compounds. Estimate from the table the boiling points of propane and heptane.

Organic compound	Molecular formula	Boiling point (°C)
methane	CH_4	−161.6
ethane	C_2H_6	−88.6
propane	C_3H_8	……
butane	C_4H_{10}	−0.5
pentane	C_5H_{12}	36.1
hexane	C_6H_{14}	69
heptane	C_7H_{16}	……
octane	C_8H_{18}	125.52

(4) The table below shows information about each planet in the solar system.

Name of planet	Average distance from Sun (km)	Diameter (km)	Time to spin on axis (a day)	Time to orbit sun (a year)	Gravity (Earth = 1)	Average temperature (°C)
Mercury	57 900 000	4878	59 d	88 d	0.38	−183 to 427
Venus	108 160 000	12 104	243 d	224 d	0.9	480
Earth	149 600 000	12 756	23 hl 56 min	365.25 d	1	14
Mars	227 936 640	6794	24 h 37 min	687 d	0.38	−63
Jupiter	778 369 000	142 984	9 h 55 min	11.86 y	2.64	−130
Saturn	1 427 034 000	120 536	10 h 39 min	29 y	1.16	−130
Uranus	2 870 658 186	51 118	17 h 14 min	84 y	1.11	−200
Neptune	4 496 976 000	49 532	16 h 7 min	164.8 y	1.21	−200

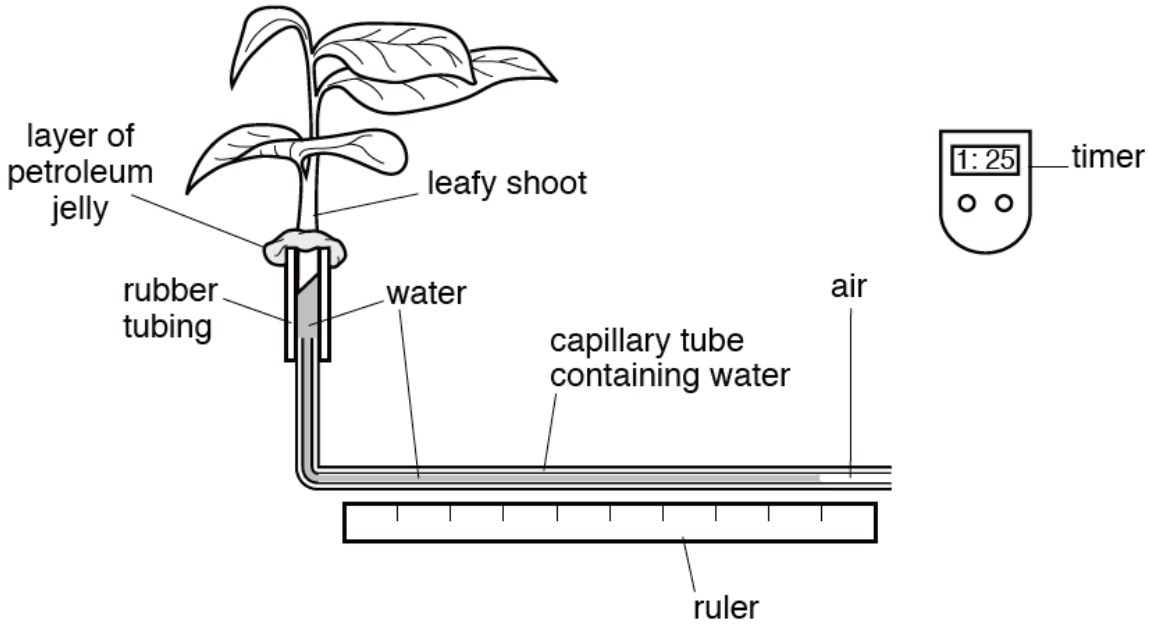
Ceres is a dwarf planet found in the asteroid belt, 413 900 000 km from the Sun. Use the information in the table to estimate:

(a) The average temperature on Ceres ……...

(b) The time it takes Ceres to orbit the Sun ……....

Worksheet 5: Observation scenario – biology

A learner wished to measure the rate of water loss from the leaves of a plant using the following equipment.



(1) What observation(s) will need to be made?

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(2) How will the learner make the measurements?

……

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……

(3) What does the learner need to take into consideration in order to take accurate measurements?

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……

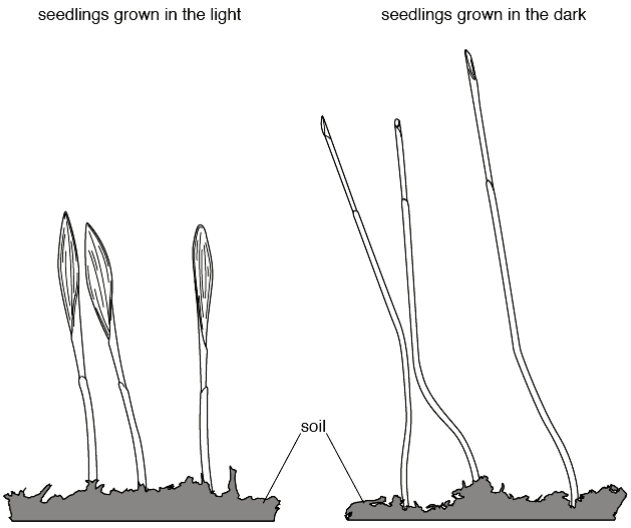
Worksheet 5: Observation scenario – biology, continued

(4) Draw a results table for this experiment. Include appropriate units.

Worksheet 6: Observation scenario – biology

A learner investigated the effect of light on the germination and early growth of maize.
They measured and observed maize grown in the light and maize grown in the dark.

The seedlings were grown at 20 °C and watered every day for 10 days.



(1) What observation(s) will need to be made?

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……

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(2) How will the learner make the measurements?

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(3) What does the learner need to take into consideration in order to take accurate measurements?

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……

Worksheet 6: Observation scenario – biology, continued

(4) Draw a results table for this experiment. Include appropriate units.

Worksheet 7: Observation scenario – chemistry

A learner investigated what happens when dilute hydrochloric acid and copper(II) sulfate solution react with different metals.

Three experiments were carried out:

Experiment 1:
A measuring cylinder was used to pour 10 cm^3 of dilute hydrochloric acid into a boiling tube.
The temperature of the hydrochloric acid was measured.
1 g of zinc was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

Experiment 2:
Experiment 1 was repeated using 1 g of iron instead of zinc.

Experiment 3:
Experiment 1 was repeated using 1 g of magnesium instead of zinc.

(1) What observation(s) will need to be made?

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……

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(2) How will the learner make the measurements?

……

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(3) What does the learner need to take into consideration in order to take accurate measurements?

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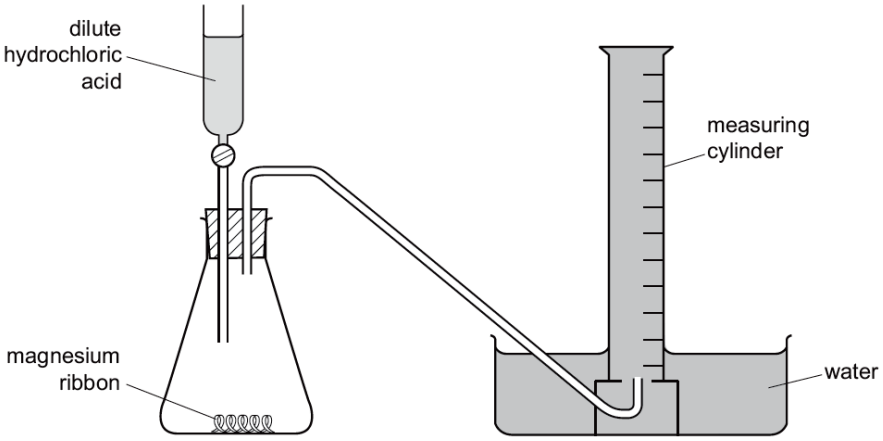
Worksheet 7: Observation scenario – chemistry, continued

(4) Draw a results table for this experiment. Include appropriate units.

Worksheet 8: Observation scenario – chemistry

A learner investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature, using the following apparatus.



30 cm^3 of dilute hydrochloric acid was added to the conical flask containing magnesium ribbon. The timer was started and the volume of gas collected in the measuring cylinder was measured every 20 s for 180 s (3 min).

(1) What observation(s) will need to be made?

……

……

……

(2) How will the learner make the measurements?

……

……

……

(3) What does the learner need to take into consideration in order to take accurate measurements?

……

……

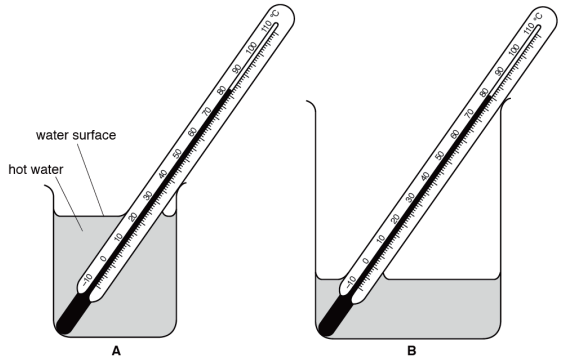
……

Worksheet 8: Observation scenario – chemistry, continued

(4) Draw a results table for this experiment. Include appropriate units.

Worksheet 9: Observation scenario – physics

A learner is investigating how the surface area of water exposed to the air affects the rate at which the water cools. They use the apparatus shown below. Beaker **B** is bigger than beaker **A**.



The learner pours 75 cm^3 of hot water into beaker **A** and 75 cm^3 of hot water into beaker **B**. They immediately start a stopwatch. The learner takes the temperature of the water every 30 s.

(1) What observation(s) will need to be made?

……

……

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(2) How will the learner make the measurements?

……

……

……

(3) What does the learner need to take into consideration in order to take accurate measurements?

……

……

……

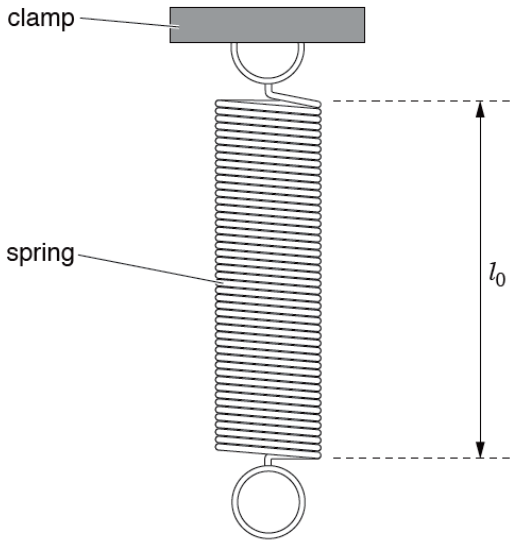
Worksheet 9: Observation scenario – physics, continued

(4) Draw a results table for this experiment. Include appropriate units.

Worksheet 10: Observation scenario – physics

A learner is investigating the stretching of a spring.

First, they measure the un-stretched length of the spring.



They then hang a load L of 1.0 N on the spring and measures the new length l of the spring.
They the repeat the measurements using 2.0 N, 3.0 N, 4.0 N and 5.0 N loads.

(1) What observation(s) will need to be made?

……

……

……

(2) How will the learner make the measurements?

……

……

……

(3) What does the learner need to take into consideration in order to take accurate measurements?

……

……

……

Worksheet 10: Observation scenario – physics, continued

(4) Draw a results table for this experiment. Include appropriate units.

Example responses

This section includes a past paper question for each of the sciences. Example responses are shown with information on how the answers could be improved. Useful terminology and examples of improves answers are included to show how learner responses could be developed.

Observation question – biology

In this question, learners are asked to measure a cylinder of potato from a diagram. Learners need a ruler to do the measurements accurately, noting which measurement corresponds to the height, length and width of the cylinder. They also need to look at the data collected from the experiment and draw a suitable results table. The best way to do this is to read carefully through the steps of the experiment in order to identify what the experimenter was measuring and how many times they were taking measurements in order to deduce how many rows and columns your table should contain. Use the information in the stem of the question to help with column headings. Units should always be included in the headings rather than the main body of the table.

1 Metabolic reactions in cells produce toxic chemicals which can be converted to harmless or less toxic chemicals.

Hydrogen peroxide is broken down using the enzyme catalase which is found in most cells.

Fig. 1.1 shows this reaction.

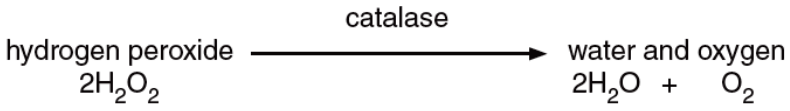


Fig. 1.1

A student investigated the effect of alcohol (ethanol) on the activity of catalase found in potato, using three pieces of potato cut to the same size.

Fig. 1.2 shows these pieces of potato.

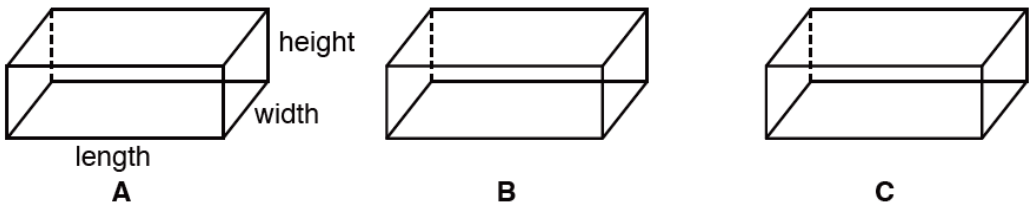


Fig. 1.2

(a) (i) Measure the length, width and height of one of these pieces of potato.

Record your results in Table 1.1.

Table 1.1

length of potato piece /mm	width of potato piece /mm	height of potato piece /mm

[1]

Step 1 The student labelled six test-tubes, **1**, **2**, **3**, **4**, **5**, and **6** and used a syringe to add 10 cm^3 of hydrogen peroxide solution to each of the test-tubes.

Step 2 They cut potato piece **A** to obtain two slices of similar size.

Step 3 The student placed the free end of a delivery tube into a large test-tube containing water.

Step 4 They placed one of the slices of potato piece **A** into the hydrogen peroxide solution in test-tube **1**.

Step 5 The student immediately placed the rubber bung attached to the delivery tube into test-tube **1** and pushed it in as tightly as possible, as shown in Fig. 1.3.

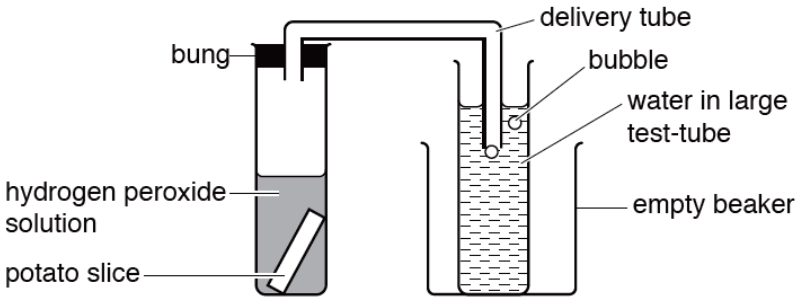


Fig. 1.3

Step 6 They counted the number of bubbles released from the delivery tube in 3 minutes.

Step 7 The student repeated steps **4–6** for the second slice of potato piece **A** using test-tube **2**.

Step 8 They repeated steps **2–7** for potato piece **B** using test-tubes **3** and **4**.

Step 9 They repeated steps **2–7** for potato piece **C** using test-tubes **5** and **6**.

The student used a tally to count the number of bubbles.

Fig. 1.4 shows their tally count.

A1	𝍸	**A2**	III
B1	𝍸 𝍸 𝍸 III	**B2**	𝍸 𝍸 I
C1	𝍸 𝍸 II	**C2**	𝍸 𝍸

Fig. 1.4

(ii) Prepare a table to record the student's results.
Your table should show:

- the numbers of bubbles produced by each slice of potato in 3 minutes
- the mean number of bubbles produced by each of potato piece **A**, **B** and **C**.

Complete your table using the results from Fig. 1.4.

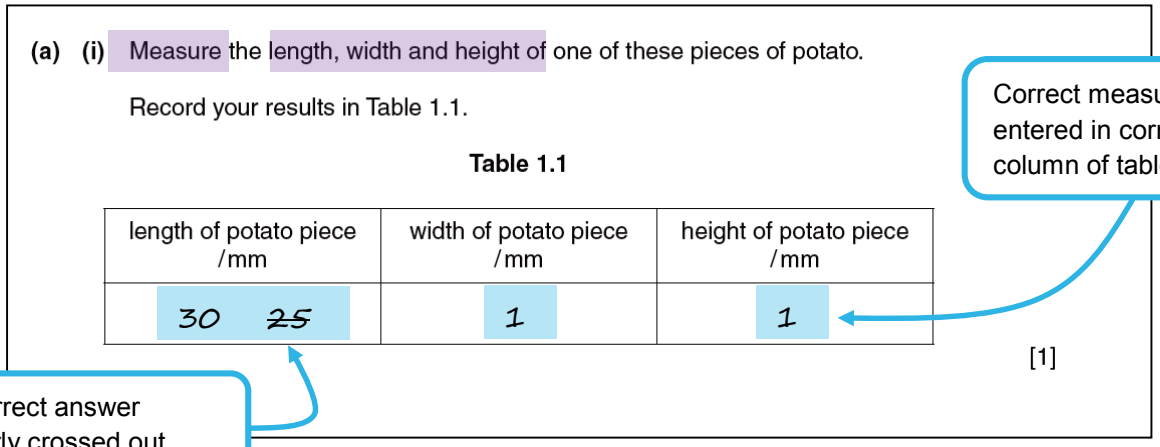
[5]

The mark scheme for this question is as follows:

Question	Mark scheme	Mark	Guidance
1 (a) (i)	*length: 30 (mm)* *width: 10 (mm)* *height: 10(mm)*	[1]	All correct for 1 mark
(ii)	1 table drawn with rows or columns; 2 table drawn with cells for at least 6 bubble readings and 3 means; 3 appropriate column headings with units (number of) bubbles per (or in) 3 minutes / min or (number of) bubbles / minute or min + potato / piece of potato / piece / tube + slice / stick and 1 or 2 + mean / average number of bubbles per 3 min (or per 1 min); 4 correct tally results recorded; 5 correct mean / average calculated for each potato piece	[5]	**I** graphs **R** if units given in cells instead of header

Example response

This response would achieve the full mark. The learner has measured the potato piece accurately and recorded the correct numbers clearly in the correct columns. Any incorrect answers are clearly crossed out.



(a) (i) Measure the length, width and height of one of these pieces of potato.

Record your results in Table 1.1.

Table 1.1

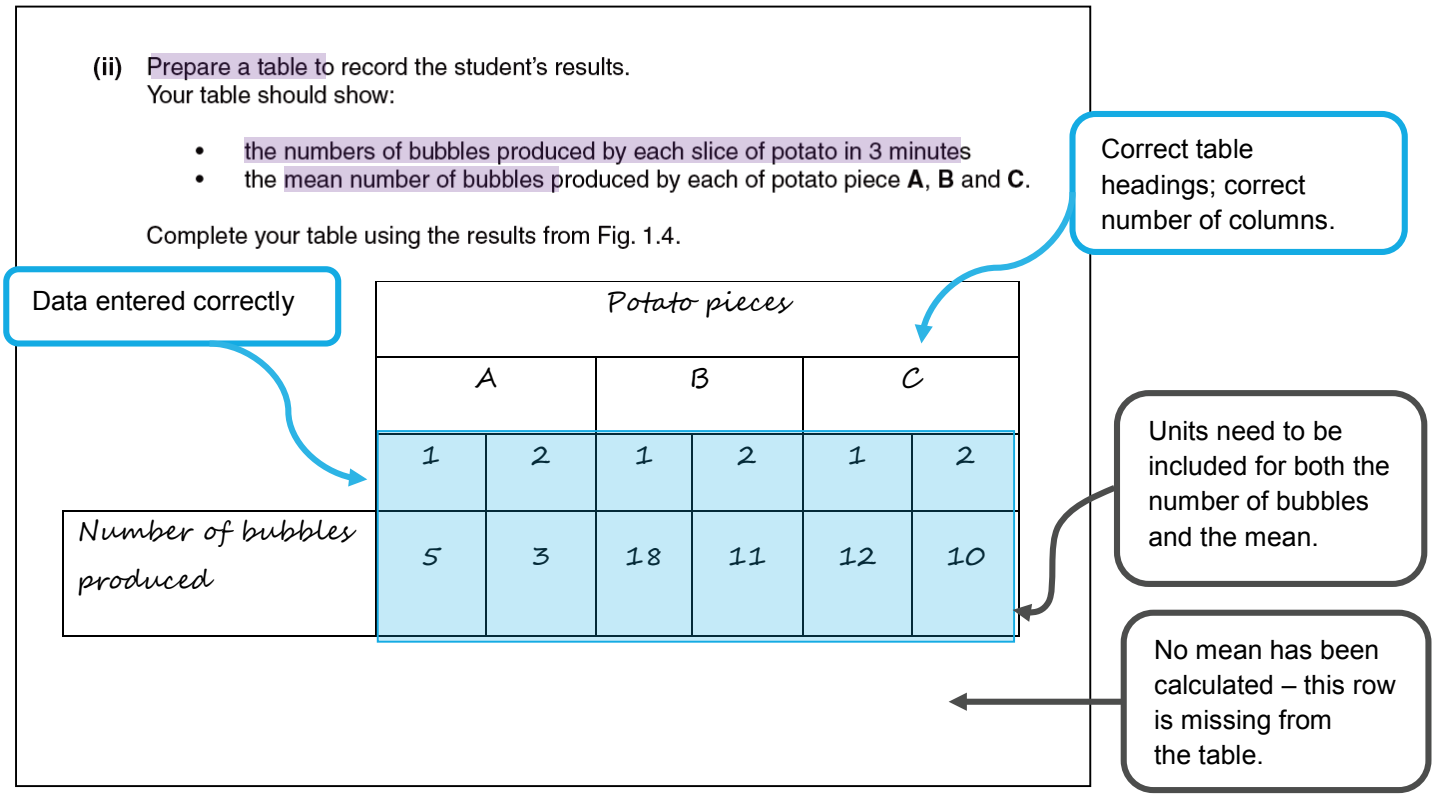
length of potato piece /mm	width of potato piece /mm	height of potato piece /mm
30 ~~25~~	1	1

[1]

Correct measurements entered in correct column of table

Incorrect answer clearly crossed out

For drawing the table, the candidate received 2 out of a possible 5 marks. They have produced a table with the correct number of columns and the data is entered correctly. However, they have missed the units from the number of bubbles row heading. There is no evidence of the candidate calculating the mean, or including this in the table.



(ii) Prepare a table to record the student's results.
Your table should show:

- the numbers of bubbles produced by each slice of potato in 3 minutes
- the mean number of bubbles produced by each of potato piece **A**, **B** and **C**.

Complete your table using the results from Fig. 1.4.

	Potato pieces					
	A		B		C	
	1	2	1	2	1	2
Number of bubbles produced	5	3	18	11	12	10

Correct table headings; correct number of columns.

Data entered correctly

Units need to be included for both the number of bubbles and the mean.

No mean has been calculated – this row is missing from the table.

Improved response

(ii) Prepare a table to record the student's results.
Your table should show:

- the numbers of bubbles produced by each slice of potato in 3 minutes
- the mean number of bubbles produced by each of potato piece **A**, **B** and **C**.

Complete your table using the results from Fig. 1.4.

	Piece of potato					
	A		B		C	
	1	2	1	2	1	2
Number of bubbles produced in 3 minutes	5	3	18	11	12	10
Mean number of bubbles produced in 3 minutes	4		14.5		11	

Complete headings (including units) are now included

This results table would gain the maximum number of marks.

Mean calculated correctly and row included in table

Observation and measurement question – chemistry

In this question learners are asked to take accurate measurements by reading off a scale and recording this information correctly in a table. To do well in this question, learners need to carefully read and use the information given as well as their scientific knowledge to think about what observations would be made. They also need to think about how to improve the accuracy of measurements.

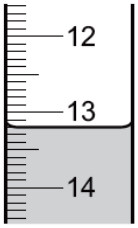
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

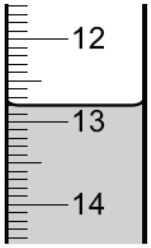
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



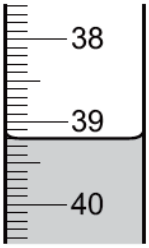
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3		
initial burette reading / cm^3		
difference / cm^3		

[4]

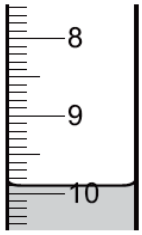
(b) What colour change was observed in the flask in experiment 2?

from ..... to ..... [1]

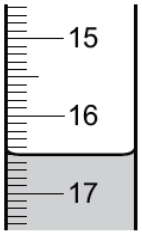
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..... [1]

(e) Complete the sentence below.

Experiment ..... needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..... [1]

The mark scheme for this question is as follows:

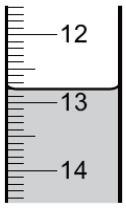
Question	Mark scheme	Mark
2 (a)		4
	final readings completed correctly: 13.2, 39.2;	1
	initial readings completed correctly: 0.0, 12.8;	1
	differences completed correctly: 13.2, 26.4;	1
	all readings and differences to 1 decimal place;	1
(b)	yellow to orange / red / pink	1
(c)		2
	initial and final readings completed correctly: 9.9, 16.5;	1
	difference completed correctly: 6.6;	1
(d)	bubbles / fizzing / effervescence;	1
(e)	experiment 2;	1
(f)	use a pipette / burette;	1

Example response

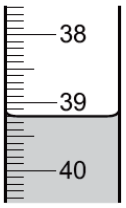
Question 2 (a): This is a mid-level response with 2 out of 4 marks being awarded. The candidate has given all numbers to one decimal place; however, they have read the scales incorrectly and not looked at the numbers either side of the line to be measured. Only the differences are correct.

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3	14.8cm^3	40.8cm^3
initial burette reading / cm^3	0.0cm^3	13.2cm^3
difference / cm^3	14.8cm^3	27.6cm^3

[4]

Scales have been read incorrectly.

All numbers given to 1 decimal place.

Differences calculated correctly.

As a result of misreading the scales, the numbers entered in the table are incorrect.

Questions 2 (b) and (c): 2(b) gained the full mark for correctly identifying the colour change from the information given. The response for question 2(c) only gained half the available marks, as the candidate had incorrectly read the measurements from the diagram (the same error as in part (a)).

(b) What colour change was observed in the flask in experiment 2?

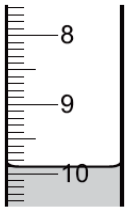
from ..yellow.. to ..Red-orange.. [1]

Correct colour change identified and written in the correct order.

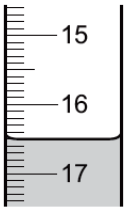
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

Scales have been read incorrectly.

	experiment 3
final burette reading / cm³	17.5 cm³
initial burette reading / cm³	10.1 cm³
difference / cm³	7.4 cm³

[2]

The difference is calculated correctly.

All numbers given to 1 decimal place.

As a result of misreading the scales, the numbers entered in the table are incorrect.

Questions 2(d), (e) and (f): The response to question 2(d) failed to gain a mark as the learner had not written down what was observed. Questions 2(e) and (f) were correctly answered.

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

A gas is formed ..... [1]

(e) Complete the sentence below.

Experiment ..2.. needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

Use a volumetric pipette ..... [1]

A gas is formed, but this is not an observation. The candidate needs to state what would be seen if a gas was produced.

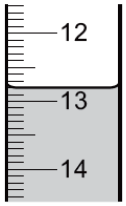
Experiment 2 identified correctly from the data.

Correct equipment stated.

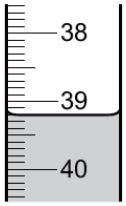
Improved response

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

Readings correctly taken by looking carefully at the scale and its direction.

	experiment 1	experiment 2
final burette reading / cm³	13.2 cm³	39.2 cm³
initial burette reading / cm³	0.0 cm³	12.8 cm³
difference / cm³	13.2 cm³	26.4 cm³

[4]

Table filled in with correct readings and differences correctly calculated. All numbers given to 1 decimal

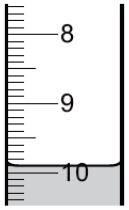
(b) What colour change was observed in the flask in experiment 2?

from ..yellow.. to ..Red-orange.. [1]

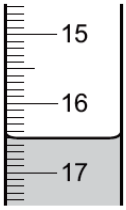
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

Readings correctly taken by looking carefully at the scale and its direction.

	experiment 3
final burette reading / cm^3	9.9 cm^3
initial burette reading / cm^3	16.5 cm^3
difference / cm^3	6.6 cm^3

[2]

Table filled in with correct readings and differences correctly calculated. All numbers given to 1 decimal place.

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..Bubbles produced.. [1]

This response now clearly describes what would be observed.

(e) Complete the sentence below.

Experiment ..2.. needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..Use a volumetric pipette.. [1]

Observation and measurement question – physics

In this question learners are asked to demonstrate their knowledge of how to use a measuring cylinder correctly to determine a volume of water. Drawing and describing a diagram would be useful here in order to get the full marks.

(e) Describe briefly how a measuring cylinder is read in order to obtain a reliable value for the volume of water. You may draw a diagram.

.....

.....

.....

.....[2]

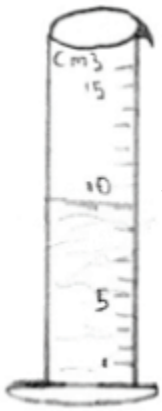
The mark scheme for this question is as follows:

Question	Mark scheme	Mark
5 (e)	Perpendicular viewing / view at right angles / eye level Reading to bottom of meniscus	1 1

Example response

This answer did not receive any marks. Although a diagram has been included, the description of how to read the scale on a measuring cylinder is vague and lacks any scientific detail.

(e) Describe briefly how a measuring cylinder is read in order to obtain a reliable value for the volume of water. You may draw a diagram.



Whist a diagram has been attempted, it is not scientific. It should be in cross-section, not three-dimensional.

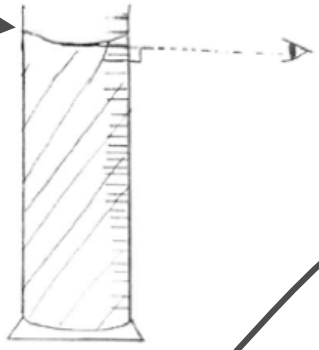
The point at which the top of the water is, is read in the scale provided, so in this case the volume of water is 9cm³.

.....[2]

This description does not give a method of how to read the scale on a measuring cylinder accurately. Key scientific terminology is absent.

Improved response

(e) Describe briefly how a measuring cylinder is read in order to obtain a reliable value for the volume of water. You may draw a diagram.



This diagram is drawn scientifically and also includes the position of the eye level.

This response accurately describes how to take a reading from a measuring cylinder. It uses key terminology such as '**meniscus**'.

Your eyes should be perpendicular to the water level and the scale on the side of the measuring cylinder. The reading should be taken at the bottom of the meniscus.

.....[2]

Worksheet 1: suggested answers

A	B	C
volume	syringe measuring cylinder burette pipette	millilitres cm^3
mass	balance	grams kilograms
force	newton meter	newtons
length	measuring tape ruler	centimetres metres millimetres
time	stopwatch	seconds milliseconds minutes
current	ammeter	amperes
voltage	voltmeter	volts
temperature	thermometer	degrees Celsius
resistance	ammeter	ohms

Worksheet 2: suggested answers

(1) 13.2 cm^3

(2) 2.8 N

(3) 88 °C

(4) 44 cm^3

(5) 1.7 V (volts)

(6) 22 s

(7) 12 cm^3

(8) 84 °C

(9) 0.17 A (amps)

Worksheet 3: suggested answers

	Observation or inference?
The mass of the block was 0.3 kg.	*observation*
The second ball bounced higher because it is made out of rubber.	*inference*
28 bubbles were released by the *Elodea* plant in 5 minutes when the lamp was at a distance of 20 cm.	*observation*
The potato changed colour from brown to blue-black when iodine was added.	*observation*
The handle of a metal spoon got hotter than the handle of a wooden spoon when it was put in hot water.	*observation*
The potassium fizzed and burnt with a purple flame when it was dropped into water.	*observation*
The potato went blue-black when iodine was added because it contains starch.	*inference*
The temperature of the water was 75 °C.	*observation*
The handle of a metal spoon got hotter than the handle of a wooden spoon when it was put in hot water because metals are good conductors of heat.	*inference*
When a piece of magnesium was placed into copper sulfate solution the magnesium turns brown because magnesium is more reactive than copper.	*inference*

Worksheet 4: suggested answers

(1)

(a) 42 °C
(b) 1 minute

(2)

(a) 32 °C
(b) 35 °C and higher

(3) Propane: accept any value in the range −88.5 °C to −0.6 °C

Heptane: accept any value in the range 70 °C to 125.51 °C

Worksheet 5: suggested answers

(1) Movement of air bubble along capillary tube in specified time

(2) Measure distance travelled by air bubble with ruler; measure time using stopwatch

(3) Ensure measurement of air bubble is taken at eye level and not at an angle; ensure air bubble is clearly visible (equipment set up correctly); ensure measurement of air bubble is taken from the same point of bubble each time

(4)

Time (s)	Distance moved by air bubble (cm)
0	
30	
60	
120 etc.	

Worksheet 6: suggested answers

(1) Length of seedlings; length of leaf

(2) Ruler

(3) Ensure measurements are taken at eye level and not at angle; ensure seedling is straight when taking measurement; ensure measurements are taken from the same point on each seedling; measure multiple seedlings

(4)

Seedling number	Length of seedling (cm)	
	Light	Dark
1		
2		
3		
4		
5		

Worksheet 7: suggested answers

(1) Temperature of mixture

(2) Thermometer

(3) Ensure measurements are taken at eye level, not at an angle; watch thermometer at all times to ensure maximum temperature is measured

(4)

Metal added to 10 cm^3 hydrochloric acid	Maximum temperature reached by mixture (°C)
zinc	
iron	
magnesium	

Worksheet 8: suggested answers

(1) Volume of gas produced

(2) Measuring cylinder; stopwatch

(3) Ensure readings are taken at eye level, not at an angle; ensure measuring cylinder is full of water and base is submerged in water at all times

(4)

Time (s)	Volume of gas (cm^3)
0	
20	
40	
60 etc.	

Worksheet 9: suggested answers

(1) Temperature of water in beaker

(2) Thermometer; stopwatch

(3) Ensure measurements are taken at eye level and not at an angle; ensure bottom of thermometer is kept submerged in water whilst taking measurements

(4)

Time (seconds)	Temperature of water beaker A (°C)	Temperature of water beaker B (°C)
0		
30		
60		
90		
120 etc.		

Worksheet 10: suggested answers

(1) Length of spring

(2) Ruler

(3) Ensure measurements are taken at eye level and not at an angle; ensure spring has stopped moving before taking measurements; ensure that measurements are taken at the same point on the spring each time

(4)

Load (N)	Length of spring (cm)
0	
1.0	
2.0	
3.0	
4.0	
5.0	

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