Marshall Cavendish Education

Cambridge Assessment International Education
Endorsed for learner support

Cambridge IGCSE™ Physics

Kaleem Akbar

PRACTICAL WORKBOOK

How to Use This Book

Physics is the study of the universe, from the smallest sub-atomic particles to the largest galaxies. It is about observing how bodies interact, recording observations, analysing results, drawing conclusions and evaluating experiments.

The quality of the evidence is important, and the development of good practical skills is essential. The experiments described in this Practical Workbook will help you to practise those skills. They will help you to become a confident learner in science, able to use a variety of apparatus and techniques to collect data, which can then be analysed and used to draw valid conclusions. This resource also reinforces some of the theoretical knowledge you will have learnt in the Student's Book by providing opportunities to apply this to practical contexts, including both core and supplement activities.

In the Cambridge IGCSE ™ Physics qualification, practical skills are assessed through either:

- the **Practical Test**, where you will carry out laboratory experiments and answer questions; or
- the **Alternative to Practical**, in which you will answer questions but not carry out any laboratory experiments.

Both of these papers assess the same practical skills. They account for 20% of the overall Cambridge IGCSE™ Physics qualification.

The information in this section is taken from the Cambridge International syllabus for examination from 2023. You should always refer to the appropriate syllabus document for the year of your examination to confirm the details and for more information. The syllabus document is available on the Cambridge International website at www.cambridgeinternational.org.

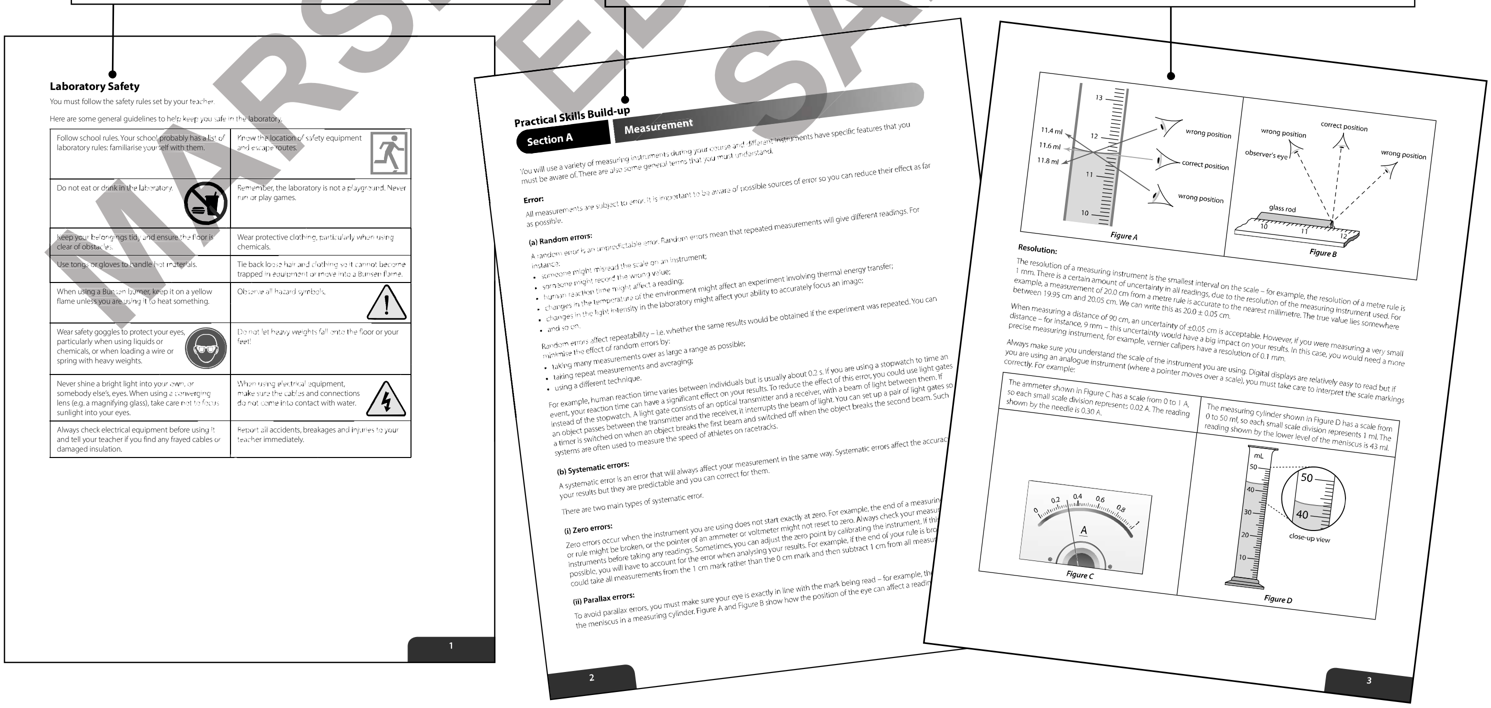
By using this book, you will learn the following:

- recognise and use the apparatus and techniques you will use most often;
- how to make and record observations and measurements accurately;
- different methods for handling observations and data;
- how to plan, carry out and evaluate experiments.

This Practical Workbook is part of the Marshall Cavendish Education suite of resources that will support you as you follow the Cambridge IGCSE and IGCSE (9–1) Physics syllabuses (0625/0972) and equip you to deal with the practical aspects of your course.

Laboratory Safety
This lists the basic safety pointers that you should be aware of.

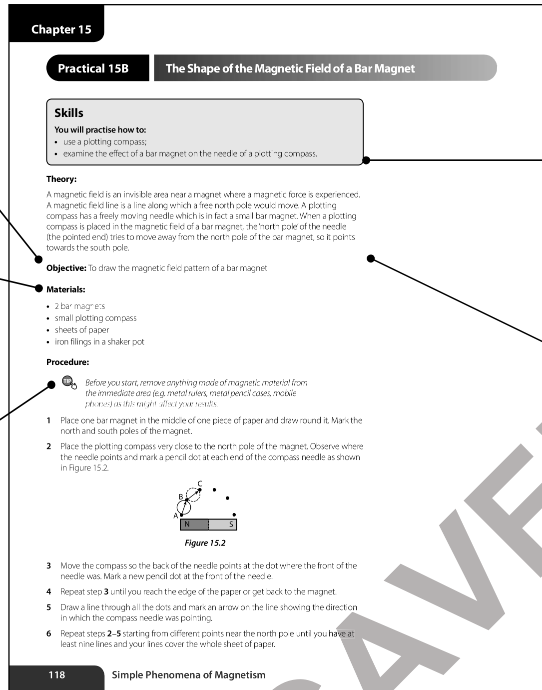
Practical Skills Build-up
This introduces essential practical skills and techniques, such as appropriate use of apparatus and methods of recording and presenting data.



Objective
This states the aim or purpose of the practical.

Materials
This lists the items required for the practical such as apparatus and chemical substances.

TIP
This icon highlights practical tips for good laboratory practices.



Practical 15B **The Shape of the Magnetic Field of a Bar Magnet**

Skills
You will practise how to:
- use a plotting compass;
- examine the effect of a bar magnet on the needle of a plotting compass.

Theory:
A magnetic field is an invisible area near a magnet where a magnetic force is experienced. A magnetic field line is a line along which a free north pole would move. A plotting compass has a freely moving needle which is in fact a small bar magnet. When a plotting compass is placed in the magnetic field of a bar magnet, the 'north pole' of the needle (the pointed end) tries to move away from the north pole of the bar magnet, so it points towards the south pole.

Objective: To draw the magnetic field pattern of a bar magnet

Materials:
- 2 bar magnets
- small plotting compass
- sheets of paper
- iron filings in a shaker pot

Procedure:

Before you start, remove anything made of magnetic material from the immediate area (e.g. metal rulers, metal pencil cases, mobile phones) as this might affect your results.

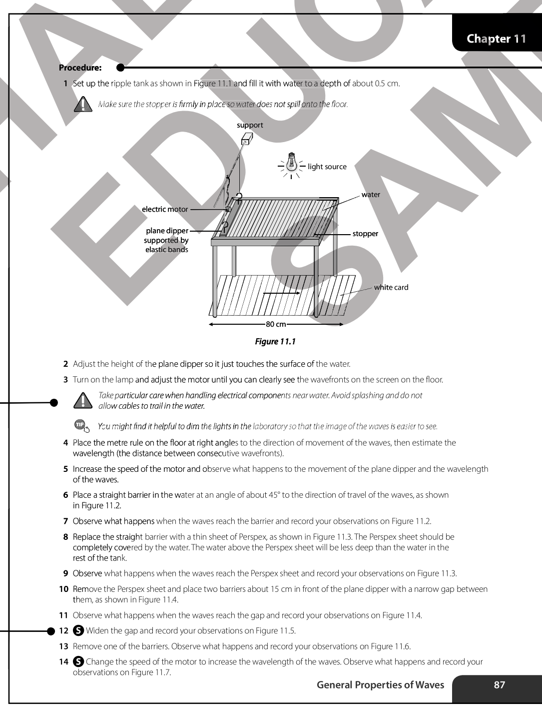
1 Place one bar magnet in the middle of one piece of paper and draw round it. Mark the north and south poles of the magnet.
2 Place the plotting compass very close to the north pole of the magnet. Observe where the needle points and mark a pencil dot at each end of the compass needle as shown in Figure 15.2.

Figure 15.2

3 Move the compass so the back of the needle points at the dot where the front of the needle was. Mark a new pencil dot at the front of the needle.
4 Repeat step **3** until you reach the edge of the paper or get back to the magnet.
5 Draw a line through all the dots and mark an arrow on the line showing the direction in which the compass needle was pointing.
6 Repeat steps **2–5** starting from different points near the north pole until you have at least nine lines and your lines cover the whole sheet of paper.

Skills
A summary of the practical skills that you will practise are listed at the beginning of each practical.

Theory
This gives a brief introduction to the theory behind the practical.



Procedure:
1 Set up the ripple tank as shown in Figure 11.1 and fill it with water to a depth of about 0.5 cm.

Make sure the stopper is firmly in place so water does not spill onto the floor.

Figure 11.1

2 Adjust the height of the plane dipper so it just touches the surface of the water.
3 Turn on the lamp and adjust the motor until you can clearly see the wavefronts on the screen on the floor.

Take particular care when handling electrical components near water. Avoid splashing and do not allow cables to trail in the water.

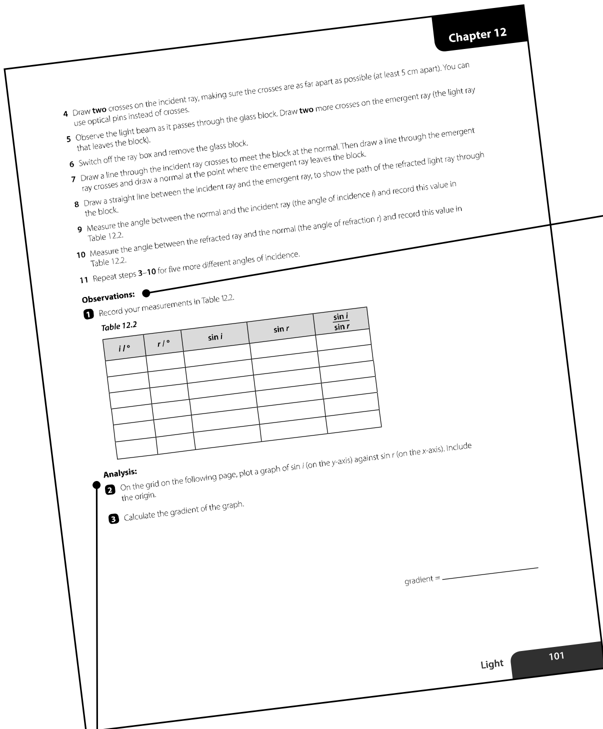
You might find it helpful to dim the lights in the laboratory so that the image of the waves is easier to see.

4 Place the metre rule on the floor at right angles to the direction of movement of the waves, then estimate the wavelength (the distance between consecutive wavefronts).
5 Increase the speed of the motor and observe what happens to the movement of the plane dipper and the wavelength of the waves.
6 Place a straight barrier in the water at an angle of about 45° to the direction of travel of the waves, as shown in Figure 11.2.
7 Observe what happens when the waves reach the barrier and record your observations on Figure 11.2.
8 Replace the straight barrier with a thin sheet of Perspex, as shown in Figure 11.3. The Perspex sheet should be completely covered by the water. The water above the Perspex sheet will be less deep than the water in the rest of the tank.
9 Observe what happens when the waves reach the Perspex sheet and record your observations on Figure 11.3.
10 Remove the Perspex sheet and place two barriers about 15 cm in front of the plane dipper with a narrow gap between them, as shown in Figure 11.4.
11 Observe what happens when the waves reach the gap and record your observations on Figure 11.4.
12 S Widen the gap and record your observations on Figure 11.5.
13 Remove one of the barriers. Observe what happens and record your observations on Figure 11.6.
14 S Change the speed of the motor to increase the wavelength of the waves. Observe what happens and record your observations on Figure 11.7.

Procedure
This lists a series of steps for the practical. Read through the procedure in full at least once before you start, taking particular note of any warnings and safety guidance. Do not start work until you are confident that you have understood everything.

This icon highlights potential hazards that you may encounter while doing the practicals.

S Supplement content is clearly marked for those studying the Extended syllabus.



Chapter 12

4 Draw **two** crosses on the incident ray, making sure the crosses are as far apart as possible (at least 5 cm apart). You can use optical pins instead of crosses.
5 Observe the light beam as it passes through the glass block. Draw **two** more crosses on the emergent ray (the light ray that leaves the block).
6 Switch off the ray box and remove the glass block.
7 Draw a line through the incident ray crosses to meet the block at the normal. Then draw a line through the emergent ray crosses and draw a normal at the point where the emergent ray leaves the block.
8 Draw a straight line between the incident ray and the emergent ray, to show the path of the refracted light ray through the block.
9 Measure the angle between the normal and the incident ray (the angle of incidence *i*) and record this value in Table 12.2.
10 Measure the angle between the refracted ray and the normal (the angle of refraction *r*) and record this value in Table 12.2.
11 Repeat steps **3**–**10** for five more different angles of incidence.

Observations:
1 Record your measurements in Table 12.2.

Table 12.2

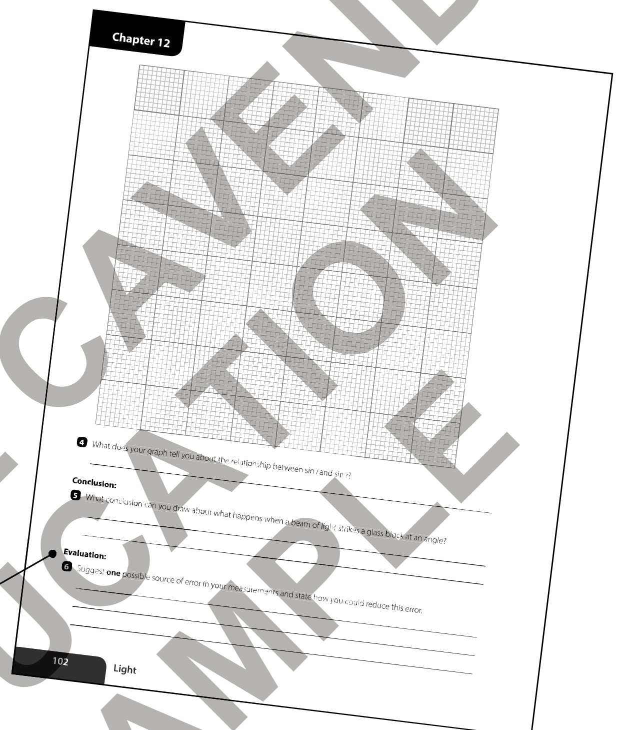
i / °	r / °	sin i	sin r	$\frac{\sin i}{\sin r}$

Analysis:
2 On the grid on the following page, plot a graph of sin i (on the y-axis) against sin r (on the x-axis). Include the origin.
3 Calculate the gradient of the graph.

gradient = ____________

Light 101

Observations
This section requires you to record your results, qualitative and/or quantitative.



Chapter 12

4 What does your graph tell you about the relationship between sin i and sin r?

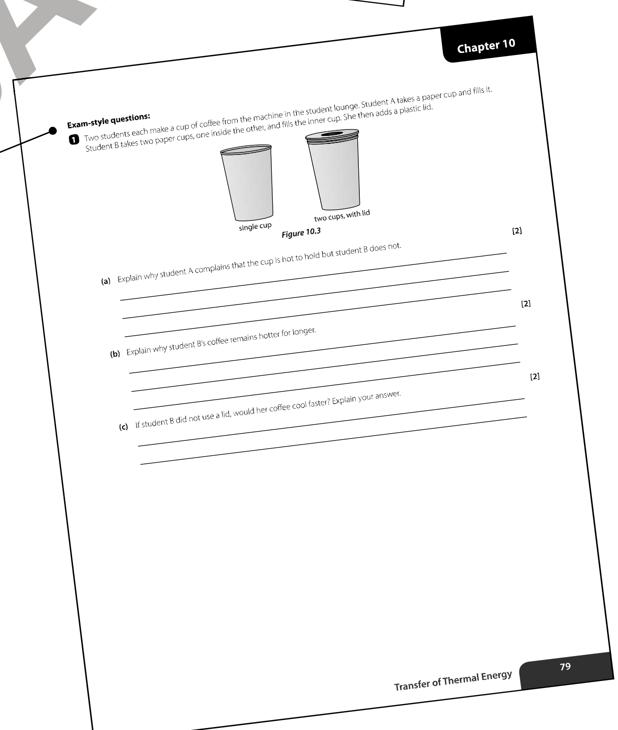
Conclusion:
5 What conclusion can you draw about what happens when a beam of light strikes a glass block at an angle?

Evaluation:
6 Suggest **one** possible source of error in your measurements and state how you could reduce this error.

102 Light

Analysis and Conclusion
Questions are provided to guide you through calculations, drawing of graphs, etc. and help you analyse your results in order to draw conclusions.

Evaluation
This section is included at the end of most practicals. You will reflect on the practical you have just performed and identify improvements or things you could have done differently.



Chapter 10

Exam-style questions:
1 Two students each make a cup of coffee from the machine in the student lounge. Student A takes a paper cup and fills it. Student B takes two paper cups, one inside the other, and fills the inner cup. She then adds a plastic lid.

Figure 10.3

(a) Explain why student A complains that the cup is hot to hold but student B does not. [2]
(b) Explain why student B's coffee remains hotter for longer. [2]
(c) If student B did not use a lid, would her coffee cool faster? Explain your answer. [2]

Transfer of Thermal Energy 79

Exam-style question
Some practicals also include exam-style questions to help you put the practical work into context.
(All exam-style questions and sample answers are written by the author.)

Contents

The chapters below and the chapter numbering throughout match the chapters of the Student's Book. Not all chapters include practical elements. This is indicated in the contents below.

Chapter 19 Nuclear Model of the Atom	No practicals in this chapter
Chapter 20 Radioactivity	No practicals in this chapter
Chapter 21 Earth and the Solar System	No practicals in this chapter
Chapter 22 Stars and the Universe	No practicals in this chapter

CHAPTER 1

Measurement of Physical Quantities

Practical 1A Measurement of Length and Volume

Skills

You will practise how to:

- follow a sequence of instructions to take various measurements;
- use a metre rule;
- use a measuring cylinder.

Theory:

In physics, it is very important that experimental results are reliable, so measurements must be accurate.

Objective: To become familiar with simple laboratory equipment and to take a variety of measurements as accurately as possible

Materials:

The materials will be arranged in a 'circus' of experiments. Your teacher will tell you when to move from one experiment to the next.

Part A

- metre rule
- pencil

Part B

- metre rule
- length of string
- protractor
- felt-tipped pen

Part C

- metre rule
- tube
- 2 set squares

Part D

- measuring cylinder
- water
- metal object
- thin string

Part E

- metre rule
- 2 set squares
- 2 wooden strips
- 5 identical marbles

Part F

- length of wire
- metre rule
- pencil

Part G

- 10 coins
- metre rule

Part A:

Procedure:

1 Place the metre rule flat on the bench, with the scale at the top.

2 Place the pencil against the scale, with the flat end (**A**) on the 1.5 cm mark, as shown in Figure 1.1.

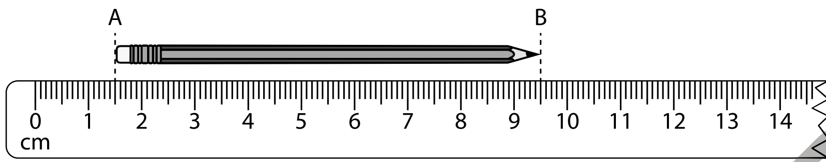


Figure 1.1

3 Record the position of the other end of the pencil (**B**). Make sure your eye is directly above the point being measured.

Observations:

1 Record the measured position of **B**: ____________________

Analysis:

2 Calculate the length of the pencil.

length = ____________________ cm

Evaluation:

3 Explain why it would have been better to align the flat end of the pencil with the 0 cm point on the ruler.

____

____

Part B:

Procedure:

You need to find the arc length (the distance around the curved part) of a protractor, from 0° to 180°, but the only measuring instrument you have is a metre rule.

1 Use the felt-tipped pen to make a mark on the piece of string, close to one end.

2 Place the string against the curved edge of the protractor, so the pen mark is aligned with the 0° point.

3 Use the string to follow the curve and make another pen mark level with the 180° point on the protractor, as shown in Figure 1.2.

4 Use the metre rule to measure the distance between the two marks on the string.

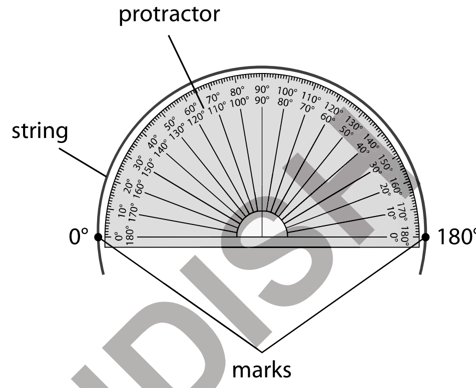


Figure 1.2

Observations:

1 Record the length of the curved edge (arc):

______________ cm = ______________ m

Analysis:

2 If the protractor was a complete circle, how would you find the circumference from the length you have measured?

____

____

3 Calculate the circumference, based on your answer to question **2**.

circumference = ______________ cm = ______________ m

Evaluation:

4 Explain why using string helped you to take an accurate measurement.

____

____

Part C:

Procedure:

You need to find the outer diameter of a tube.

1 Place the metre rule flat on the bench, with the scale at the top.

2 Place the tube against the scale, standing upright on one end.

3 Place the two set squares against the outer edges of the tube, as shown in Figure 1.3. Make sure they are touching the tube and aligned with the metre rule as shown.

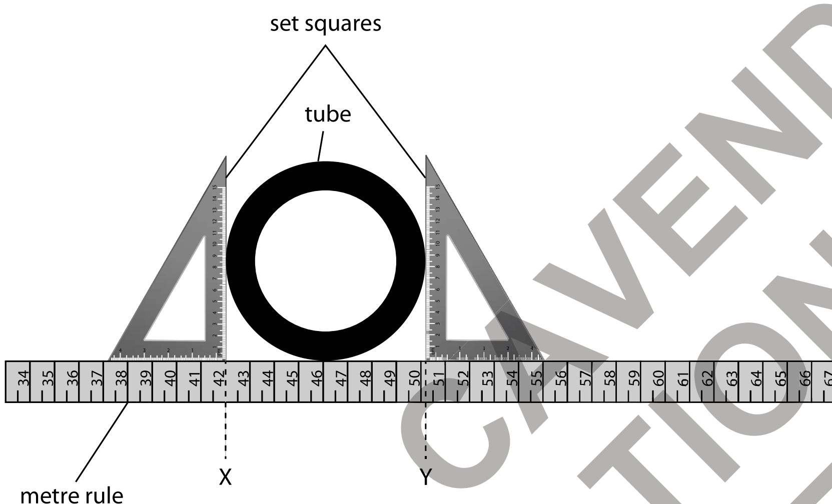


Figure 1.3

4 Record the readings where the set squares touch the metre rule, marked **X** and **Y** in Figure 1.3.

5 Repeat steps **2**–**4** twice more, rotating the tube a quarter-turn each time.

Observations:

1 Record your results in Table 1.1.

Table 1.1

	Reading X / cm	Reading Y / cm	Diameter of tube / cm
1			
2			
3			

Evaluation:

2 Suggest a reason for repeating your measurements.

____

____

3 Describe a method that could be used to calculate the average value for the diameter from your results.

____

____

4 Calculate the average diameter of the tube.

diameter = ______________ cm

5 Explain the purpose of the two set squares.

____

____

Part D:

Procedure:

You need to use a measuring cylinder to measure the volume of water and find the volume of a piece of metal.

1 Add water to the measuring cylinder until it is approximately half full.

2 Position your eye so it is level with the bottom of the meniscus, as shown in Figure 1.4.

3 Read the volume of water in the measuring cylinder. Record this value in Table 1.2.

4 Tie a length of thin string around the metal object.

5 Carefully lower the metal object into the water, taking care not to splash. Make sure the object is completely covered by the water.

6 Read the new volume of water in the measuring cylinder (the volume of the water and the metal object). Record this value in Table 1.2.

7 Carefully remove the metal object and repeat steps **5**–**6** twice more.

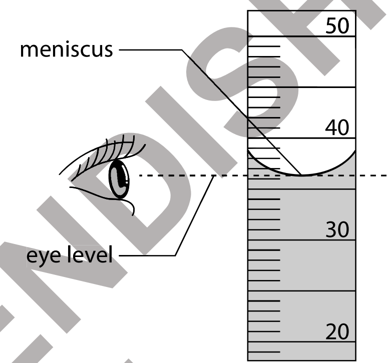


Figure 1.4

Observations:

1 Record your results in Table 1.2.

Table 1.2

	Volume of water / cm^3	Volume of water + object / cm^3
1		
2		
3		

Analysis:

2 How will you calculate the volume of the object? Note that 1 ml = 1 cm^3.

____

____

3 Calculate an average value for the volume of the object.

volume of object = ____________________ cm^3

Evaluation:

4 Explain why you must level your eye with the bottom of the meniscus when taking your readings.

____

____

5 Why is it important that the string tied to the metal object is thin?

____

____

Part E:

Procedure:

You need to measure the diameter of a marble.

1 Place one marble on top of a metre rule and try to measure its diameter.

2 Place the metre rule on the top of the bench and lay 5 identical marbles side by side and in contact with each other on top of the rule, as in Figure 1.5 below. Use the two wooden strips to stop the marbles moving.

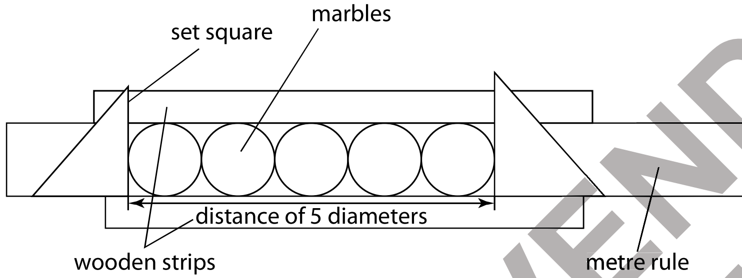


Figure 1.5

3 Use the two set squares to measure the distance of 5 diameters.

Observations:

1 Record your measurement of the diameter of a single marble from step 1 in the procedure.

diameter………………..cm

2 Record your measurement of 5 diameters. 5 diameters ………………cm

Analysis:

3 How would you calculate an average value for the diameter of one marble?

____

____

4 Use your results to calculate an average value for the diameter of the marble.

diameter = ______________ cm

5 Compare this calculated value for the diameter of the marble with the measurement you took in step 1 above. Explain any differences you notice.

____

____

Evaluation:

6 Why is it important for the marbles to be in contact with each other?

____

____

Part F:

Procedure:

You need to measure the diameter of a wire.

1 Wrap the wire tightly around the pencil until you have 10 turns. Make sure the turns touch each other but do not overlap, as shown in Figure 1.6.

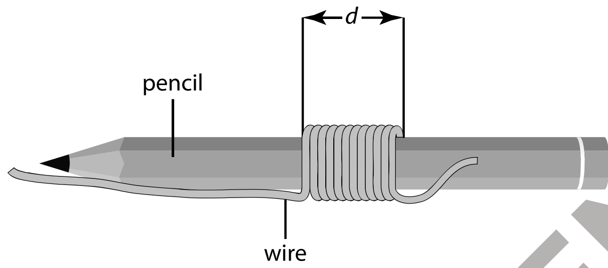


Figure 1.6

2 Use the metre rule to measure the distance *d*, in cm. Record this reading in Table 1.3.

3 Calculate the diameter of the wire in mm.

4 Repeat steps **1**–**3** with 15 turns, and then with 20 turns.

5 Record your results in Table 1.3.

Observations:

1 Record your observations in Table 1.3.

Table 1.3

Turns	*d* / cm	Diameter / mm
10		
15		
20		

Analysis:

2 How would you calculate an average value for the diameter of the wire?

____

____

3 Use your results to calculate an average value for the diameter of the wire.

diameter = ______________ mm

Evaluation:

4 Why is it important that the turns of wire are close together (touching) but do not overlap?

____

____

____

Part G:

Procedure:

You need to measure the thickness of a coin.

1 Make a neat stack of 10 coins, as shown in Figure 1.7.

2 Use the metre rule to measure the height of the stack of coins and record your result. Make sure the zero mark on the rule is level with the bottom of the stack of coins.

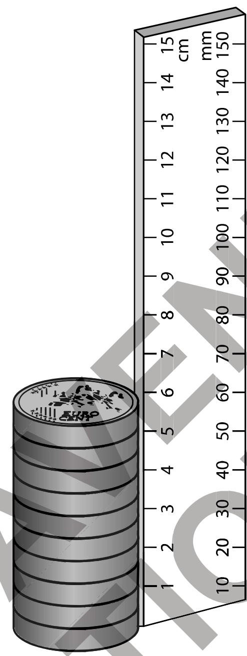


Figure 1.7

Observations:

1 Record the height of 10 coins: ______________ cm

Analysis:

2 Use your measurement for the height of 10 coins to calculate the thickness of one coin.

thickness of one coin = ______________ cm = ______________ mm

3 Why can't you use a metre rule to accurately measure the thickness of one coin? Justify your answer by referring to your results.

____

____

____

Practical 1B Pendulum

Skills

You will practise how to:

- follow a sequence of instructions to investigate the relationship between the period of a pendulum and its length;
- use a stopwatch;
- plot a graph of time period T against length l;
- plot a graph of T^2 against l;
- make a valid conclusion from experimental results.

Theory:

A pendulum is a heavy weight, called a bob, attached to a rod or string. The other end of the string is attached to a fixed point. When the pendulum bob is pulled to one side and then released, it swings back and forth at the end of the string. One oscillation of a pendulum is a complete swing, i.e. from one side to the other and then back to the starting position. The time period of a pendulum, T, is the time taken for one complete oscillation.

Objective: To vary the length l of a pendulum, measure the time period T for various lengths, and find the relationship between T and l

Materials:

- pendulum
- split cork
- retort stand and clamp
- metre rule
- stopwatch

Procedure:

1 Thread the string of the pendulum through the split cork, then clamp the cork so the pendulum hangs freely as shown in Figure 1.8.

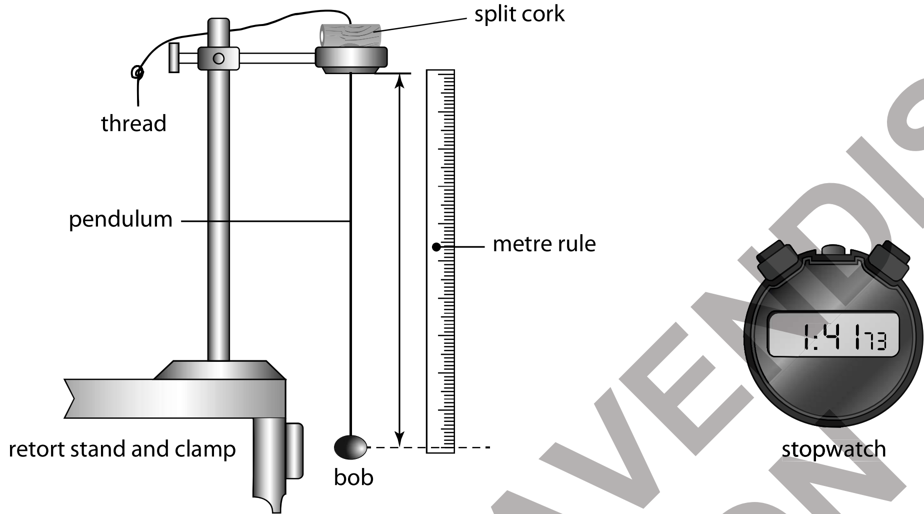


Figure 1.8

2 Use the metre rule to measure the length of the pendulum, from the bottom of the cork to the centre of the pendulum bob. Record this length in Table 1.4.

3 Pull the pendulum bob to the side so it makes an angle of about 20° from the vertical. Release the bob and let it swing to and fro (oscillate).

4 After a few oscillations, start the stopwatch as the bob passes through the lowest point.

TIP *Using a piece of chalk place a vertical mark on the bench behind the pendulum when it is at rest. This will help to ensure that you always time the swings from the same point.*

5 Count the oscillations, remembering the bob will pass through the lowest point **twice** in each complete oscillation. After 20 oscillations, stop the stopwatch and record the time t_1.

6 Repeat steps **3**–**5** and record the time t_2.

7 Repeat steps **1**–**6** five more times, for five more different lengths. Record your results in Table 1.4.

8 For each length, calculate the average time for 20 oscillations, the time period T, and the time period squared, T^2.

Observations:

1 Record your measured and calculated values in Table 1.4.

Table 1.4

Length l / m	Time for 20 oscillations t_1 / s	Time for 20 oscillations t_2 / s	Average time for 20 oscillations / s	Period T / s	T^2 / s²

Analysis:

2 Plot a graph of *T* (on the *y*-axis) against ***l*** (on the *x*-axis). Include the origin.

3 Draw a line of best fit through your plotted points.

4 What can you observe about your graph?

____

____

5 Use your graph to determine the length of pendulum that would give a time period of 1.0 s. Show clearly on the graph how you obtained the necessary information.

length of pendulum = ____________________ m

6 Plot a graph of T^2 (on the y-axis) against l (on the x-axis). Include the origin.

7 Draw a line of best fit through your plotted points.

8 What can you observe about your graph?

____

____

Conclusion:

9 What do your observations from question **8** tell you about the relationship between T^2 and l?

____

____

Evaluation:

10 What steps have you taken to ensure your readings are accurate?

____

____

____

Exam-style question:

1 A student is investigating the oscillations of a pendulum. The apparatus is shown in Figure 1.9. The graph shows her results.

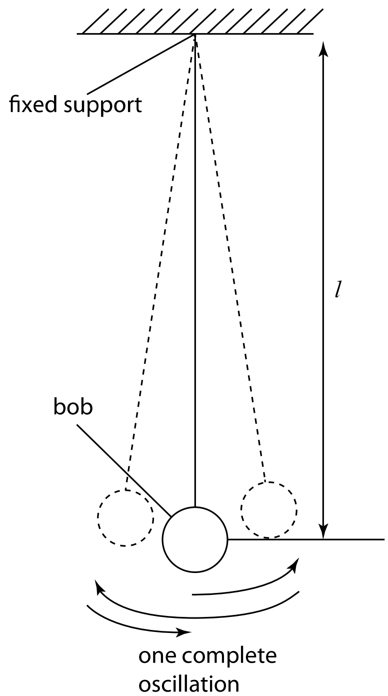
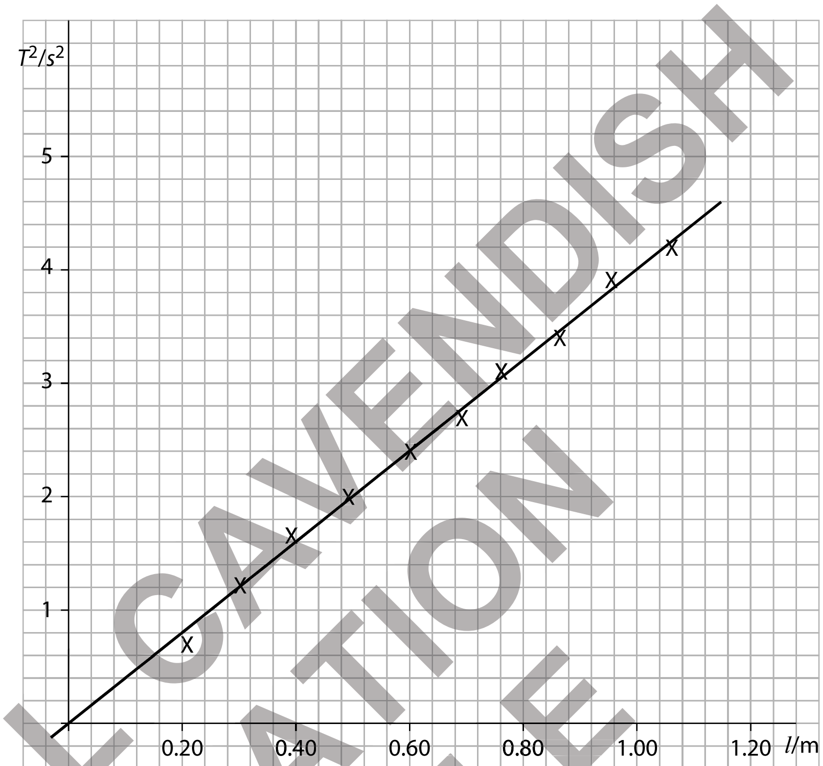


Figure 1.9



(a) Using the graph, determine the length l of a pendulum that has a period $T = 1.0$ s. Show clearly on the graph how you obtained the information. **[3]**

l = ______________________________

(b) To calculate the period, the student measured the time for 20 oscillations. She believed this would give her a more accurate value for T.

Was she correct in this belief? Explain your answer. **[2]**

____

____

(c) Another student would like to investigate how changing the mass of the pendulum bob might affect the period.

(i) How many masses should he try? ______________________ **[1]**

(ii) What range of masses should he use? ______________________ **[1]**

For over 60 years Marshall Cavendish Education has been empowering educators and students in over 80 countries with high-quality, research-based, Pre-K-12 educational solutions. We nurture world-ready global citizens by equipping students with crucial 21st century skills through our resources for schools and education centres worldwide, including Cambridge schools, catering to national and international curricula.

The *Marshall Cavendish Education Cambridge IGCSE™ Physics* series is designed for students preparing for the Cambridge IGCSE and IGCSE (9–1) Physics syllabuses (0625/0972). The series translates insights from educational psychology classic "How People Learn" into highly effective learner-centred classroom practices.

PWB The **Practical Workbook** is designed to complement the Student's Book and help learners develop necessary investigative and experimental skills. Good laboratory practice is encouraged with safety tips and pointers on good experimental technique, while probing questions test students' understanding of underlying theory and experimental design.

This resource is endorsed by Cambridge Assessment International Education

- ✓ Provides learner support for the Cambridge IGCSE and IGCSE (9–1) Physics syllabuses (0625/0972) for examination from 2023
- ✓ Has passed Cambridge International's rigorous quality-assurance process
- ✓ Developed by subject experts
- ✓ For Cambridge schools worldwide

Series architecture

- Student's Book
- Theory Workbook
- Practical Workbook
- Teacher's Guide
- e-book

ISBN 978-981-4927-97-0
9 789814 927970

Marshall Cavendish Education