CHAPTER 1

Measurement of physical quantities

Experiment 1.1 Measurement of length and volume

Experimental skills

You will practise how to:

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

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
- two set squares

Part D
- measuring cylinder
- water
- metal object
- thin string

Part E
- vernier calipers
- marble

Part F
- length of wire
- metre rule
- pencil

Part G
- ten coins
- metre rule

Experiment 1.2 Pendulum

Experimental 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 **Fig. 1.8**.

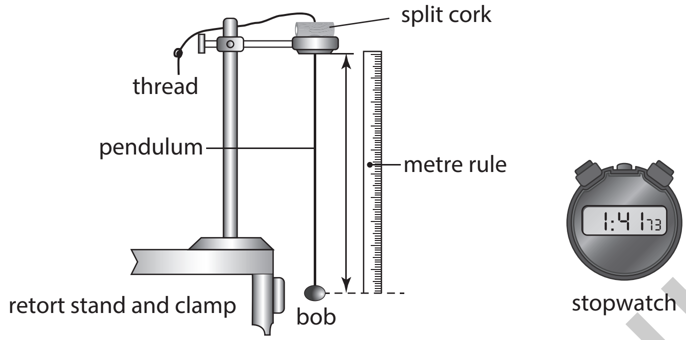

Fig. 1.8

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.

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:

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 / s^2

Analysis:

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

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

3. What can you observe about your graph?

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4. 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

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

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

7 What can you observe about your graph?

Conclusion:

8 What do your observations from question **7** tell you about the relationship between T^2 and l?

Evaluation:

9 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 **Fig. 1.9**. The graph shows her results.

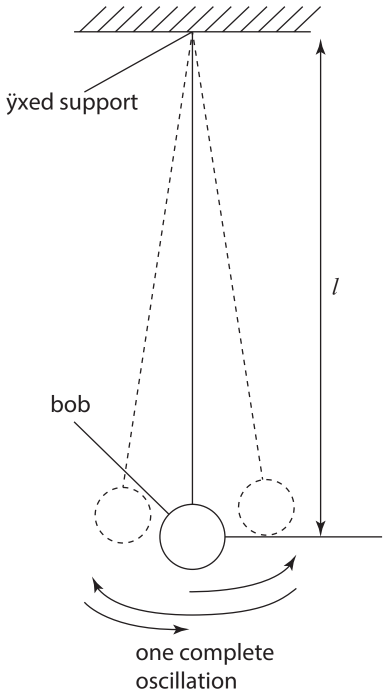
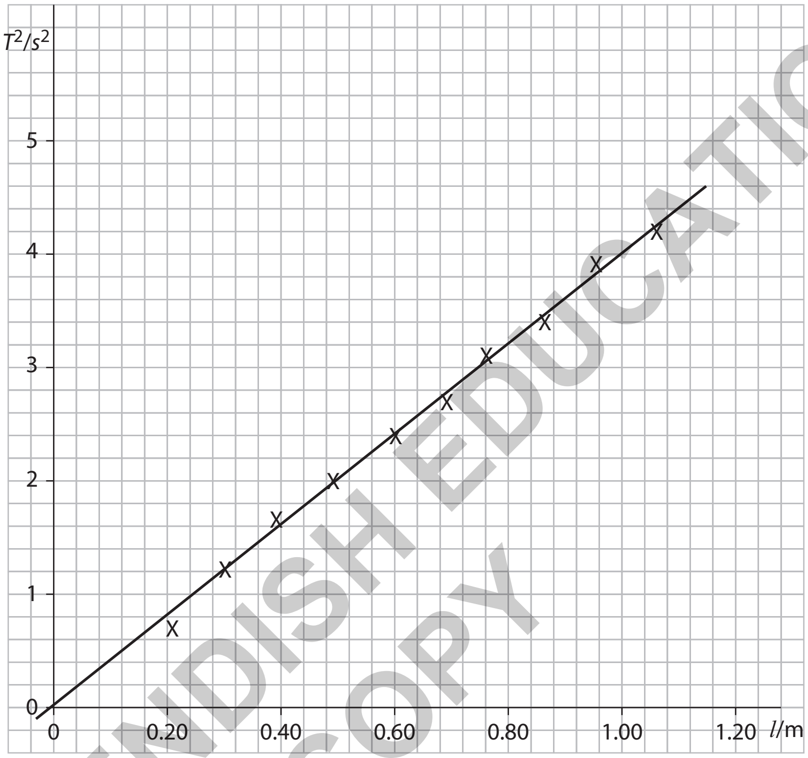


Fig. 1.9



(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.

l = ______________________ **[3]**

(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]**

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(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]**