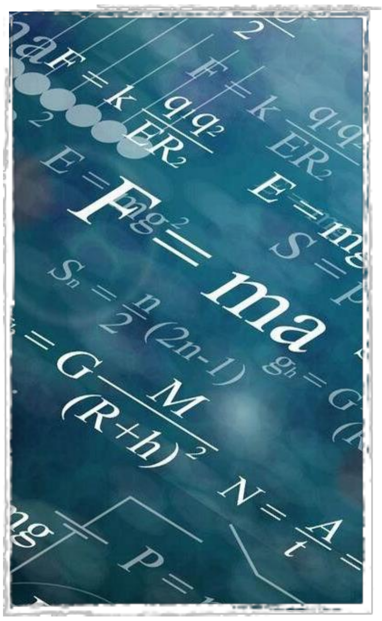
深圳国际交流学院

Shenzhen College of International Education

办中国最好的国际高中



G1PHYSICS LAB MANUAL

2023~2024 IGCSE

Name:____________________

ID:________________________

Class:____________________

Teacher:_________________

CONTENT

ADVICE FOR IGCSE PRACTICAL WORK

In the IGCSE physics practical exam, all the calculated answers are allowed to have **2 or 3 significant figures**.

Definition of significant figures

- All non-zero digits are significant: 1, 2, 3, 4, 5, 6, 7, 8, 9.
- Zeros between non-zero digits are significant: 102, 2005, 50009.
- Leading zeros are never significant: 0.02, 001.887, 0.000515.
- In a number *with* a decimal point, trailing zeros (those to the right of the last non-zero digit) are significant: 2.02000; 5.400; 57.5400.

The result of a calculation should be expressed to the minimum number of significant figures used in the data for X or ÷ （or one more.). For + or – give the answer to the fewest number of decimal places (d.p.)

e.g a=2.05m b=2.1m c= 3.5000m

a+b+c = 2.05 +2.1 + 3.5000 = 7.65m

Final answer can be written as 7.7m

Test yourself

How many significant figures to these numbers have?

0.00516

705524

4500

9.650×10^3

Solve these calculations rounding your final answer to the correct number of S.F:

0.15 cm + 1.15 cm + 2.051 cm=

1.35 m x 2.467 m=

505 kg – 450.25 kg=

$(1.278 \times 10^3\ m^2) / (1.4267 \times 10^2\ m)$ =

Precision of measuring values

The correct **decimal places** of recording values are based on the instruments you used to take the measurements.

Instrument	Precision with unit
Meter rule	
Protractor	
Thermometer	
Measuring cylinder	
Stopwatch	
multimeter	
Newton meter	

Table of data

Complete the heading of the table with correct units, separated with a slash or bracket.

No need to write units in the body of the table.

Diameter /cm	Time 1 /s	Time 2 /s	Time 3 /s	Average Time /s
1.3	2.01	2.02	2.03	2.02
2.4	3.23	3.21	3.20	3.21
5.6	4.76	4.67	4.71	4.71
7.7	5.98	5.88	5.92	5.93

Column 1, 2, 3, 4 of measuring data must have **consistent decimal places** according to the precision of the equipment.

Column 5 of calculated data has the correct **significant figures** of 3.

Independent, dependent and control variables

The **independent variable** is the variable that is altered or changed by the experimentalist.

The **dependent variable** is the result of the experiment, it is what you measure in the experiment.

The **control variables** are the ones will be kept constant to make it a fair experiment.

How to correctly draw graphs

- Always use a sharpened pencil (NOT a pen) and a transparent ruler.
- Requirements according to marking scheme:

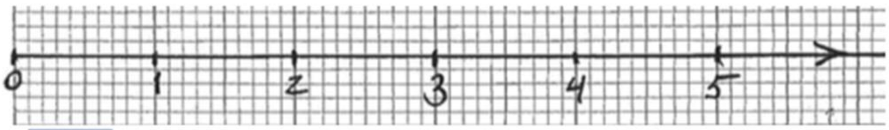
(1) axes with correct orientation, both labelled with quantity and unit 1
(2) appropriate scales (plots occupying at least ½ grid) 1
(3) plots all correct to ½ small square and precise plots 1
(4) well-judged line and thin line 1

(1) axes:

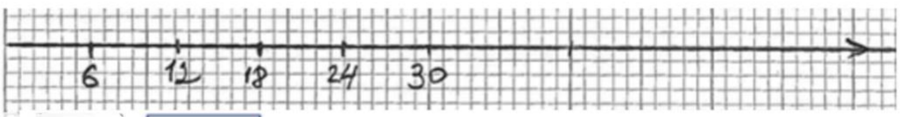
- The independent variable goes on the horizontal x axis with correct quantity and units slashed. The dependent variable goes on the vertical y axis with correct quantity and units slashed.

(2) scale:

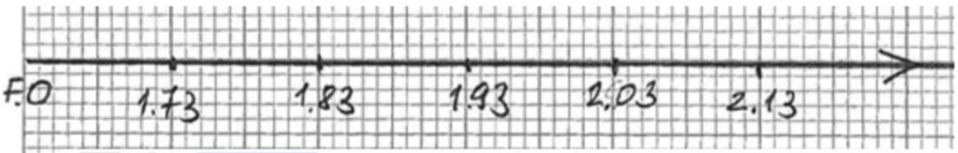
- The plotted points should **occupy at least half of the grid** in both the x and y axes.
- The scale does not always start from (0,0), the scale of each large box (10 little boxes) is only allowed to be a multiple of 1, 2, or 5.



Good scale



Awkward scale



Awkward scale

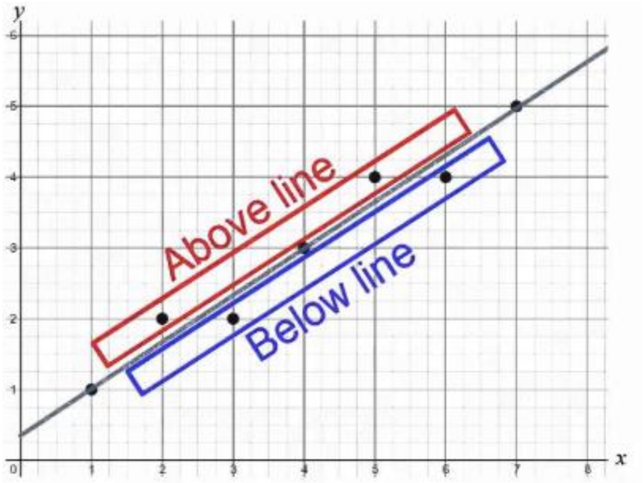
(3) plotting points:

- All points must be plotted to an accuracy of a half a small square. Make little cross X's instead of dots. If your dots are bigger than half a small square you will lose the mark for plotting your points.
- If there are many anomalies (you allowed to have not more than 1 on your graph) then wipe off the row with wrongly taken readings and REMEASURE and RECALCULATE).
- Indicate any anomalies but identify them as anomalous by drawing a circle around them.(An anomaly is point that lies far away from the rest of the points)

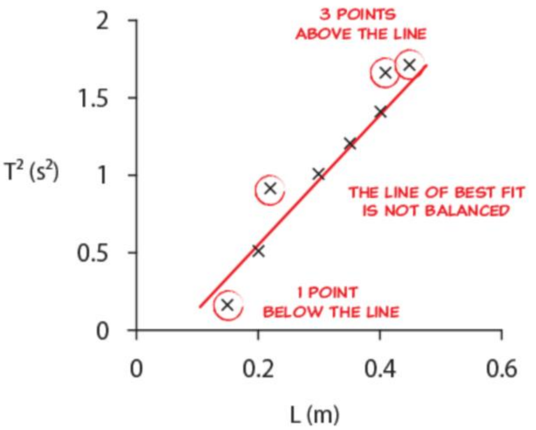
(4) best fit line:

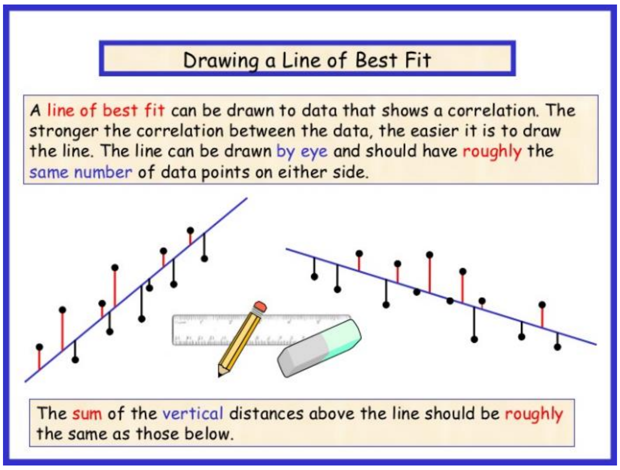
- Never just connect the points in a dot-to-dot.
- Do not alter your data to give you a perfect line - the examiners know what real data looks like - you may lose all the points for your data if it appears that you made the data up.
- You are trying to draw a line that has the minimum distance between the line and your points.
- Your line of best fit should have an equal number of dots above and below the line at each end of the line.
- The line should be extended to the axes.
- Ignore anomalous points when drawing the best fit line straight line.
- The line of best fit could be a straight line or a curved line. In IGCSE, most lines of best fit are straight lines except cooling rate graph, d-i° graph of reflection, V-I or R-V graph of a filament lamp.

Diagrams to help you understand how to draw a best fit line

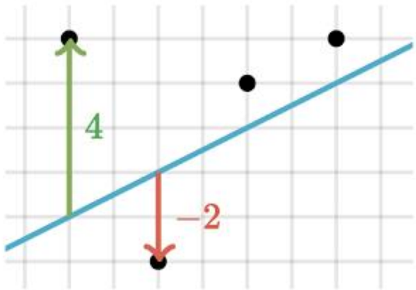


The line drawn is the best fit line. The number of points above the line should be equal to the number of points below the line

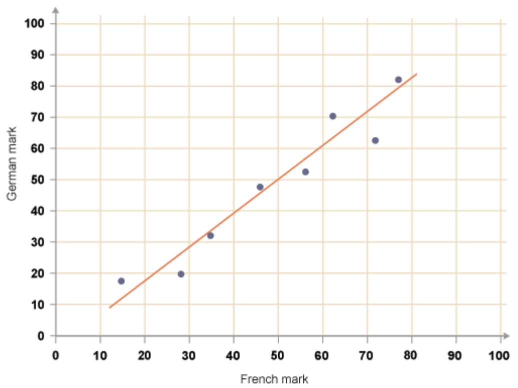




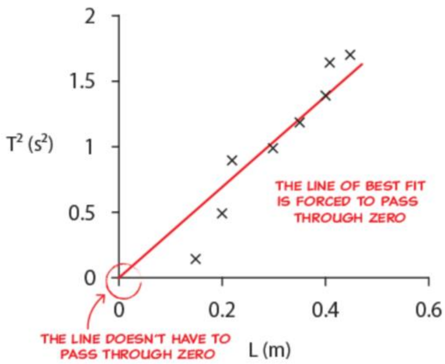
The sum of the vertical distances above the line should be roughly the same as the sum of the distances below the line.



An example of a poorly drawn best fit line. There are three points above the line and only two below. The sum of the vertical distances above the line is not equal to the sum of those bellow. F a point lies far from the line, it is an anomalous point and a circle should be drawn around it.



An example of a good best fit line

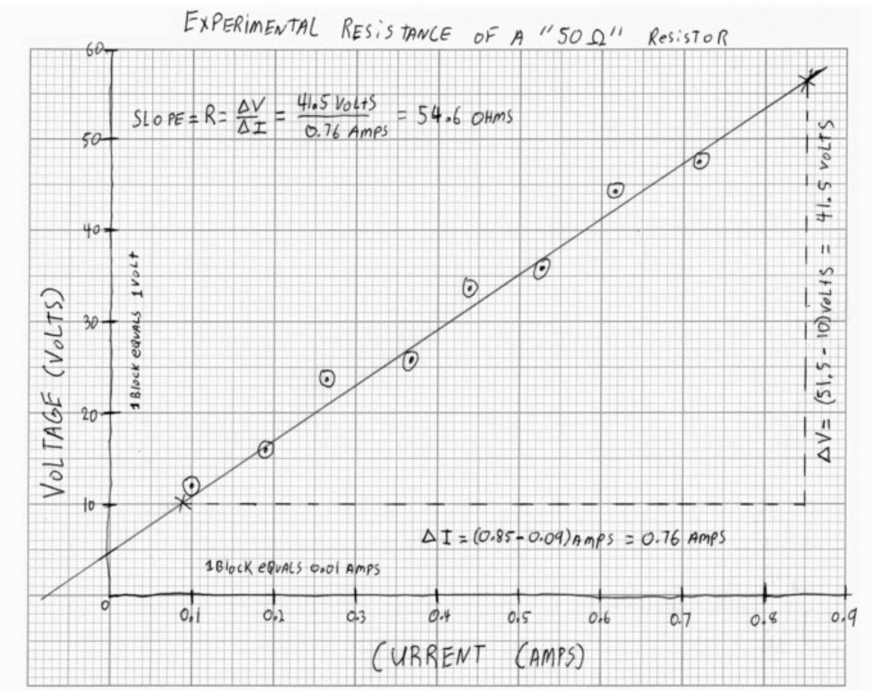


If there is no (0,0) in the data table, do not force the best fit line through the origin.

Calculating the gradient

Once we have drawn the best fit line we are usually required to calculate the gradient of the line. Follow the correct procedure:

- Choose a point from each end (the plotted points cannot be used). Draw a big triangle over half of the best fit line on the graph.
- The corners of your triangle should line up with the grid lines, so it is easy to read off x_1, y_1, x_2, and y_2.
- x_1, y_1, x_2, and y_2 must be from the line of best fit not the data table. It is NOT allowed to use plotted points for calculating the gradient.



Test yourself

A student investigates the period of a pendulum. Fig. 1.1 and Fig. 1.2 show the arrangement.

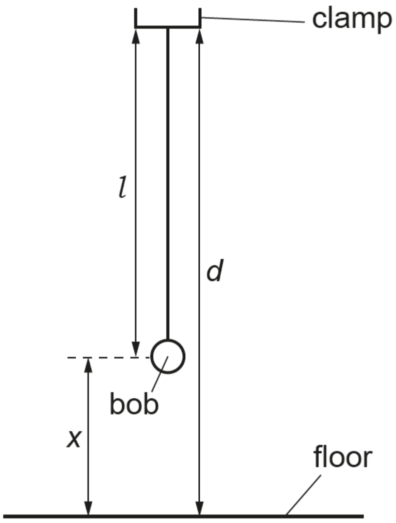


Fig. 1.1

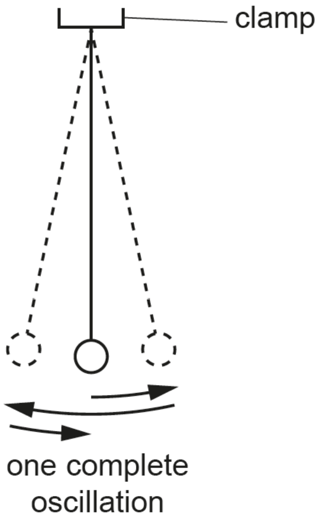


Fig. 1.2

The student measures the distance *d =120 cm* between the bottom of the clamp and the floor.

This distance *d* remains constant throughout the experiment.

He adjusts the length *l* of the pendulum to 70.0 cm. Calculate the distance *x* between the centre of the pendulum bob and the floor. Record the value of *x* in the first row of Table 1.1. [1]

The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum. He measures, and records in the first row of Table 1.1, the time *t* for 10 complete oscillations.

(i) Calculate, and record in the first row of Table 1.1, the period *T* of the pendulum. The period is the time for one complete oscillation. [1]

(ii) Calculate, and record in the first row of Table 1.1, *T* 2. [2]

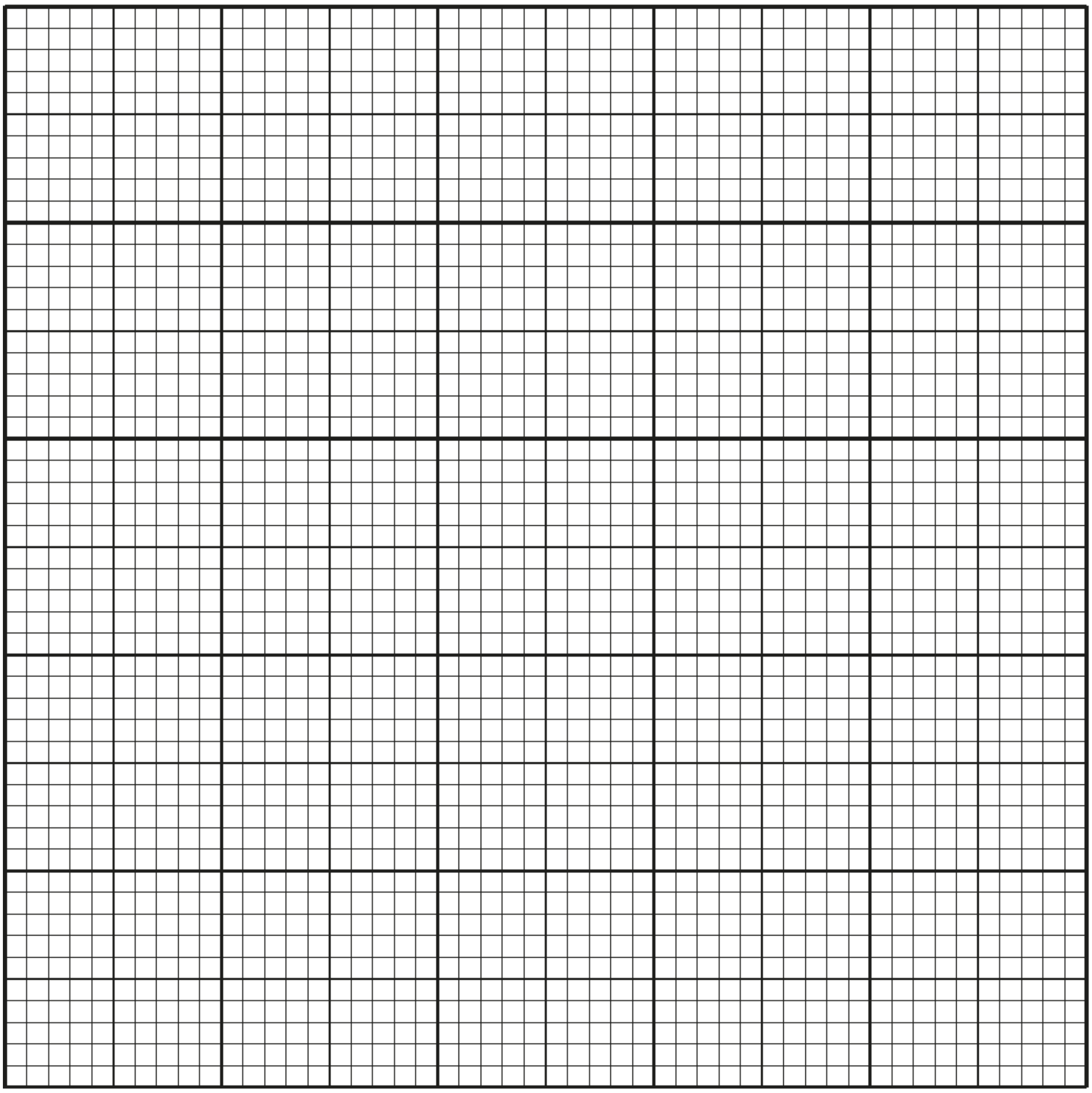
(iii) Complete the column headings in Table 1.1.

He repeats the procedure using *x* = 45.0 cm, 40.0 cm, 35.0 cm and 30.0 cm. He records the readings in Table 1.1.

Table 1.1

x /	*t* /	*T* /	T^2 /
	16.7		
45.0	17.3	1.73	2.99
40.0	17.9	1.79	3.20
35.0	18.4	1.84	3.39
30.0	19.0	1.90	3.61

Plot a graph of T^2 (*y*-axis) against *x* (*x*-axis). You do **not** need to start your axes at the origin (0,0).
[4]



State whether the graph line shows that T^2 is proportional to *x*. Give a reason for your answer.
statement ....

reason ....

Experiment plan template

(1) **Variables:** list the independent variable, dependent variable, **2** control variables

(2) **Apparatus list**, you may draw a diagram

(3) **Method**: set up the apparatus first, use the instruments to take measurements, record the readings in the table, repeat the steps above for **5** different values of independent variable listed.

(4) **Table of columns**:

Independent variable /unit	Dependent variable/ unit

(5) **How to reach a conclusion**: you could compare the readings to find out the change of dependent variable, the more independent variable, the more (or less) dependent variable.

or plot a graph with axis, discuss the gradient.

(6) **Precautions:** two or more precautions

PLANNING 1

A student has a selection of rubber bands of different widths. He is investigating the extension produced by adding loads. The figure shows the set-up used.

In addition to the apparatus shown in Fig. 4.1, the following apparatus is available to the student:

A metre rule

A selection of different rubber bands

A selection of loads.

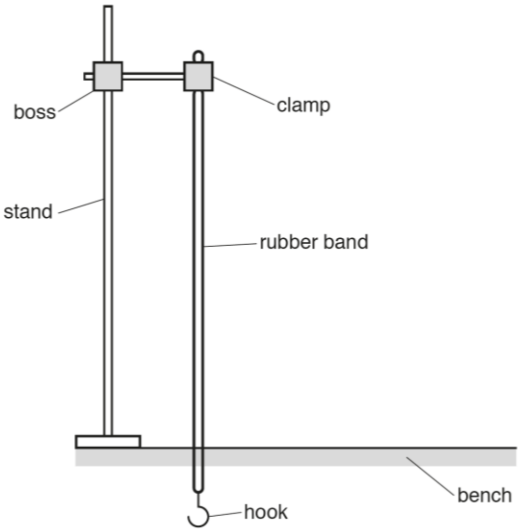
Plan an experiment to investigate how strips of rubber of different widths stretch when loaded.

You should

- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, with column headings to show how you would display your readings

(You are **not** required to enter any readings in the table.)

- explain briefly how you would use your readings to reach a conclusion.



[7]

PRACTICAL 1 – PERIOD OF A PENDULUM

AIM: USING THE PERIOD OF A PENDULUM TO DETERMINE g

SAFETY

No safety considerations are required for this experiment.

APPARATUS

- Pendulum bob
- Stand
- Boss and clamp
- Two wooden pieces
- Stopwatch
- Meter rule

INTRODUCTION

The pendulum is a common device used in both elementary and advanced physics. The pendulum has a period which is related to both its length and the acceleration due to gravity, g.

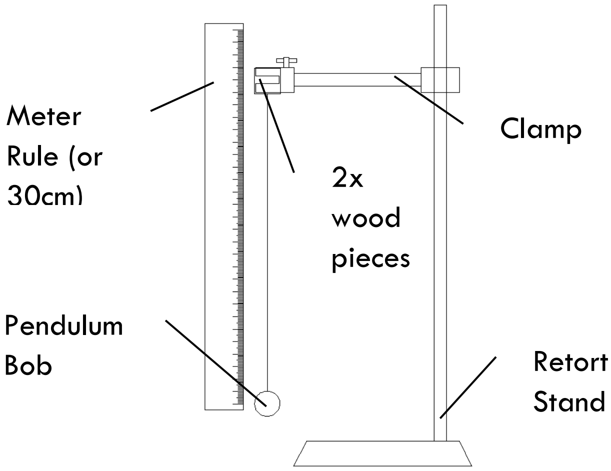
$$T = 2\pi\sqrt{\frac{l}{g}}$$

In this practical we will vary the length of the pendulum and obtain values of period, T. By plotting a graph and taking the gradient, we will then obtain a value of g.

DEFINE THE PROBLEM

	Independent variable	Dependent variable	Control / Constants
Method of measurement			

PROCEDURE



1 Set up the pendulum as shown in the diagram on the right. Ensure that the string/thread doesn't slide while between the two wooden pieces and that the stand does not move while the pendulum is oscillating (weigh it down with books if necessary).

2 Try timing a single oscillation with a stopwatch. Explain why measuring the time of a single period is likely to be inaccurate.

………

3 Now measure the time for 10 oscillations. Write this time into the table below and include your answer for a single swing.

Length of Pendulum l /m	Time for 10 oscillations /s	Time for one oscillation, T /s	T^2 /s^2

4 Shorten the pendulum by roughly 5cm. Record the time again for 10 swings in the table above. Repeat this for four more values, filling the table above as you do so.

You do not need to use exact increments of 40.0cm, 35.0cm etc. In fact, using rough values is a more scientifically sound approach. e.g. <u>41.2cm</u>, <u>35.4cm</u> etc.

5 Plot of a graph of T^2 vs. l on the next page. Draw a line of best fit.

6 Take the gradient of the best fit line (step 5). Use a gradient triangle roughly more than half the size of the drawn line.

Gradient = ………………. s^2m^{-1}

7 The relation of the gradient to the acceleration due to gravity, g is shown below.

$$gradient = \frac{4\pi^2}{g}$$

Use this formula with your obtained value of gradient to calculate g.

g = ……………. ms^{-2}

Graph of T^2 vs. l to determine the acceleration due to gravity, g

Ensure there are an equal number of plots <u>above and below the line</u>. The best fit line actually does not need to go through any of your plots!

Turn over to the next page

EXTENSION

a What happens to the period of a pendulum as you *increase the length of the string*? What do you think would happen if you *increased the mass of the pendulum bob*?

………

………

………

b Suppose that there were two pendulums: one on earth and one on the moon, both with the same length of string holding the bob. What would the ratio of the period of a pendulum on the moon to that of a pendulum of earth be? (g_{moon} = 1.6 ms^{-2})

T_{moon}/T_{earth} = …………….

c Make use of the pendulum you have set up. Discuss the following points with your partner:

a. At what position is the speed of the pendulum bob zero?

…………………………………………………………………………………………………

b. At what position is the speed of the pendulum bob the greatest?

…………………………………………………………………………………………………

c. At what position should the bob be when you start and stop the time for 10 oscillations using a stopwatch in order to be the most accurate?

…………………………………………………………………………………………………

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 MAY/JUNE 2013

4 A student carries out an experiment using a simple pendulum.

Fig. 4.1 shows the apparatus.

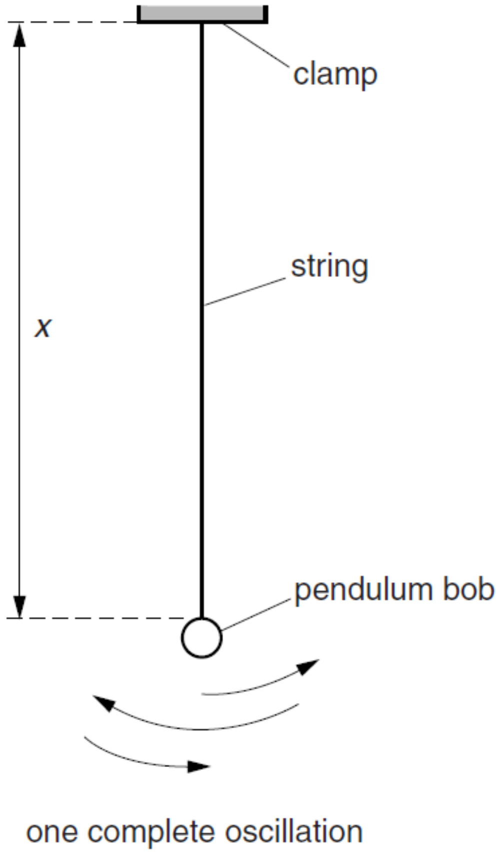


Fig. 4.1

The student records the time *t* taken for 20 complete oscillations of the pendulum for a range of different lengths *x* of the string. The readings are shown in Table 4.1.

Table 4.1

x/cm	t/s	T/s
90.0	38.5	
80.0	36.0	
70.0	33.4	
60.0	31.4	
50.0	28.2	
40.0	25.5	

(a) The period T of the pendulum is the time taken for one complete oscillation.

For each set of readings in the table, calculate the period T and enter the results in the table. [2]

(b) Suggest a reason for measuring the time for twenty oscillations rather than just one.

....

....

....[1]

(c) In this experiment, the length x of the string is measured with a metre rule.

Suggest one precaution that you would take when measuring the length in order to obtain an accurate reading.

....

....[1]

(d) The student decides that a more useful result is possible if the length is measured to the centre of mass of the pendulum bob.

The pendulum bob is a small metal ball. The student has a 30 cm ruler and two rectangular blocks of wood that are about 10 cm long.

Suggest how the student can use this equipment to measure accurately the diameter of the pendulum bob. You may draw a diagram.

....

....

....[2]

[Total: 6]

1 In this experiment, you will determine the density of water using two methods.

(a) Method 1

Carry out the following instructions, referring to Figs. 1.1 and 1.2.

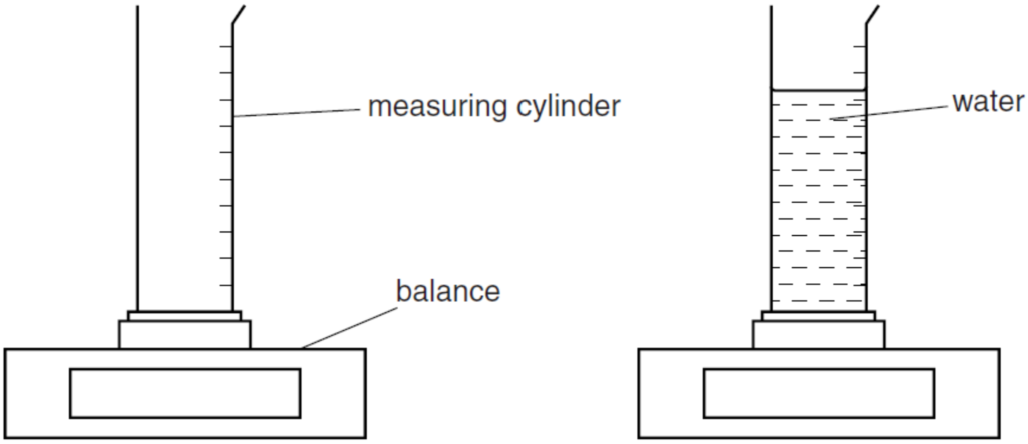


Fig. 1.1 **Fig. 1.2**

(i) Place the empty measuring cylinder on the balance as shown in Fig. 1.1. Measure and record the mass m_1 of the empty measuring cylinder. Remove the measuring cylinder from the balance.

m_1 = ...g

(ii) Pour approximately 70 cm^3 of water into the measuring cylinder. Measure and record the volume V_1 of the water.

V_1 = ... cm^3

(iii) Place the measuring cylinder containing the water on the balance as shown in Fig. 1.2. Measure and record the mass m_2 of the measuring cylinder and water.

m_2 = ...g
[2]

Leave the water in the measuring cylinder for use in **Method 2**. Remove the measuring cylinder from the balance.

(iv) Calculate a value ρ_1 for the density of water using the equation $\rho_1 = \dfrac{m_2 - m_1}{V_1}$. Give an appropriate unit.

(b) Method 2

Carry out the following instructions, referring to Figs. 1.3 and 1.4.

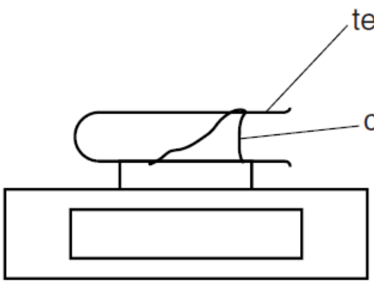


Fig. 1.3

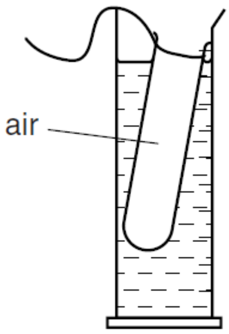


Fig. 1.4

(i) Place the empty test-tube on the balance as shown in Fig. 1.3. Measure and record the mass m_3 of the test-tube.

m_3 = ...g

(ii) Carefully lower the test-tube, by means of the cotton, into the measuring cylinder until it floats as shown in Fig. 1.4. Measure and record the new water level V_2 in the measuring cylinder.

V_2 = ... cm^3

(iii) Using your results from **(a)(ii)** and **(b)(ii)**, calculate V_3, the change in the water level, where $V_3 = (V_2 - V_1)$.

V_3 = ... cm^3
[2]

(iv) Calculate and record a value ρ_2 for the density of water using the equation $\rho_2 = \dfrac{m_3}{V_3}$.

ρ_2 = ...[1]

(c) Calculate an average value ρ_{AV} for the density of water using your results from **(a)(iv)** and **(b)(iv)**.

ρ_{AV} = ...[1]

(d) Suggest a precaution that should be taken in **Method 1** to ensure that the volume reading is as accurate as possible. You may draw a diagram.

....

....

....[1]

(e) Suggest a possible source of experimental inaccuracy in **Method 2**, other than with the volume reading.

State and explain the effect that this would have on your value for ρ_2.

suggestion ....

....

effect and explanation..

....

[2]

ALTERNATIVE TO PRACTICAL QUESTION - 0625/63 MAY/JUNE 2013

4 The IGCSE class has been asked to determine the density of an object.

One student is finding the volume of the object using a measuring cylinder containing water in which the object is to be placed.

The measuring cylinder containing only water is shown in Fig. 4.1.

The measuring cylinder after the object has been placed in the water is shown in Fig. 4.2.

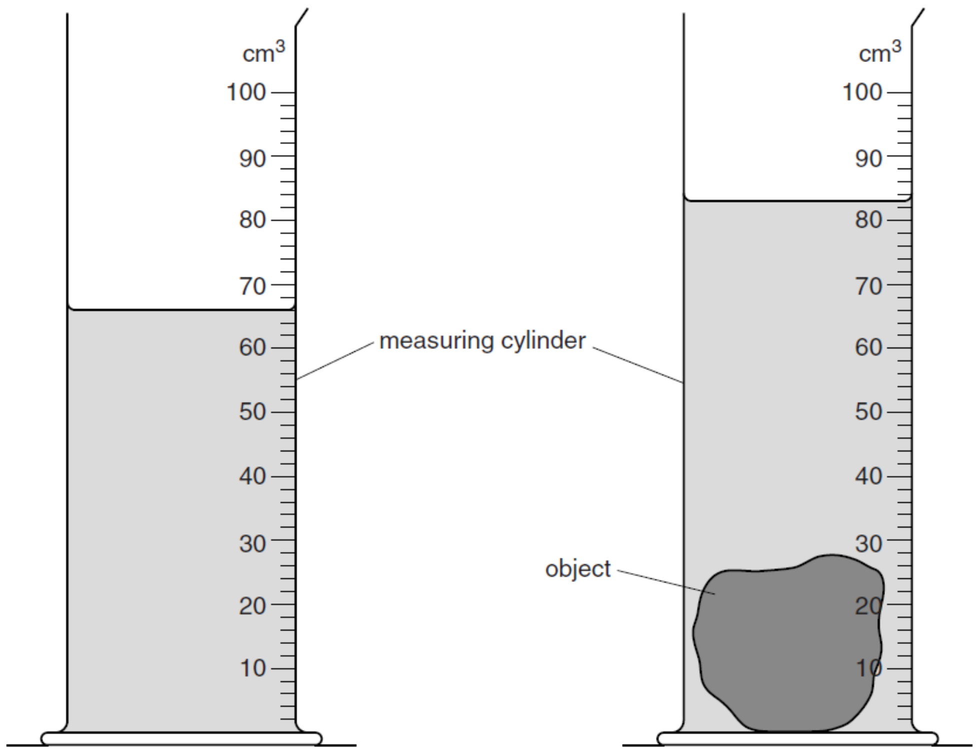


Fig. 4.1 **Fig. 4.2**

(a) **(i)** Read and record the volume V_1 of the water in the measuring cylinder shown in Fig. 4.1.

V_1 = ...

(ii) Read and record the volume V_2 of the water in the measuring cylinder shown in Fig. 4.2.

V_2 = ...

[2]

(b) The student then uses a balance to measure the mass m of the object, as shown in Fig. 4.3.

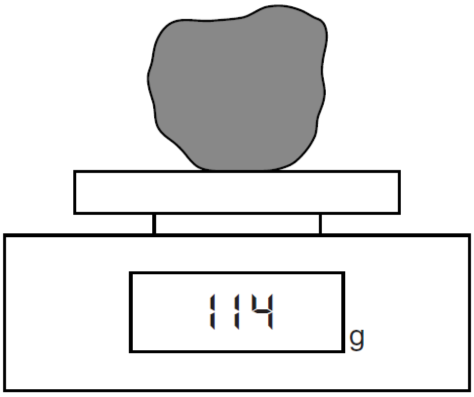


Fig. 4.3

Calculate the density of the object using the equation

$$\text{density} = \frac{m}{(V_2 - V_1)}.$$

density = ...[2]

(c) Suggest a possible practical cause of inaccuracy in this method.

....

....

....[1]

[Total: 5]

PRACTICAL 3 - FALLING BODIES

AIM: INVESTIGATE THE MOTION OF A FALLING OBJECT USING A STOPWATCH AND TICKER TAPE

SAFETY

None required

APPARATUS

- Meter rule
- Piece of masking tape (as a marker)
- Stopwatch
- Tennis and ping pong ball

INTRODUCTION

In this practical you will investigate the motion of an object in a uniform gravitational field, neglecting air resistance in your calculations. In the first part you will use a stopwatch to time the fall of the object and determine the value of the acceleration due to gravity, g.

In the second part you will learn to make use of a ticker tape to determine g, and comment on its accuracy. In the extension you will also consider the use and benefit of light gates in this type of experiment.

DEFINE THE PROBLEM

	Independent variable	Dependent variable	Control / Constants
Method of measurement			

PROCEDURE

1 Choose and measure the height from the floor through which the tennis ball will drop. You may use a piece of masking tape to mark the position if this helps.

Height: ……………………… m

2 Using a stopwatch, find the time it takes for the tennis ball to drop from the starting position to the floor. Repeat and take two more readings. Calculate the average of all three readings.

Trial (tennis ball)	Time Taken /s	Average Time /s
1		
2		
3		

3 Substituting your recorded values of height and average time taken into one of your *equations of motion*, calculate the acceleration of the ball. Assume that the initial speed is from rest (u = 0).

g : ……………………… ms^{-2}

4 Now repeat steps 2 & 3 for a ping pong ball to calculate g.

Trial (ping pong ball)	Time Taken /s	Average Time /s
1		
2		
3		

g : …………………… ms^{-2}

5 If your measurements were accurate, the time reading for your tennis ball should be shorter than the reading for the ping pong ball. Explain why this is the case.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

6 Now attempt the same experiment again but with ticker tape. Attach the tape to the ball and start the ticker tape at the same time of the release of the ball.

7 One example of a used ticker tape is shown in Figure 1 below. The distance between two successive dots represents the distance travelled by the object over a constant time interval.

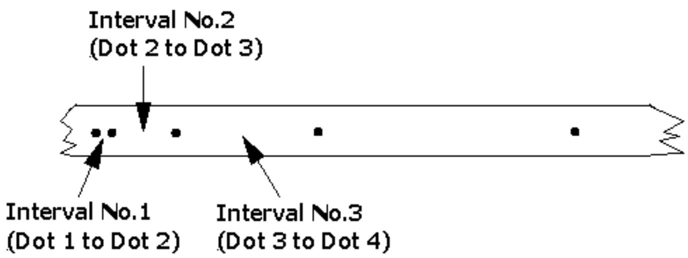


Figure 1

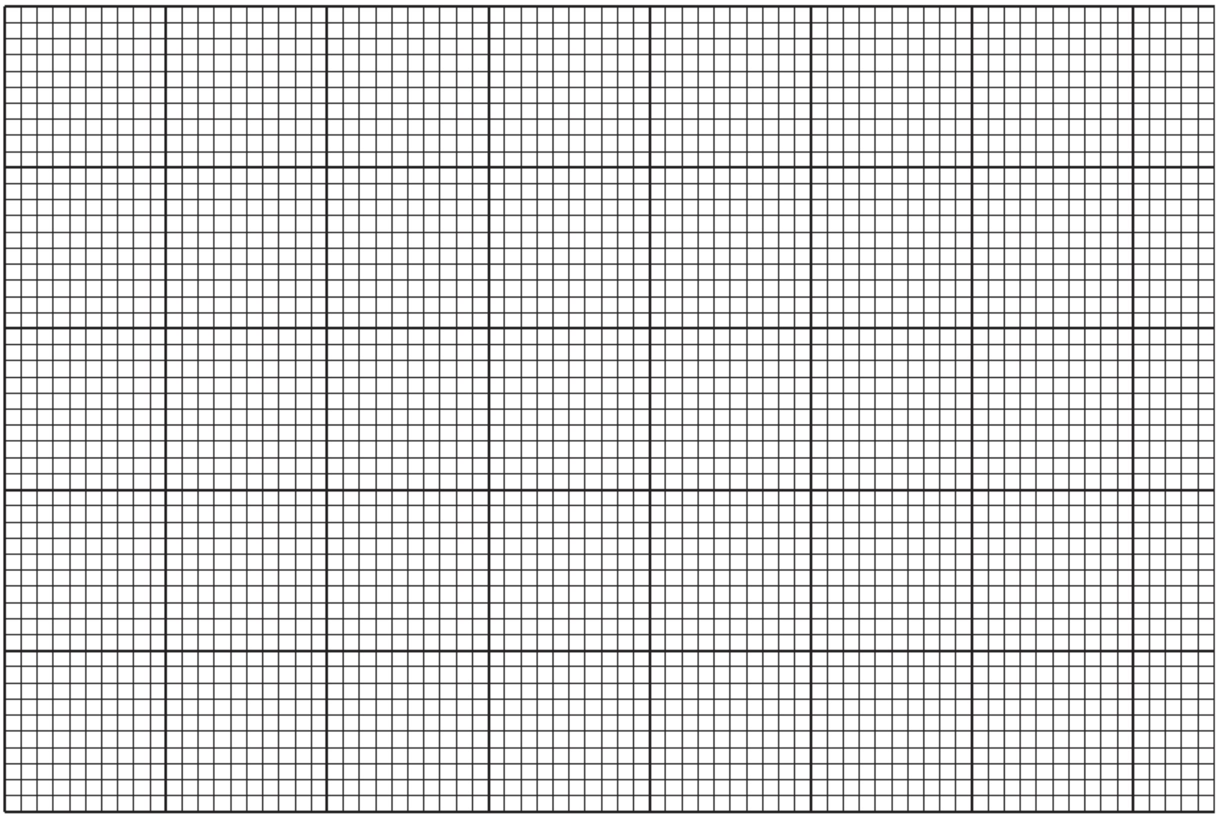
Analyse the dots from the first time interval to the furthest time interval you obtained. The ticker tape has a known time interval of duration 0.02s. Complete the table on the next page.

PRACTICAL 3 – FALLING BODIES

Table of ticker tape readings/measurements

Interval No.	Time for each interval /s	Displacement of each interval /m	Average velocity during each interval /ms^{-1}	Elapsed time to middle of interval /s
1	0.02			0.01
2	0.02			0.03
3	0.02			0.05
4				
5				
6				
7				

8 Plot a graph of the average velocity vs. elapsed time (x-axis). Include labels and units on your axes and use an appropriate scale.



9 Indicate whether the acceleration of the object is constant. By taking the gradient from one part of the graph, calculate the acceleration of the object.

Calculated value of g = ………………. ms^{-2}

EXTENSION

a What was the main difficulty you encountered while using a stopwatch? State an advantage of using a ticker timer instead.

……

……

b Calculate the frequency of the ticker timer, making use of its time interval.

Frequency = ………………. s^{-1}

c A student suggests that we should take the gradient at the beginning of the graph to obtain an accurate value of g. Explain why this value would be more accurate.

……

……

d An experimental setup with a single light gate is shown in Figure 2 on the next page. Explain how a 'double interrupt card' is used to find the acceleration.

……

……

……

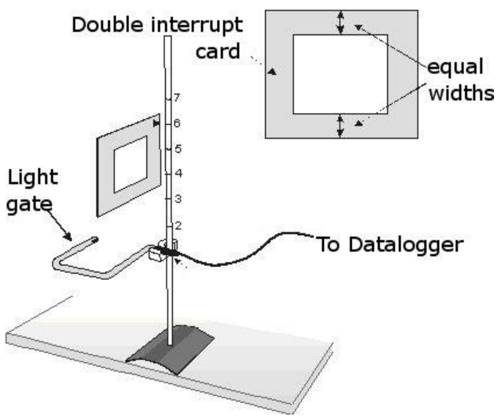


Figure 2

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2015

5 The class is investigating the motion of a small steel ball when it is dropped on to a tray full of sand. Fig. 5.1 shows the apparatus.

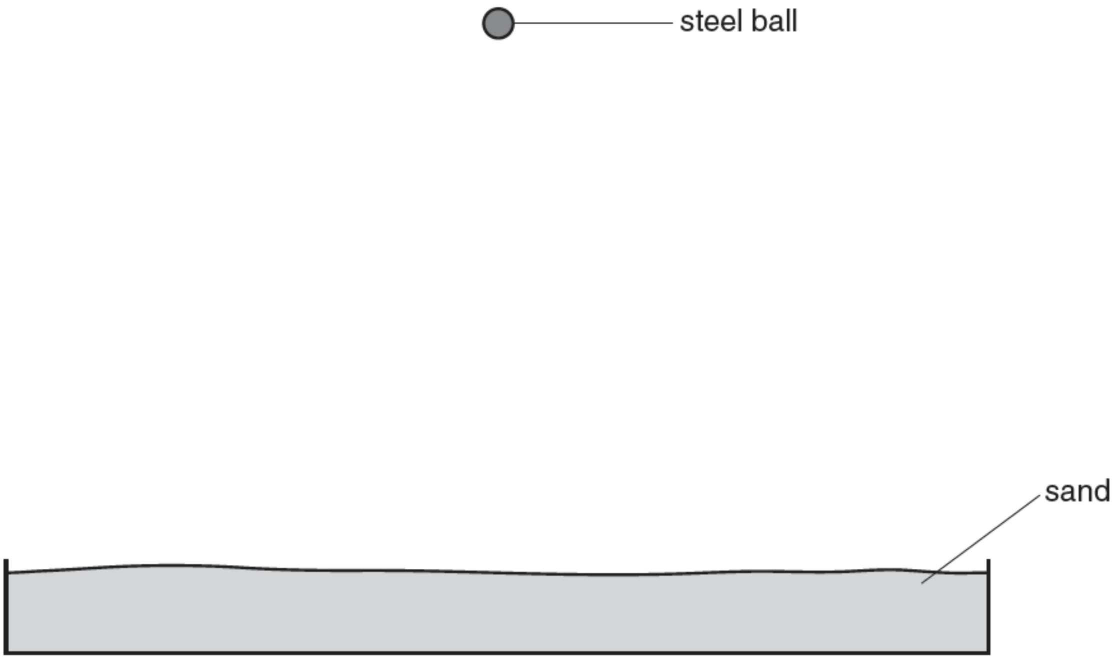


Fig. 5.1

(a) A student is measuring the time it takes for the steel ball to fall through 2.00 m on to the sand. He uses a stopwatch.

Suggest a cause of inaccuracy in the timing.

....

....[1]

(b) When the steel ball falls into the sand it creates a circular hole.

Suggest how you would measure the diameter of the hole as reliably as possible. Name the measuring device that you would use. You may draw a diagram.

....

....

....[2]

(c) The student suggests that the diameter of the hole depends on the height from which the ball is dropped, because this affects the speed.

Suggest two other variables on which the size of the hole may depend.

1. ....

2. ....

[2]

[Total: 5]

PRACTICAL 4 - THE SPRING CONSTANT

AIM: TO DETERMINE THE SPRING CONSTANT OF A SPRING AND TO VERIFY THE SPRING CONSTANT IN PARALLEL AND SERIES

SAFETY

Springs are a hazard to your eyes - do not load the spring with too many masses. This can also damage the spring permanently. Safety goggles should be worn. Ensure the nail is positioned so that it doesn't hurt anybody, and is not positioned at eye level.

APPARATUS

- Two helical springs
- Two stands; two clamps
- Two nails
- Wooden
- Hanging masses (20g)
- Meter rule / ruler (measure in mm)

INTRODUCTION

In this experiment you will determine the spring constant of a simple spring by measuring the extension of the spring under a load. Following this you will combine duplicate (the same) springs together in series and in parallel, investigating the spring constant in these configurations.

Studies of the simple spring form the basis for the study of materials in physics, for example both springs and metals obey Hooke's Law.

DEFINE THE PROBLEM

	Independent variable	Dependent variable	Control / Constants
Method of measurement			

PROCEDURE

Spring constant of a single spring

1 Lay the spring out on the desk in front of you and measure the original, *unstretched* length, L of the spring from the very top to the very bottom with a ruler. Record it below:

Original Length, L : ………………………… m

2 Set up a stand, clamp and nail so that the nail can hold the spring freely without it falling off.

3 Suspend one loop of the spring through the nail and add one 20g mass. Record its stretched length in the table below:

Mass / kg	Force / N	Stretched Length / m	Extension /m
0.02	0.196		

4 Add another 20g mass and record the new mass, force and length. Repeat this again with four more masses. Ask the teacher if in doubt on how to hang more masses onto the spring.

5 Calculate the extension. Extension = recorded length – original length. *This is how far the spring has been stretched.*

6 Plot the graph of force vs. extension on the next page.

7 Calculate the gradient, $\Delta F/\Delta x$. Don't forget to use a gradient triangle at least more than half the size of the graph you drew.

Spring constant, $\Delta F/\Delta x$: …………. N/m

Springs in series

8 For this part you will now use two springs which are ideally the same. It is suggested that you verify the second spring's spring constant by performing the previous steps, otherwise you can assume both springs have the same spring constant.

9 Set up the two springs in series as shown below in Figure 1. You should be able to attach the loops together without damaging the springs. Repeat the previous procedure to record six readings of force and extension for this combined spring.

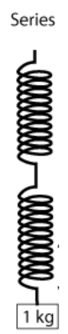


Figure 1

Force / N	Stretched Length / m	Extension /m

10 Plot the graph of force vs. extension on the graph again, this time labelling it 'combined in series'. Calculate the gradient.

Series spring constant, $\Delta F/\Delta x$: …………. N/m

Springs in parallel

11 Set up the two springs in parallel. Repeat the same procedure as you did for springs in series.

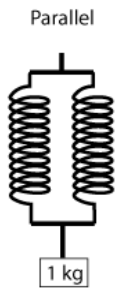


Figure 2

Force / N	Stretched Length / m	Extension /m

12 Label the graph 'combined in parallel'. Calculate the gradient.

Parallel spring constant, $\Delta F/\Delta x$: …………. N/m

Spring Constant Graph for a) a single spring b) two springs in series c) two springs in parallel

EXTENSION

a Using your spring constant of a single spring, substitute it into the equations below and following that, identify which equations correspond to which combination of springs; *parallel* or *series* combination.

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

k = ……………

_____________ combination

$$k = k_1 + k_2$$

k = ……………

_____________ combination

b If you were given springs of spring constant 2.5N/m, how would you combine any number of these to make a spring constant of:

a. 7.5N/m ?

b. 0.83N/m ?

c. 3.75N/m ? (try more than one combination together!)

c Suggest what would happen to force and extension if the *cross-sectional area* of a metal wire was doubled.

……

……

ALTERNATIVE TO PRACITICAL QUESTION - 0625/61 MAY/JUNE 2014

1 The IGCSE class is investigating the motion of a mass hanging on a spring.

Fig. 1.1 shows the apparatus

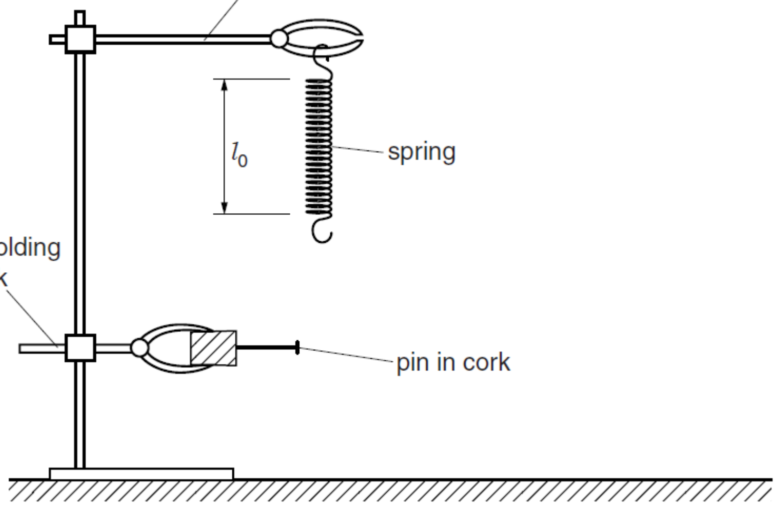


Fig. 1.1

(a) On Fig. 1.1, measure the length l_0 of the unstretched spring, in mm.

l_0 = ... mm [1]

(b) The diagram is drawn one tenth of actual size. Write down the actual length L_0 of the unstretched spring, in mm.

L_0 = ...mm [1]

A student hangs a 300 g mass on the spring and measures the new length L of the spring.

L = 255 mm

(i) Calculate the extension e of the spring using the equation $e = (L - L_0)$.

e = ...mm

(ii) Calculate a value for the spring constant k using the equation $k = \frac{F}{e}$, where F = 3.0 N. Include the appropriate unit.

k = ...

[2]

(c) The student adjusts the position of the lower clamp so that the pin is level with the bottom of the mass when the mass is not moving. She pulls the mass down a short distance and releases it so that it oscillates up and down. Fig. 1.2 shows one complete oscillation.

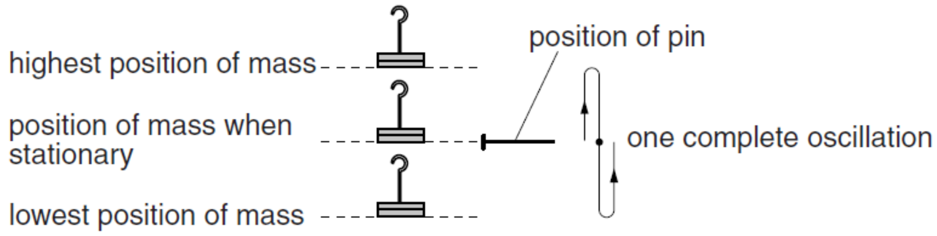


Fig. 1.2

She measures the time t taken for 20 complete oscillations.

t = ...26.84 s......

Calculate the time T taken for one complete oscillation.

T = ... [1]

(d) She replaces the 300 g mass with a 500 g mass. She repeats the timing as described in part **(c)**.

t = ...34.48 s......

(i) Calculate the time T taken for one complete oscillation.

T = ...

(ii) The student suggests that the time taken for the oscillations of the spring should not be affected by the change in mass.

State whether her results support this suggestion and justify your answer by reference to the results.

statement ....

justification ....

....

....

[2]

(e) Explain briefly how you avoid a line-of-sight (parallax) error when measuring the length of a spring in this type of experiment. You may draw a diagram.

....

....

....[1]

[Total: 8]

PRACTICAL 5 - FRICTION

AIM: INVESTIGATE THE FRICTIONAL FORCE OF A BLOCK ON A RAMP

SAFETY

No safety considerations are required for this experiment.

APPARATUS

- Wooden ramp
- Wooden block with different masses
- 50g and 10g masses
- Protractor
- Newton meter

INTRODUCTION

You will investigate the frictional force acting on a wooden block when it is in contact with the surface of a wooden ramp. By changing the slope of the ramp you will then be able to find the relationship between the angle made by the ramp and the frictional force on the block.

DEFINE THE PROBLEM

	Independent variable	Dependent variable	Control / Constants
Method of measurement			

PROCEDURE

1 Measure the weight of the block using the Newton meter provided.

Weight: .... N

2 Check that the ramp is placed level and horizontal on the desk. Place the block on the ramp with no masses inserted.

3 Attach the Newton meter to one end of the string attached to the block. Now pull very gently on the Newton meter, gradually increasing the force until the block suddenly moves. Make a note of the force reading, F, at the point it moved.

Force, F: .... N

4 Now place an object (such as a book or wood block) at one end of the ramp so that it makes an angle with the horizontal. Measure the angle with the protractor provided and measure the force that moves the block. Add this reading to the table on the next page alongside your reading from step 3.

5 Varying the angle of the ramp, record four more readings and complete the table below.

Angle to horizontal θ /°	F/N	sin θ
0		

6 Calculate the values of sin θ in the third column. Then plot a graph of sin θ on the x-axis vs. force on the y-axis. Draw a line of best fit.

7 Take the gradient from the best fit you drew on your graph (step 6) using a suitably sized triangle.

Gradient: ……………………

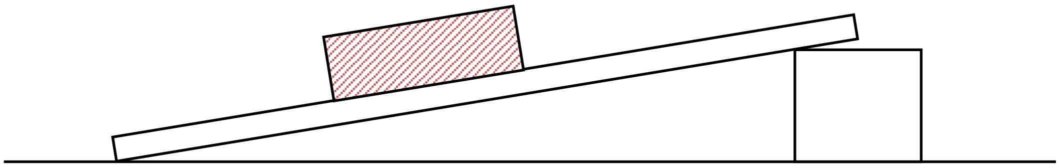
8 Was the gradient you obtained the same as the weight of the block? If not, *suggest a reason* why the value isn't the same.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

EXTENSION

a A simple diagram of the block on the ramp is drawn below. Complete the diagram to show all three forces: weight, normal force and frictional force.



b The block does not move and therefore the forces on it are said to be in equilibrium. Draw a vector triangle in the blank space below of all three forces to show that the forces are in equilibrium.

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2013

5 The IGCSE class is investigating pressure.

A student places a rectangular block on a sheet of paper on the bench and draws the outline.

Fig. 5.1 shows the outline.

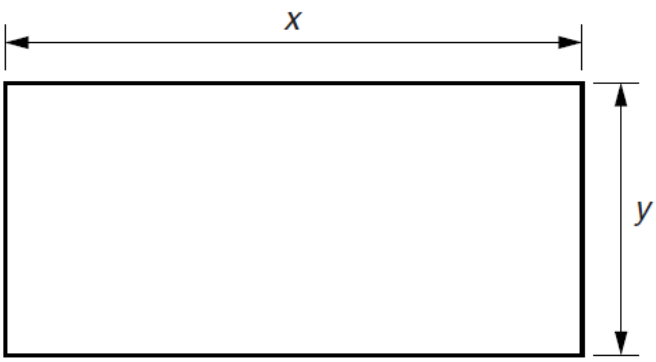


Fig. 5.1

(a) **(i)** On Fig. 5.1, measure the length x of the block.

x = ...[1]

(ii) On Fig. 5.1, measure the width y of the block.

y = ...[1]

(b) Fig. 5.2 shows the block being weighed using a forcemeter.

(i) Using Fig. 5.2, write down the weight *W* of the block.

W = ...[1]

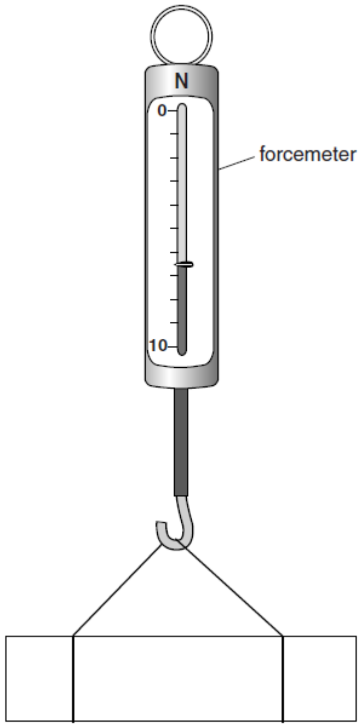


Fig. 5.2

(ii) Calculate the pressure *P* that the block exerts on the bench. Use the equation $P = \frac{W}{A}$ where *A* is the area of the block in contact with the bench ($A = xy$).

P = ...
[1]

(c) The value calculated for *P* is slightly too small.

Suggest one practical source of inaccuracy that would account for this.

....

....[1]

[Total: 5]

PRACTICAL 6 – EQUILIBRIUM OF MOMENTS

AIM: TO VERIFY THE PRINCIPLE OF MOMENTS

SAFETY

No safety considerations are required for this experiment.

APPARATUS

- Stand and clamp
- A loop of string (approx. 5cm circumference)
- Mass hanger
- Triangular block to act as a pivot for the metre rule
- Hanging masses (50g & 10g)
- A 100 g mass, labelled P
- Meter rule with loops on both sides
- Hanging container
- Sand

INTRODUCTION

You will set up a simple 'balance' on which you can move masses back and forth on a meter rule; by doing so you can get potentially accurate readings and verify the Law of Moments within a reasonable accuracy. Through the use of a meter rule it will be relatively easy to record the position of the pivot, thereby making it easy to find the displacement of the pivot from the mass hanger.

PROCEDURE

1. In this experiment, you will determine the weight of a metre rule using a balancing method.

Carry out the following instructions, referring to Fig. 1.1.

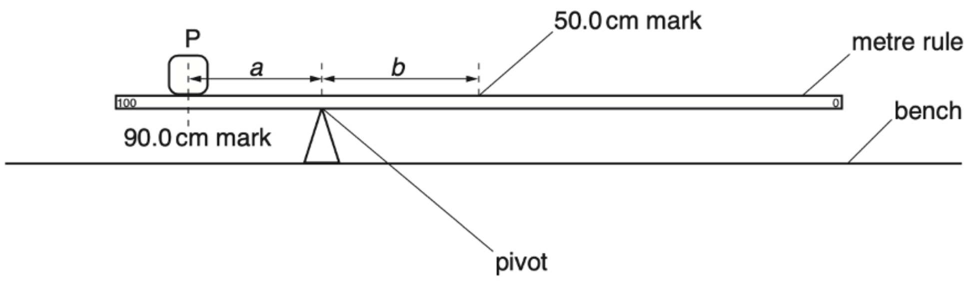


Fig. 1.1

(a) Place the metre rule on the pivot. Place the load P with its centre on the metre rule at the 90.0 cm mark. Keeping the load P at the 90.0 cm mark, adjust the position of the metre rule on the pivot so that the metre rule is as near as possible to being balanced.

Measure, and record in the first row of Table 1.1, the distance *a* from the 90.0 cm mark to the pivot.

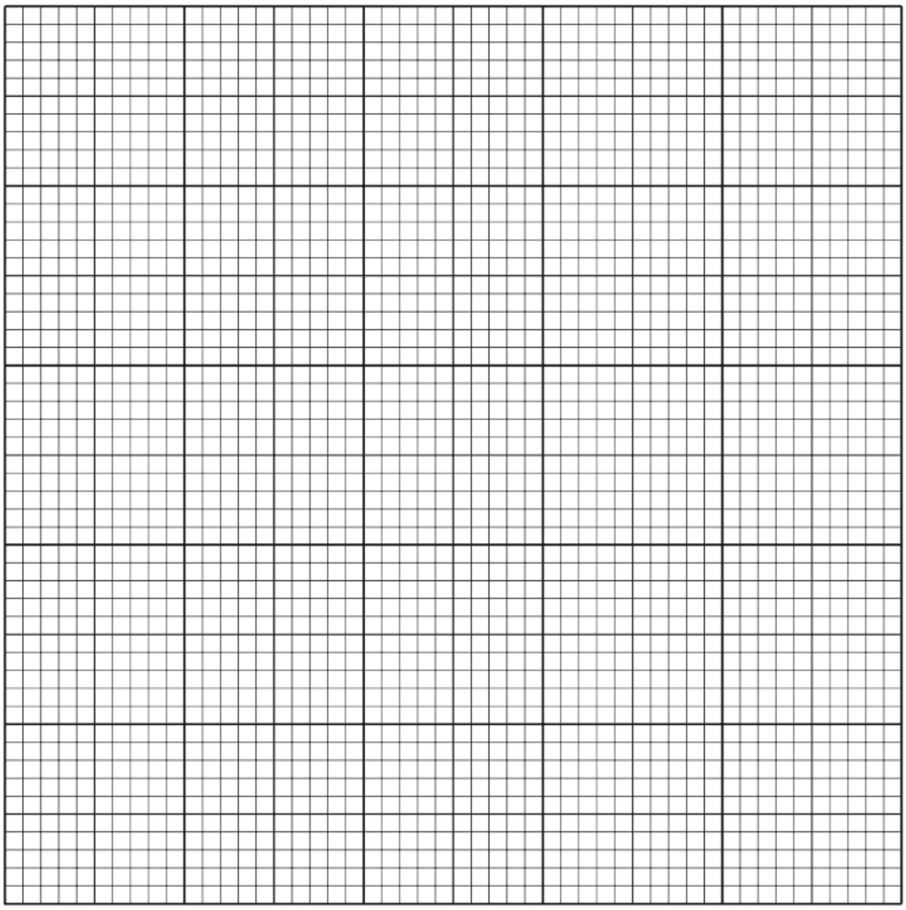
Measure, and record in the first row of Table 1.1, the distance *b* from the pivot to the 50.0 cm mark.

Repeat the steps above, placing the centre of the load P at the 85.0 cm, 80.0 cm, 75.0 cm and 70.0 cm marks. Record all values of *a* and *b* in Table 1.1.

Table 1.1

a/cm	b/cm

(b) Plot a graph of a / cm (y-axis) against b / cm (x-axis). You do **not** need to begin your axes at the origin (0, 0).



[4]

(c) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ...

(d) Calculate the weight W of the metre rule using the equation $W = G \times P$, where P = 1.0 N.

W = ...

(e) Suggest **one** practical reason why it is difficult to obtain accurate readings for a and b in this type of experiment.

....

(f) Use the balance provided to measure the mass of the metre rule.

mass = ...

2.

1 Start by putting the clamp through the loop. Then you can put the meter rule through the loop so that it balances roughly in the middle. It will not be perfect, so ensure that it doesn't slip and fall to the floor.

2 Place a 50g mass at one of the ends of the meter rule by hanging it on the string. Then hang the 100g mass hanger on the string of the other end.

3 Move the ruler so that it balances (by moving the pivot closer to the 100g mass hanger). Record the distance between the pivot and the 100g mass hanger. Record it in the first row of the table below.

4 Add a small 10g mass on top of the mass hanger. Move the ruler so that it balances again. Record the new reading in the table.

Mass of hanger / kg	Weight of hanger / N	Distance from pivot/m	Moment / Nm
0.1	0.98		

5 Repeat the procedure by adding 10g more each time until you have six results in total.

6 A moment of a force is calculated as follows: moment = F x d . In the third column of your table, calculate the *moment* of the six results you obtained.

7 Are your results the same? If not, do they still remain within an error of 10% ? A blank space is provided below for any working you carry out.

....

Finally you will test the accuracy of your balance using the procedure as follows.

8 Take the 50g mass off the string, placing the empty container on it instead. Employing one of the results you obtained, set up the mass hanger and the pivot position to the same value. This should mean that the other end of the meter rule will need to have a 50g weight in total.

9 Start pouring sand into the container, pouring slowly until the meter rule is balanced.

10 If you wish, you can try employing one or two more of your results to confirm that the container and sand are precisely 50g.

11 Once you are confident that you have reached a precise value of 50g, take your container of sand over to the electronic mass balance and see if you got the weight right!

12 Was it correct?

Yes! / No!

EXTENSION

a In this experiment, suggest what is meant by equilibrium of:

a. Forces

....

b. Moments

....

b The 50g mass is replaced with a 100g mass instead, and the six results recorded again. Suggest two differences you would observe in your table of results.

1. ....
2. ....

ALTERNATIVE TO PRACTICAL QUESTION - 0625/63 MAY/JUNE 2012

1 The IGCSE class is investigating the effect of a load on a metre rule attached to a forcemeter.

The apparatus is shown in Fig. 1.1.

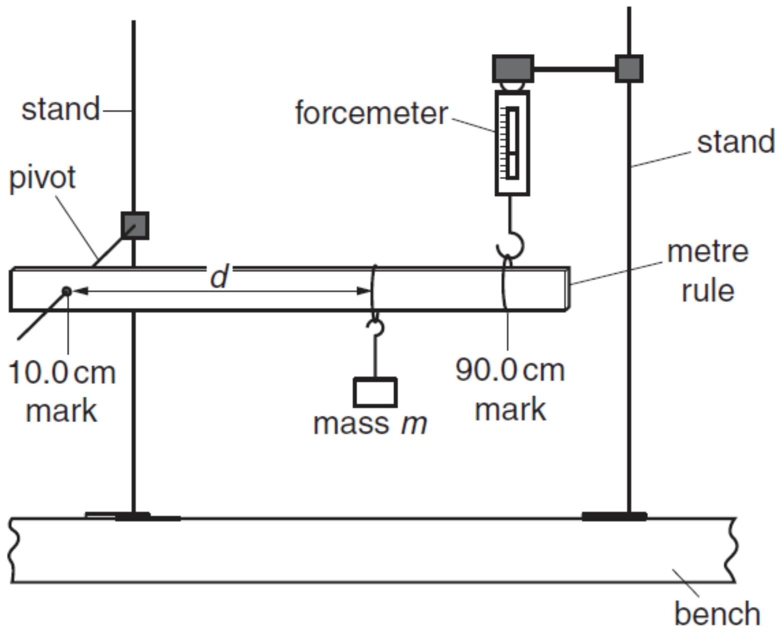


Fig. 1.1

The rule is pivoted near one end at the 10.0 cm mark. Near the other end, at the 90.0 cm mark, the rule is attached to a forcemeter. A mass is hanging from the rule at a distance d from the pivot.

(a) A student moves the mass to a distance d = 70.0 cm from the pivot. He adjusts the height of the forcemeter until the rule is again horizontal. He records the reading F on the forcemeter.

He repeats the procedure using d values of 60.0 cm, 50.0 cm, 40.0 cm, 30.0 cm, 20.0 cm and 10.0 cm. The forcemeter readings are shown in Table 1.1.

Table 1.1

d/	F/
	2.9
	2.5
	2.2
	1.8
	1.5
	1.2
	0.8

(i) Record the *d* values in the table.

(ii) Complete the column headings in the table. [2]

(b) The student thinks that *F* is directly proportional to *d*.

(i) Suggest the graph that you could plot to test this idea. You are not asked to plot the graph.

.... against ....

(ii) State the properties of the line that would indicate that *F* is directly proportional to *d*.

1. ....

2. ....
[3]

(c) A spirit level is a piece of equipment that is placed on a surface to check whether the surface is horizontal.

Suggest why a spirit level balanced on the rule is not suitable for checking whether the rule is horizontal in this experiment.

....

....[1]

(d) Describe briefly how you would check that the rule is horizontal in this experiment. You may draw a diagram.

....

....

....[1]

[Total: 7]

PRACTICAL 7 – CENTRE OF MASS

AIM: TO DEMONSTRATE THE TECHNIQUE OF FINDING THE CENTRE OF MASS OF A 2D OBJECT AND INVESTIGATE THE BEHAVIOUR OF A TOPPLING CONTAINER

SAFETY

Place the stand, clamp and pin on the desk where the pin cannot hurt anybody. Do not place the pin at eye level!

APPARATUS

- Stand and Clamp
- Two wooden pieces
- Pin
- Plumb line
- Irregularly shaped card
- Measuring Cylinder/Container
- Beaker filled with water
- Protractor
- Paper towels

INTRODUCTION

You will hang a 2D piece of card from a pin attached to a clamp, followed by hanging a plumb line which hangs vertically; by doing so you will find the line of gravity that passes through the centre of mass. Pushing the pin into another location of the card we will then be able to accurately pinpoint the centre of mass where the *lines of gravity intersect*.

In the second experiment you will test how the amount of water in a container affects its ability to topple over and then answer questions about everyday problems associated with toppling.

PROCEDURE

Finding the centre of mass of a 2D object

1 Use the pin to make a hole near the edge of the card (anywhere you prefer) so that you can place the card on the clamp. Ensure the card swings freely and that the hole is not too small.

2 Attach the plumb line on the pin in front of the card to determine the line of gravity, as seen in Figure 1 below.

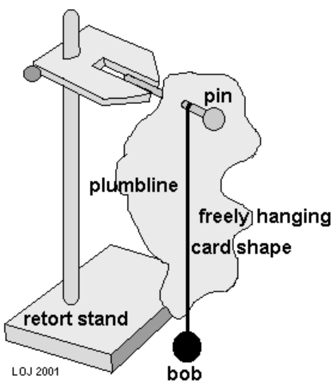


Figure 1

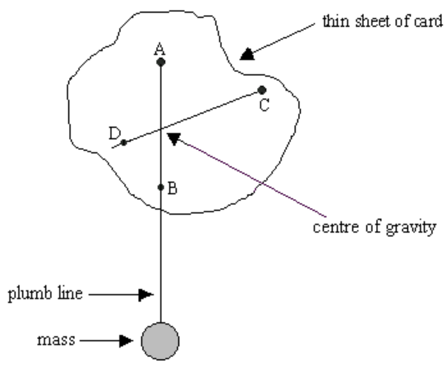


Figure 2

3 Using a pencil, make two clear dots on the card so that you can draw a line. See Figure 2: by drawing dots **A** and **B**, a line of gravity can be drawn onto the card using a ruler. The same applies to **C** and **D**.

It is suggested that you take the card off the pin and use a ruler to connect the two points with a line.

4 Repeat the steps two more times so that you have *three lines* drawn onto the card.

5 You should have three lines which intersect at the centre of gravity. Mark this point and very carefully make a hole there (you only have one chance!) Place the card on the clamped pin and see if it can be rotated to any position without moving. If it does move, then you didn't quite get the centre of mass right! Try again and draw further lines until you establish the right point!

Investigating the behaviour of a toppling object

1 Now you will investigate the toppling of a container. You should start with an empty container with no water inside.

2 Ensuring the container does not slip; tilt the container to the point it starts to topple (not letting it fall over).

3 Use a protractor to measure the angle of toppling. You'll find that you will need to keep the container *close to the edge of the desk* so you can align the centre of the protractor correctly.

4 Note your reading in the table below for 0 ml of water.

Amount of water in container / ml	Angle of toppling / °
0	

5 How does the angle of toppling change with amount of water? Why?

………

………

6 Now proceed to measure the angle of toppling for an increasing amount of water added to the container. If any water spills over, please wipe it up immediately with the paper towels provided. Record your results in the table above.

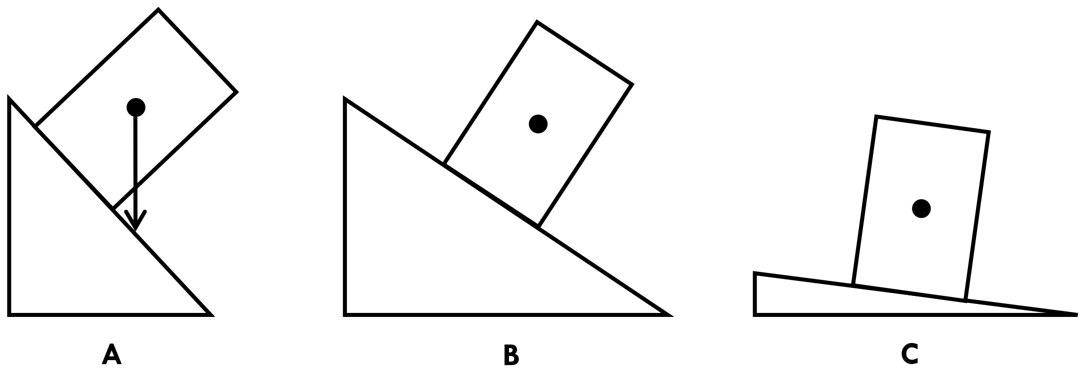
7 Plot a graph of angle vs. amount of water on the next page.

Step 7 – A graph of angle of toppling vs. amount of water in a container

Turn over to the next page for extension questions

EXTENSION

a Three diagrams are shown below. The first diagram already has the weight drawn for you. Draw the weight on the other two. Remember that the weight for all three is the same!



Suggest which container will definitely topple, and explain in terms of the direction of the weight why it will.

b Explain why:

a. When the container is filled with a little water it is more stable than an empty container.

……

b. When the container is nearly full of water it is more stable than an empty container.

……

c Double-decker buses are tested rigorously to ensure they do not topple easily, and must not topple at the range of angles equal to and below 35°. Observing the picture below, explain why the bus doesn't topple even at the extreme angle that was tested.

……

……

……

PRACTICAL 7 - CENTRE OF MASS

ALTERNATIVE TO PRACTICAL QUESTION - 0625/61 MAY/JUNE 2013

1 The IGCSE class is investigating the stability of a block of wood.

Figs. 1.1 and 1.2 show the dimensions of the block.

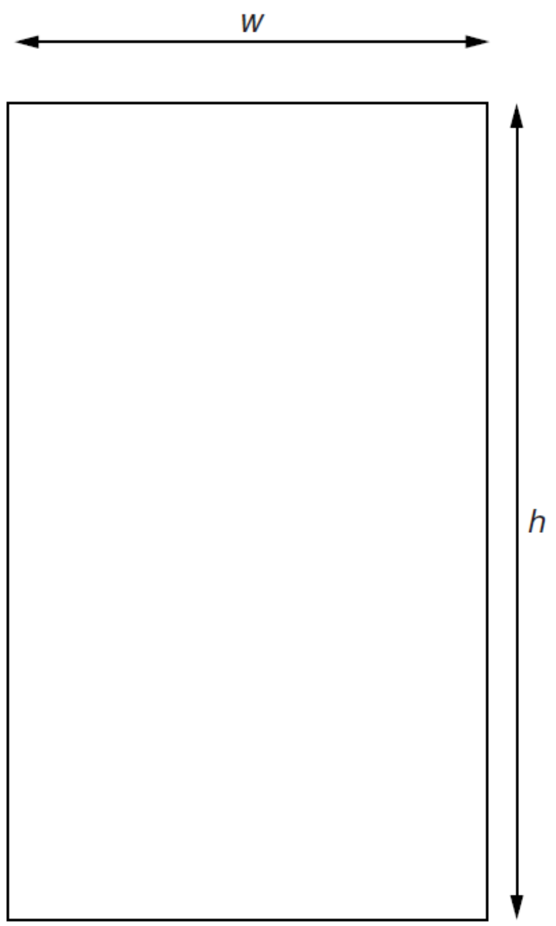


Fig. 1.1

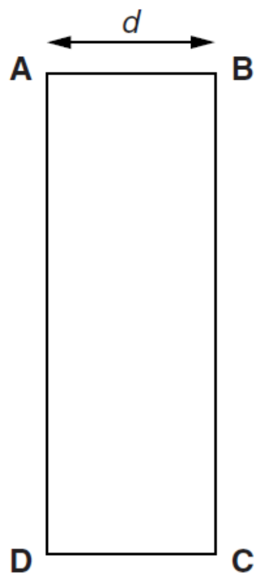


Fig. 1.2

(a) (i) On Figs. 1.1 and 1.2, measure the height *h*, width *w* and depth *d* of the block.

h = ...

w = ...

d = ...
[2]

(ii) On Fig. 1.2, draw the line **AC**. [1]

(iii) Measure and record the angle α between lines **AD** and **AC**.

α = ...[1]

(b) A student places the block on the edge of the bench, as shown in Fig. 1.3.

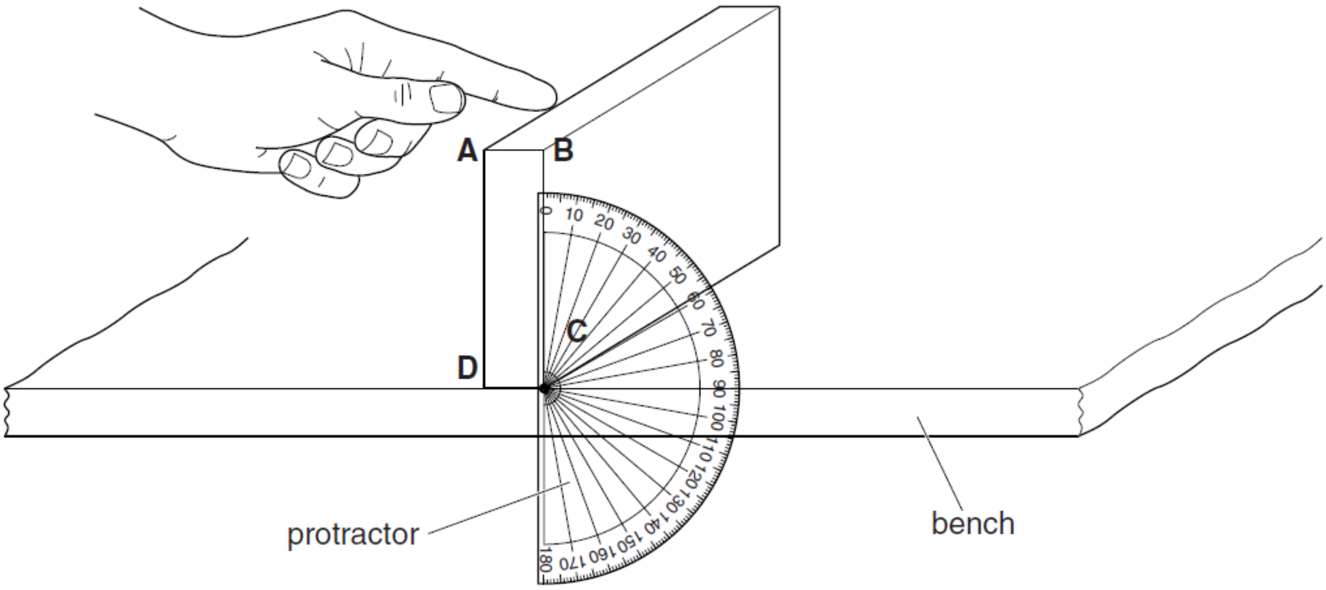


Fig. 1.3

He holds the protractor next to face **ABCD** of the block, as shown in Fig. 1.3. He gently pushes the top of the block (as indicated in Fig. 1.3) so that the block tips over.

He records the angle θ between side **BC** of the block and the vertical line on the protractor. The angle θ is when the block just tips over. He repeats this procedure a suitable number of times.

Suggest the number of measurements of θ that you think would be suitable for this experiment.

number = ...[1]

(c) The student calculates the average value θ_{av} of all his values for θ.

θ_{av} = ...20°..........................

He suggests that θ_{av} should be equal to α. State whether the results support this suggestion. Justify your statement by reference to the results.

statement ....

justification ....

....

....

[2]

[Total: 7]

A student has noticed that different types of paper have different strengths.

Plan an experiment which will enable you to compare the strengths of different samples of thin paper, prepared as shown in Fig. 4.1.

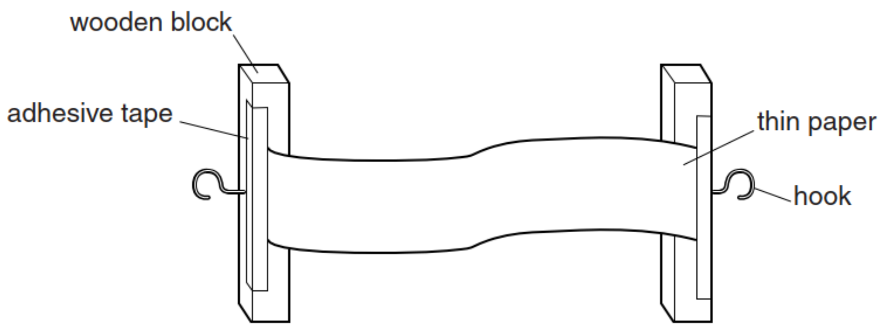


Fig. 4.1

Write a plan for the experiment, including:

- the additional apparatus needed
- instructions for carrying out the experiment, including any precautions you will take
- what you will measure
- how you will present your results
- how you will determine which paper is the strongest
- the variables you will keep the same to ensure the comparison is a fair test.

You may draw a diagram if it helps to explain your plan.

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.... [7]

[Total: 7]

PRACTICAL 8 – SPECIFIC HEAT CAPACITY

AIM: TO MEASURE THE SPECIFIC HEAT CAPACITY OF WATER

SAFETY

Hot water- wear glass and gloves when pouring water into the beaker.

APPARATUS

- Thermometer
- Electric immersion heater (10 W)
- Power supply
- Water
- Electronic balance
- Stopwatch

INTRODUCTION

You will investigate the Specific Heat Capacity of your given water by measuring the change of temperature as heat energy is supplied to it. The heat is supplied by the immersion heater which we can assume to be 100% efficient at converting electrical energy to heat. Electrical power can be determined using the readings of V and I, and the duration of the power supplied can in turn allow us to obtain the total energy supplied to the water.

You will obtain data that should show a rough linear relationship; the accuracy of which will be a topic of discussion.

DEFINE THE PROBLEM

	Independent variable	Dependent variable	Control / Constants
Method of measurement			

PRACTICAL 8 – SPECIFIC HEAT CAPACITY

PROCEDURE

1 Measure and record the mass of the water by using the mass balance provided.

Mass: ………….………… kg

2 Prepare the water by placing it on a lid and ensuring it is properly insulated with the insulating material provided. Very little heat should be able to escape from it.

3 Place the immersion heater into the larger hole and the thermometer into the smaller one. Check to see if the thermometer is indicating a change in temperature!

4 Take the first reading of temperature at 90 seconds. Continue to take a reading every 90 seconds and complete the table below.

Temperature / °	Time / s	Energy supplied / J
	90	

5 Using the power given in the electric immersion heater, calculate the energy supplied by the time of each reading. E.g. for 90 seconds, 'energy supplied = power x 90'.

6 Once the temperature is equal to or above 65°, take your final reading and immediately turn off the power supply and stop the stopwatch. Move onto the next step. Do not touch the water and allow it to cool for at least 10 minutes.

7 Plot a graph of energy supplied vs. temperature on the next page. Draw a line of best fit. You may need to judge which data the line of best fit should account for.

8 Take the gradient from the best fit you drew on your graph using a suitably sized triangle.

Gradient: ………….…………

9 The specific heat capacity of the test water can be calculated using the relation below, which is obtained by rearranging the equation for Specific Heat Capacity.

$$gradient = mc$$

Use the relation to calculate the specific heat capacity, c.

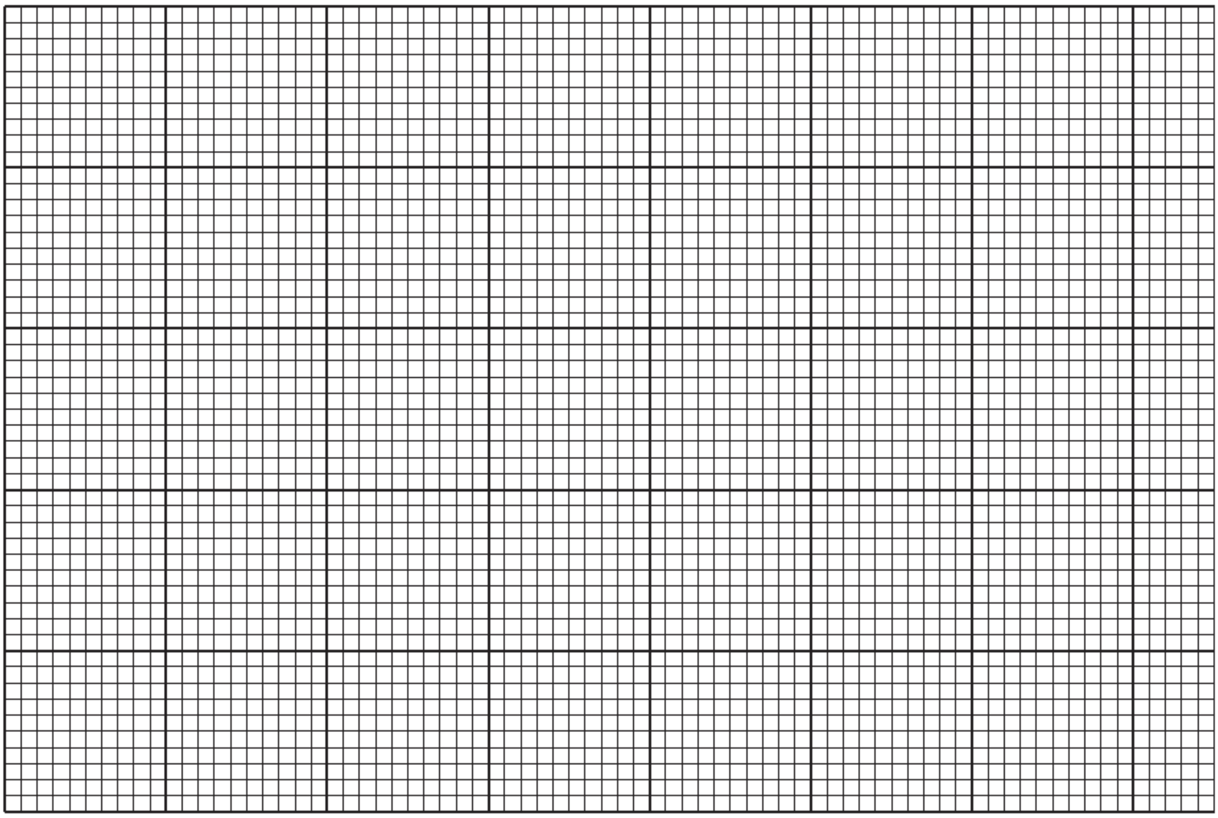
Specific Heat Capacity, c: …………. J/kg/°C

10 Compare your result with the known value of specific heat capacity for your test water. If your value is greater or smaller, suggest a suitable explanation why.

....

....

Energy vs temperature graph



EXTENSION

a What is the main difference between temperature and heat?

....

....

b State the physical quantity that the temperature of an object depends on

....

c At the start of heating the water (between 0 – 90 seconds, or more), your data for temperature is likely to have been very non-linear. This is due to only having just switched on the immersion heater. Suggest why the immersion heater requires some time before heating the water.

....

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2014

2 The IGCSE class is investigating the cooling of hot water as cold water is added.

The apparatus is shown in Fig. 2.1.

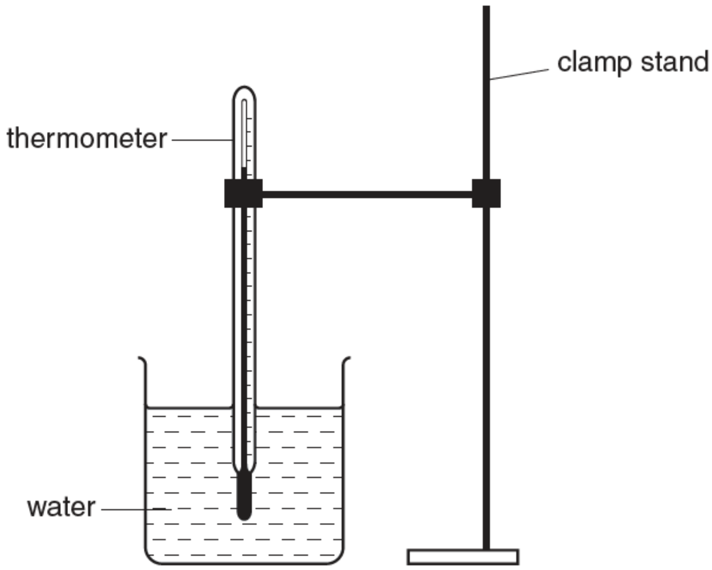


Fig. 2.1

(a) Record room temperature θ_R as shown on the thermometer in Fig. 2.2.

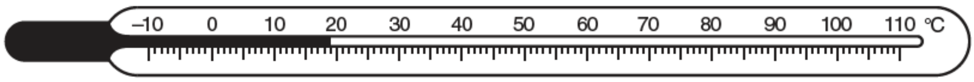


Fig. 2.2

θ_R = ... [1]

(b) A student pours approximately 150 cm^3 of hot water into a beaker. She measures the temperature θ of the water in the beaker.

She adds a volume V = 10 cm^3 of water at room temperature to the hot water in the beaker and stirs it briefly. She measures the temperature of the water in the beaker.

She adds a total of 50 cm^3 of cold water, 10 cm^3 at a time, stirring and measuring the temperature each time. The readings are shown in Table 2.1.

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2014

Table 2.1

V/	θ/
0	82
	75
	69
	65
	61
	58

(i) The total volume of cold water added is V.

In Table 2.1, complete the volume V column.

(ii) Complete the column headings in the table.

[2]

(c) Suggest one way you could reduce the loss of thermal energy to the surroundings during the experiment.

....

.... [1]

(d) The student has a drinks cup, held above a measuring cylinder, as shown in Fig. 2.3. The cup has a small hole in its base.

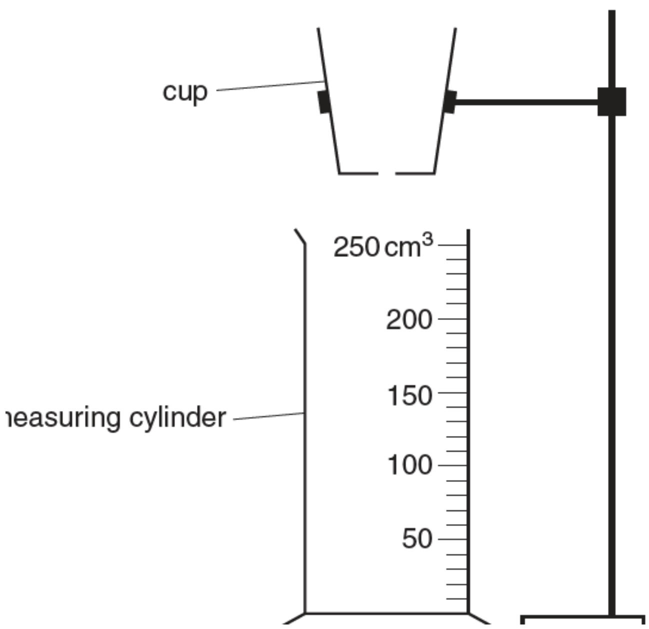


Fig 2.3

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2014

She pours water into the cup until it is about two-thirds full. She measures the time t_1 taken for $50\,cm^3$ of water to fall into the measuring cylinder. The stopwatch reading is shown in Fig. 2.4.

Fig. 2.4

After setting the stopwatch to zero, she measures the time t_2 taken for the next $50\,cm^3$ of water to fall into the measuring cylinder. The stopwatch reading is shown in Fig. 2.5.

Fig. 2.5

(i) Calculate the average rate of flow of water R_1 for the first $50\,cm^3$, using the equation $R_1 = \frac{k}{t_1}$, where $k = 50\,cm^3$.

R_1 = ...

(ii) Calculate the average rate of flow of water R_2 for the next $50\,cm^3$, using the equation $R_2 = \frac{k}{t_2}$, where $k = 50\,cm^3$.

R_2 = ...

[2]

ALTERNATIVE TO PRACTICAL QUESTION - 0625/62 OCTOBER/NOVEMBER 2014

(e) A student suggests that the experiment described in part **(b)** would be improved by having a steady flow of cold water added to the hot water.

Suggest one possible disadvantage of using the method described in part **(d)** to produce such a flow of water.

....

....
[1]

(f) The experiment described in part **(b)** could be repeated to check the results.

Suggest two conditions that should be kept constant in order to provide a reliable check.

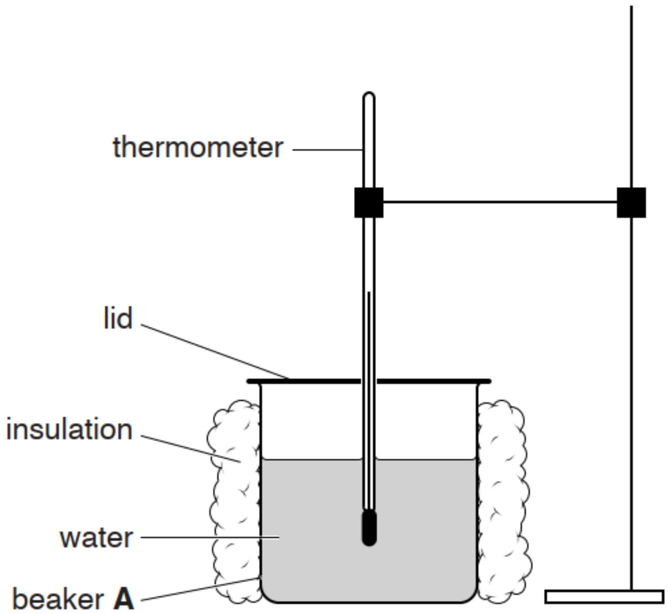
1. ....

2. ....
[2]

[Total: 9]

In this experiment, you will investigate the cooling of water.

Carry out the following instructions, referring to the figure below.



(a)
- Pour 200 cm^3 of hot water into beaker **A**. Place the thermometer in beaker **A**, as shown in the figure aove, with the lid covering the top of the beaker. This beaker is insulated and has a lid.
- Measure the temperature θ of the hot water in beaker **A**. Record this temperature in Table 2.1 at time $t = 0$ s.
- Immediately start the stopclock.
- After 30 s, measure the temperature θ shown on the thermometer. Record the temperature in the table.
- Continue recording the temperature every 30 s until you have six sets of readings.
- Repeat the procedure using beaker **B**. This beaker is insulated but has no lid.
- Repeat the procedure using beaker **C**. This beaker has a lid but no insulation.

	beaker **A** insulation and lid	beaker **B** insulation, no lid	beaker **C** lid, no insulation
t/s	θ/	θ/	θ/
0			
30			
60			
90			
120			
150			

[4]

(b) Complete the column headings in the table. [1]

(c) **(i)** Tick the statement that best describes the results of your experiment.

☐ Removing the lid speeds up the cooling significantly more than removing the insulation.

☐ Removing the insulation speeds up the cooling significantly more than removing the lid.

☐ There is no significant difference between removing the lid and removing the insulation.

[1]

(ii) Justify your answer by reference to your readings.

....

....

....[1]

(d) State two of the conditions that should be kept the same in this experiment in order for the comparison to be fair.

1. ....

....

2. ....

....

[2]

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

....

....

....

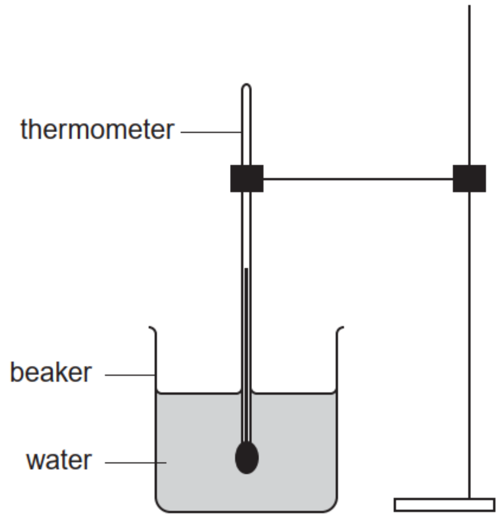
....[2]

[Total: 11]

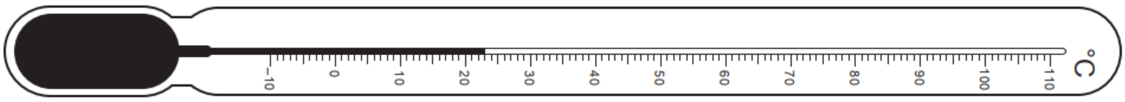
ALTERNATIVE TO PRACTICAL QUESTION

The IGCSE class is investigating the rate of cooling of water.

The apparatus is shown in the figure below.



(a) Record room temperature θ_R as shown on the thermometer in the figure below.



θ_R = ...[1]

(b) The beaker contains 200 cm^3 of hot water. A student takes temperature readings as the water cools, as shown in the table.

t /	*θ* /
0	79
30	65
60	58
90	55
120	53
150	52
180	51

(i) Complete the column headings in the table.

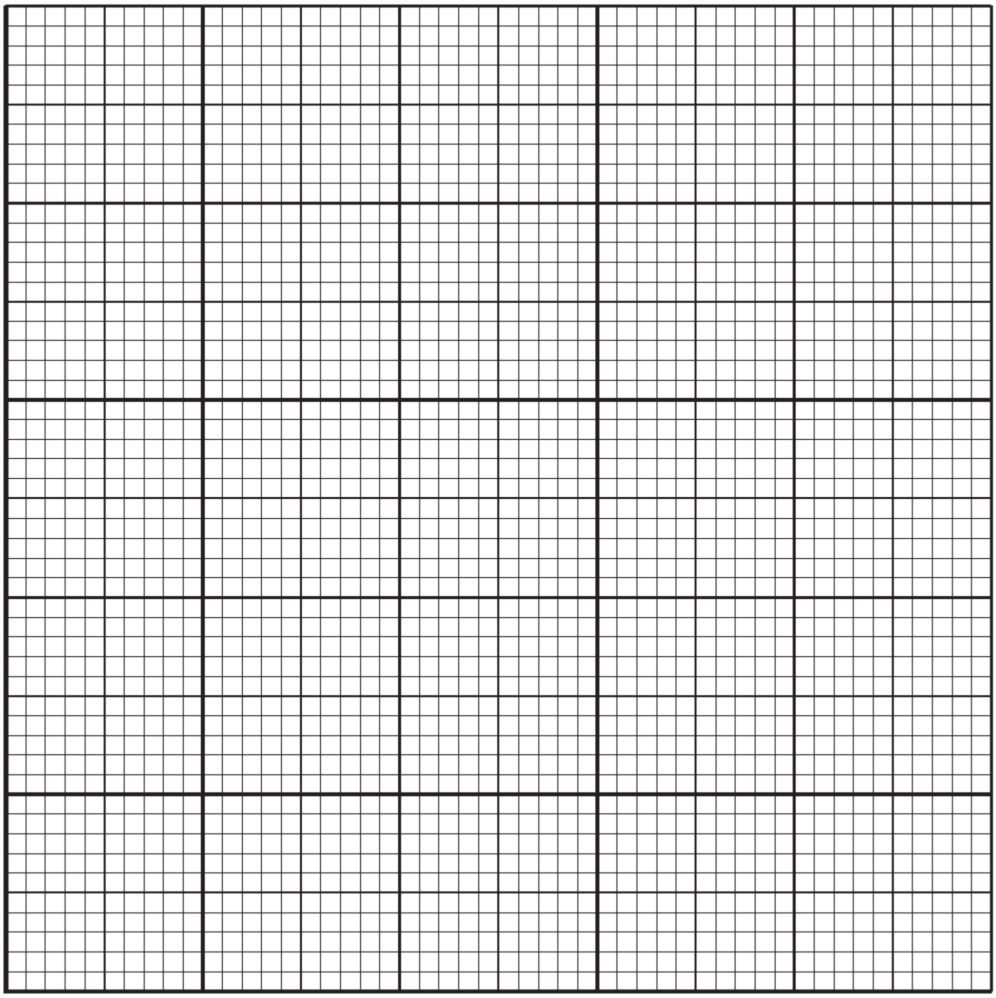
(ii) Calculate the temperature fall T_1 during the first 30 s of cooling.

T_1 = ...

(iii) Calculate the temperature fall T_2 during the final 30 s of cooling.

T_2 = ...[3]

(c) Plot the graph of temperature (*y*-axis) against time (*x*-axis).



(d) **(i)** State how the rate of cooling in the first 30 s differs from that in the final 30 s.

....

....

(ii) Explain how the graph line shows this difference.

....

....[2]

[Total: 11]

0625/63 OCTOBER/NOVEMBER 2018

Plan an experiment to compare the rates at which different metals conduct thermal energy. You are **not** required to carry out the experiment.
The apparatus available includes:

strips of different metals, shaped as shown in the figure.

a test-tube in a clamp stand
a beaker
a supply of cold water

a supply of hot water.

The shorter section of each strip of metal can fit inside a test-tube.

Write a plan for the experiment.
You should:

- list any additional apparatus needed
- draw a labelled diagram of how the apparatus will be arranged
- explain briefly how you will carry out the experiment
- explain how the metals will be compared
- state the precautions which should be taken to obtain reliable results.

....

....

....

....

....

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....

....

....

....

....

.... [7]

In this experiment, you will investigate reflection using a plane mirror.

Carry out the following instructions, using the separate ray-trace sheet provided. You may refer to Fig. 10.1 for guidance.

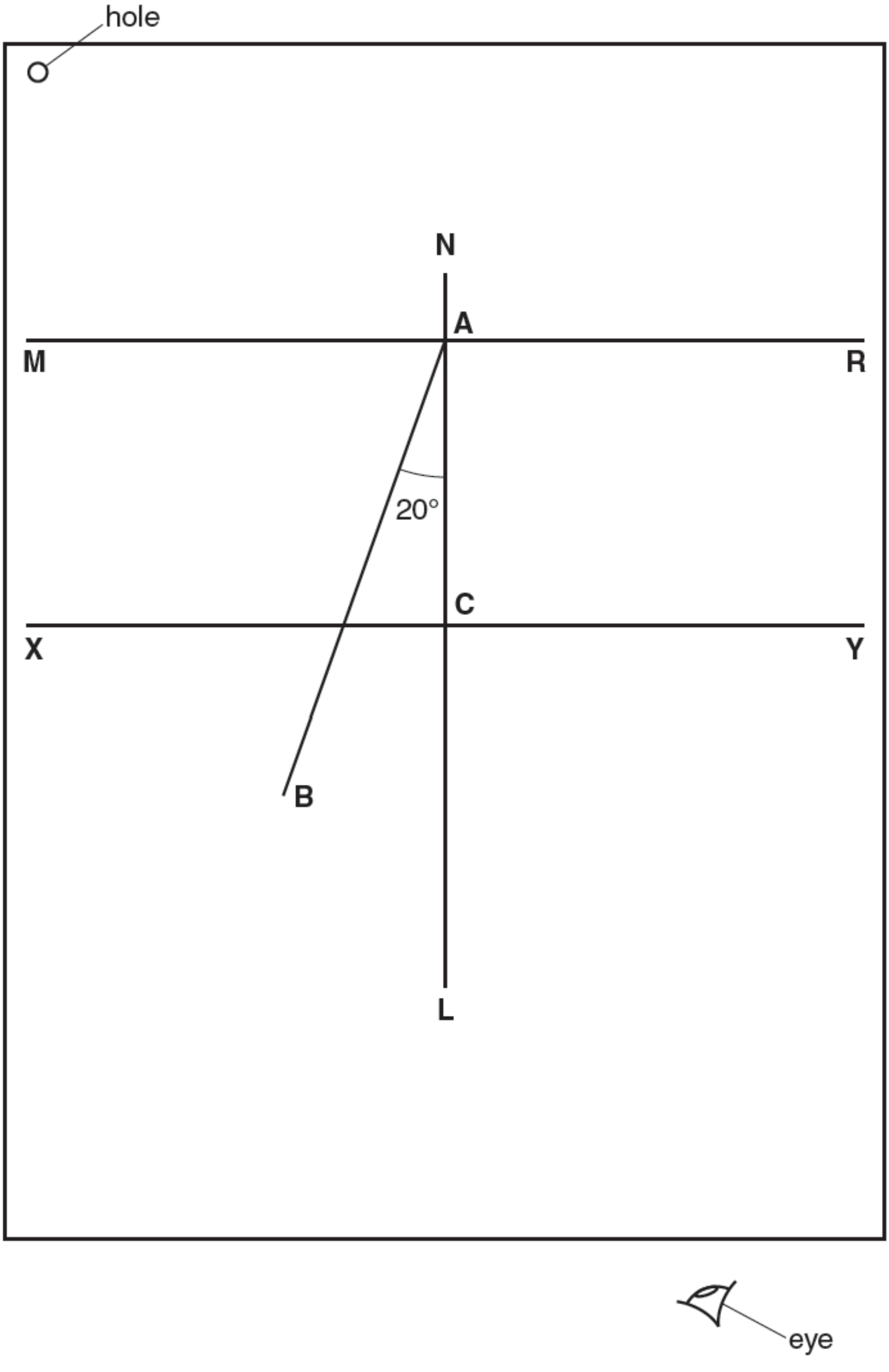


Fig. 10.1

(a) • Draw a line 18.0 cm long near the top of your ray-trace sheet. Label the line **MR**.

• Draw a normal to this line that passes through its centre. Label the normal **NL**. Label the point at which **NL** crosses **MR** with the letter **A**.

• Draw a line 8.0 cm long from **A** at an angle of incidence i = 20° to the normal, below **MR** and to the left of the normal. Label the end of this line **B**.

• Draw a line 18.0 cm long, 5.0 cm below **MR** and parallel to **MR**. Label the line **XY**. Label the point at which **NL** crosses **XY** with the letter **C**. [2]

(b) • Place the reflecting face of the mirror vertically along the line **MR**. The mirror should be approximately centred on point **A**.

• Place a pin P_1 at point **B**, 8.0 cm from the point **A**.

• Place a pin P_2 on line **AB** a suitable distance from pin P_1.

• View the images of pins P_1 and P_2 from the direction indicated by the eye in Fig. 10.1.

Place two pins P3 and P4, a suitable distance apart, so that pins P_3 and P_4, and the images of P_2 and P1, all appear exactly one behind the other. Label the positions of P_3 and P_4. [1]

(c) • Remove the pins and the mirror. Draw the line joining the positions of P_3 and P_4. Label the point at which this line crosses **XY** with the letter **D**.

• Measure, and record in Table 10.1, the distance d between **C** and **D**, for i = 20°.

• When i = 0°, d = 0.0 cm. These values are already entered in Table 10.1.

• Repeat the procedure to determine the distance d for lines with i values of 30°, 40°, 50° and 60°. Record all your results in Table 10.1. [3]

Table 10.1

i/°	d/cm
0	0.0
20	
30	
40	
50	
60	

(d) Plot a graph of d/cm (y-axis) against i/° (x-axis).

[4]

(e) Suggest one practical difficulty in obtaining accurate readings in this experiment.

....

....[1]

Tie your ray-trace sheet into this Booklet.

[Total: 11]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/61MAY/JUNE 2011

4 The IGCSE class is investigating reflection of light using a plane mirror.

A student has set up a ray trace sheet and this is shown in Fig. 4.1. The line **MR** shows the position of a plane mirror.

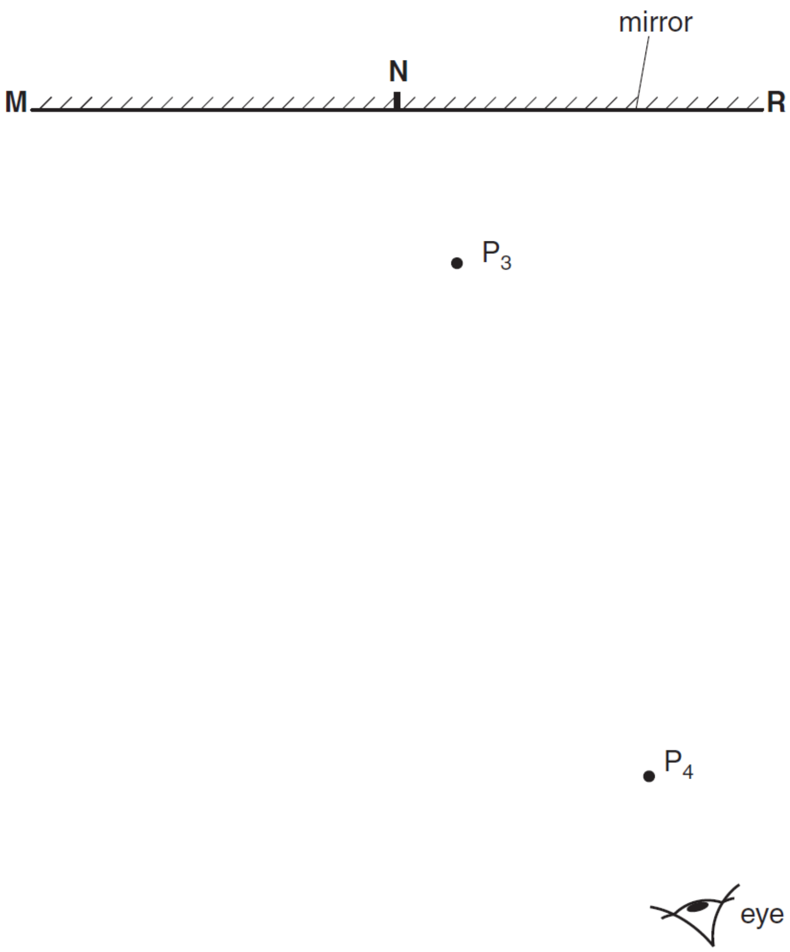


Fig. 4.1

(a) **(i)** Draw a normal to line **MR** at **N**.

(ii) Draw a line 10 cm long that is parallel to line **MR** and 12 cm below it. The ends of this line must be at the same distance from the edges of the page as the ends of line **MR**. Label this line **CD** with **C** directly below **M**. [3]

(b) The student places a pin P_1 so that it stands vertically at **C**. He places another pin P_2 as close as possible to the point **N**.

(i) Draw a line from **C** to **N**.

(ii) Measure and record the angle of incidence *i* between the line **CN** and the normal.

i = ...[2]

(c) The student views the image in the mirror of the pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_3 and P_4 some distance apart so that pins P_4, P_3, P_2 and the image of P_1 all appear exactly one behind the other. The positions of P_3 and P_4 are shown on Fig. 4.1.

(i) Draw in the line joining the positions of P_3 and P_4. Continue the line until it meets the normal.

(ii) Measure and record the angle of reflection *r* between the normal and line P_3P_4.

r = ...[2]

(d) Several students found that, in spite of carrying out this experiment with reasonable care, the measured value of the angle of reflection *r* was not exactly the same as the value obtained from theory.

Suggest two possible causes of this inaccuracy.

1. ....

....

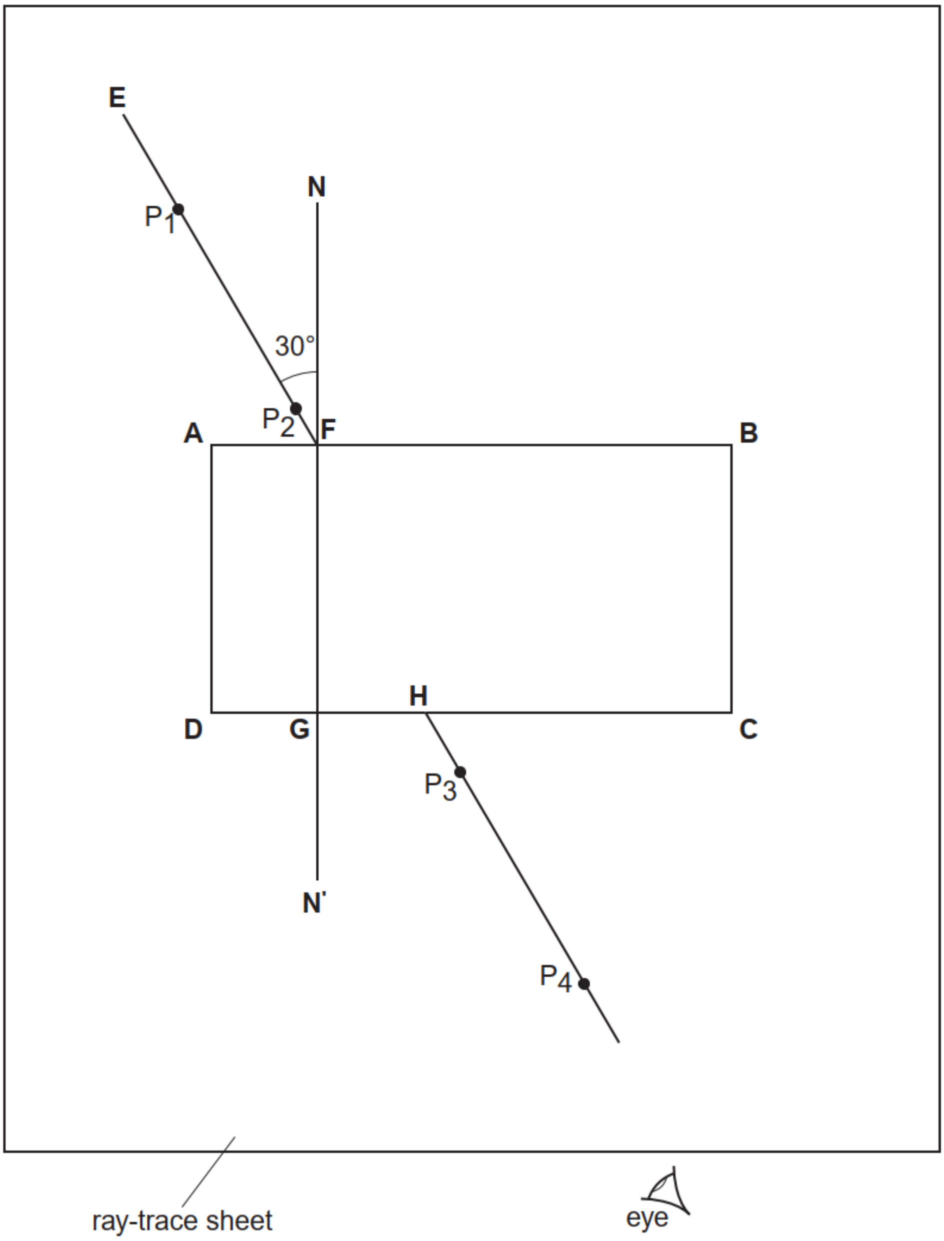
2. ....

....[2]

[Total: 9]

In this experiment you are to determine a quantity called the refractive index of the material of a transparent block.

Carry out the following instructions referring to the figure below.



(a) Place the transparent block, largest face down, on the ray-trace sheet supplied. The block should be approximately in the middle of the paper. Draw the outline of the block **ABCD**.

(b) Remove the block and draw the normal **NN'** to side **AB** so that the normal is 2.0 cm from **A**. Label the point **G** where **NN'** crosses **DC**. Label the point **F** where **NN'** crosses **AB**.

(c) Draw the line **EF**

(d) Place the paper on the pin board.

(e) Place two pins P_1 and P_2 on line **EF**

(f) Replace the block and observe the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other.
Place two pins P_3 and P_4 between your eye and the block so that P_3 and P_4 and the images of P_1 and P_2, seen through the block, appear one behind the other.
Mark the positions of P_1, P_2, P_3 and P_4. Remove the block.

(g) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **H**.

(h) Measure and record the length *a* of the line **GH**.

a = ...[1]

(i) Draw the line **HF**.

(j) Measure and record the length *b* of the line HF.

b = ...[1]

(k) Extend the straight line **EF** through the outline of the block to a point **J**. The point **J** must be at least 5 cm from the block. The line **EJ** crosses the line **CD**. Label this point **K**.

(l) **(i)** Measure and record the length *c* of the line **GK**.

c = ...

(ii) Measure and record the length *d* of the line **FK**.

d = ...[1]

(m) Calculate the refractive index *n* of the material of the block using the equation

$$n = \frac{cb}{ad}$$

n = ...[2]

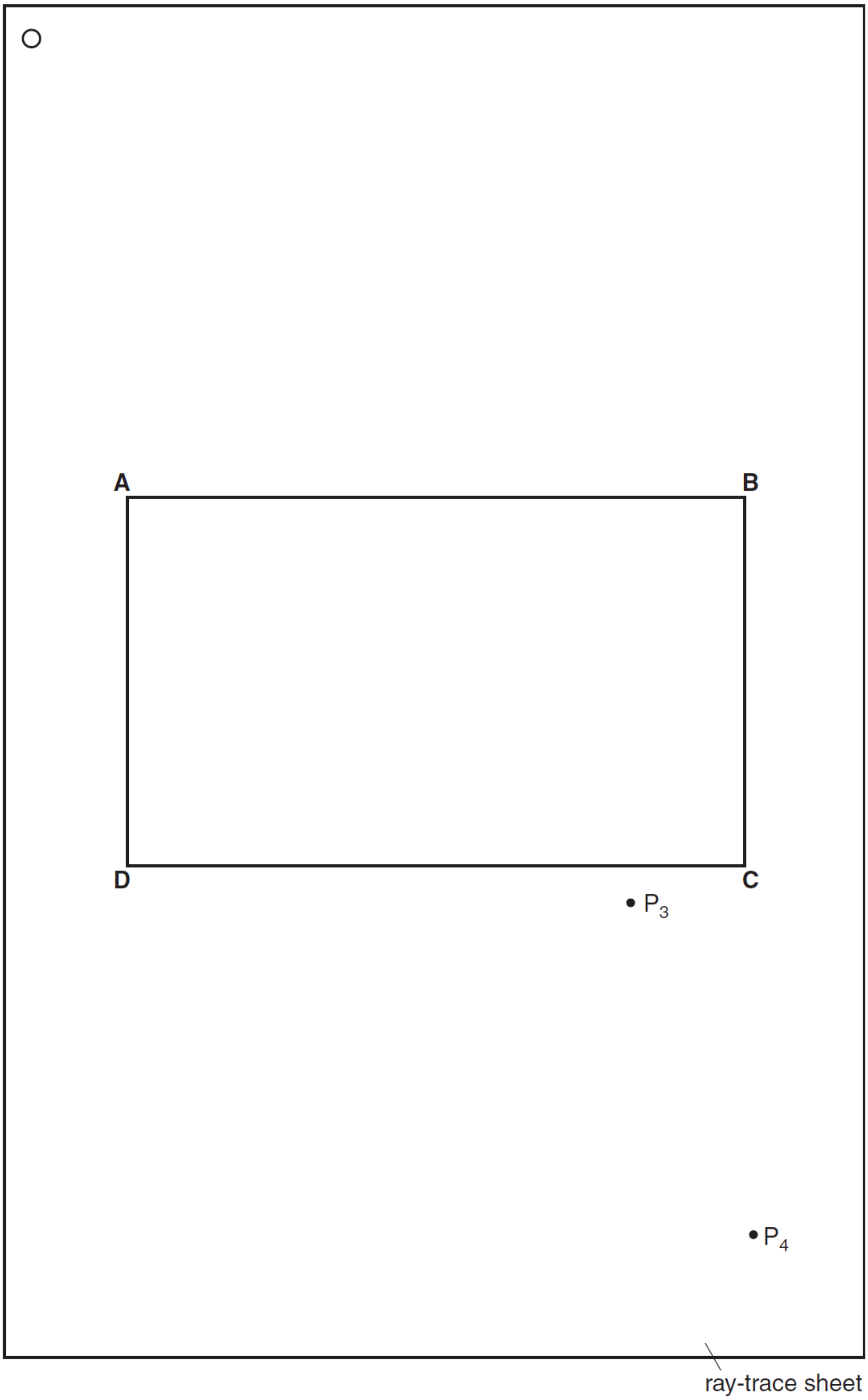
Tie your ray-trace sheet opposite this page. [5]

[Total: 10]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/63MAY/JUNE 2012

5 The IGCSE class is determining the refractive index of the material of a transparent block.

Fig. 5.1 shows a student's ray-trace sheet.



(a) **ABCD** is a transparent block placed, largest face down, on the ray-trace sheet.

(i) On Fig. 5.1, draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**. Mark a point **N** on the normal 4.0 cm from **E** and outside the outline of the block. [1]

(ii) Draw a line **NF** from **N** to the block. This line must be to the right of the normal and at an angle of 20° to the normal. Mark the point **F** where the line meets **AB**. Measure and record the length *a* of the line **NF**.

a = ... [2]

(b) The student places two pins P_1 and P_2 on the line through **F** and **N**. She observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other.

She places two pins P_3 and P_4 between her eye and the block so that P_3 and P_4 and the images of P_1 and P_2, seen through the block, appear one behind the other. The positions of P_3 and P_4 are marked on Fig. 5.1.

(i) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **G**.

(ii) Draw the line **GF** and continue it until it meets the normal. Label this point **H**.

(iii) Measure and record the length *b* of the line **FH**.

b = ...

[3]

(iv) Calculate the refractive index *n* of the material of the block, using the equation $n = \frac{b}{a}$.

n = ...[2]

(c) Suggest one precaution that you would take in this experiment to obtain readings that are as accurate as possible.

....

....[1]

[Total: 9]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/63 MAY/JUNE 2011

4 The IGCSE class is investigating the refraction of light through a transparent block.

Fig. 4.1 shows a student's ray trace sheet. It is not drawn full size.

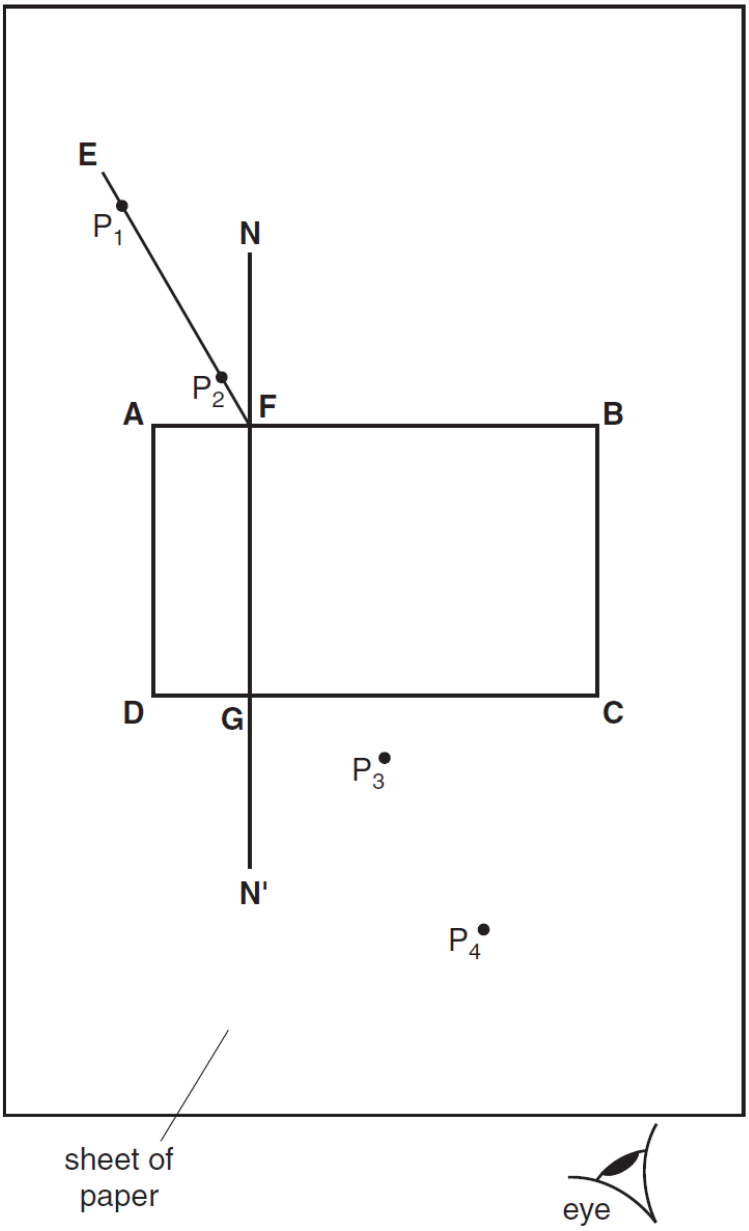


Fig. 4.1

(a) The student places a transparent block, largest face down, on a sheet of plain paper and draws the outline **ABCD** of the block. She removes the block and draws the normal **NN'** to side **AB**. She then draws the line **EF** at an angle of incidence *i*.

On Fig. 4.1, measure the angle of incidence *i*.

i = ...[1]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/63 MAY/JUNE 2011

(b) She places two pins P_1 and P_2 on line **EF**, as shown in Fig. 4.1, and replaces the block. She observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other. She places two pins P_3 and P_4 between her eye and the block so that P_3, P_4 and the images of P_1 and P_2, seen through the block, appear one behind the other.

(i) On Fig. 4.1, draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **H**.

(ii) Measure and record the length *a* of the line **GH**.

a = ...

(iii) Draw the line **HF**.

(iv) Measure and record the length *b* of the line **HF**.

b = ...

(v) Calculate the refractive index *n* of the material of the block using the equation $n = \frac{b}{2a}$.

n = ...

[5]

(c) **(i)** Suggest how far apart you would place the pins P_3 and P_4 if you were carrying out this experiment using a ray trace sheet the same size as this page.

suggested distance = ...

(ii) Give a reason for your answer to **(i)**.

reason ....

[2]

(d) This experiment may be carried out using a ray of light, produced by a ray box, instead of by using optical pins. A student suggests that the ray box method will be more accurate. Assuming that the experiment is carried out with care, suggest one possible cause of inaccuracy using the optical pin method and one using the ray box method.

optical pin method ....

....

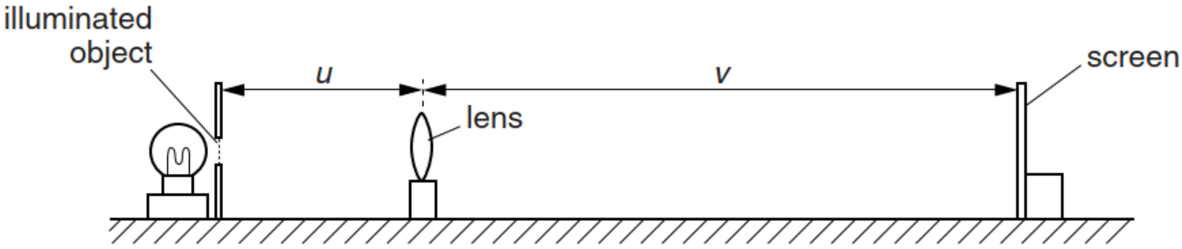
ray box method ....

....[2]

[Total: 10]

In this experiment, you will determine the focal length of a converging lens.

Carry out the following instructions, referring to the figure below.



(a) **(i)** Set the object distance u to 0.200 m.

(ii) Place the screen near the lens. Move the screen until a sharp image of the object is seen on the screen.

(iii) Carefully measure, and record in the table, the image distance v in metres.

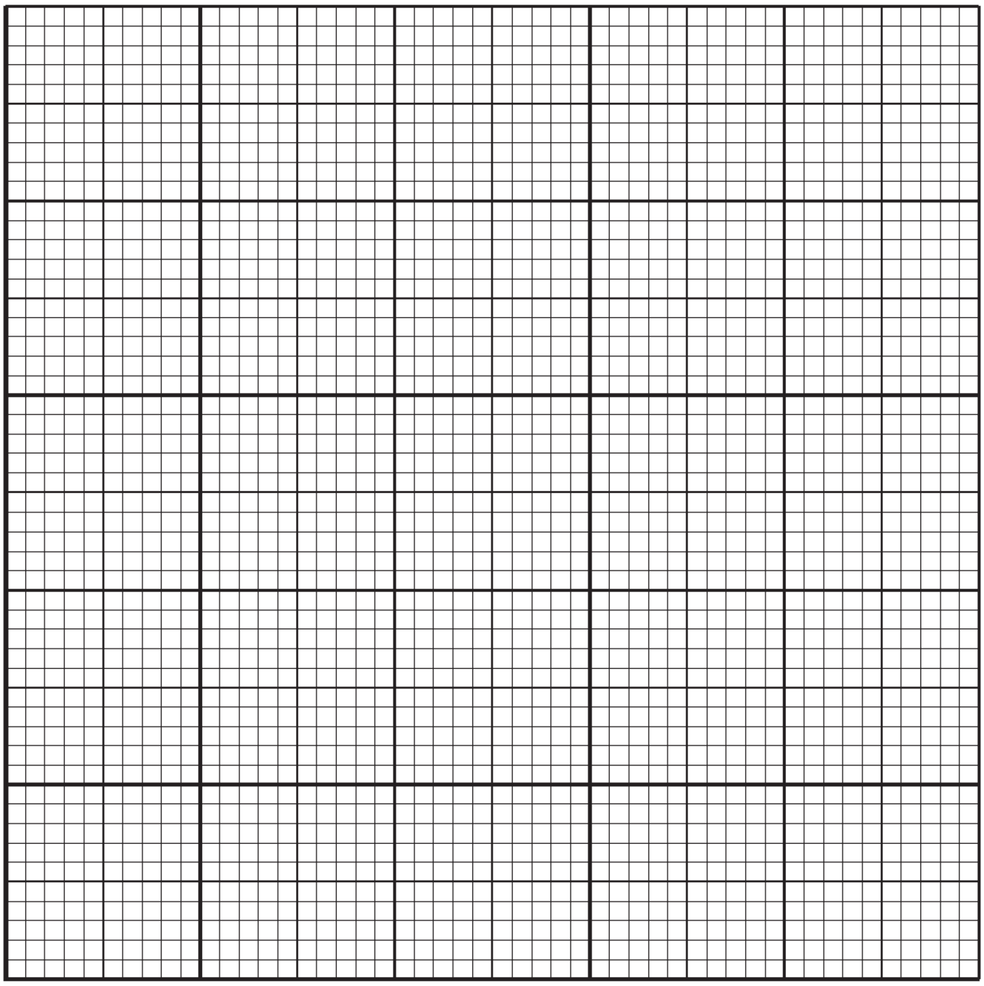
(iv) Repeat steps **(ii)** and **(iii)** for object distances u of 0.250 m, 0.350 m, 0.450 m and 0.600 m.

(b) Calculate the values of $\frac{1}{v}$ and record them in the table.

u / m	$\frac{1}{u} \Big/ \frac{1}{\text{m}}$	v / m	$\frac{1}{v} \Big/ \frac{1}{\text{m}}$
0.200	5.00		
0.250	4.00		
0.350	2.86		
0.450	2.22		
0.600	1.67		

[3]

(c) Plot a graph of $\frac{1}{v}\Big/\frac{1}{\text{m}}$ (y-axis) against $\frac{1}{u}\Big/\frac{1}{\text{m}}$ (x-axis). Begin both axes at the origin (0,0). The scale must allow the best-fit line, when extended beyond the range of the data, to cross both axes.



[4]

(d) (i) From the graph, determine the value p of $\frac{1}{u}$ when $\frac{1}{v}$ is zero (the x-intercept).

p = ...

(ii) From the graph, determine the value q of $\frac{1}{v}$ when $\frac{1}{u}$ is zero (the y-intercept).

q = ...[1]

(e) (i) Calculate z, where z is the average of p and q.

z = ...

(ii) Calculate the focal length f of the lens where $f = \frac{1}{z}$.

f = ...

[2]

[Total: 10]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/61 MAY/JUNE 2012

4 The IGCSE class is determining the focal length of a lens.

The apparatus is shown in Fig. 4.1.

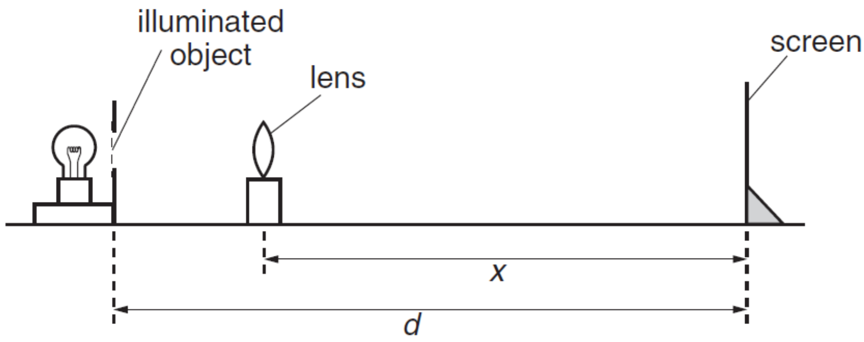


Fig. 4.1

(a) A student places the lens between the object and the screen and close to the object. She moves the lens towards the screen until a clearly focused, **enlarged** image is formed on the screen.

(i) On Fig. 4.1, measure and record the distance *d* between the object and the screen.

d = ...

(ii) On Fig. 4.1, measure and record the distance *x* between the centre of the lens and the screen.

x = ...

[2]

(iii) Fig. 4.1 is drawn one tenth actual size.

1. Calculate the actual distance *D* between the object and the screen.

D = ...

2. Calculate the actual distance *X* between the centre of the lens and the screen.

X = ...

[1]

(b) Without moving the illuminated object or the screen, the student moves the lens towards the screen until a clearly focused, **diminished** image is formed on the screen. She measures the distance *Y* between the centre of the lens and the screen: *Y* = 19.0 cm.

Calculate the focal length *f* of the lens using the equation $f = \frac{XY}{D}$.

(c) The student turns the lens through an angle of 180° and repeats the procedure obtaining a value for the focal length $f = 14.7\,\text{cm}$.

Theory suggests that the two values of the focal length f should be the same. State whether the results support this theory and justify your answer by reference to the results.

statement ....

justification ....

.... [2]

(d) Briefly describe a precaution that you would take in this experiment in order to obtain a reliable result.

....

....

.... [1]

[Total: 8]

ALTERNATIVE TO PRACTICAL QUESTIONS - 0625/62 MAY/JUNE 2014

4 An IGCSE student is determining the focal length of a lens.

Fig. 4.1 shows the apparatus.

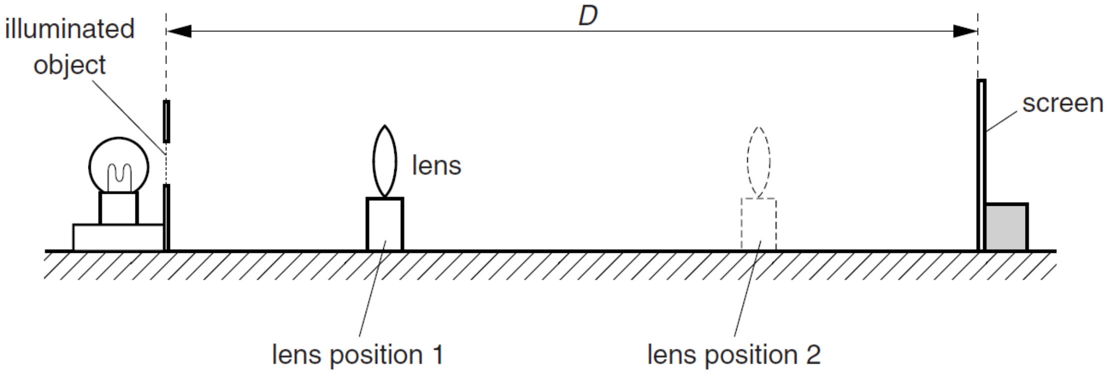


Fig. 4.1

(a) The student places the screen at a distance D = 80.0 cm from the illuminated object. He places the lens close to the illuminated object. He moves the lens until a sharply-focused image of the object is seen on the screen (lens position 1).

He measures the distance x from the illuminated object to the centre of the lens.

x = 19.5 cm

He does not move the object or the screen, but moves the lens towards the screen until another sharply-focused image of the object is seen on the screen (lens position 2). He measures the distance y from the illuminated object to the centre of the lens.

y = 60.4 cm

(i) On Fig. 4.1, carefully mark and label the distances x and y. [1]

(ii) Calculate d using the equation $d = (y - x)$.

d = ...

(iii) Calculate d^2.

d^2 = ...

(iv) Calculate the focal length f of the lens, using the equation $f = \dfrac{D^2 - d^2}{4D}$.

f = ...
[2]

(b) State two precautions that you would take in this experiment to obtain reliable results.

1. ....

....

2. ....

....
[2]

(c) In the experiment, the student produces two images on the screen. They are both sharply focused.

(i) Suggest two differences between the two images.

1. ....

2. ....

(ii) Suggest one similarity between the two images.

....

....
[3]

(d) Suggest a variable that could be changed when repeating this experiment to check the accuracy of the value obtained for the focal length f.

....[1]

[Total: 9]

PLANNING 4

A student has a box of converging lenses but does not know their focal lengths.

Plan an experiment which will enable her to determine an accurate value for the focal length f of one of the lenses, using the equation

$$f = \frac{uv}{(u + v)}$$

where u is the distance between an object and the lens and v is the distance between the lens and the focused image of the object.

The apparatus available includes:

a lens holder
a 12 V lamp in a holder, with a power supply
a card with a triangular hole covered with tracing paper.

Write a plan for the experiment.

You should:

- list any additional apparatus needed
- draw a diagram of how the apparatus will be arranged, clearly labelling u and v
- write a method for carrying out the experiment including how f will be determined
- state the precautions which should be taken to obtain a clear, focused image
- state the precautions which should be taken to ensure that measurements are accurate once a focused image has been obtained.

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[Total: 7]