1.1 Length and time

1. 0625_s20_qp_62 Q: 1

A student investigates the period of a pendulum. Fig. 1.1 and Fig. 1.2 show the apparatus she uses.

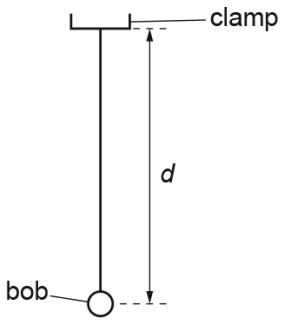


Fig. 1.1

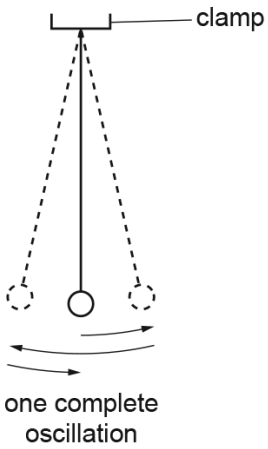


Fig. 1.2

(a) Explain briefly, with the help of a diagram, how you would use a metre rule and set square to measure the length *d* of a pendulum as accurately as possible.

Diagram:

.....

.....

..... [3]

(b) The student adjusts the pendulum so that *d* = 50.0 cm. She displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.
She measures the time t_1 for 20 complete oscillations.

(i) Record the time t_1 shown in Fig. 1.3.

Fig. 1.3

t_1 = ... [1]

(ii) Calculate the period T_1 of the pendulum. The period is the time for one complete oscillation.

T_1 = ... [1]

(c) The student adjusts the pendulum until the distance d is 100.0 cm.

She repeats the procedure and records the time t_2 for 20 oscillations and the period T_2.

t_2 = 39.80 s

T_2 = 1.99 s

She measures the mass m_A of the pendulum bob. The reading on the balance is shown in Fig. 1.4.

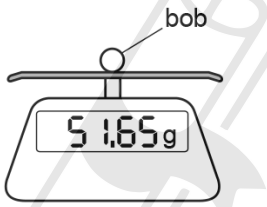


Fig. 1.4

Record mass m_A of the pendulum bob to the nearest gram.

m_A = ... g [1]

The student repeats the procedure using a pendulum bob of mass m_B.

m_B = 109 g

She obtains these results:

distance d = 50.0 cm

period T_3 = 1.39 s

distance d = 100.0 cm

period T_4 = 2.02 s

(d) **(i)** Using the results T_1, T_2, T_3 and T_4, for the period of each of the pendulums, tick (✓) the response that matches your results within the limits of experimental accuracy.

- ☐ the period T is affected by d only
- ☐ the period T is affected by both d and m
- ☐ the period T is affected by m only
- ☐ the period T is not affected by d or m

[1]

(ii) Justify your answer to **(d)(i)** by reference to the results.

.....

..... [1]

(e) The student now investigates the effect of the size of the oscillations on the period of the pendulum.

(i) Suggest briefly how you would measure the size of an oscillation. You may draw a diagram.

.....

..... [2]

(ii) State **one** variable that you would keep constant during this part of the investigation.

..... [1]

[Total: 11]

2. 0625_w19_qp_62 Q: 1

A student investigates a pendulum. Fig. 1.1 and Fig. 1.2 show some of the apparatus used.

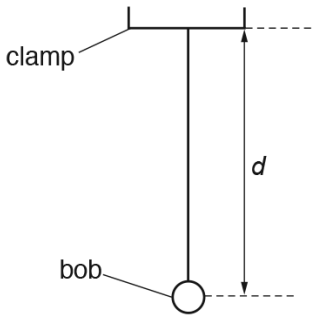


Fig. 1.1

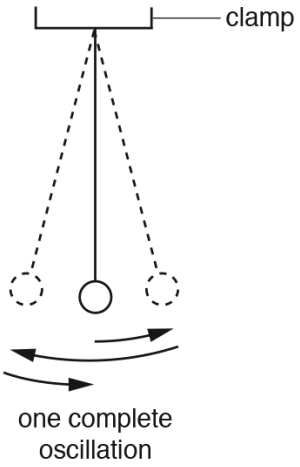


Fig. 1.2

(a) The student adjusts the length of the pendulum until the distance *d*, measured to the centre of the bob, is 50.0 cm. State one precaution that you would take to obtain the length of 50.0 cm as accurately as possible.

.....

..... [1]

(b) The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

(i) He measures the time *t* for 20 complete oscillations. The time *t* is shown on the stopwatch in Fig. 1.3.

Fig. 1.3

In the first row of Table 1.1, record the time *t* shown in Fig. 1.3. [1]

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

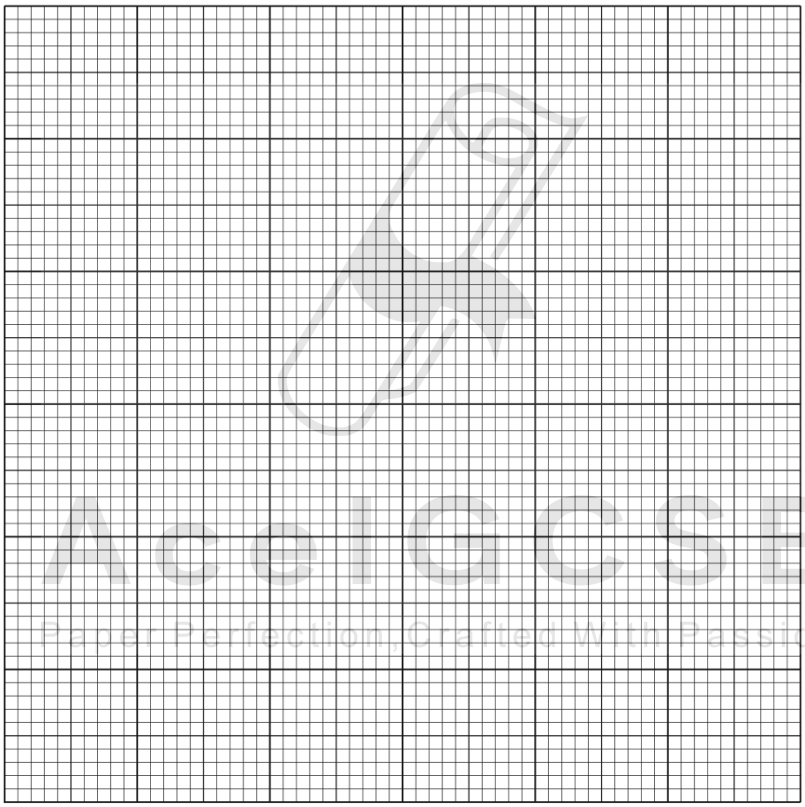
(iii) Calculate T^2. Record its value in Table 1.1. [1]

(c) The student repeats the procedure in **(b)** using d = 60.0 cm, 70.0 cm, 80.0 cm and 100.0 cm. The readings are shown in Table 1.1.

Table 1.1

d/cm	t/s	T/s	T^2/s^2
50.0			
60.0	30.00	1.50	2.25
70.0	33.20	1.66	2.76
80.0	35.80	1.79	3.20
100.0	39.80	1.99	3.96

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



[4]

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

G = ... [2]

(e) Calculate the acceleration of free fall g in m/s^2 using the equation $g = \frac{0.395}{G}$, where G is your gradient from **(d)**.

Write down the value of g to a suitable number of significant figures for this experiment.

g = ...m/s^2 [2]

[Total: 12]

3. 0625_s17_qp_61 Q: 4

The class is investigating the motion of a pendulum.

Fig. 4.1 shows the apparatus.

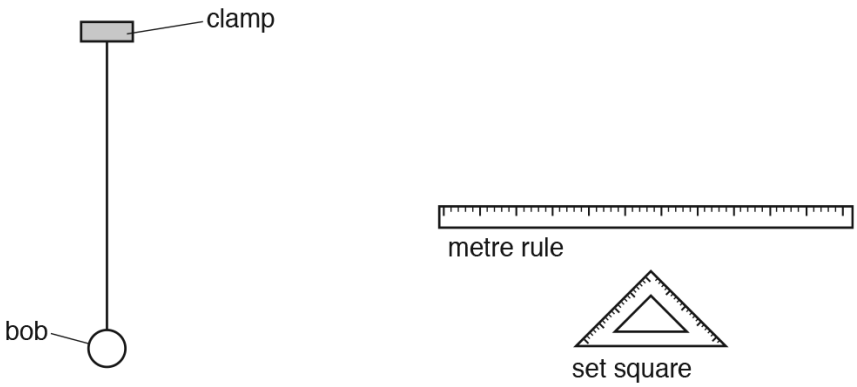


Fig. 4.1

(a) (i) On Fig. 4.1, show clearly the length l of the pendulum. [1]

(ii) Use Fig. 4.2 to explain how you would measure the length l accurately. You may draw on the diagram.

Fig. 4.2

.....

.....

.....

.....

.....[2]

(b) A student determines the period T of the pendulum. The period is the time taken for one complete oscillation. The student measures the time t for 20 oscillations.

Fig. 4.3 shows the time t.

Fig. 4.3

(i) Calculate the period T of the pendulum.

T = ...[1]

(ii) Explain how measuring the time for 20 oscillations rather than one oscillation helps the student to obtain a more reliable value for the period.

.....

.....

.....[2]

(c) The student wants to determine a value for the acceleration of free fall from his results. He needs the value of T^2 to do this.

Calculate T^2.

Give your answer to a suitable number of significant figures and include the unit.

T^2 = ... [2]

[Total: 8]

4. 0625_w17_qp_61 Q: 3

A student is investigating whether the diameter of a pendulum bob affects the period of a pendulum. The period is the time taken for one complete oscillation of the pendulum. Fig. 3.1 shows a pendulum.

Fig. 3.2 shows one complete oscillation.

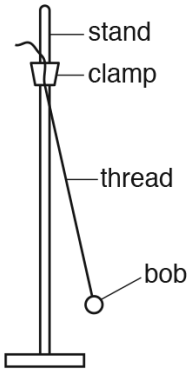


Fig. 3.1

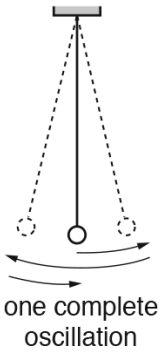


Fig. 3.2

The student has the following apparatus:

pendulum bobs made of polystyrene with diameters 1 cm, 2 cm, 3 cm, 4 cm and 5 cm
a supply of thread and a pair of scissors
clamp and stand.

Plan an experiment to investigate whether the diameter of a pendulum bob affects the period of a pendulum.

You should:

- list additional apparatus that you would require
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table 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.

.....

.....

.....

.....

.....

.....

.....

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.....

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.....

.....

.....

.....

.....[7]

[Total: 7]

5. 0625_w17_qp_62 Q: 1

A student is comparing the oscillations of two pendulums. Fig. 1.1 shows the first pendulum.

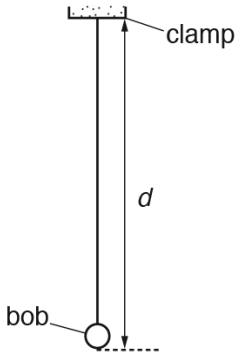


Fig. 1.1

(a) (i) On Fig. 1.1, measure the distance *d*, from the bottom of the clamp to the bottom of the bob.

d = ... cm [1]

(ii) Fig. 1.1 is drawn 1/10th actual size. Calculate the actual distance *D* from the bottom of the clamp to the bottom of the bob.

D = ... cm [1]

(iii) Explain briefly how to use a set-square to avoid a parallax (line-of-sight) error when measuring the length of this pendulum. You may draw a diagram.

.....

.....[1]

(b) The student displaces the bob slightly and releases it so that it swings. She measures the time t for 20 complete oscillations. The time t is shown on the stopwatch in Fig. 1.2.

Fig. 1.2

(i) Write down the time t shown in Fig. 1.2.

t = ...[1]

(ii) Calculate the period T_1 of the pendulum. The period is the time for one complete oscillation.

T_1 = ...[2]

(c) The student repeats the procedure using another pendulum as shown in Fig. 1.3. This has a long, thin pendulum bob. The distance *D* from the bottom of the clamp to the bottom of the pendulum bob is the same as for the first pendulum.

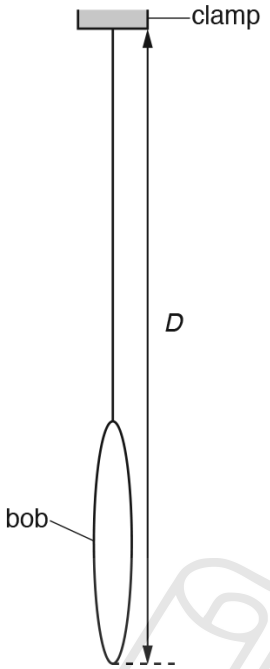


Fig. 1.3

She determines the period T_2 of this pendulum.

T_2 = 1.37 s

In this experiment, both pendulum bobs have the same mass. A student suggests that since both pendulums have the same overall length *D* and mass, the periods T_1 and T_2 should be equal. State whether the results support this suggestion. Justify your answer by reference to the results.

statement .....

justification .....

.....

.....[2]

(d) The period T of a pendulum can be determined by measuring the time t for 20 complete oscillations and then calculating the period. Some students are asked to explain the reason for this method being more accurate than measuring the time taken for a single oscillation.

Tick the box next to the sentence that gives the best explanation.

- ☐ The method eliminates errors from the measurements.
- ☐ The method is more accurate because the experiment is repeated.
- ☐ The method includes more readings so there is less chance for errors.
- ☐ The method reduces the effect of errors when starting and stopping the stopwatch.

[1]

(e) A student plans to carry out more pendulum experiments. He considers possible variables and precautions to improve accuracy.

In the following list, mark the possible variables with the letter **V** and the precautions with the letter **P**.

- ☐ amplitude of swing
- ☐ length of pendulum
- ☐ mass of pendulum bob
- ☐ shape of pendulum bob
- ☐ use of a reference point to aid counting
- ☐ viewing the rule at right-angles when measuring the length

[2]

[Total: 11]

6. 0625_w16_qp_62 Q: 3

(a) A student hangs a mass on a spring and observes it as it oscillates up and down.

The student wants to find the factors that affect the time taken for one complete oscillation. She finds that increasing the mass increases the time.

Suggest two other variables that the student could investigate.

1. .....

2. .....
[2]

(b) Another student is investigating the oscillations of the pendulum shown in Fig. 3.1.

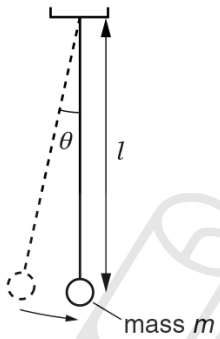


Fig. 3.1

The variables are

- the length l of the pendulum
- the mass m of the pendulum bob
- the amplitude θ of the swing.

The time taken for one complete oscillation is called the period T.

She carries out three experiments. Each experiment investigates the effect on the period T of changing one variable.

Her results are shown in Tables 3.1, 3.2 and 3.3.

Table 3.1

l/m	T/s
0.200	0.89
0.400	1.25
0.600	1.54
0.800	1.78
1.000	1.99

Table 3.2

m/g	T/s
50	1.40
60	1.42
70	1.39
80	1.41
90	1.38

Table 3.3

θ/°	T/s
4	2.00
6	1.98
8	2.06
10	2.02
12	1.97

(i) Study the results tables and use words from this list to complete the sentences.

increases

decreases

has no effect on

is proportional to

- An increase in length l ..... the period T.
- An increase in mass m ..... the period T.
- An increase in amplitude θ ..... the period T.

[3]

(ii) Suggest a precaution you would take in this pendulum experiment to obtain T values that are as reliable as possible.

.....

.....

.....[1]

[Total: 6]

7. 0625_s15_qp_61 Q: 5

The class is investigating the oscillations of a pendulum.

Figs. 5.1 and 5.2 show the apparatus.

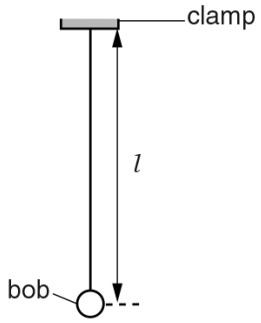


Fig. 5.1

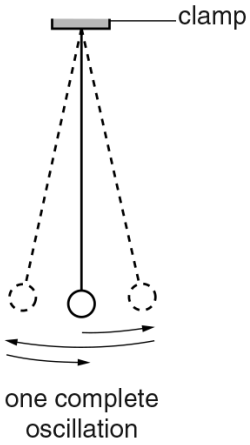


Fig. 5.2

A student measures the length l of the pendulum and takes readings of the time t for 20 complete oscillations. She calculates the period T of the pendulum. T is the time taken for one complete oscillation. She repeats the procedure for a range of lengths.

She plots a graph of T^2/s^2 against l/m. Fig. 5.3 shows the graph.

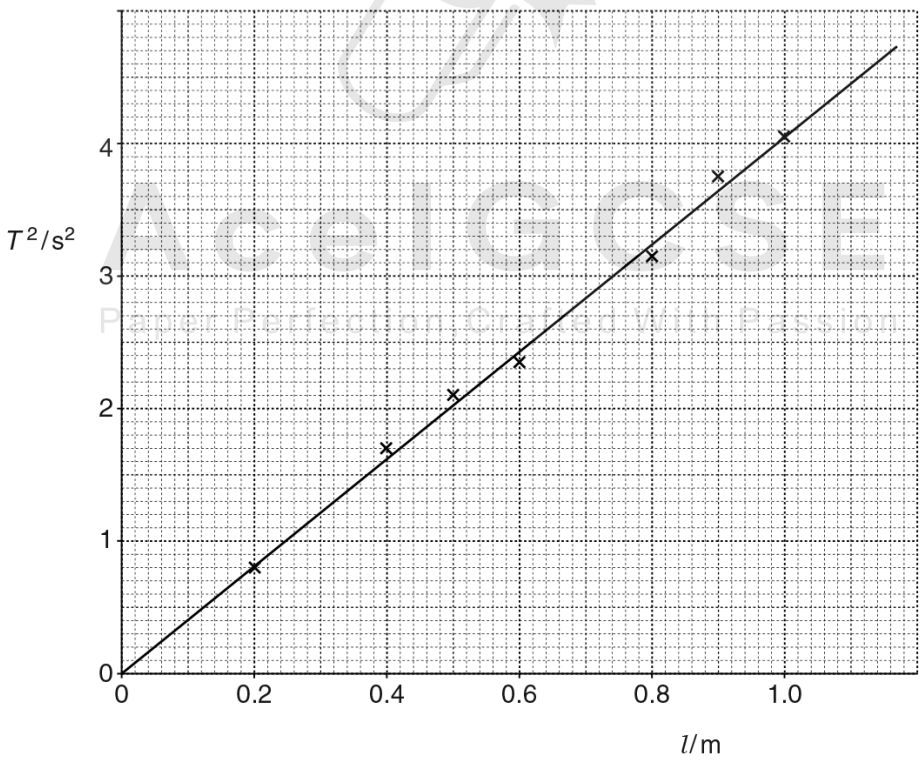


Fig. 5.3

(a) Using the graph, determine the length l of a pendulum that has a period T = 2.0 s. Show clearly on the graph how you obtained the necessary information.

l = ...[3]

(b) Explain why measuring the time for 20 swings, rather than for 1 swing, gives a more accurate value for T.

.....

.....[1]

(c) Another student investigates the effect that changing the mass m of the pendulum bob has on the period T of the pendulum.

(i) Suggest how many different masses the student should use for this laboratory experiment.

number of different masses = ...

(ii) Suggest a range of suitable values for the masses.

suitable range of masses = ...
[2]

[Total: 6]

8. 0625_s15_qp_62 Q: 1

The class is investigating a pendulum.

Figs. 1.1 and 1.2 show the pendulum.

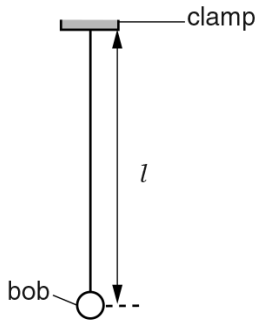


Fig. 1.1

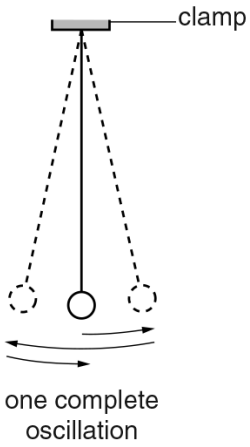


Fig. 1.2

(a) A student adjusts the pendulum until its length $l = 50.0\,\text{cm}$.

State one precaution that you would take to measure the length l as accurately as possible. You may draw a diagram.

(b) The student displaces the pendulum bob slightly and releases it so that it swings. She measures the time t for 20 complete oscillations of the pendulum (see Fig. 1.2).

(i) Record the time t, in s, shown on the stopwatch in Fig. 1.3.

Fig. 1.3

t = ... s [1]

(ii) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

T = ...[1]

(iii) Explain why measuring the time for 20 oscillations, rather than 1 oscillation, gives a more accurate value for T.

.....

.....[1]

(c) The student adjusts the length of the pendulum until its length l = 100.0 cm. She repeats the procedure and obtains a value for the period T.

T = ...2.06 s.....

Another student suggests that doubling the length l of the pendulum should double the period T.

State whether the results support this suggestion. Justify your answer by reference to the results.

statement .....

justification .....

.....
[2]

(d) To continue the investigation of the relationship between the length l of the pendulum and the period T, it is necessary to use a range of values of length l.

List additional l values that you would plan to use in the laboratory.

.....[2]

9. 0625_w15_qp_61 Q: 1

The class is investigating two different types of pendulum.

Figs. 1.1 and 1.2 show the apparatus used.

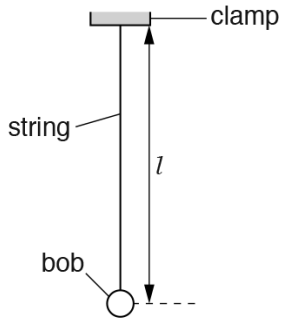


Fig. 1.1

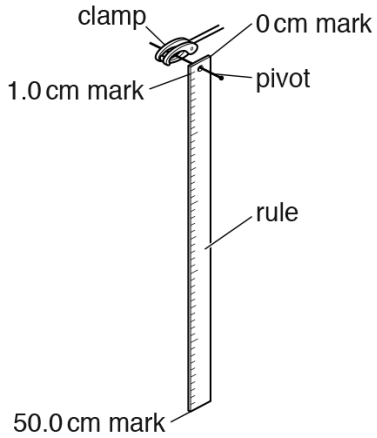


Fig. 1.2

(a) (i) On Fig. 1.1, measure the length l of the pendulum.

l = ...[1]

(ii) Explain briefly how you would measure the length l of a pendulum, of the type shown in Fig. 1.1, as accurately as possible.

.....

.....[1]

(b) A student adjusts the length l of the pendulum shown in Fig. 1.1 to be exactly 50.0 cm. She displaces the pendulum bob slightly and releases it so that it swings. She measures the time t_S for 20 complete oscillations of the pendulum.

(i) Record the time t_S as shown in Fig. 1.3.

Fig. 1.3

t_S = ...[1]

(ii) Calculate the period T_S of the pendulum. The period is the time for one complete oscillation.

T_S = ...[1]

(iii) Explain why measuring the time for 20 oscillations, rather than for 1 oscillation, gives a more accurate value for T_S.

.....

.....

.....[1]

(c) The pendulum shown in Fig. 1.2 is a 50.0 cm rule. The student displaces this pendulum slightly and releases it so that it swings. She measures the time t_C for 20 complete oscillations of the pendulum.

t_C = 23.2 s

(i) State a precaution that you would take to ensure that the measurement of time t_C is reliable.

.....

(ii) Calculate the period T_C of the pendulum. The period is the time for one complete oscillation.

T_C = ...
[1]

(d) A student suggests that T_C should be equal to T_S.

State whether the results support this suggestion. Justify your answer by reference to the results.

statement .....

justification .....

.....

.....
[2]

(e) Assume that the length l of the first pendulum has been measured accurately at 50.0 cm and that the length of the strip that forms the second pendulum is exactly 50.0 cm long.

Suggest why it may not be correct to state that both pendulums have the same length l = 50.0 cm.

.....

.....[1]

[Total: 9]

10. 0625_s14_qp_62 Q: 1

An IGCSE student is taking measurements of a pencil.

Fig. 1.1 shows the pencil, drawn full size.

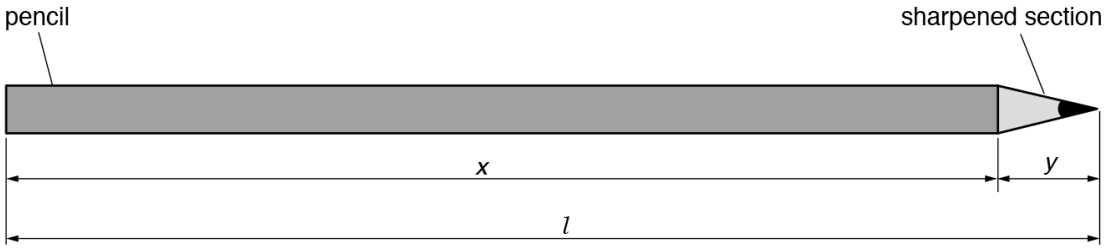


Fig. 1.1

(a) (i) On Fig. 1.1, measure, in cm, the total length l of the pencil.

l = ... cm

(ii) Measure, in cm, the length x of the unsharpened section of the pencil.

x = ... cm

(iii) Calculate the length y of the sharpened section of the pencil, using the equation $y = (l - x)$.

y = ... cm
[2]

(b) Describe how you would use a length of string and a rule to determine the circumference c of the unsharpened section of the pencil.

.....

.....

.....

.....

.....[2]

(c) The student's value for the circumference is $c = 2.4\,\text{cm}$.

(i) Suggest a source of inaccuracy in determining the circumference of the pencil.

.....

.....[1]

(ii) Calculate the volume V of the unsharpened section of the pencil using the equation $V = \frac{c^2 x}{4\pi}$.

V = ... [1]

(iii) Estimate the volume V_E of the sharpened section of the pencil. Show your working or reasoning.

V_E = ... [2]

[Total: 8]

11. 0625_w14_qp_61 Q: 5

An IGCSE student is taking measurements of a drinks cup.

Carry out the following instructions, referring to Fig. 5.1.

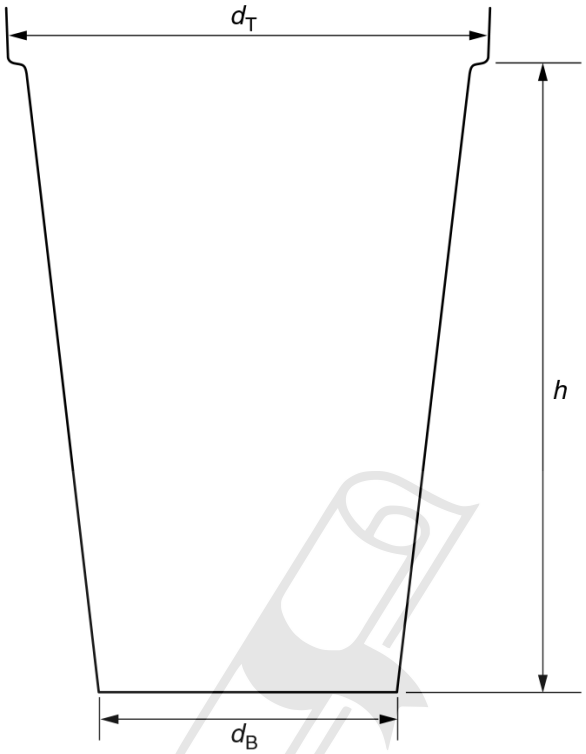


Fig. 5.1

(a) (i) On Fig. 5.1, measure the height h of the cup.

h = ... cm

(ii) On Fig. 5.1, measure the diameter d_T of the top of the cup.

d_T = ... cm

(iii) On Fig. 5.1, measure the diameter d_B of the bottom of the cup.

d_B = ... cm

(iv) Calculate the average diameter d_A, using the equation $d_A = \frac{d_T + d_B}{2}$.

d_A = ... cm

(v) Calculate an approximate value for the volume V of the cup, using the equation $V = \frac{\pi d_A^2 h}{4}$.

V = ...
[3]

(b) The student determines the average circumference of the cup, using a 50 cm length of string and a metre rule.

Fig. 5.2 shows how the student used the string to determine the average circumference.

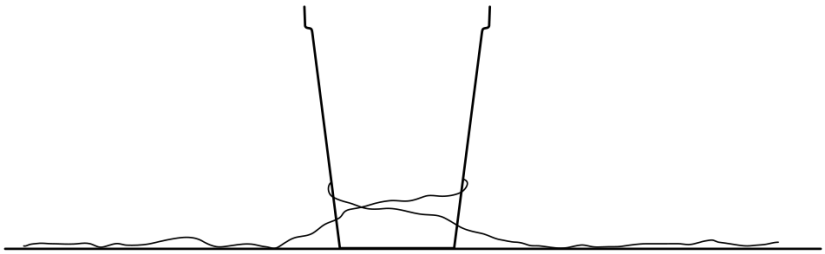


Fig. 5.2

Describe how you would use the string to obtain a more reliable value for the average circumference.

.....

.....

.....[2]

(c) The student fills a measuring cylinder to the 500 cm^3 mark. He pours water from the measuring cylinder into the cup until the cup is full. Fig. 5.3 shows the water remaining in the measuring cylinder.

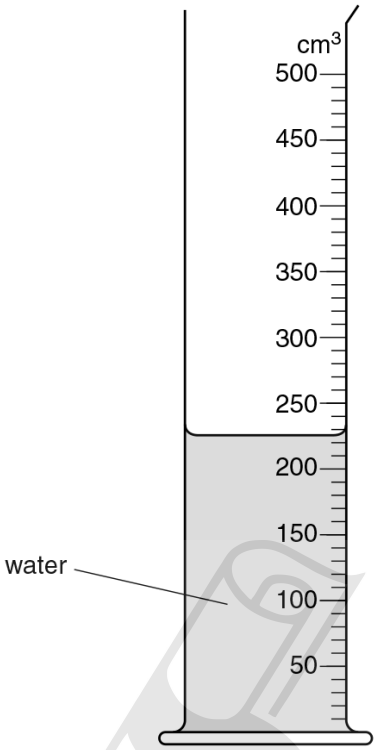


Fig. 5.3

(i) Record the volume of water V_R remaining in the measuring cylinder.

V_R = ...

(ii) Calculate the volume V_W of the water in the cup.

V_W = ... [2]

(d) On Fig. 5.3, show clearly the line of sight required to take the reading of V_R. [1]

[Total: 8]

12. 0625_w14_qp_62 Q: 1

An IGCSE student is taking measurements of a sample of modelling clay. She has moulded the sample of modelling clay into a cube, as shown in Fig. 1.1.

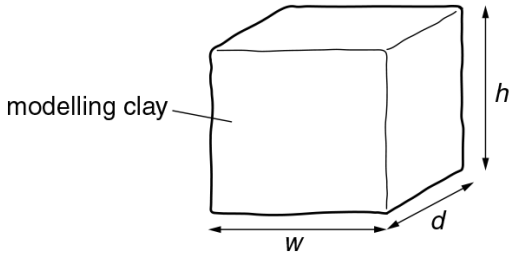


Fig. 1.1

(a) (i) On Fig. 1.2, measure the height *h* and width *w* of the piece of modelling clay.

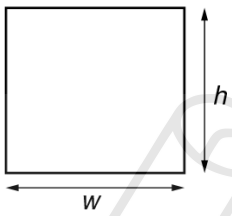


Fig. 1.2

h = ... cm

w = ... cm

(ii) On Fig. 1.3, measure the depth *d* of the piece of modelling clay.

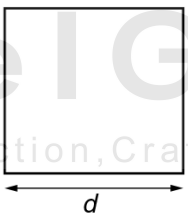


Fig. 1.3

d = ... cm

(iii) Calculate the volume V_A of the modelling clay using the equation $V_A = hwd$.

V_A = ... cm^3

(iv) The mass m of the piece of modelling clay is shown in Fig. 1.4.

Calculate the density ρ of the modelling clay using the equation $\rho = \frac{m}{V_A}$.

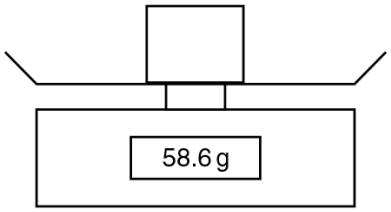


Fig. 1.4

ρ = ...
[3]

(b) The student moulds the piece of modelling clay into a spherical shape.

Draw a diagram to show how you would use two rectangular blocks of wood and a rule to measure the diameter of the sphere of modelling clay.

[1]

(c) The student pours water into a measuring cylinder, as shown in Fig. 1.5.

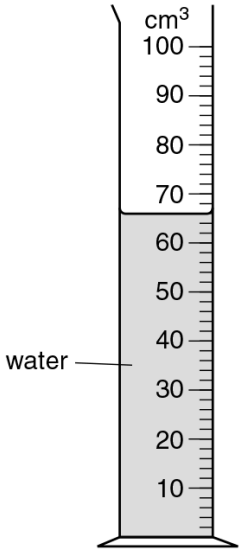


Fig. 1.5

(i) Record the volume V_1 of water shown in Fig. 1.5.

V_1 = ...[1]

(ii) On Fig. 1.5, show clearly the line of sight required to take the reading of V_1. [1]

(d) The student uses a piece of string to lower the sample of modelling clay into the measuring cylinder until it is completely covered with water. The new volume reading V_2 is 84 cm^3.

Calculate the volume V_B of the modelling clay using the equation $V_B = (V_2 - V_1)$.

V_B = ...[1]

(e) The student suggests that the volume of the modelling clay should not change when the shape is changed.

Assuming that the experiment has been carried out with care, suggest two reasons why the values V_A and V_B may not be the same.

1. .....

.....

2. .....

..... [2]

13. 0625_s13_qp_62 Q: 4

A student carries out an experiment using a simple pendulum.

Fig. 4.1 shows the apparatus.

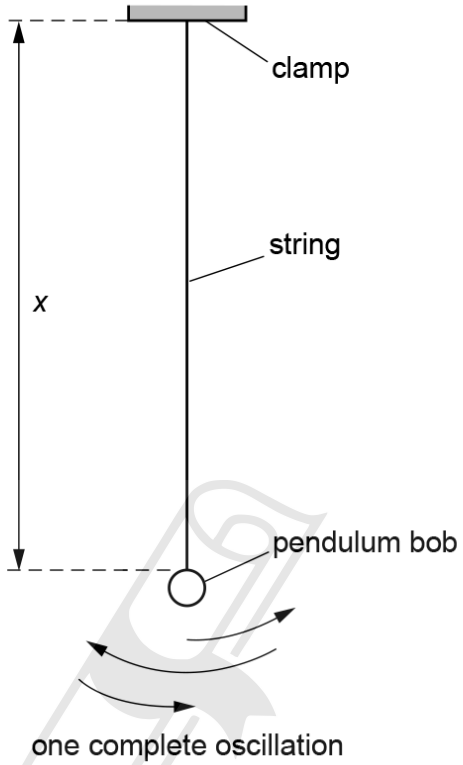


Fig. 4.1

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]

14. 0625_s13_qp_63 Q: 2

The IGCSE class is investigating the oscillation of a pendulum.

The apparatus is set up as shown in Fig. 2.1.

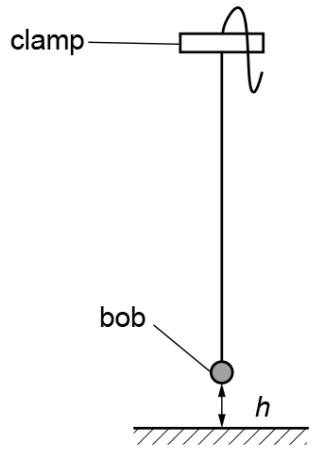


Fig. 2.1

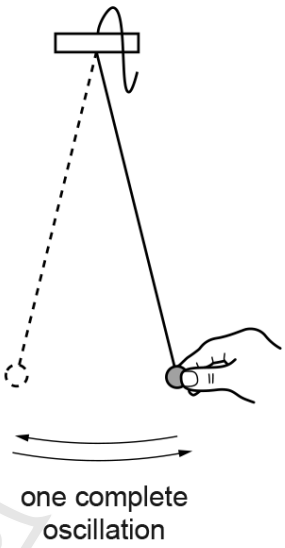


Fig. 2.2

The height *h* of the pendulum bob above the bench is measured and recorded.

This is repeated, to obtain a total of five different values of *h*, by shortening the string of the pendulum but without changing the height of the clamp.

For each value of *h*, the pendulum bob is pulled to one side by a small distance, as shown in Fig. 2.2.

The pendulum is then released and the time *t* for 10 complete oscillations is measured and recorded.

(a) Describe a precaution which the IGCSE students might have taken in order to measure *h* as accurately as possible. You may draw a diagram.

.....

.....

.....[1]

(b) Figs. 2.3 to 2.7 are scale diagrams showing the height h of the pendulum bob above the bench for each of the five experiments.

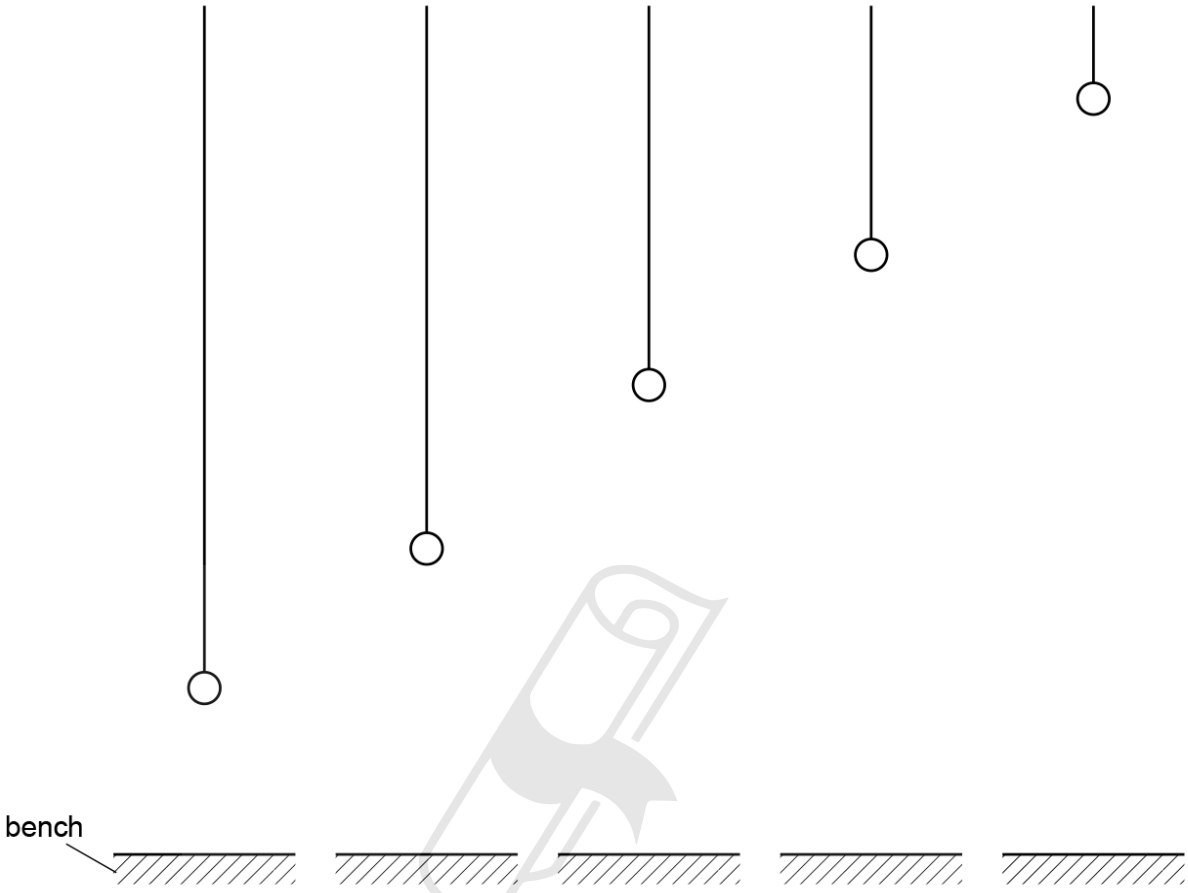


Fig. 2.3 **Fig. 2.4** **Fig. 2.5** **Fig. 2.6** **Fig. 2.7**

(i) Measure, and record in Table 2.1, the height h in each experiment.

(ii) The diagrams are drawn to 1/5 scale.

Calculate, and record in Table 2.1, the actual heights H of the pendulum bob above the bench. [2]

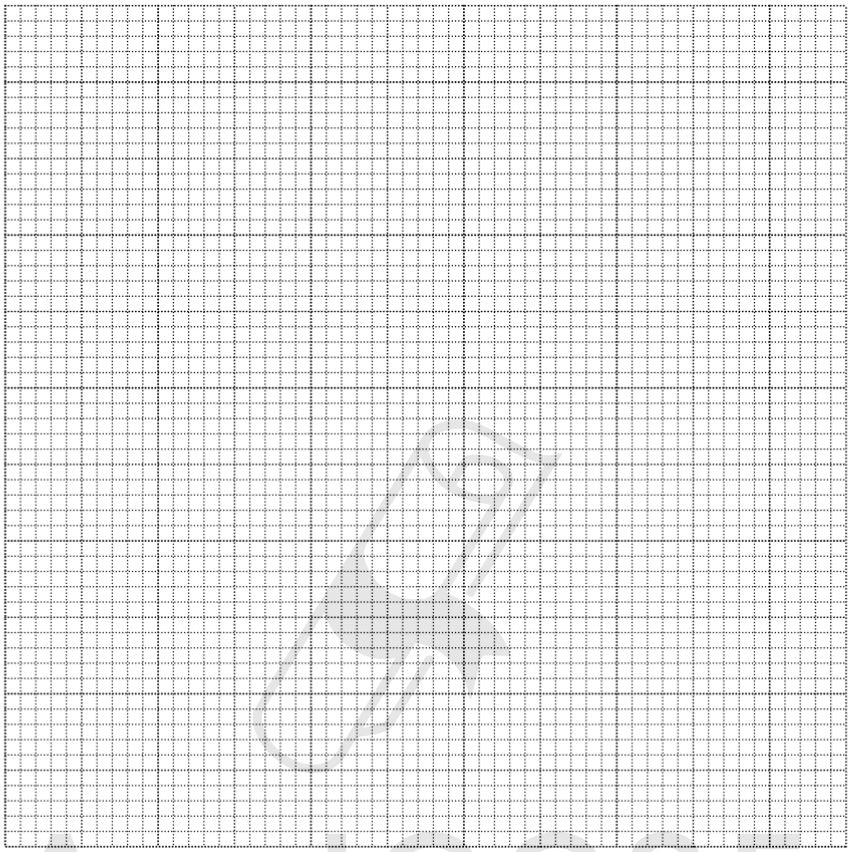
Table 2.1

	h/cm	H/cm	t/s	T/s	T^2/s^2
Fig. 2.3			14.01		
Fig. 2.4			12.39		
Fig. 2.5			10.85		
Fig. 2.6			8.93		
Fig. 2.7			6.30		

(c) **(i)** For each value of height h, calculate the time T for one complete oscillation, using the equation $T = \frac{t}{10}$. Record these values in Table 2.1.

(ii) Calculate the values of T^2 and record these in the table. [1]

(d) Plot a graph of T^2/s^2 (y-axis) against H/cm (x-axis).



[4]

(e) Determine the gradient G of the graph.

Show clearly on the graph how you obtained the necessary information.

G = ...
[1]

(f) One of the students wishes to carry out the experiment again to obtain results which are more reliable.

Describe one change she might make to the method to achieve this.

.....

.....

.....[1]

[Total: 10]

15. 0625_w13_qp_62 Q: 1

The IGCSE class is investigating pendulums.

The apparatus is shown in Figs. 1.1 and 1.2.

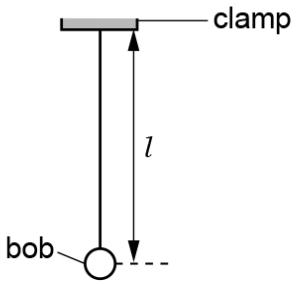


Fig. 1.1

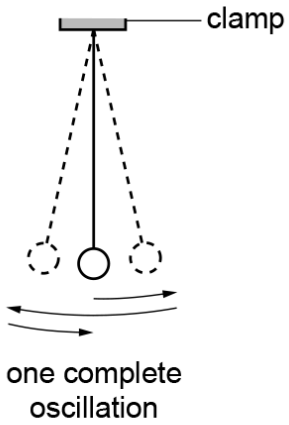


Fig. 1.2

(a) (i) On Fig. 1.1, measure the length l of the pendulum.

l = ...[1]

(ii) The pendulum is drawn 1/10th of actual size.

Write the actual length of the pendulum in the first row of Table 1.1.

(b) A student displaces the pendulum bob slightly and releases it so that it swings.

Fig. 1.2 shows one complete oscillation of the pendulum bob.

The student uses a stopwatch to record the time t for 20 complete oscillations of the pendulum. The reading is recorded in the table.

(i) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

Record the value of T in Table 1.1.

(ii) Complete the column headings in the table.

Table 1.1

l/ cm	t/	T/
	22.4	
61.9	31.6	1.58

[3]

(c) The student adjusts the length of the pendulum until its length l = 61.9 cm. He repeats the procedure in **(b)** and calculates T. The results are shown in Table 1.1.

The student suggests that doubling the length l of the pendulum should double the period T.

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

statement .....

justification .....

.....

[2]

(d) The student repeats the procedure in **(b)** four more times with different lengths of the pendulum.

The student plots a graph of l against T^2.

State two pieces of information from the graph that would indicate that l is directly proportional to T^2.

1. .....

2. .....

[2]

(e) The student uses another pendulum.

This pendulum has a mass that is double the mass of the first pendulum. Its length is 61.9 cm. The period T = 1.61 s.

Suggest a conclusion about the effect of doubling the mass of the pendulum.

.....

.....[1]

[Total: 9]

16. 0625_w13_qp_63 Q: 1

An IGCSE student is measuring the capacity of a drinks cup by three methods.

The capacity of a cup is the maximum volume of liquid that it will hold in normal use. This maximum level is marked on the cup, as shown in Fig. 1.1.

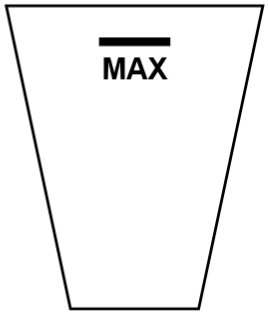


Fig. 1.1

Fig. 1.2

(a) Method 1

In Method 1, the capacity V_1 is determined from the mass of water in the cup.

(i) The cup is filled to the marked level with water. It is then placed on the balance, as shown in Fig. 1.2.

Read and record its mass m.

m = ... [1]

(ii) Calculate a value for the capacity V_1, using your reading from **(a)(i)** and the equation $V_1 = \frac{m}{\rho}$, where $\rho = 1.00\,\text{g/cm}^3$.

V_1 = ... [2]

(b) Method 2

In Method 2, the capacity V_2 is measured directly from the volume of water in the cup.

The cup is filled to the marked level and the water is tipped into a measuring cylinder, as shown in Fig. 1.3.

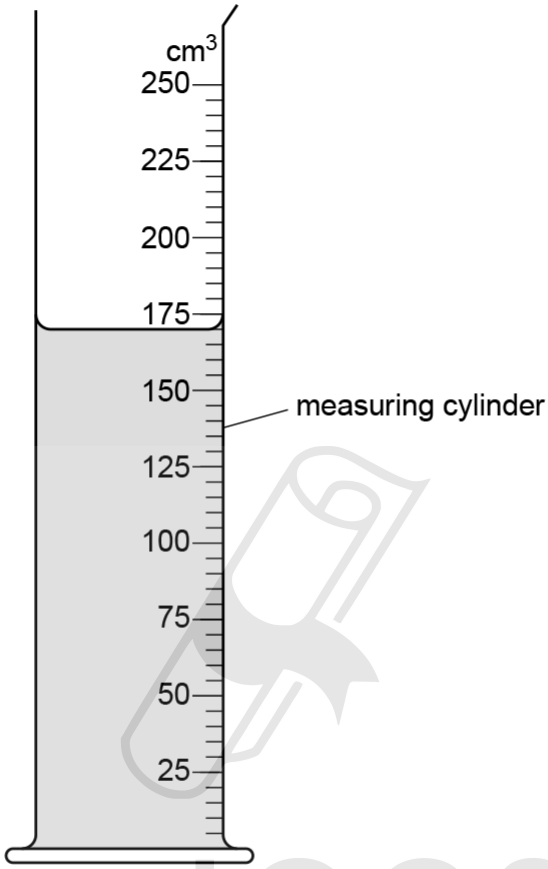


Fig. 1.3

Read and record the volume V_2 of water in the measuring cylinder.

V_2 = ... [1]

(c) Method 3

In Method 3, the capacity V_3 is calculated by considering the cup as a cylinder, using the average diameter of the cup and an approximate equation.

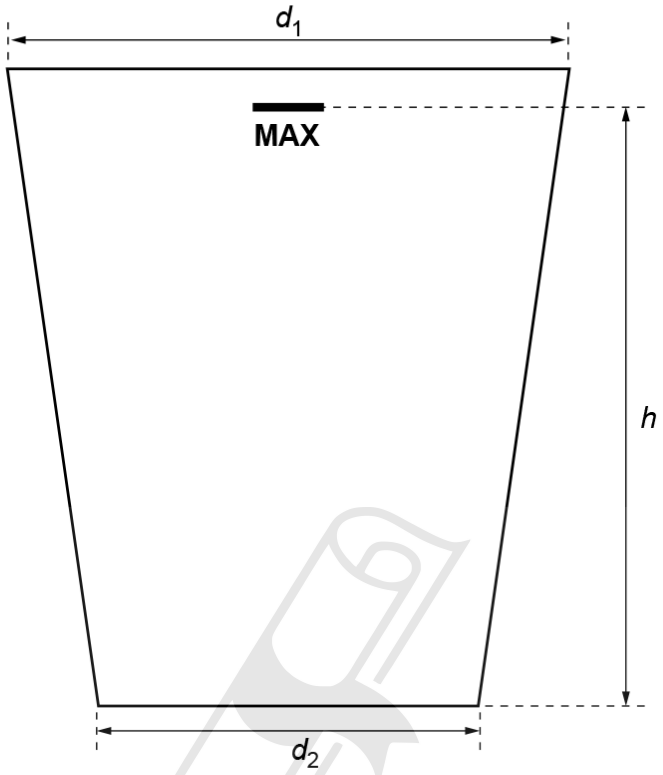


Fig. 1.4

(i) On Fig. 1.4, measure and record the diameter d_1 of the top of the cup.

d_1 = ... cm

(ii) On Fig. 1.4, measure and record the diameter d_2 of the base of the cup.

d_2 = ... cm

(iii) On Fig. 1.4, measure and record the height h from the base to the marked level **MAX**.

h = ... cm

[1]

(iv) Calculate the average diameter D using your readings from **(c)(i)** and **(c)(ii)**, and the equation $D = \frac{(d_1 + d_2)}{2}$.

D = ...

(v) Calculate a value for the capacity V_3, using your results from **(c)(iii)** and **(c)(iv)** and the equation $V_3 = \frac{\pi D^2 h}{4}$.

V_3 = ...
[2]

(d) State a possible practical source of inaccuracy in **Method 2** and a possible practical source of inaccuracy in **Method 3**.

Method 2 .....

.....

Method 3 .....

.....
[2]

(e) State an additional measurement which could be taken to give a more accurate result in **Method 1**.

.....

..... [1]

[Total: 10]

17. 0625_s12_qp_61 Q: 5

The IGCSE class is determining the internal volume of a test-tube using two displacement methods.

The apparatus used is shown in Figs. 5.1, 5.2 and 5.3.

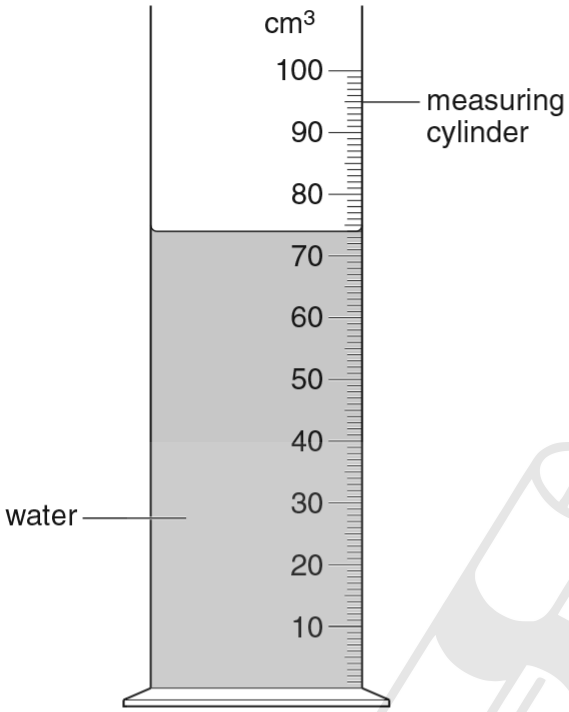


Fig. 5.1

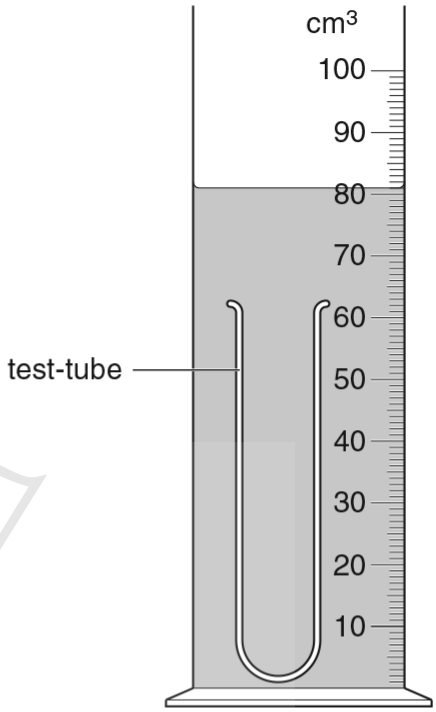


Fig. 5.2

(a) (i) Fig. 5.1 shows water in a measuring cylinder. Record the volume V_1 of the water.

V_1 = ... [1]

(ii) On Fig. 5.1, show clearly the line of sight that you would use to obtain an accurate volume reading. [2]

(b) (i) A student lowers a test-tube, closed end first, into the water in the measuring cylinder and pushes the tube down until it is filled with water. From Fig. 5.2, record the new water level V_2.

V_2 = ...

(ii) Calculate the volume V_G of the glass of the test-tube using the equation $V_G = (V_2 - V_1)$.

V_G = ...
[2]

(c) The student removes the test-tube from the measuring cylinder and empties the water back into the measuring cylinder. He then puts the test-tube, open end first, into the water in the measuring cylinder and carefully pushes it down with his finger until it is covered with water as shown in Fig. 5.3.

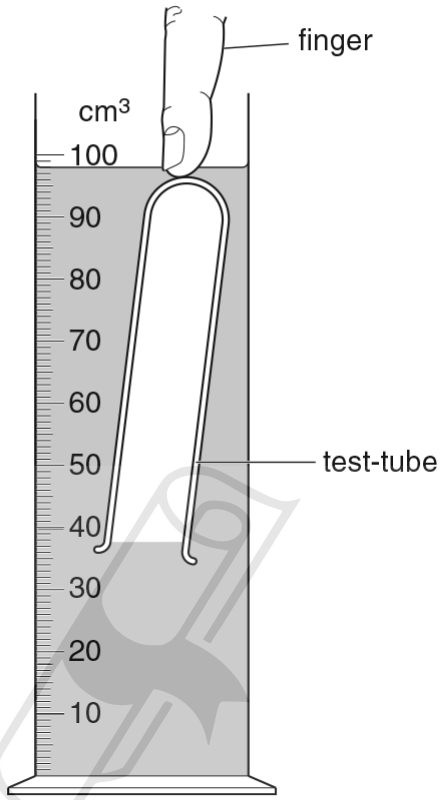


Fig. 5.3

(i) Record the new water level V_3.

V_3 = ...

(ii) Calculate the increase in water level $(V_3 - V_1)$.

$(V_3 - V_1)$ = ...

(iii) Calculate the volume V_A of air in the test-tube using the equation $V_A = (V_3 - V_1) - V_G$.

V_A = ...
[1]

(d) The student removes the test-tube from the measuring cylinder and fills the test-tube with water from a beaker. He pours the water from the test-tube into an empty measuring cylinder and records the volume V_W of water:

V_W = 18 cm^3

The student has attempted to determine the internal volume of the test-tube by two methods. His two values for the internal volume are V_A and V_W.

Assuming that the experiments have been carried out correctly and carefully and that the measuring cylinder scale is accurate, suggest two reasons why the value V_A may be inaccurate and two reasons why the value V_W may be inaccurate.

V_A:

reason 1 .....

.....

reason 2 .....

.....

V_W:

reason 1 .....

.....

reason 2 .....

.....

[3]

[Total: 9]

18. 0625_s12_qp_62 Q: 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.

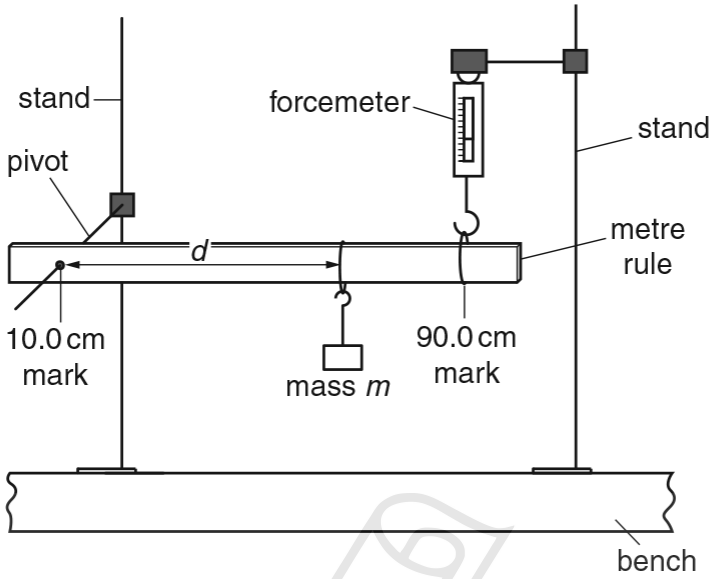


Fig. 1.1

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]

19. 0625_s12_qp_63 Q: 4

A student is measuring some small glass spheres.

(a) The student has a 30 cm rule and two rectangular blocks of wood.

In the space below, draw a diagram to show clearly how you would arrange the apparatus to measure the diameter of **one** of the spheres.

[2]

(b) The student then determines the average volume of a glass sphere by a displacement method. She pours some cold water into a measuring cylinder and records the volume V of the water, as shown in Fig. 4.1.

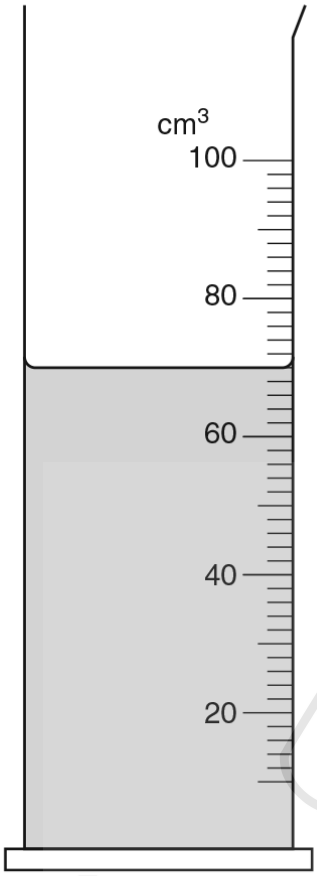


Fig. 4.1

(i) On Fig. 4.1, show clearly the line of sight that you would use to obtain an accurate volume reading. [2]

(ii) Using Fig. 4.1, record the volume V of water in the measuring cylinder.

V = ... [1]

(iii) The student carefully puts 15 of the glass spheres into the measuring cylinder. The new water level reading is 78 cm^3.

Calculate the volume V_1 of **one** sphere.

V_1 = ... [1]

[Total: 6]

20. 0625_w12_qp_62 Q: 5

The IGCSE class is investigating a pendulum.

The apparatus is shown in Fig. 5.1.

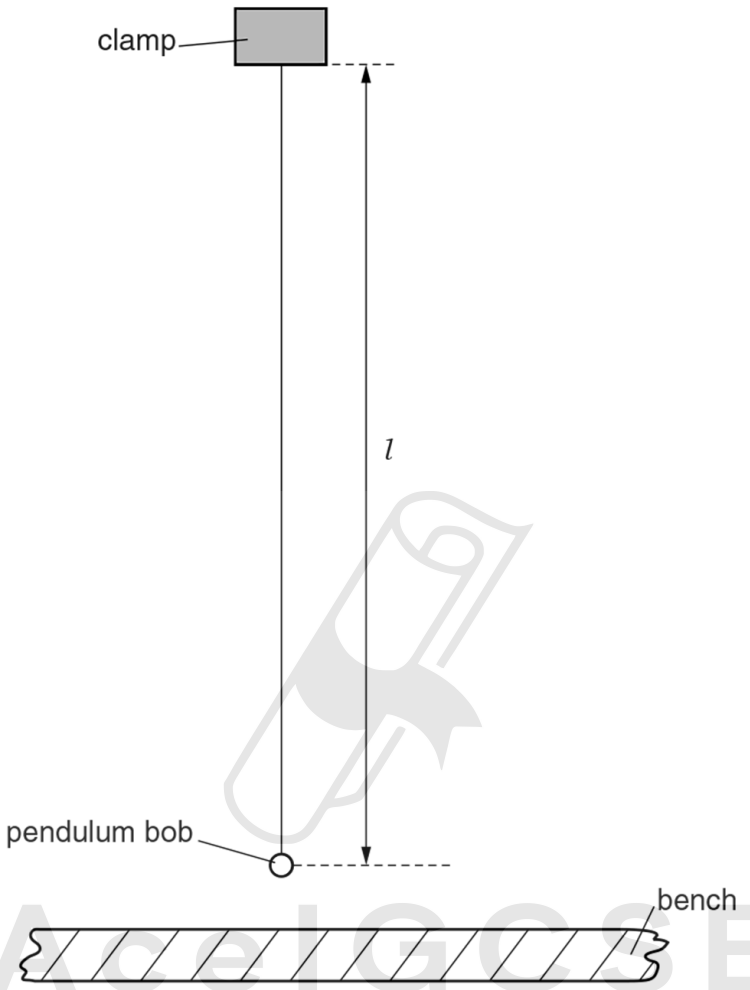


Fig. 5.1

(a) On Fig. 5.1, measure the length l of the pendulum.

l = ...[1]

(b) The diagram is drawn 1/5th actual size.

Calculate the actual length L of the pendulum.

L = ...[2]

(c) A student places a metre rule on the bench so that the 50.0 cm mark is vertically below the centre of the pendulum bob. Describe how you would judge that the 50.0 cm mark is vertically below the centre of the pendulum bob. You may draw a diagram.

.....

.....[1]

(d) The student pulls the pendulum bob to one side until it is vertically above the 52.0 cm mark on the rule. He has moved the pendulum bob a horizontal distance $d = 2.0$ cm.

He releases the pendulum bob, then measures the time t taken for 12 complete swings of the pendulum. He repeats the procedure using a range of d values. The values of d and t are shown in Table 5.1.

Table 5.1

d/	t/	T/
2.0	17.4	
3.0	17.6	
4.0	17.2	
5.0	17.3	
6.0	17.5	

(i) Calculate the period T of the pendulum for each value of d. Enter the values in the table. The period T is the time taken for one complete swing of the pendulum. [2]

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

(e) Using the evidence in the table, describe the effect on the period T of increasing the distance d. Justify your answer by reference to your results.

description .....

.....

justification .....

.....

.....

[2]

(f) Suggest why the student measures the time taken for twelve swings of the pendulum rather than for one swing.

.....

.....

.....[1]

[Total: 10

Appendix A

Answers

1. 0625_s20_MS_62 Q: 1

(a)	clear diagram showing use of set square and rule with horizontal line of set square across to vertical rule from approximate centre of bob	1
	rule positioned to enable measurement of *d* from bottom of clamp	1
	wording to include perpendicular viewing of the rule	1
(b)(i)	t_1 = 28.12 (s)	1
(b)(ii)	T_1 = 1.406 (s)	1
(c)	m_A = 52	1
(d)(i)	first box only ticked (error carried forward possible)	1
(d)(ii)	justified by correct reference to results	1
(e)(i)	rule or protractor used	1
	method explained / diagram drawn	1
(e)(ii)	length	1

---

2. 0625_w19_MS_62 Q: 1

(a)	perpendicular viewing of scale / use of horizontal aid, e.g. set-square / clamp rule / rule close to pendulum	1
(b)(i)	27.6(0)	1
(b)(ii)	1.38	1
(b)(iii)	1.90	1
(c)	graph: axes correctly labelled and right way round	1
	suitable scales	1
	all plots correct to ½ small square	1
	good line judgement, thin, continuous line	1
(d)	triangle method indicated on graph	1
	with triangle at least half of candidate's line between the extreme plotted points	1
(e)	correct calculation of *g*	1
	to 2 or 3 significant figures	1

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3. 0625_s17_MS_61 Q: 4

(a)(i)	*l* shown clearly from bottom of clamp to centre of bob	**1**
(a)(ii)	Any 2 from: Metre rule close to pendulum Measurement from bottom of clamp Set-square used as a horizontal reference	**2**
(b)(i)	1.01(1)	**1**
(b)(ii)	Any 2 from: Idea of averaging Reaction time / judgement of when to stop / start (owtte) Reduces effect of error / spreads error over 20 swings (owtte)	**2**
(c)	1.02(212) with 2, 3 or 4 significant figures	**1**
	unit s^2	**1**
	Total:	**8**

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4. 0625_w17_MS_61 Q: 3

	MP1	Stopwatch (or equivalent) AND (metre) rule / ruler	**1**
	MP2	Measure time for 5 (□) oscillations	**1**
	MP3	Divide by number of oscillations to find period (*T*)	**1**
	MP4	Repeat for each bob	**1**
	MP5	Variable; one from: Initial amplitude / starting position Length of pendulum / thread Number of oscillations	**1**
	MP6	Table with column headings for *t*, or period (*T*), or both AND *d*, with correct units	**1**
	MP7	Conclusion: Plot graph(s) of *d* against period (*T*) or *t* (or vice versa) OR compare period (*T*) or *t* values for different diameters	**1**

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5. 0625_w17_MS_62 Q: 1

(a)(i)	*d* = 5.0 (cm)	**1**
(a)(ii)	*D* = 50 cm	**1**
(a)(iii)	clear correct use of set-square AND vertical ruler	**1**
(b)(i)	28.12	**1**
(b)(ii)	1.406 / 1.41 / 1.4	**1**
	unit s / secs / seconds seen in **1(b)(i)** or **1(b)(ii)** at least once	**1**
(c)	statement to match readings justification to include the idea of within (or beyond e.c.f.)	**1**
	the limits of experimental accuracy e.g. (very) close / almost equal	**1**
(d)	final box ticked	**1**
(e)	V, V, V, V, P, P all correct = 2 marks 4 or 5 correct = 1 mark Fewer than 4 correct = 0 marks	**2**

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6. 0625_w16_MS_62 Q: 3

(a)	any two from: length of spring / number of coils diameter / thickness of spring material / type / stiffness / elasticity / spring constant of spring how far spring is displaced / amplitude (of oscillations)	**2**
(b)(i)	increases has no effect on has no effect on	**1** **1** **1**
(b)(ii)	one from: repeats large number of oscillations and divide timing sensor / light gate use a fiducial mark (however expressed) counting down to zero (before starting the timer)	**1**
	Total:	**6**

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7. 0625_s15_MS_61 Q: 5

(a) use of $T^2 = 4\,s^2$ [1]

correct method shown clearly on graph [1]

l = 0.99 (m) cao OR ecf 0.49 if $T^2 = 2\,s^2$ used [1]

(b) reduce (percentage) uncertainty OR reduce (the effect of) error due to starting/stopping [1]

(c) **(i)** 5 – 10 [1]

(ii) minimum not less than 10 g; maximum not more than 1000 g; maximum must be at least double the minimum [1]

[Total: 6]

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8. 0625_s15_MS_62 Q: 1

(a) any one from:
- reference to how to determine the centre of the bob
- measure to top of bob then add on half diameter measured with blocks and rule or callipers
- measure to top and bottom of bob and average
- reference to perpendicular viewing (reducing parallax)
- rule parallel with/close to string/appropriate use of set-square [1]

(b) (i) t = 28.4(0) NOT 28:4 [1]

(ii) T = 1.42 (s) allow ecf from **(i)** [1]

(iii) reduce effect of errors in starting/stopping stopwatch [1]

(c) statement to match results (expect no) [1]

justification using results, including idea of difference is beyond limits of experimental uncertainty owtte [1]

(d) minimum of three more values [1]

all values ≥ 20 cm and ≤ 300 cm, and three values are at least 10 cm apart [1]

[Total: 8]

9. 0625_w15_MS_61 Q: 1

(a) **(i)** 4.2 (cm) OR 42 (mm) [1]

(ii) centre of bob touching rule OR how to use fiducial aid, e.g. set-square OR measure to top / bottom of bob and add / subtract radius OR measure to top and bottom of bob and average OR look perpendicularly at scale [1]

(b) **(i)** 28.2(0) (s) [1]

(ii) 1.41(s) (e.c.f. from **(i)** AND T_C = 1.16(s)) [1]

(iii) (reaction time) inaccuracy – smaller part of total time measured owtte [1]

(c) **(i)** repeats OR start counting at nought OR use a fiducial mark owtte [1]

(ii) see **(b)(ii)**

(d) correct statement for results [1]
justification must include idea of too different to be within limits of experimental accuracy
(e.c.f. close enough to be within limits of experimental accuracy) [1]

(e) pivot at 1 cm mark owtte OR centre of mass of rule not 50 cm below pivot [1]

[Total: 9]

10. 0625_s14_MS_62 Q: 1

(a) **(i)** l in range 17.1–17.2 (cm) [1]

(ii) x in range 15.5–15.6 (cm) **and** correct calculation of y (e.c.f. incorrect l) [1]

(b) use of at least 3 turns [1]

(mark string and) measure distance (between marks) **and** divide by number of turns [1]

(c) **(i)** any one from:
- stretching of string
- thickness of string
- thickness of mark
- gaps between turns
- winding of turns at an angle [1]

(ii) V = 7.1(0)–7.2(0) $\underline{\text{cm}^3}$ e.c.f. **(a)(ii)** [1]

(iii) V_E = 0.2–0.6 (cm^3) [1]
(expect estimate to nearest 0.1 cm^3)

sensible reasoning/working/method which takes account of sharpened shape and length [1]

[Total: 8]

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11. 0625_w14_MS_61 Q: 5

(a) h = 9.5cm d_T = 7.2 cm – 7.3 cm and d_B = 4.5 cm [1]

d_A = 5.85/5.9 cm (no mark), V rounds to 260 cm^3 (no ecf) [1]

2 or 3 significant figures and cm^3 [1]

(b) measurement of circumference half way up, or at top and bottom [1]

more than one revolution used for the measurement in at least one position, and divide [1]

(c) **(i)** 225 [1]

(ii) 275 (ecf 500 – candidate's **(c)(i)** [1]

(d) correct line of sight clearly shown at right angles outside measuring cylinder [1]

[Total: 5]

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12. 0625_w14_MS_62 Q: 1

(a) **(i)** $h = 2.5$, $w = 2.7$, and $d = 2.7$ [1]

(ii) $V_A = 18.225$ (cm^3) to 2 or more sig. figs. ecf **(i)** [1]

(iii) density = 3.22 g/cm^3 to 2 or 3 sig. figs. ecf **(ii)** [1]
unit needed, penalise additional sig. figs.

(b) diagram showing blocks and rule correctly used – blocks touching the sphere, and rule spanning gap and touching blocks [1]

(c) **(i)** $V_1 = 66$ (cm^3) [1]

(ii) line of sight at right angles to measuring cylinder [1]

(d) $V_B = 18$ (cm^3) ecf from candidate's V_1 [1]

(e) any two from:
measuring cylinder not sensitive owtte
some clay left on fingers
cube not perfectly shaped / difficult to measure owtte
air bubbles clinging to modelling clay / within the modelling clay
volume of string
difficult to judge the bottom of the meniscus / bubble on meniscus [2]
ignore parallax
do not credit poor experimental practice e.g. spills or splashes

[Total: 9]

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13. 0625_s13_MS_62 Q: 4

(a) 1.925, 1.800, 1.670, 1.570, 1.410, 1.275 (2 or more sig. figs.) [1]
all T values consistently to 2 or 3 significant figures [1]

(b) any one from:
gives a more accurate value of T
gives an average value (of T)
reduces (effect of) human reaction error
reaction time less significant
T too small / oscillations are too quick / bob swings too fast [1]

(c) avoidance of parallax error explained [1]

(d) blocks arranged parallel either side of bob and touching bob [1]
rule correctly placed, touching the blocks and spanning the gap [1]

[Total: 6]

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14. 0625_s13_MS_63 Q: 2

(a) appropriate precaution (can be written or diagram):
e.g. take reading with eye line perpendicular to rule / use set square to ensure rule vertical [1]

(b) *h* recorded, increasing and with consistent 2 or 3 sig. figs. [1]
H = 10.0, 19.5, 30.5, 39.0, 49.5 [1]

(c) *T* seen and T^2 = 1.96, 1.54, 1.18, 0.80, 0.40 [1]

(d) axes labelled with appropriate scales [1]
plots correct [1]
well judged line [1]
thin neat line, fine plots [1]

(e) *G* recorded to 2 or 3 sig. figs. (expect range (–)0.032 to (–)0.047)
and triangle method seen on graph, using at least half of line [1]

(f) appropriate change which improves reliability:
e.g. repeat readings for each length (and take average) / greater no. of oscillations [1]

[Total: 10]

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15. 0625_w13_MS_62 Q: 1

(a) **(i)** 3.1 cm (31 mm), unit required [1]

(b) table:
s, s [1]
31.(0) e.c.f. **(a)** [1]
1.12 c.a.o. [1]

(c) statement matches results (expect NO) [1]
justification using idea of within or beyond limits of experimental accuracy (o.w.t.t.e.) [1]

(d) straight line / constant gradient [1]
through the origin [1]

(e) has no effect [1]

[Total: 9]

(a) m = 180.2(0) and unit (g) [1]
V_1 value = m [1]
unit $\underline{cm}^3$ c.a.o. [1]

(b) V_2 = 170 c.a.o. [1]

(c) d_1 = 7.35 to 7.4, d_2 = 5.0 to 5.1, h = 7.9 [1]
D = 6.2 to 6.3 allow e.c.f. [1]
V_3 = 239 to 246 and 2 or 3 significant figures only allow e.c.f. [1]

(d) method 2 – one from:
some water left in cup/spilt
measuring cylinder not read at eye level/perpendicularly/bottom of meniscus
parallax explained [1]

method 3 – one from:
d_1 not at liquid level
d_1 and d_2 not inside diameters
difficult to measure h (because of sloping side)
h not measured at eye level/perpendicularly/parallax explained [1]

(e) mass of cup / zero reading on balance [1]

[Total: 10]

17. 0625_s12_MS_61 Q: 5

(a) $V_1 = 74$ [1]
Line of sight perpendicular to scale [1]
Perpendicular line continues to measuring cylinder at surface level [1]

(b) $V_2 = 81$, $V_G = 7$ (ecf allowed) [1]
All volumes in cm^3, unit given at least once, not contradicted [1]

(c) $(V_3 - V_1) = 24$, $V_A = 17$ (ecf allowed) [1]

(d) Any three from:
V_A: Finger increases V_3 / tube not pushed in far enough
Some water in test-tube/air is compressed
V_W: Water remaining in tube
Water remaining in measuring cylinder
Tube overfilled, wtte (surface tension effect) [3]
Either V_A or V_W (accept only once):
Measuring cylinder readings not very sensitive
Subtraction produces large percentage uncertainty

[Total: 9]

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18. 0625_s12_MS_62 Q: 1

(a) Table:
correct *d* values
70.0, 60.0, 50.0, 40.0, 30.0, 20.0, 10.0 [1]
cm, N ALLOW m, mm if consistent with figures [1]

(b) **(i)** *d* against *F* (or vice versa) OR distance against force/forcemeter reading
NOT 'extension', 'forcemeter', quantity expressed just as units [1]

(ii) Straight line [1]
Through origin or wtte [1]

(c) Would change forcemeter reading/change mass on rule/wtte [1]

(d) Check distance from bench is the same at two points or wtte/
Line up by eye with windowsill (or suitable horizontal reference) [1]

[Total: 7]

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19. 0625_s12_MS_63 Q: 4

(a) Blocks parallel with ONE sphere completely between [1]
Rule correctly placed [1]

(b) **(i)** Line of sight perpendicular to scale [1]
Line of sight along bottom of meniscus [1]

(ii) 70 (cm^3) [1]

(iii) 0.53 cm^3, 2 or 3 significant figures, with unit [1]

[Total: 6]

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20. 0625_w12_MS_62 Q: 5

(a) *l* value 10.5 (cm) / 105 (mm) [1]

(b) *l* value 52.5 / 525 (ecf) [1]
Both in cm/mm with unit stated at least once [1]

(c) Use blocks/protractor/set square; move ruler close to bob/lower bob
(Can score the mark from a well-drawn diagram) [1]

(d) *T* values 1.45, 1.47, 1.43, 1.44, 1.46 [1]
T values consistent 2 or 3 significant figures [1]
Table: cm, s, s [1]

(e) Description: little or no effect (owtte) allow ecf from **5(d)** [1]
Justification: *T* values very similar (owtte) [1]
