1. Motion, forces and energy

1.1 Physical quantities and measurement techniques

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 A student wants to measure the diameter of a wire. The wire is thinner than a single gradation on her ruler. She coils the wire carefully and makes 12 loops as shown in Fig. 2.1.

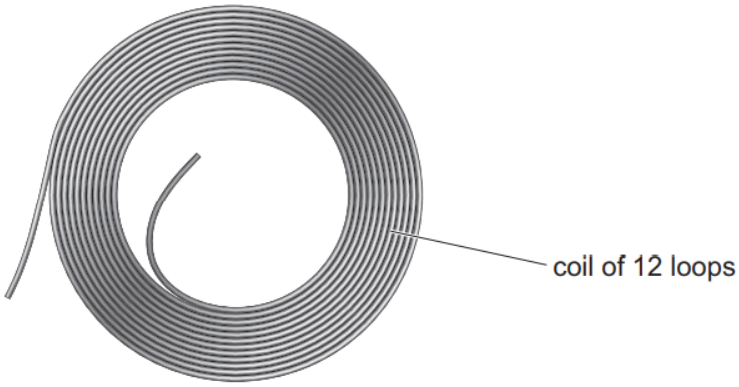

Fig. 2.1

(a) Describe how she can use her ruler to determine the diameter of the wire accurately.
You may draw on Fig. 2.1 as part of your answer.

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..... [3]

2 A student places six 100 g masses in a stack, as shown in Fig. 2.1.

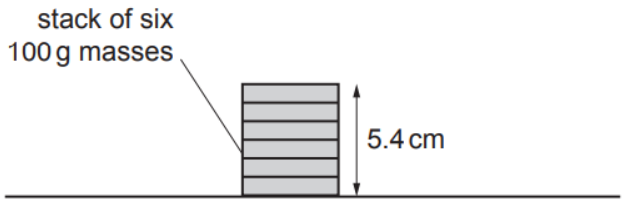

Fig. 2.1 (not to scale)

(a) The height of the stack of masses is 5.4 cm.

Calculate the average thickness of **one** mass.

average thickness of **one** mass = ... cm [2]

(b) Fig. 2.2 shows the masses, a measuring cylinder and a beaker containing some water.

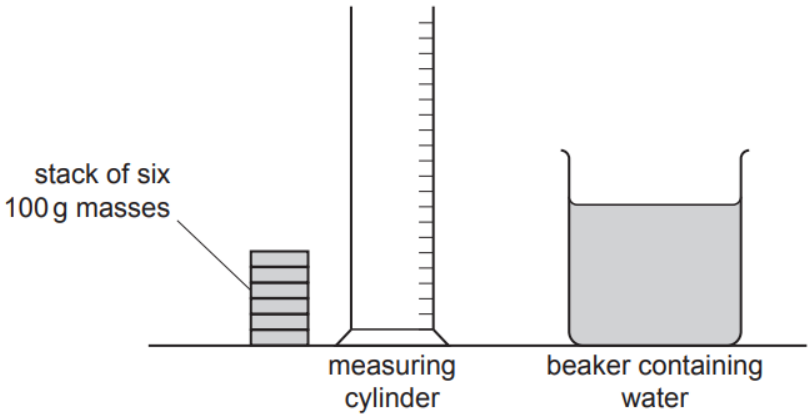

Fig. 2.2

The student uses the equipment in Fig. 2.2 to determine the total volume of the six masses.

Describe a method that the student uses.

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..... [3]

[Total: 5]

3 A student measures the diameter of some identical steel balls. Fig. 1.1 shows the arrangement she uses.

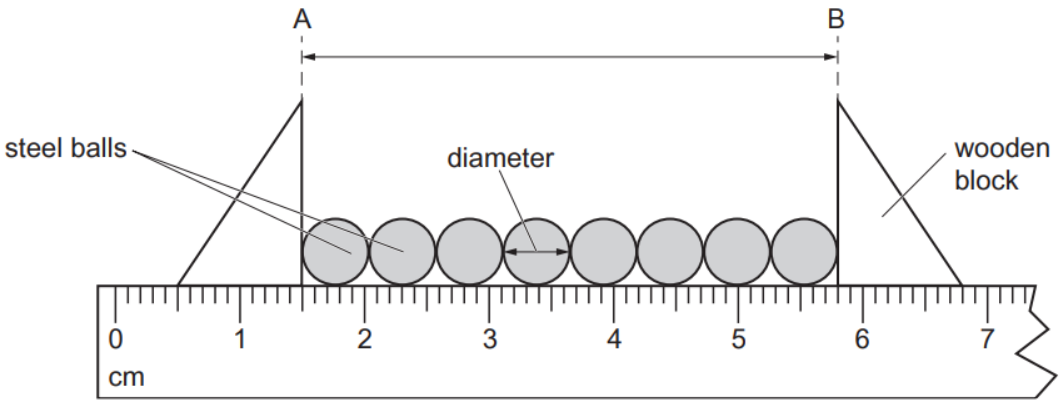

Fig. 1.1 (not to scale)

(a) (i) Using the ruler in Fig. 1.1, determine the distance AB on Fig. 1.1.

distance AB = ... cm [2]

(ii) Use the distance AB to determine the diameter of one steel ball.

diameter of one steel ball = ... cm [2]

4 Fig. 1.1 shows a measuring cylinder containing some water.

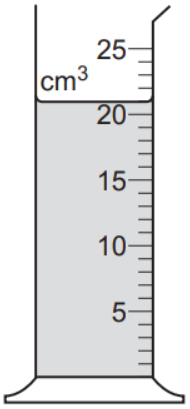

Fig. 1.1

(a) State the volume of the water in the measuring cylinder.

volume = ... cm^3 [1]

(b) A student adds 20 drops of water to the water that is in the measuring cylinder in Fig. 1.1. The new volume of water in the measuring cylinder is 25 cm^3.

Calculate the average volume of one drop of water.

average volume of one drop = ... cm^3 [4]

(c) A student has a measuring cylinder and a small, irregularly shaped piece of metal. The piece of metal can easily fit into the measuring cylinder.

Describe how the student can use the measuring cylinder and some water to find the volume of the metal.

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..... [4]

[Total: 9]

5 Fig. 1.1 shows a dripping tap and a measuring cylinder. The water drops all have the same volume. The drops fall from the tap at equal time intervals.

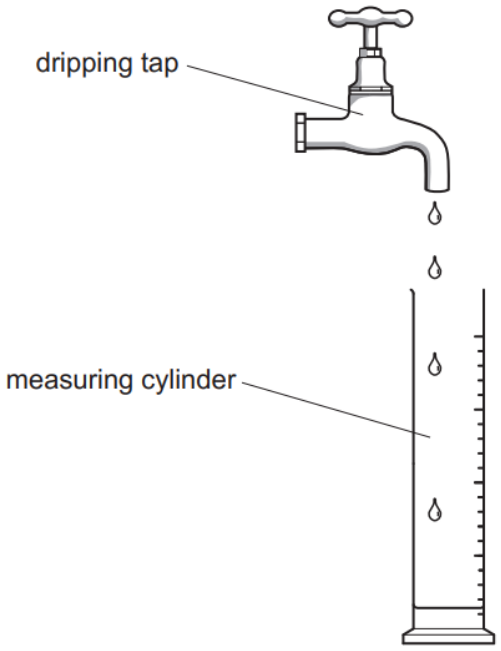

Fig. 1.1 (not to scale)

(a) (i) The student collects 200 of the drops in a measuring cylinder. The total volume collected is 60 cm^3.

Calculate the average volume of **one** drop of water.

volume = ... cm^3 [3]

(ii) Another student uses a stop-watch to measure the time taken for the tap to produce 200 drops. Fig. 1.2 shows the time reading on the stop-watch.

Fig. 1.2

Determine the time, in seconds, for the tap to produce 200 drops.

time = ... s [2]

(iii) Determine the average time interval between one drop starting to fall and the next drop starting to fall.

time interval = ... s [2]

(b) Fig. 1.3 shows the volume of water collected in the measuring cylinder by another student.

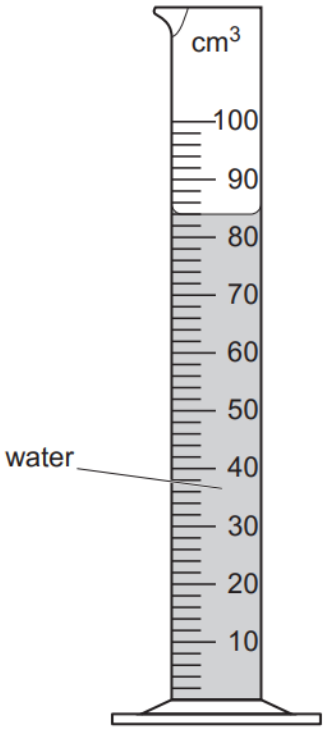

Fig. 1.3

Determine the volume of water in the measuring cylinder in Fig. 1.3.

volume = ... cm^3 [1]

[Total: 8]

6 A student uses a ruler to measure the length of a piece of wire, as shown in Fig. 1.1.

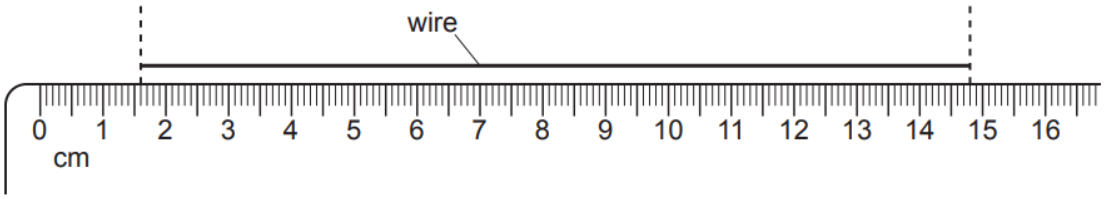

Fig. 1.1 (not to scale)

(a) Use the ruler in Fig. 1.1 to determine the length of the piece of wire.

length of wire = ... cm [2]

(b) The student folds the piece of wire and measures its mass.

(i) State the name of an instrument the student can use to measure mass.

..... [1]

(ii) The student determines the volume of the wire.

He uses a measuring cylinder part-filled with water and places the wire in it, as shown in Fig. 1.2.

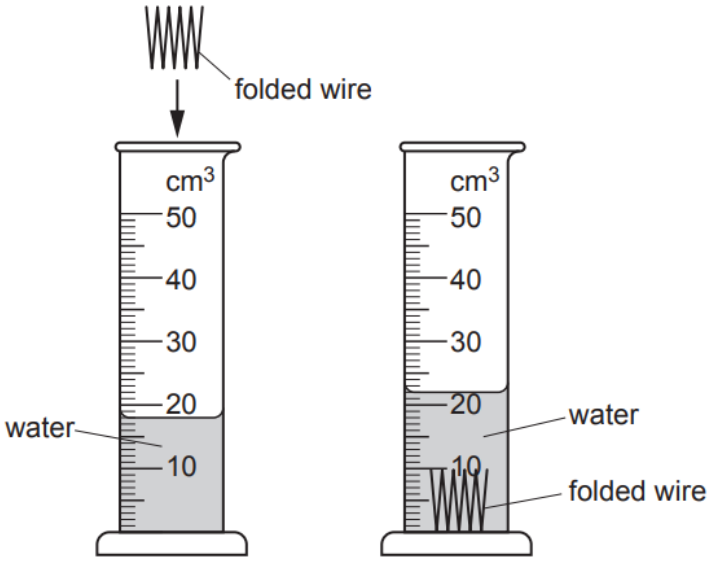

Fig. 1.2

Determine the volume of the wire by using information in Fig. 1.2.

volume of wire = ...cm^3 [2]

(c) The student measures the mass and the volume of a piece of metal.
The mass of the piece of metal is 93.6 g and its volume is 12 cm^3.

Calculate the density of the metal.

density of metal = ...g/cm^3 [3]

[Total: 8]

7 Fig. 1.1 shows a coil of wire.

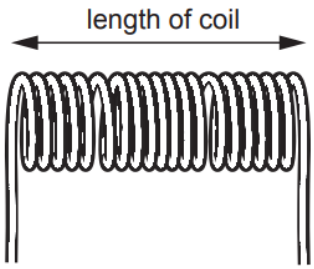

Fig. 1.1 (not to scale)

(a) A student measures the length of the coil using a ruler. His measurement is 3.8 cm.

There are 20 turns of wire in the coil. The student uses his measurement to calculate the average thickness of the wire.

(i) Show that the average thickness of the wire is about 0.2 cm.

average thickness of wire = ... cm [2]

(ii) The student's measurement of 3.8 cm is inaccurate.

Suggest **one** reason why the measurement is inaccurate.

.....

..... [1]

(b) The volume of the wire in the coil is 16.6 cm^3 and its mass is 148 g.

Calculate the density of the metal used for the wire in the coil.

density = ... g/cm^3 [3]

(c) The student has a measuring cylinder and a beaker of water, as shown in Fig. 1.2.

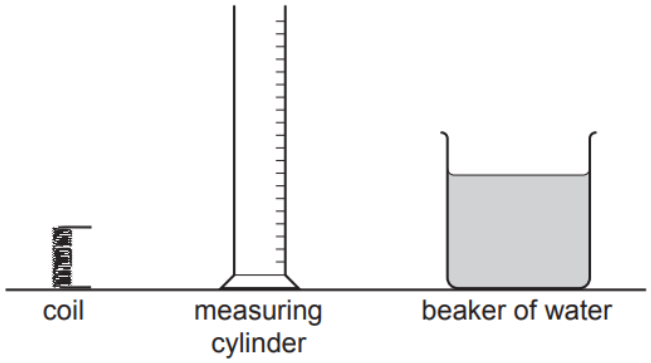

Fig. 1.2

Describe how the student can determine the volume of the coil by using the equipment shown in Fig. 1.2.

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

8 Some students observe drops of water falling from a tap that leaks, as shown in Fig. 1.1.

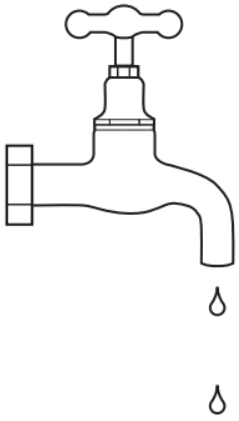

Fig. 1.1

(a) The students measure the time for 50 drops to fall from the tap. The time for 50 drops to fall is 20 s.

Calculate the average time between two drops falling.

average time = ... s [2]

(b) The students collect some drops of water.

(i) The students measure the volume of the water they collect.

State the term for the equipment that is suitable for measuring the volume accurately.

..... [1]

(ii) In a similar experiment, another student collects 0.21 kg of water.

Calculate the weight of this water.

weight of water = ... N [3]

[Total: 6]

9 Four students P, Q, R and S each attempt to measure the time period (the time for one complete oscillation) of a pendulum. The arrows in Fig. 2.1 show the movements of the pendulum that each student times.

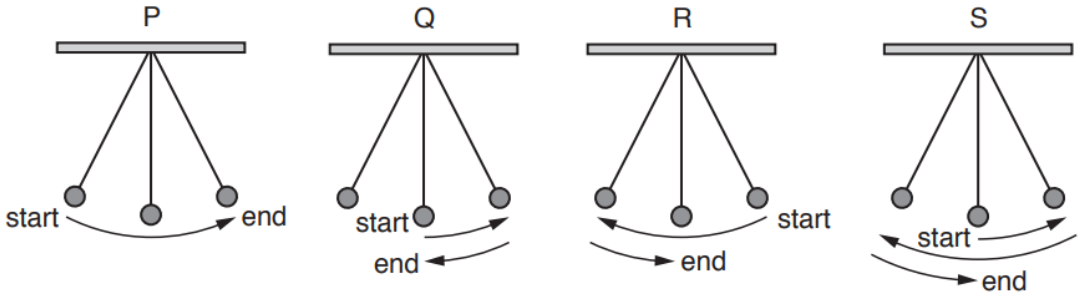

Fig. 2.1

(a) State the student who has chosen the correct movement for one period of a pendulum.

student ..... [1]

(b) Another student uses a stopwatch to measure the time taken for 50 periods of a pendulum. Fig. 2.2 shows the time taken on the stopwatch.

Fig. 2.2

Calculate the time for one period of the pendulum. Give your answer to 3 significant figures.

time for one period = ... s [3]

(c) The student measures the displacement of the pendulum bob from its rest position. The displacement is 16.5 cm, as shown in Fig. 2.3.

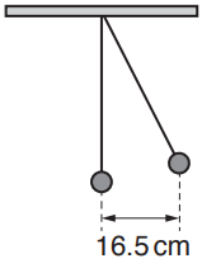

Fig. 2.3

State the displacement in millimetres.

displacement = ... mm [1]

[Total: 5]

10 A teacher investigates the reaction time of five students. A 0.50 m ruler is held above the hand of a student before being allowed to fall. The arrangement is shown in Fig. 3.1.

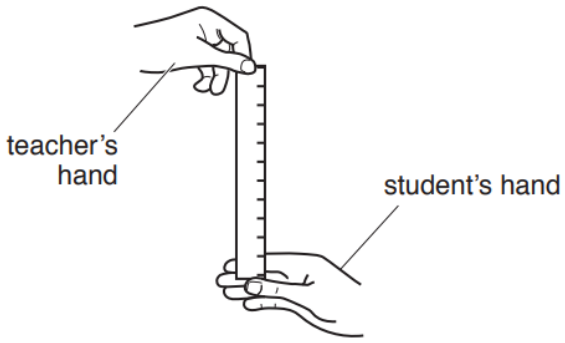

Fig. 3.1

As soon as the ruler falls the student closes their hand, catching the ruler. The further the ruler falls, the greater the reaction time of the student. The results obtained are shown in Fig. 3.2.

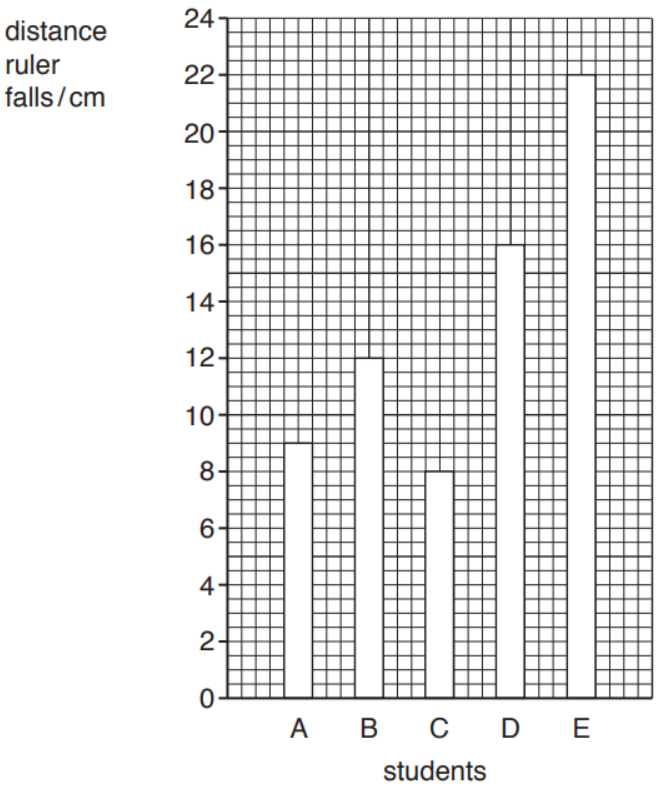

Fig. 3.2

(a) Using the results shown in Fig. 3.2, calculate the average distance that the ruler drops.

average distance = ... cm [2]

(b) List the students in order of their reaction times, with the shortest reaction time at the top of the table. One has been done for you.

order	student
1st	
2nd	
3rd	B
4th	
5th	

[2]

(c) In a similar investigation, a ruler drops a distance of 11.0 cm and has an average speed of 16 cm/s.

Calculate the reaction time.

reaction time = ... s [3]

[Total: 7]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

11 **(a)** A pendulum swings with a time period of approximately one second.

Describe how to use a stop-watch to determine the time period of the pendulum.

.....

.....

.....

..... [3]

(b) Complete Table 2.1 by writing in each space of the right-hand column which **one** of the following devices is used to measure the quantity in the left-hand column.

digital balance	measuring cylinder	metre rule
micrometer screw gauge	stop-watch	thermocouple

Table 2.1

quantity	device
volume of water in a glass	
width of a small swimming pool	
thickness of a piece of aluminium foil	

[3]

[Total: 6]

12 Some physical quantities are scalars and other physical quantities are vectors. **(extended only)**

(a) State how a vector quantity differs from a scalar quantity.

.....

..... [1]

(b) Circle the vector quantities in the list.

acceleration energy mass momentum temperature time speed velocity

[2]