1. Nov/2023/Paper_ 9702/11/No.1

What is a reasonable estimate of the cross-sectional area of the wire in a paper clip?

A $1 \times 10^{-3}\,m^2$ **B** $8 \times 10^{-5}\,m^2$ **C** $8 \times 10^{-7}\,m^2$ **D** $1 \times 10^{-9}\,m^2$

2. Nov/2023/Paper_ 9702/11/No.2

Which quantity is **not** an SI base quantity?

A charge

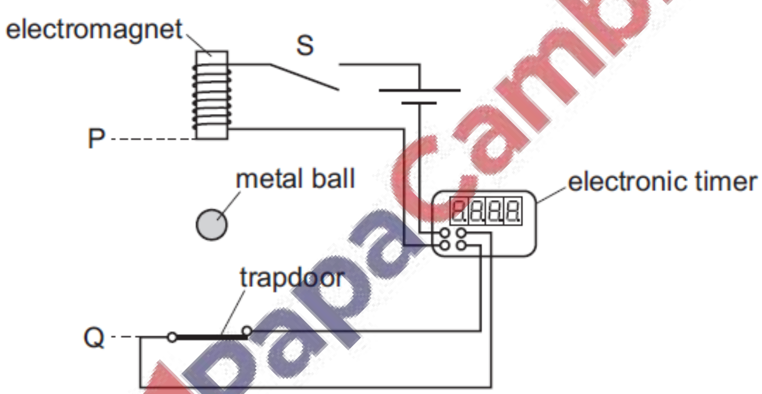
B mass

C temperature

D time

3. Nov/2023/Paper_ 9702/11/No.3

A student determines the acceleration of free fall by using a small metal ball, as shown.



When switch S is opened, the ball is released from an electromagnet and an electronic timer is started. The ball then falls vertically downwards. The timer stops when the ball hits a trapdoor. The student measures the distance PQ between the electromagnet and the trapdoor. This distance and the reading on the timer are then used to calculate the acceleration of free fall.

Which statement about errors in the experiment is correct?

A The random error can be reduced by adding the diameter of the ball to the distance PQ.

B The random error can be reduced by subtracting the diameter of the ball from the distance PQ.

C The systematic error can be reduced by adding the diameter of the ball to the distance PQ.

D The systematic error can be reduced by subtracting the diameter of the ball from the distance PQ.

4. Nov/2023/Paper_ 9702/12/No.1

A student estimates the maximum speed of some different moving objects.

Which maximum speed is **not** a reasonable estimate?

A container ship: $10\,m\,s^{-1}$

B Olympic sprinter: $0.1\,km\,s^{-1}$

C racing car: $9000\,cm\,s^{-1}$

D snail: $0.01\,km\,h^{-1}$

5. Nov/2023/Paper_ 9702/12/No.2

Which quantity is an SI base quantity?

A force

B newton

C second

D time

6. Nov/2023/Paper_ 9702/12/No.3

A student takes measurements to determine the constant acceleration of a model car moving from rest in a straight line. The measured values with their absolute uncertainties are shown.

quantity	measured value	uncertainty
displacement	16.5 m	± 0.1 m
time	15.0 s	± 1.0 s

The student uses the equation $s = \frac{1}{2}at^2$ to calculate the acceleration of the car.

What is the acceleration and its absolute uncertainty?

A $(0.11 \pm 0.01)\,m\,s^{-2}$

B $(0.11 \pm 0.02)\,m\,s^{-2}$

C $(0.15 \pm 0.01)\,m\,s^{-2}$

D $(0.15 \pm 0.02)\,m\,s^{-2}$

7. Nov/2023/Paper_ 9702/13/No.3

A set of repeated measurements is made of a fixed quantity. An average of these measurements is calculated.

What is the effect of averaging on the random error and the systematic error in the measurements?

A Random error and systematic error are both reduced.

B Random error and systematic error are both unaffected.

C Random error is reduced but systematic error is unaffected.

D Random error is unaffected but systematic error is reduced.

8. Nov/2023/Paper_ 9702/21/No.1

(a) Compare scalar and vector quantities.

....

....

.... [2]

(b) The radius of a small sphere is determined from a measurement of the volume of the sphere. The sphere is submerged in water, displacing some of the water into a measuring cylinder as shown in Fig. 1.1.

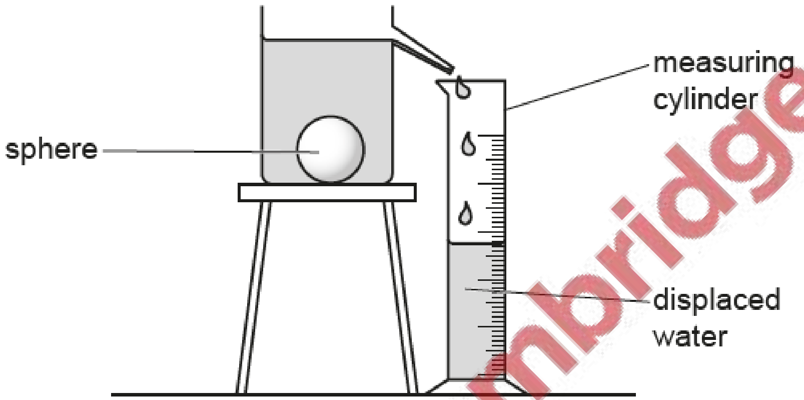


Fig. 1.1 (not to scale)

The measured volume of displaced water is $(28.0 \pm 0.5)\,cm^3$.

Calculate:

(i) the radius, in cm, of the sphere

radius = ... cm [1]

(ii) the percentage uncertainty in the radius of the sphere.

percentage uncertainty = ... % [2]

[Total: 5]

9. Nov/2023/Paper_ 9702/22/No.1(a)

(a) In the following list, underline **all** quantities that are SI base quantities.

charge   electric current   force   time   [1]

10. Nov/2023/Paper_ 9702/23/No.1

(a) Table 1.1 lists some physical quantities. Complete the table by placing a tick (✓) next to the scalar quantities.

Table 1.1

acceleration	
charge	
momentum	
power	
upthrust	

[1]

(b) A uniform cylinder has diameter D, length L and mass M.
The density ρ of the cylinder is given by

$$\rho = \frac{4M}{\pi D^2 L}.$$

Table 1.2 shows the data obtained from an experiment to determine the density of the cylinder.

Table 1.2

quantity	measurement	percentage uncertainty
D	(26.2 ± 0.1) mm	................%
L	(162 ± 1) mm	................%
M	(247 ± 1) g	0.4%

(i) Calculate the percentage uncertainties in D and L. Write your answers in Table 1.2.

[1]

(ii) Calculate the density of the cylinder. Give your answer to three significant figures.

density = ... $kg\,m^{-3}$ [2]

(iii) Calculate the percentage uncertainty in the density.

percentage uncertainty = ...% [2]

[Total: 6]