

# Additional Topic 1 questions

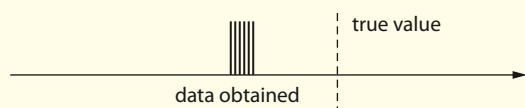
## ? Test yourself

### 1.1 Measurement in physics

- What is the radius of the Earth (6380 km) expressed in units of the Planck length?
- Assuming the entire universe to be made up of hydrogen gas, how many molecules of hydrogen are there?
- How many apples do you need to make up the mass of an average elephant?
- Give an order-of-magnitude estimate for the time taken by light to travel across the diameter of the Milky Way galaxy.
- Give an order-of-magnitude estimate for the gravitational force of attraction between two people 1 m apart.
- Calculate the acceleration of a block of mass 2.42 kg that is acted upon by a force of 15 N. ( $F = ma$ )

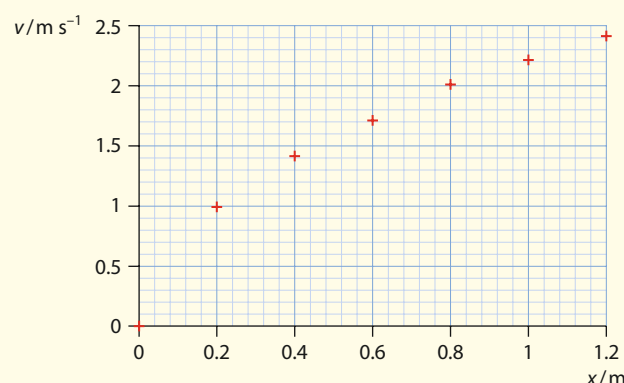
### 1.2 Uncertainties and errors

- The mass of a rectangular block is measured to be 2.2 kg with an uncertainty of 0.2 kg. The sides are measured as  $60 \pm 3$  mm,  $50 \pm 1$  mm and  $40 \pm 2$  mm. Find the density of the cube in kilograms per cubic metre, giving the uncertainty in the result.
- The radius  $r$  of a sphere is measured to be  $22.7 \text{ cm} \pm 0.2 \text{ cm}$ . Find the uncertainty in:
  - the surface area of the sphere
  - the volume of the sphere.
- The length of a pendulum is measured with a percentage uncertainty of 5% and the period with a percentage uncertainty of 6%. Find the percentage uncertainty in the measured value of the acceleration due to gravity.
- A student measured a given quantity many times and got the results shown in the diagram. The true value of the quantity is indicated by the dotted line.

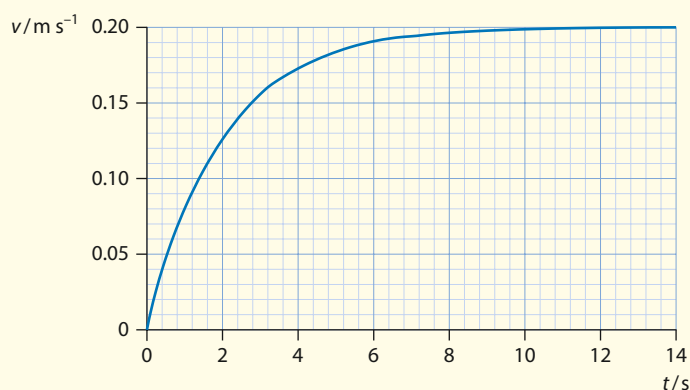


- Discuss whether she should continue accumulating more data in the hope of getting a result that agrees with the true value.
- Suggest whether the source of error is systematic or random.

- In yet another experiment, the following data was collected for current and voltage:  $(V, I) = \{(0.1, 29), (0.2, 46), (0.3, 62), (0.4, 80)\}$ , with uncertainty of  $\pm 4 \text{ mA}$  in the current.
  - Plot the current versus the voltage and draw the best-fit line. Suggest whether the current is proportional to the voltage.
  - The experimenter is convinced that the straight line fitting the data should go through the origin. What can allow for this?
- The velocity of an object after a distance  $x$  is given by  $v^2 = 2ax$ , where  $a$  is the constant acceleration. The graph shows the results of an experiment in which velocity and distance travelled were measured. Copy the graph and draw a smooth curve through the points. Estimate the acceleration and the velocity of the object after a distance of 2.0 m.



- A sphere and a cube have the same surface area. Which shape has the larger volume?
- The graph shows how the velocity of a steel ball depends on time as it falls through a viscous medium. Find the equation that gives the velocity as a function of time.



- 15 The table shows the data collected in an experiment.

$x/\pm 0.1$	$y$
1.0	$2.0 \pm 0.1$
2.0	$11.3 \pm 0.8$
3.0	$31 \pm 3$
4.0	$64 \pm 6$
5.0	$112 \pm 10$
6.0	$176 \pm 20$

- Plot  $y$  against  $x$  and draw the best-fit line.
- Assuming the suspected relationship between the variables is  $y = cx^{2.5}$ , plot the data in order to get a straight line and then find the value of the constant  $c$ .

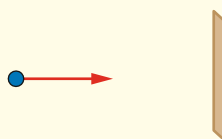
### 1.3 Vectors and scalars

- 16 A person walks 5.0 km due east, then 3.0 km due north and finally stops after walking an additional 2.0 km due north east. How far and in what direction relative to her starting point is she?

- 17 Vectors  $\mathbf{A}$  and  $\mathbf{B}$  have components ( $A_x = 3.00$ ,  $A_y = 4.00$ ) and ( $B_x = -1.00$ ,  $B_y = 5.00$ ). Find the magnitude and direction of the vector  $\mathbf{C}$  such that  $\mathbf{A} - \mathbf{B} + \mathbf{C} = 0$ .

- 18 Points P and Q have coordinates  $P = (x_1, y_1)$ ,  $Q = (x_2, y_2)$ .
- Find the components of the vector from P to Q.
  - What are the components of the vector from Q to P?
  - What is the magnitude of the vector from the origin to P?

- 19 A molecule with a velocity of  $352 \text{ ms}^{-1}$  collides with a wall as shown in the diagram, and bounces back with the same speed.



- What is the change in the molecule's velocity?
- What is the change in the speed?