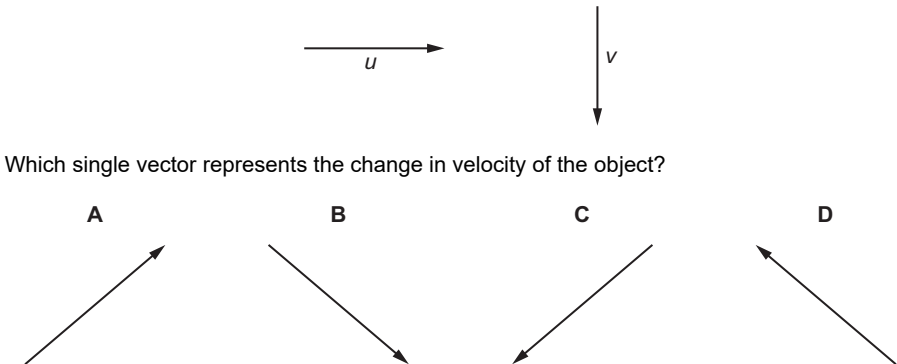


- 2 A small car travels in a town.
- What is a reasonable estimate of the kinetic energy of the car?
- A $5 \times 10^4 \text{ J}$ B $5 \times 10^7 \text{ J}$ C $5 \times 10^{10} \text{ J}$ D $5 \times 10^{13} \text{ J}$
- 3 A solid bar has a square cross-section. Its length is measured as $50.0 \pm 0.2 \text{ cm}$ and its width is measured as $2.00 \pm 0.01 \text{ cm}$.
- These values are used to calculate the volume of the bar.
- What is the percentage uncertainty in the calculated volume?
- A $\pm 0.21\%$ B $\pm 0.22\%$ C $\pm 0.90\%$ D $\pm 1.4\%$

- 1 Which unit is an SI base unit?
- A ampere
B coulomb
C degree Celsius
D gram
- 3 The velocity of an object changes from an initial velocity u to a final velocity v . The vectors represent these velocities.



- 1 (a) In the following list, underline all units that are SI base units.
- ampere degree Celsius kilogram newton [1]
- (b) Fig. 1.1 shows a horizontal beam clamped at one end with a block attached to the other end.

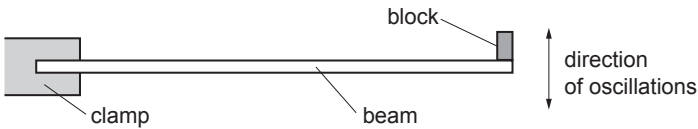


Fig. 1.1

The block is made to oscillate vertically.

The Young modulus E of the material of the beam is given by

$$E = \frac{kM}{T^2}$$

where M is the mass of the block,
 T is the period of the oscillations
and k is a constant.

A student determines the values and percentage uncertainties of k , M and T .
Table 1.1 lists the percentage uncertainties.

Table 1.1

quantity	percentage uncertainty
k	$\pm 2.1\%$
M	$\pm 0.6\%$
T	$\pm 1.5\%$

The student uses the values of k , M and T to calculate the value of E as $8.245 \times 10^9 \text{ Pa}$.

- (i) Calculate the percentage uncertainty in the value of E .

percentage uncertainty = % [2]

(ii) Use your answer in (b)(i) to determine the value of E , with its absolute uncertainty, to an appropriate number of significant figures.

$E = (\text{.....} \pm \text{.....}) \times 10^9 \text{ Pa}$ [2]

[Total: 5]

1 The rate of flow Q of a liquid along a narrow pipe of length L and radius r is given by

$$Q = \frac{\alpha r^4}{L}$$

where α is a constant.

An experiment is carried out to determine the value of α . The data from the experiment are shown in Table 1.1.

Table 1.1

quantity	value	percentage uncertainty
Q	$2.72 \times 10^{-8} \text{ m}^3 \text{ s}^{-1}$	$\pm 3\%$
r	$7.1 \times 10^{-5} \text{ m}$	$\pm 2\%$
L	$2.5 \times 10^{-2} \text{ m}$	$\pm 4\%$

(a) Use information in Table 1.1 to show that the SI base unit of α is s^{-1} .

[1]

(b) Show that the percentage uncertainty in α is 15%.

[1]

(c) Calculate α with its absolute uncertainty. Give your answer to an appropriate number of significant figures.

$\alpha = (\text{.....} \pm \text{.....}) \times 10^7 \text{ s}^{-1}$ [3]

[Total: 5]

2 (a) State what is meant by *work done*.

.....

..... [1]

(b) Use your answer in (a) to show that the SI base units of energy are $\text{kg m}^2 \text{s}^{-2}$.

[1]

(c) A metal rod is heated at one end so that thermal energy flows to the other end. The thermal energy E that flows through the rod in time t is given by

$$E = \frac{cA(T_1 - T_2)t}{L}$$

where A is the cross-sectional area of the rod,
 T_1 and T_2 are the temperatures of the ends of the rod,
 L is the length of the rod,
and c is a constant.

Determine the SI base units of c .

SI base units [3]

[Total: 5]

1 (a) A unit may be stated with a prefix that represents a power-of-ten multiple or submultiple.

Complete Table 1.1 to show the name and symbol of each prefix and the corresponding power-of-ten multiple or submultiple.

Table 1.1

prefix	power-of-ten multiple or submultiple
kilo (k)	10^3
tera (T)	
()	10^{-12}

[2]

(b) In the following list, underline all the units that are SI base units.

ampere coulomb metre newton [1]

(c) The potential difference V between the two ends of a uniform metal wire is given by

$$V = \frac{4\rho LI}{\pi d^2}$$

where d is the diameter of the wire,
 I is the current in the wire,
 L is the length of the wire,
and ρ is the resistivity of the metal.

For a particular wire, the percentage uncertainties in the values of some of the above quantities are listed in Table 1.2.

Table 1.2

quantity	percentage uncertainty
d	$\pm 3.0\%$
I	$\pm 2.0\%$
L	$\pm 2.5\%$
V	$\pm 3.5\%$

The quantities listed in Table 1.2 have values that are used to calculate ρ as $4.1 \times 10^{-7} \Omega \text{m}$.

For this value of ρ , calculate:

(i) the percentage uncertainty

percentage uncertainty =% [2]

(ii) the absolute uncertainty.

absolute uncertainty = Ωm [1]

[Total: 6]

1 (a) Underline **all** the SI base units in the following list.

ampere coulomb current kelvin newton [1]

(b) A toy car moves in a horizontal straight line. The displacement s of the car is given by the equation

$$s = \frac{v^2}{2a}$$

where a is the acceleration of the car and v is its final velocity.

State **two** conditions that apply to the motion of the car in order for the above equation to be valid.

1

2 [2]

(c) An experiment is performed to determine the acceleration of the car in (b). The following measurements are obtained:

$$s = 3.89 \text{ m} \pm 0.5\%$$

$$v = 2.75 \text{ m s}^{-1} \pm 0.8\%$$

(i) Calculate the acceleration a of the car.

$$a = \text{ m s}^{-2} \text{ [1]}$$

(ii) Determine the percentage uncertainty, to two significant figures, in a .

percentage uncertainty =% [2]

- (iii) Use your answers in (c)(i) and (c)(ii) to determine the absolute uncertainty in the calculated value of a .

absolute uncertainty = ms^{-2} [1]

[Total: 7]

- 1 (a) The boxes in Fig. 1.1 contain terms on the left-hand side and examples of these terms on the right-hand side.

Draw a line between each term on the left and the correct example on the right.

base quantity	coulomb
base unit	electric current
derived quantity	force
derived unit	kilogram

Fig. 1.1

[2]

- (b) A set of experimental measurements is described as precise and not accurate.

State what is meant by:

- (i) precise

.....
 [1]

- (ii) not accurate.

.....
 [1]

- (c) An object of mass m travels with speed v in a circle of radius r . The force F acting on the object is given by

$$F = \frac{mv^2}{r}.$$

The percentage uncertainties of three of the quantities are given in Table 1.1.

Table 1.1

quantity	percentage uncertainty
F	$\pm 3\%$
m	$\pm 4\%$
r	$\pm 5\%$

The value of v is determined from F , m and r .

- (i) Calculate the percentage uncertainty in v .

percentage uncertainty = % [2]

- (ii) The value of v is 15.0 m s^{-1} .

Calculate the absolute uncertainty in v .

absolute uncertainty = m s^{-1} [1]

[Total: 7]