Section A

1. Which pair of units contains one derived unit and one S*I* base unit?
   A ampere coulomb
   B kilogram kelvin
   C metre second
   D newton pascal

2. What is equivalent to 2000 microvolts?
   A $2\,\mu J\,C^{-1}$ **B** 2 mV **C** 2 pV **D** 2000 mV

3. The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation

$$v = k\left(\frac{\Delta P}{\rho}\right)^{n}$$

   where k is a constant that has no units.
   What is the value of n ?
   A $\frac{1}{2}$ **B** 1 **C** $\frac{3}{2}$ **D** 2

4. An experiment is carried out to measure the resistance of a wire.
   The current in the wire is (1.0 ± 0.2) A and the potential difference across the wire is (8.0 ± 0.4) V.
   What is the resistance of the wire and its uncertainty?
   A $(8.0 \pm 0.2)\Omega$
   B $(8.0 \pm 0.6)\Omega$
   C $(8 \pm 1)\Omega$
   D $(8 \pm 2)\Omega$

5. The Young modulus of the material of a wire is to be found. The Young modulus E is given by the equation below.

$$E = \frac{4Fl}{\pi d^2 x}$$

   The wire is extended by a known force and the following measurements are made.
   Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus?

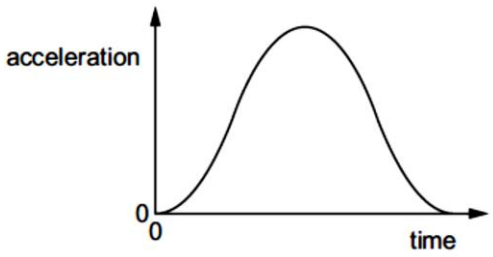
	measurement	symbol	value
A	length of wire before force applied	l	2.043 ± 0.002 m
B	diameter of wire	d	0.54 ± 0.02 mm
C	force applied	F	19.62 ± 0.01 N
D	extension of wire with force applied	x	5.2 ± 0.2 mm

6. A tennis ball is thrown horizontally in air from the top of a tall building.
If the effect of air resistance is not negligible, what happens to the horizontal and vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	constant	constant
B	constant	increases at a constant rate
C	decreases to zero	increases at a constant rate
D	decreases to zero	increases to a maximum value

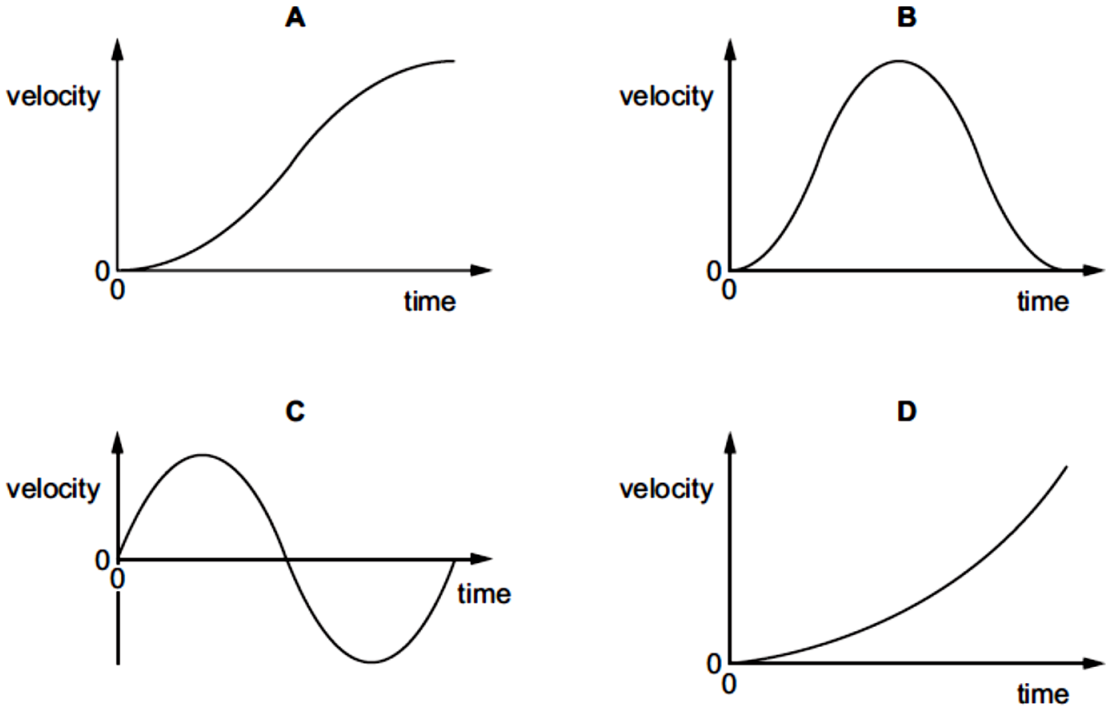
7. An object is thrown with velocity 5.2 m s^{-1} vertically upwards on the Moon. The acceleration due to gravity on the Moon is 1.62 m s^{-2}.
What is the time taken for the object to return to its starting point?
A 2.5 s B 3.2 s C 4.5 s D 6.4 s

8. The graph shows how the acceleration of an object moving in a straight line varies with time.



The object starts from rest.

Which graph shows the variation with time of the velocity of the object over the same time interval?



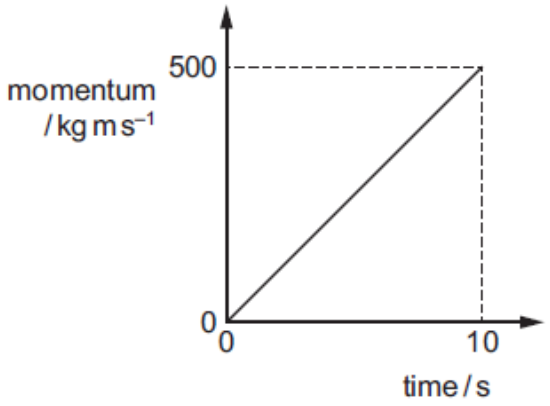
9. An object of mass 4.0 kg moving with a speed of 3.0 m s^{-1} strikes a stationary object in an inelastic collision.
Which statement is correct?
A After collision, the total kinetic energy is 18 J.

B After collision, the total kinetic energy is less than 18 J.

C Before collision, the total kinetic energy is 12 J.

D Before collision, the total kinetic energy is less than 12 J.

10. The graph shows how the momentum of a motorcycle changes with time.



What is the resultant force on the motorcycle?

A 50 N B 500 N C 2500 N D 5000 N

Section B

1. (a) (i) Define *velocity*.
(ii) Distinguish between *speed* and *velocity*.
(b) A car of mass 1500 kg moves along a straight, horizontal road. The variation with time *t* of the velocity *v* for the car is shown in Fig. 1.1.

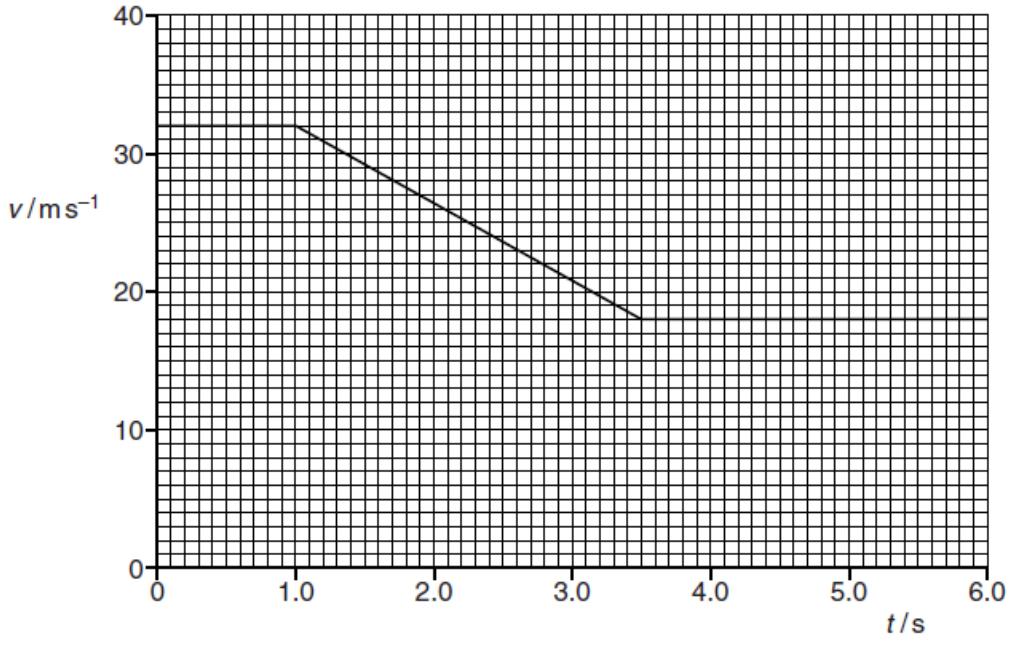


Fig. 1.1

The brakes of the car are applied from t = 1.0 s to t = 3.5 s.
For the time when the brakes are applied,

(i) calculate the distance moved by the car,

(ii) calculate the magnitude of the resultant force on the car.

(c) The direction of motion of the car in **(b)** at time t = 2.0 s is shown in Fig. 1.2.

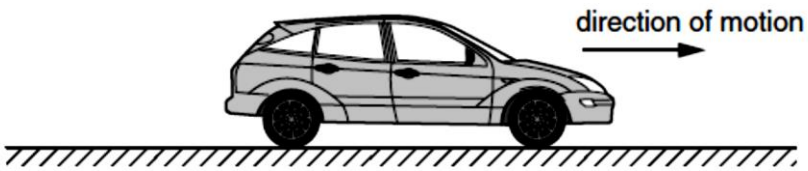


Fig. 1.2

On Fig. 1.2, show with arrows the directions of the acceleration (label this arrow A) and the resultant force (label this arrow F).

2. **(a)** State Newton's first law of motion.

(b) A box slides down a slope, as shown in Fig. 2.1.

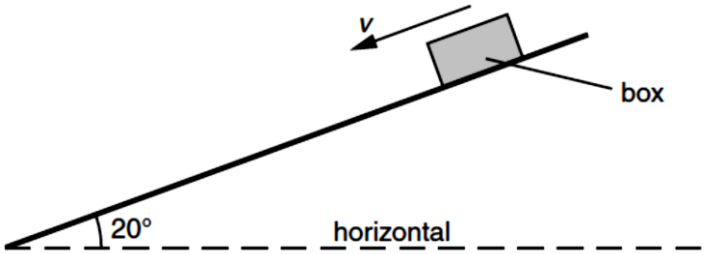


Fig 2.1

The angle of the slope to the horizontal is 20°. The box has a mass of 65 kg. The total resistive force R acting on the box is constant as it slides down the slope.

(i) State the names and directions of the other two forces acting on the box.

(ii) The variation with time t of the velocity v of the box as it moves down the slope is shown in Fig. 2.2.

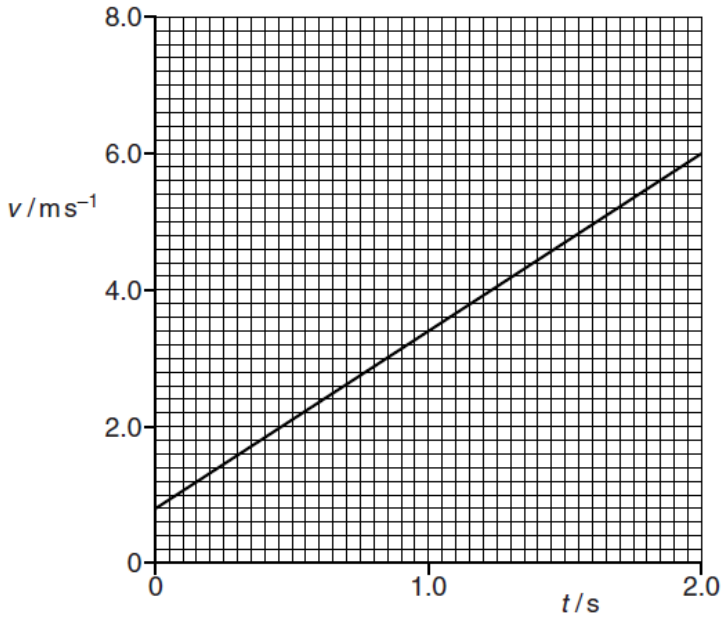


Fig 2.2

1. Use data from Fig. 2.2 to show that the acceleration of the box is 2.6 m s^{-2}.
2. Calculate the resultant force on the box.
3. Determine the resistive force *R* on the box.

3. **(a)** Explain what is meant by a *scalar* quantity and by a *vector* quantity.
(b) A ball leaves point P at the top of a cliff with a horizontal velocity of 15 m s^{-1}, as shown in Fig. 3.1.

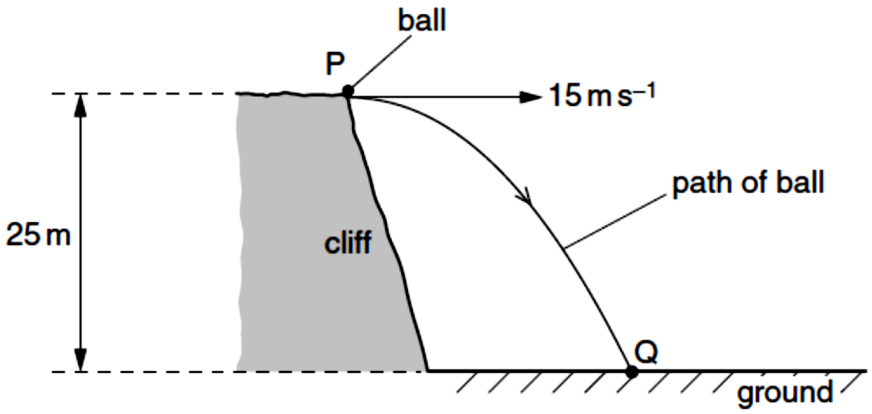


Fig 3.1

The height of the cliff is 25 m. The ball hits the ground at point Q.
Air resistance is negligible.

(i) Calculate the vertical velocity of the ball just before it makes impact with the ground at Q.
(ii) Show that the time taken for the ball to fall to the ground is 2.3 s.
(iii) Calculate the magnitude of the displacement of the ball at point Q from point P.
(iv) Explain why the distance travelled by the ball is different from the magnitude of the displacement of the ball.

4. **(a)** Mass, length and time are SI base quantities.
(b) A mass *m* is placed on the end of a spring that is hanging vertically, as shown in Fig. 4.1.

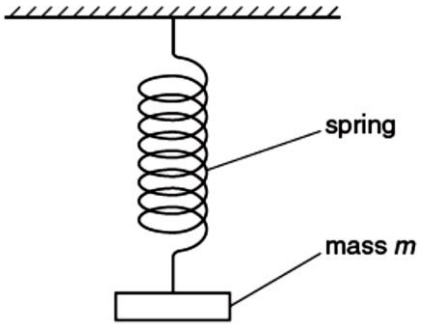


Fig 4.1

The mass is made to oscillate vertically. The time period of the oscillations of the mass is *T*.
The period *T* is given by

$$T = C\sqrt{\frac{m}{k}}$$

where *C* is a constant and *k* is the spring constant.
Show that *C* has no units.

5. **(a)** Define *pressure*.

(b) A cylinder is placed on a horizontal surface, as shown in Fig. 5.1.

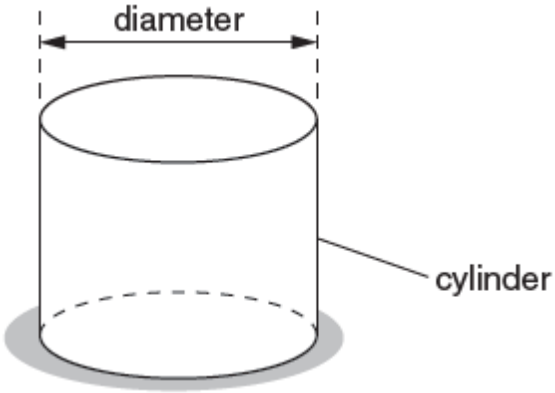


Fig 5.1

The following measurements were made on the cylinder:

mass = 5.09 ± 0.01 kg

diameter = 9.4 ± 0.1 cm.

(i) Calculate the pressure produced by the cylinder on the surface.

(ii) Calculate the actual uncertainty in the pressure.

(iii) State the pressure, with its actual uncertainty.

pressure = ... ± ..... Pa

6. A microphone detects a musical note of frequency *f*. The microphone is connected to a cathode- ray oscilloscope (c.r.o.). The signal from the microphone is observed on the c.r.o. as illustrated in Fig. 6.1.

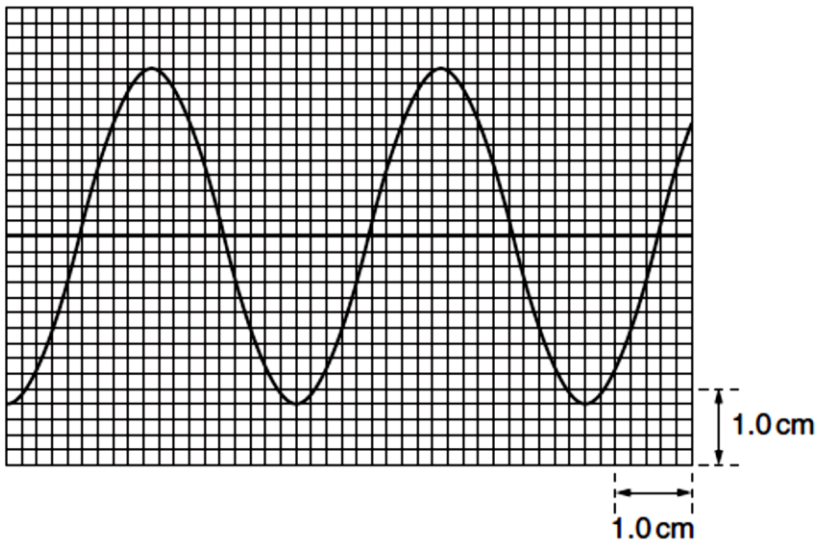


Fig 6.1

The time-base setting of the c.r.o. is 0.50 ms cm^{-1}. The Y-plate setting is 2.5 mV cm^{-1}.

(a) Use Fig. 6.1 to determine

(i) the amplitude of the signal,

(ii) the frequency *f*,

(iii) the actual uncertainty in *f* caused by reading the scale on the c.r.o.

(b) State *f* with its actual uncertainty.

f = ... ± ..... Hz