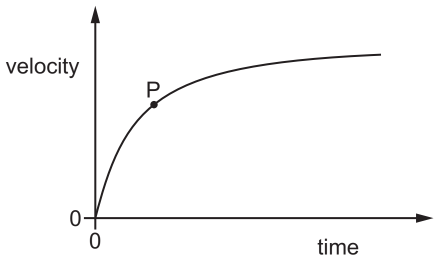
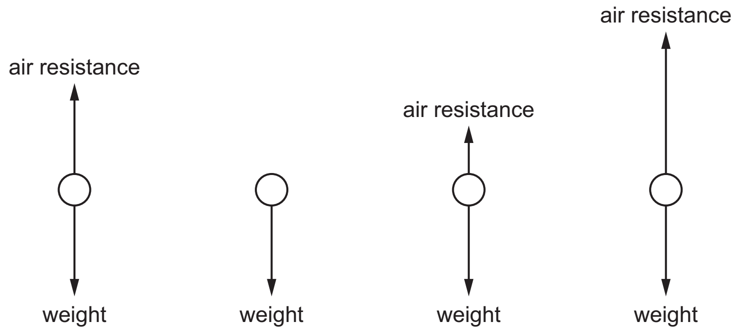
8 A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.



Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?

A **B** **C** **D**



9 In which situation is total linear momentum **always** conserved?

A in all collisions between two objects

B in collisions between two objects moving at equal and opposite velocity

C in collisions between two objects that form an isolated system

D in collisions between two objects with the same mass

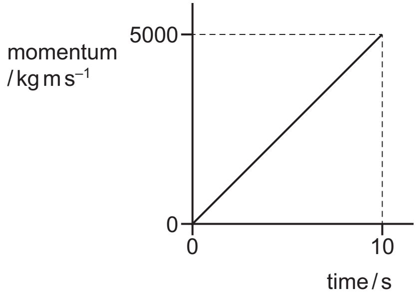
10 An object of mass m moving with velocity $9.0\,\mathrm{m\,s^{-1}}$ has a head-on elastic collision with a stationary object of mass $2m$.

After the collision, both objects are moving. No external forces act on the system.

What is the velocity of the object of mass $2m$ after the collision?

A $-6.0\,\mathrm{m\,s^{-1}}$ **B** $-3.0\,\mathrm{m\,s^{-1}}$ **C** $4.5\,\mathrm{m\,s^{-1}}$ **D** $6.0\,\mathrm{m\,s^{-1}}$

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



What is the resultant force on the motorcycle?

A 500 N **B** 5000 N **C** 25 000 N **D** 50 000 N

12 A rocket has a weight of W and an initial acceleration of a as the rocket leaves the ground vertically. The acceleration of free fall is g.

Which expression gives the initial upward force exerted on the rocket due to the engine?

A $\dfrac{Wa}{g} + W$ **B** $\dfrac{Wa}{g}$ **C** $\dfrac{Wa}{g} - W$ **D** $Wa + W$

1 Scientists are investigating the variation in air pressure at different locations on a mountain.

(a) The scientists take measurements of several physical quantities at each location.

Complete Table 1.1 by stating the SI base unit for each quantity and identifying with a tick (✓) whether each quantity is a scalar or a vector. Use the space for any working.

Table 1.1

quantity measured	SI base unit	scalar	vector
air temperature			
air pressure			

[2]

(b) (i) At one location, the density of the air is $1.1\,\text{kg}\,\text{m}^{-3}$. A spherical weather balloon is filled with a gas and released from rest. The balloon has radius 0.90 m.

Calculate the upthrust acting on the balloon when it is released.

upthrust = ... N [2]

(ii) Explain why an upthrust acts on the balloon.

....

....

....

.... [2]

(iii) The balloon has weight 19 N.

Calculate the magnitude of the initial acceleration of the balloon.

acceleration = ... $\text{m}\,\text{s}^{-2}$ [3]

(c) A quantity c relating to the motion of the balloon is calculated from three measured quantities k, F and v using the formula

$$c = \frac{2kF}{v^2}.$$

The percentage uncertainties in the measured quantities are given in Table 1.2.

Table 1.2

measured quantity	percentage uncertainty
k	5%
F	3%
v	4%

The calculated value of c is 1.8.

Determine the absolute uncertainty in c.

absolute uncertainty = ... [2]

[Total: 11]

2 **(a)** **(i)** Define pressure.

....

.... [1]

(ii) Explain how hydrostatic pressure results in an upthrust force acting on a solid object immersed in a liquid.

....

....

....

.... [2]

(b) A small steel ball of radius r and mass m falls vertically at terminal speed v through oil.

The viscous drag force D that acts on the ball is given by

$$D = 6\pi\eta rv$$

where η is a property of the oil called its viscosity.

(i) On Fig. 2.1, draw labelled arrows from the ball to show the directions of the **three** forces that act on the ball as it falls.

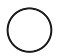


Fig. 2.1

[3]

(ii) Determine the SI base units of η.

base units .... [2]

(c) The oil in **(b)** has a density of $920\,\text{kg}\,\text{m}^{-3}$ and a viscosity of 4.7 in SI units.

The steel ball has a mass of $2.4 \times 10^{-3}\,\text{kg}$ and a radius of $4.2 \times 10^{-3}\,\text{m}$.

(i) Show that the upthrust force acting on the ball is $2.8 \times 10^{-3}\,\text{N}$.

[1]

(ii) Determine the terminal speed v of the ball.

v = ... $\text{m}\,\text{s}^{-1}$ [3]

[Total: 12]

2 **(a)** Define linear momentum.

....

.... [1]

(b) A car of mass 1800 kg is moving in a straight line. Fig. 2.1 shows the variation with time t of the momentum p of the car.

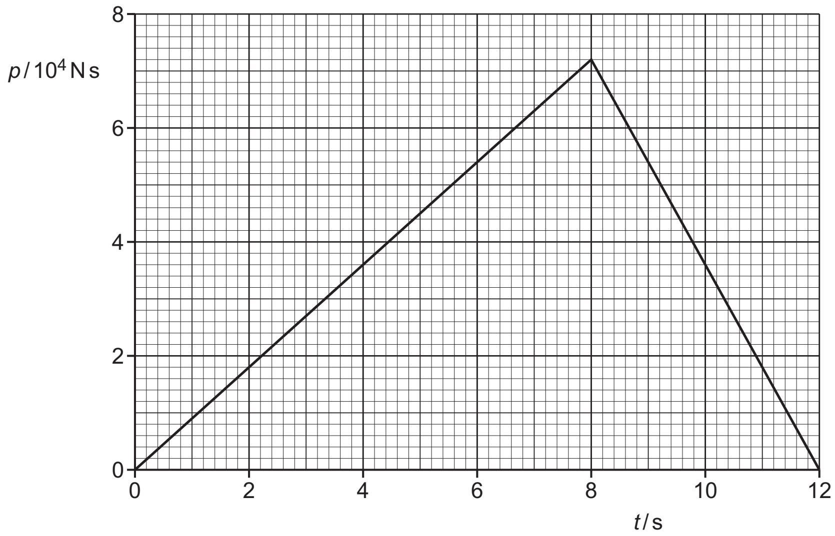


Fig. 2.1

(i) Calculate the maximum speed reached by the car.

maximum speed = ... $m s^{-1}$ [1]

(ii) Calculate the maximum kinetic energy of the car.

maximum kinetic energy = ... J [2]

(iii) Show that the acceleration of the car at time t = 4.0 s is 5.0 $m s^{-2}$.

[2]

(iv) Determine the distance travelled by the car between times t = 0 and t = 12.0 s.

distance = ... m [2]

(c) On Fig. 2.2, sketch the variation with time t of the acceleration a of the car in **(b)** from t = 0 to t = 12.0 s.

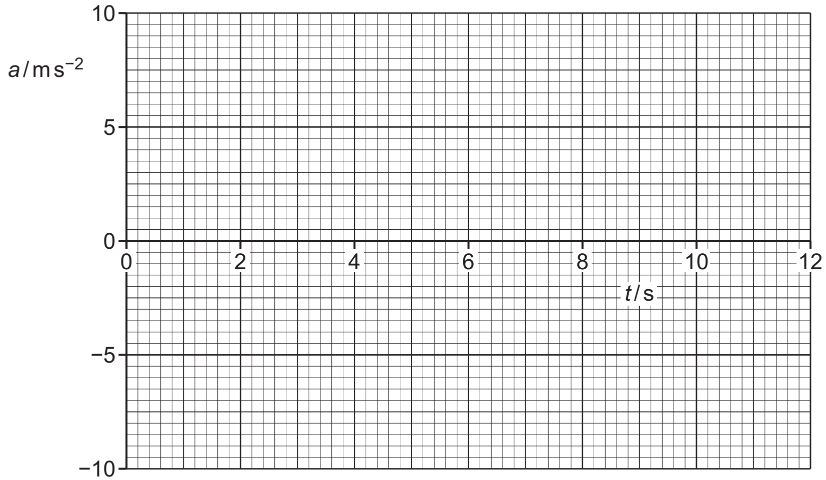


Fig. 2.2

[3]

[Total: 11]