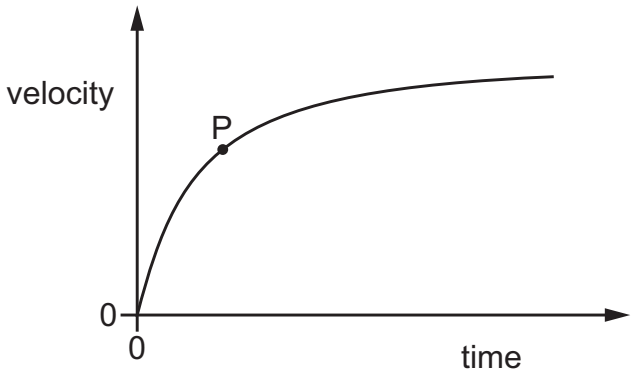
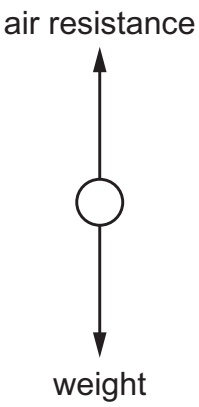
8 A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.



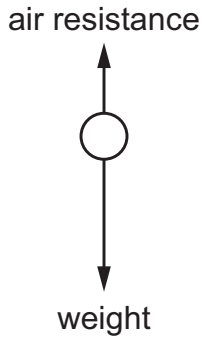
Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?

A

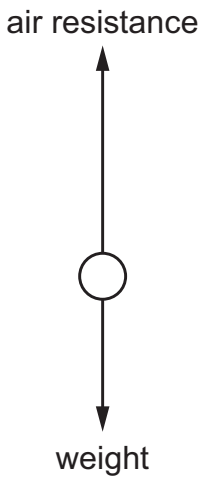


B

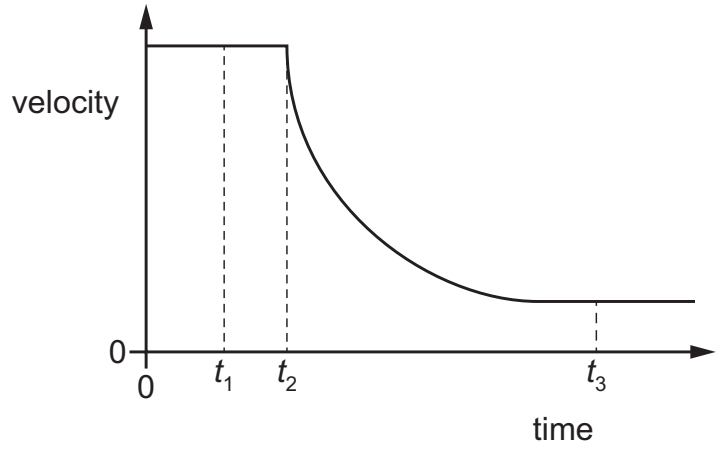
C



D



11 A skydiver is falling at constant velocity. She then opens her parachute. The graph shows the variation with time of her velocity.



Which statements about the motion of the skydiver are correct?

1 The magnitude of the acceleration is maximum at time t_2.

2 The magnitude of the drag force at time t_1 equals the magnitude of the drag force at time t_3.

3 The magnitude of the drag force is maximum at time t_1.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

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 kg m^{-3} and a viscosity of 4.7 in SI units.

The steel ball has a mass of 2.4×10^{-3} kg and a radius of 4.2×10^{-3} m.

(i) Show that the upthrust force acting on the ball is 2.8×10^{-3} N.

[1]

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

v = ... m s^{-1} [3]

[Total: 12]

20 A parachutist is falling at constant (terminal) velocity.

Which statement is **not** correct?

A Gravitational potential energy is converted into kinetic energy of the air.

B Gravitational potential energy is converted into kinetic energy of the parachutist.

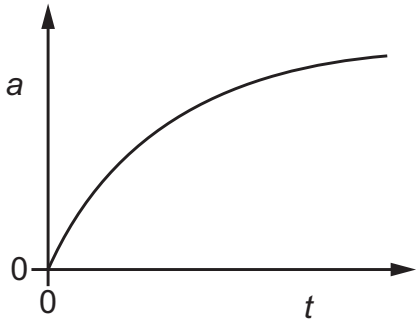
C Gravitational potential energy is converted into thermal energy of the air.

D Gravitational potential energy is converted into thermal energy of the parachutist.

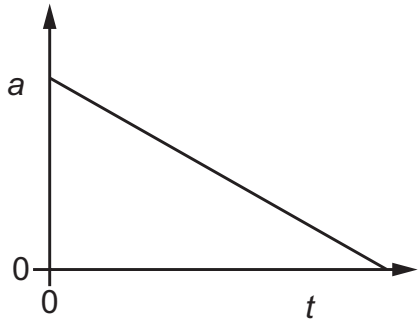
12 A stone is released from rest and falls a long distance in air.

Which graph could show the variation with time *t* of the acceleration *a* of the stone?

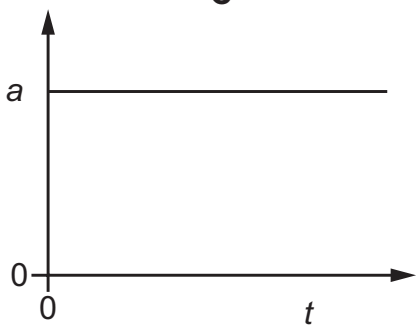
A



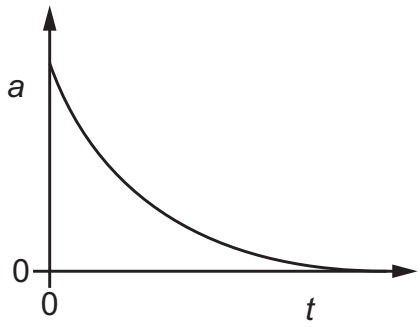
B



C



D



8 Two spheres are released from rest at equal heights above the ground.

Both spheres reach terminal velocity.

One sphere has a larger density than the other sphere.

Both spheres have equal volumes.

Which statement is correct while both spheres are at terminal velocity?

A The drag forces on the spheres are equal.

B The resultant forces on the spheres are equal.

C The velocities of the spheres are equal.

D The weights of the spheres are equal.

8 A skydiver is falling vertically with terminal velocity when their parachute opens fully.

Which statement describes the motion of the skydiver for the first few seconds after the parachute opens fully?

A falling with non-uniform acceleration and increasing speed

B falling with non-uniform acceleration and decreasing speed

C falling with uniform acceleration and increasing speed

D falling with uniform acceleration and decreasing speed

3 A car of mass 1500 kg is travelling along a straight horizontal road at constant velocity v. The car is subject to a total resistive force F, as shown in Fig. 3.1.

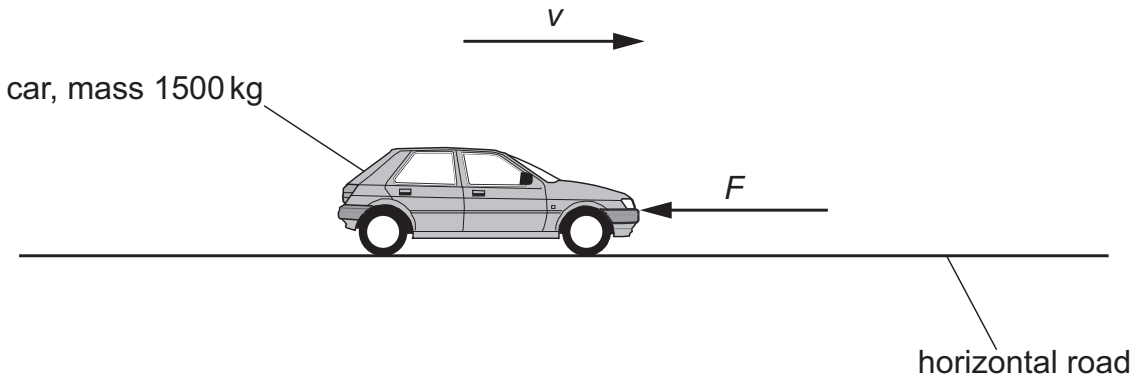


Fig. 3.1

(a) Show that the power P developed by the engine in overcoming the total resistive force is given by the equation

$$P = Fv .$$

[2]

(b) The car now moves up a slope at a constant speed of $30\,m\,s^{-1}$.
The slope is at an angle to the horizontal of 6.0°, as shown in Fig. 3.2.

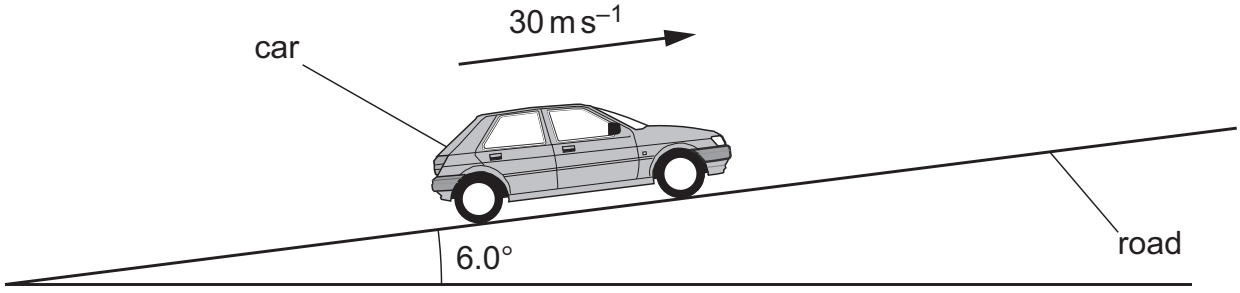


Fig. 3.2

The total resistive force acting on the car is 1600 N.

(i) Show that the increase in gravitational potential energy of the car in a time of 1.0 s is 46 000 J.

[2]

(ii) Use the information in **(b)(i)** to determine the power developed by the engine to move the car up the slope.

power = ... W [2]

(c) The car picks up a passenger and then continues up the slope at the same speed as in **(b)**.

State and explain the effect, if any, that the passenger has on:

(i) the air resistance acting on the car

.....

..... [1]

(ii) the power developed by the engine.

.....

..... [1]

[Total: 8]