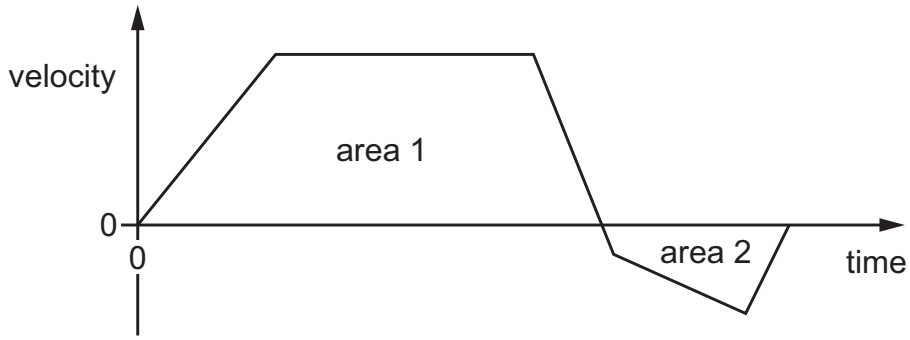
7 The velocity–time graph for an object is shown.



Which expression gives the total displacement of the object?

A area 1 – area 2

B $\frac{(\text{area 1} + \text{area 2})}{2}$

C area 1 + area 2

D area 2 – area 1

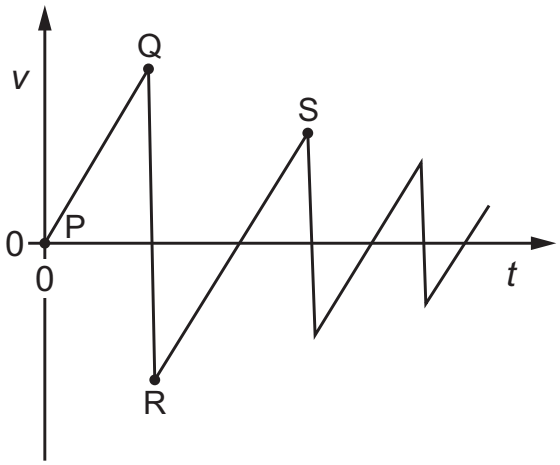
5 A goods train passes through a station at a constant speed of $10\,\text{m}\,\text{s}^{-1}$ at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of $0.5\,\text{m}\,\text{s}^{-2}$ just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

A 6 s **B** 10 s **C** 20 s **D** 40 s

6 A ball is held above the ground and released. It falls to the ground and bounces several times.

The graph shows the variation with time *t* of the velocity *v* of the ball.



Four points on the graph are labelled P, Q, R and S.

Which statement is **not** correct?

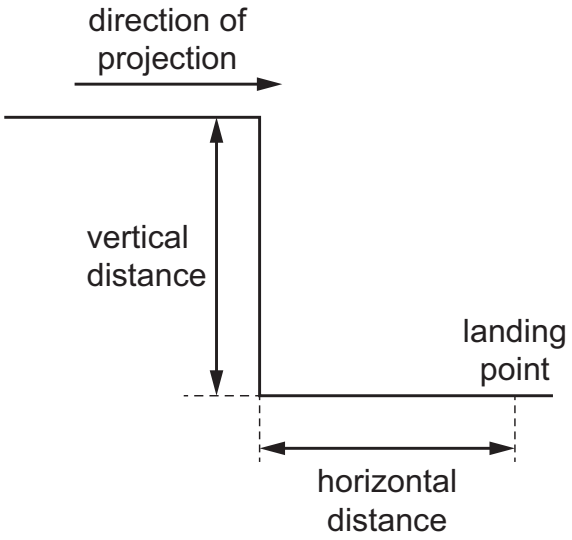
A The area under line PQ represents the initial height of the ball.

B The collisions of the ball with the ground are inelastic.

C The gradient of the line RS represents the acceleration due to free fall.

D The maximum upwards velocity of the ball is reached at point P.

7 An object is projected horizontally. The object falls a vertical distance *y* and travels a horizontal distance *x* before landing on the ground.



A second object is projected horizontally with the same initial velocity and falls a vertical distance 4*y* before landing on the ground.

Assume that air resistance is negligible.

Which horizontal distance does the second object travel?

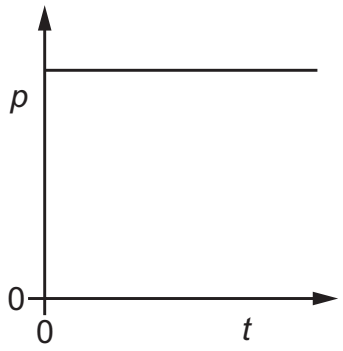
A *x** **B** 2*x** **C** 4*x** **D** 16*x*

4 An object falls from rest towards the ground.

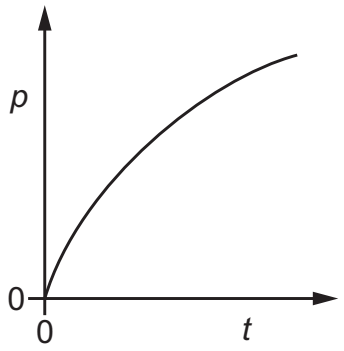
Air resistance is negligible.

Which graph shows the variation of the momentum p of the object with time t until it hits the ground?

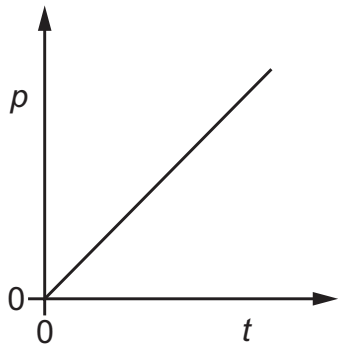
A



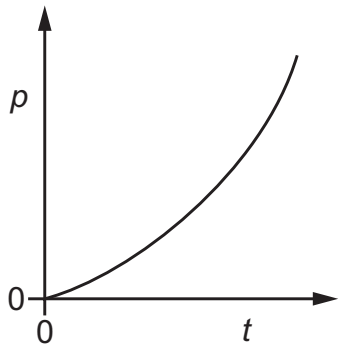
B



C



D



1 **(a)** Define acceleration.

.....

..... [1]

(b) A rocket is launched vertically from the surface of the Earth.

Fig. 1.1 shows the variation of the velocity of the rocket with time for the first 20 s after its launch.

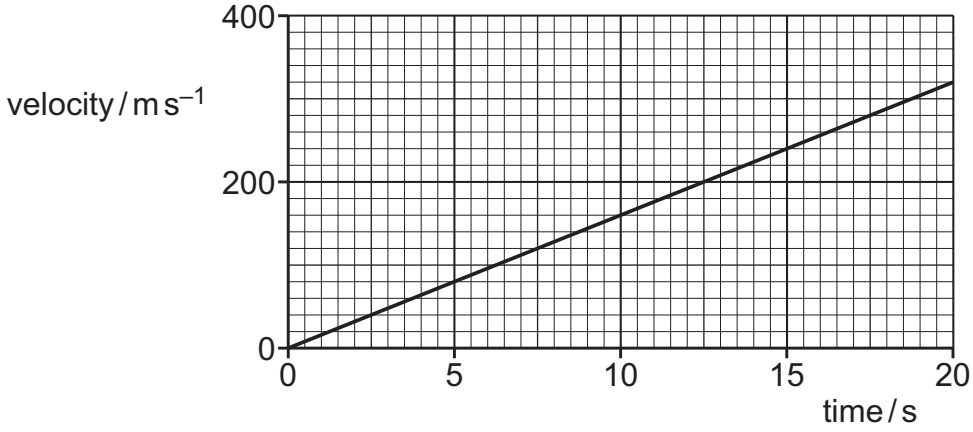


Fig. 1.1

(i) Determine the acceleration of the rocket.

acceleration = ... $m\,s^{-2}$ [1]

(ii) Show that the height of the rocket above the surface of the Earth at a time of 20 s after launch is 3.2 km.

[2]

(c) The mass of the rocket in **(b)** is 2.9×10^6 kg. Assume that this mass remains constant.

For this rocket, from launch to its height at a time of 20 s after launch:

(i) calculate the gain in gravitational potential energy ΔE_P

ΔE_P = ... J [2]

(ii) calculate the gain in kinetic energy ΔE_K

ΔE_K = ... J [2]

(iii) determine the average power output of the rocket engines. Assume that resistive forces are negligible.

power = ... W [2]

[Total: 10]

1 **(a)** Define velocity.

.....

..... [1]

(b) In an experiment, two objects A and B are released from the side of a building, as shown in Fig. 1.1.

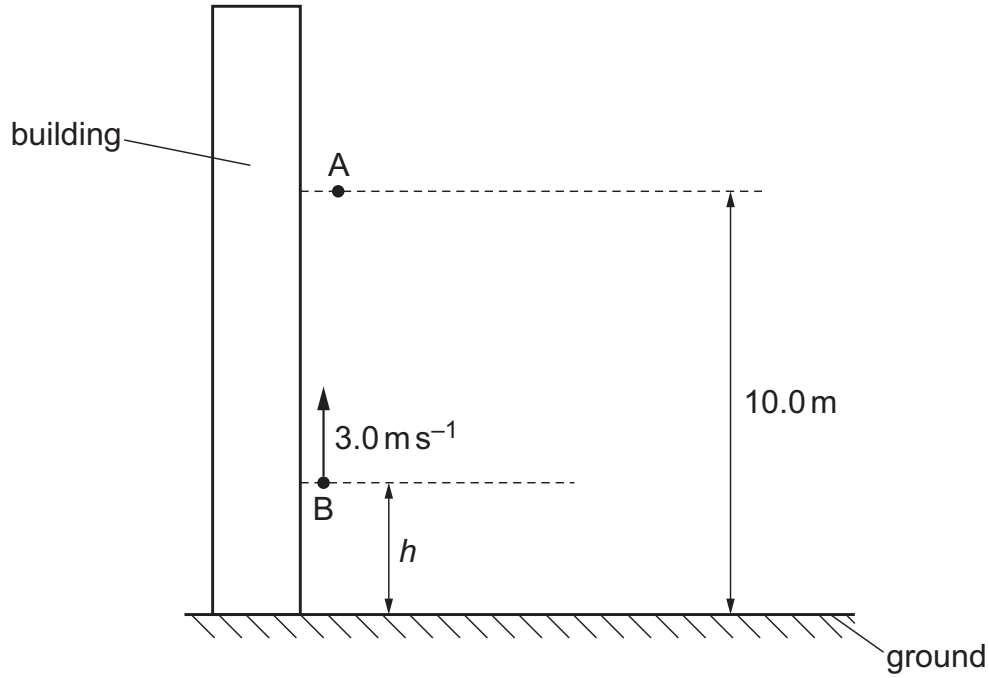


Fig. 1.1 (not to scale)

Object A is released from rest at a height of 10.0 m above horizontal ground.
Object B is released with an initial upward velocity of 3.0 m s^{-1} at a height *h* above the ground.
Both objects take the same time to reach the ground and they do not collide with each other.
Air resistance is negligible.

Calculate *h*.

h = ... m [3]

(c) In a second experiment, object B is released from the same height as in **(b)** but with a speed of $6.0\,m\,s^{-1}$ at an angle of 60° to the vertical, as shown in Fig. 1.2.

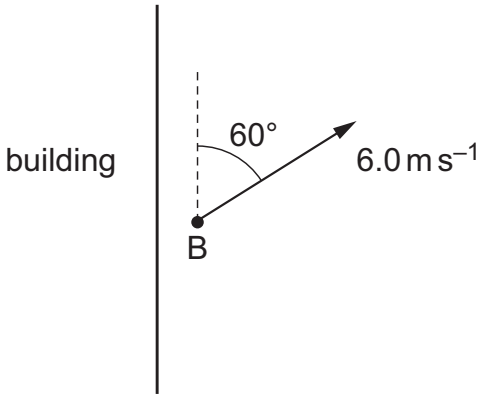


Fig. 1.2

(i) State and explain whether the time taken for object B to reach the ground is less than, the same as, or greater than the time taken in the first experiment.

.....

.....

..... [2]

(ii) By considering energy, state and explain whether the speed at which object B reaches the ground is less than, the same as, or greater than in the first experiment.

.....

.....

..... [2]

[Total: 8]

1 A thin solid disc of radius r and thickness z is attached to a thin axle. String is wrapped around the axle, as shown in Fig. 1.1.

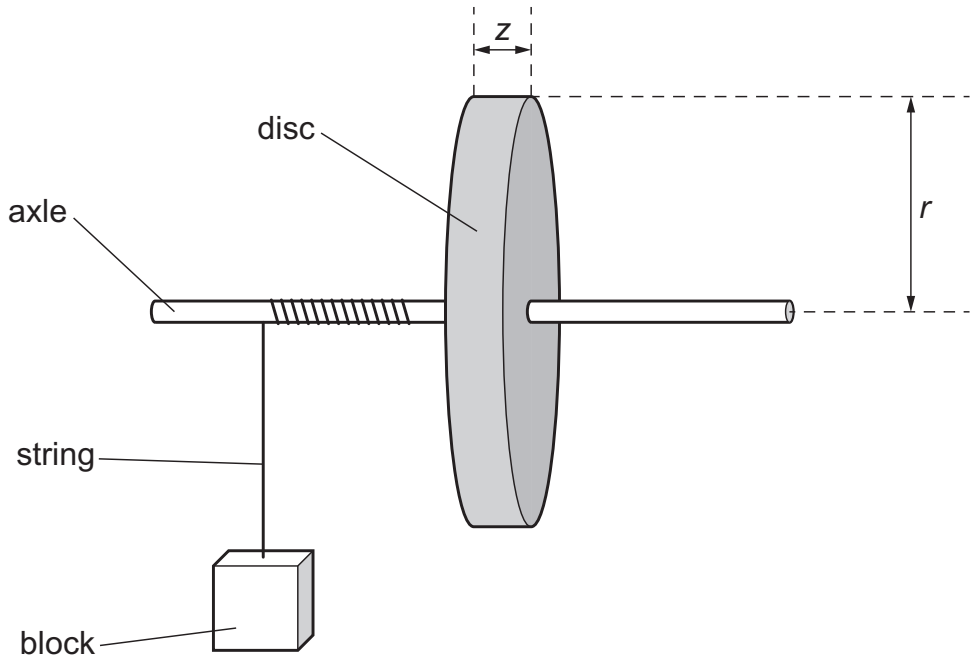


Fig. 1.1

A block of mass m is attached to the string.

The block is released from rest and falls downwards. The block has speed v when it has fallen through a distance h from the point of release. The value of v is determined using **one** light gate connected to a timer.

It is suggested that v is related to m by the relationship

$$\frac{h}{v^2} = \frac{\pi r^2 z}{2PQm} + \frac{1}{P}$$

where P and Q are constants.

Plan a laboratory experiment to test the relationship between v and m.

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for P and Q.

In your plan you should include:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

Diagram

[15]