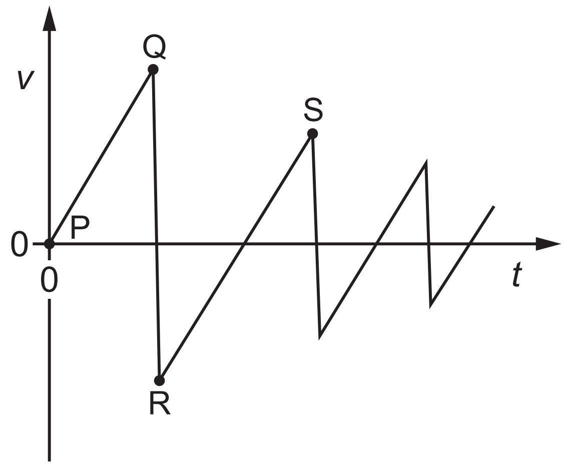
5 A goods train passes through a station at a constant speed of $10\,m\,s^{-1}$ at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of $0.5\,m\,s^{-2}$ just as the goods train goes past. Both trains move in the same direction on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

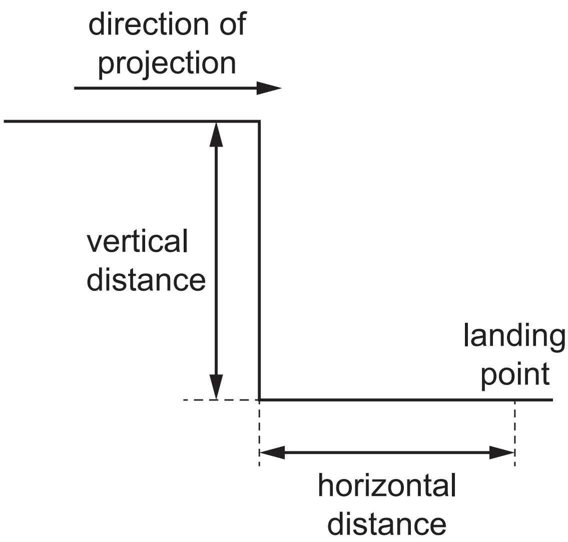
A The area under line PQ represents the initial height of the ball.

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 $4y$ before landing on the ground.

Assume that air resistance is negligible.

Which horizontal distance does the second object travel?

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

A-Level Physics: **w25 12**

5 A car has an initial velocity u. The car then moves with constant acceleration a in a straight line through a displacement d. The car reaches a final velocity v.

Which expression gives the initial velocity u of the car?

A $v - ad$ **B** $\sqrt{v^2 - 2ad}$ **C** $v + ad$ **D** $v - \frac{1}{2}ad^2$

6 A bicycle brakes so that it undergoes uniform deceleration from a speed of $8\,\mathrm{m\,s^{-1}}$ to $6\,\mathrm{m\,s^{-1}}$ over a distance of 7 m.

The deceleration of the bicycle remains constant.

Which further distance will the bicycle travel before coming to rest?

A 7 m **B** 9 m **C** 16 m **D** 21 m

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.

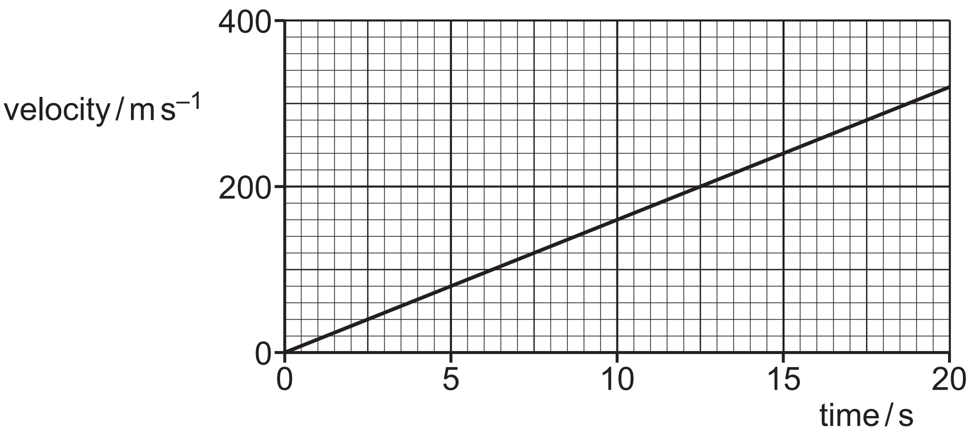


Fig. 1.1

(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 child kicks a ball so that it leaves horizontal ground with a velocity of $28\,\mathrm{m\,s^{-1}}$ at an angle of 34° to the horizontal, as shown in Fig. 1.1.

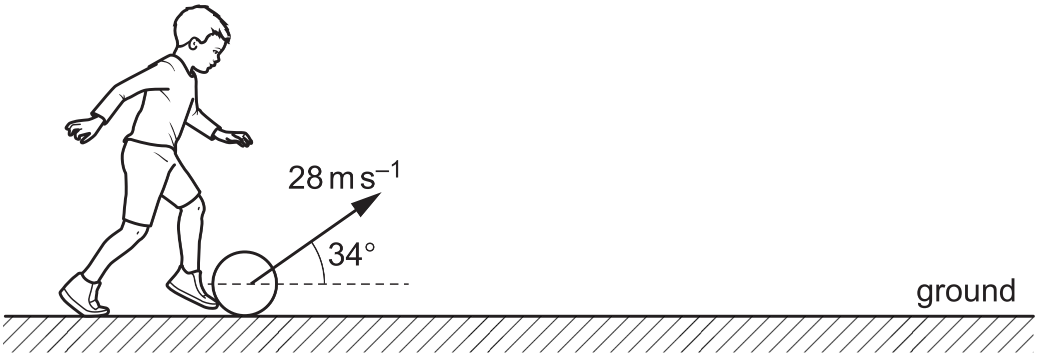


Fig. 1.1

Air resistance is negligible. The ball leaves the ground at time $t = 0$.

(a) (i) Calculate the horizontal component v_H and the vertical component v_V of the velocity of the ball immediately after it has left the ground.

v_H = ... $\mathrm{m\,s^{-1}}$

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

(ii) Show that the ball reaches its maximum height at time $t = 1.6\,\mathrm{s}$.

[1]

(iii) On Fig. 1.2, sketch the variation of v_H with time t between $t = 0$ and $t = 3.2$ s. Label your line H.

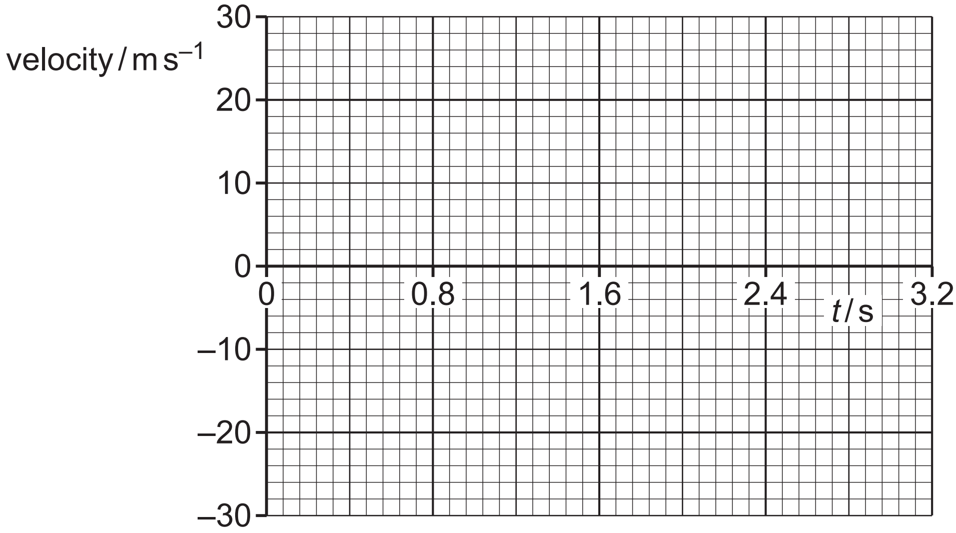


Fig. 1.2

[1]

(iv) On Fig. 1.2, sketch the variation of v_V with time t between $t = 0$ and $t = 3.2$ s. Assume that velocity in the upward direction is positive. Label your line V. [3]

(b) The total change in momentum of the ball between leaving the ground at $t = 0$ and landing on the ground at $t = 3.2$ s is 13 kg m s^{-1}.

(i) Define momentum.

....

.... [1]

(ii) Calculate the force that acts on the ball while it is in the air.

force = ... N [2]

(iii) Determine the mass of the ball.

mass = ... kg [1]

[Total: 11]

7 Which equation of uniformly accelerated motion can be derived using only the gradient of a velocity–time graph?

A $s = \frac{1}{2}(u + v)t$

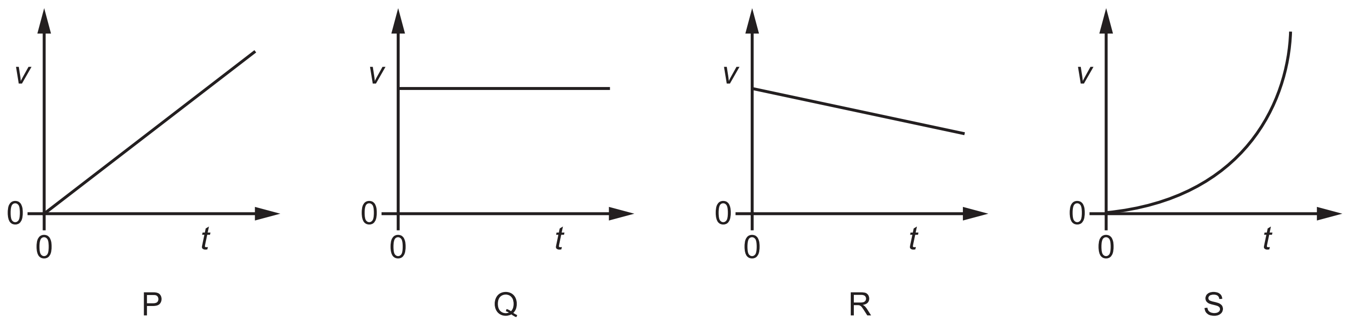
B $s = ut + \frac{1}{2}at^2$

C $v = u + at$

D $v^2 = u^2 + 2as$

8 An object is projected horizontally from a table at time t = 0. The object falls in a uniform gravitational field. Air resistance is negligible.

Graphs P, Q, R and S are velocity–time graphs.



Which graphs represent the horizontal and vertical components of the velocity of the object?

	horizontal	vertical
A	Q	P
B	Q	S
C	R	P
D	R	S

1 **(a)** Define acceleration.

....

.... [1]

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

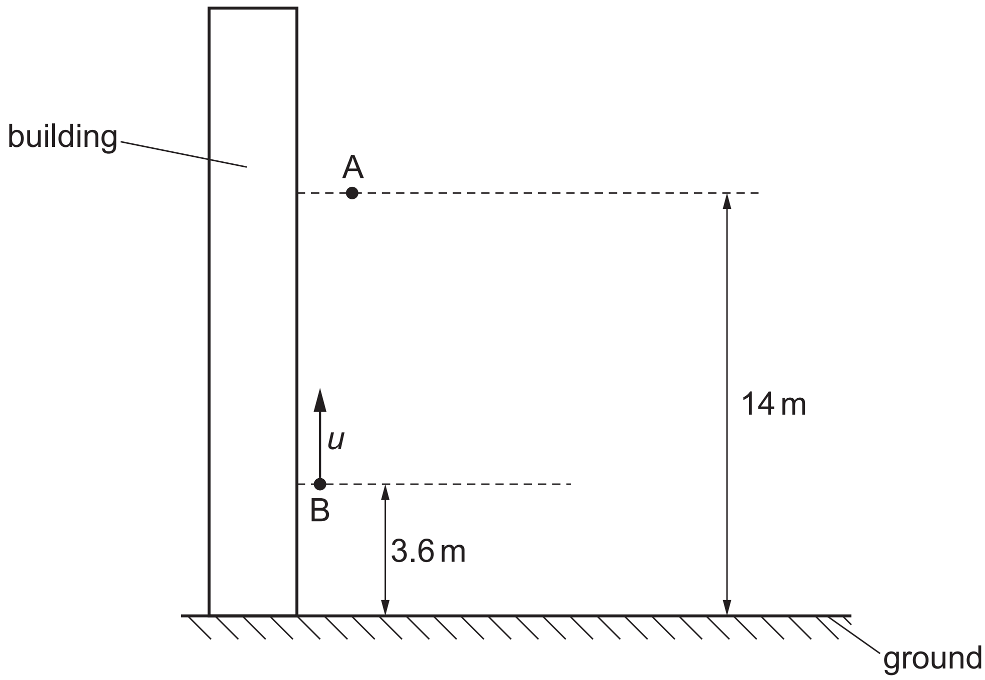


Fig. 1.1 (not to scale)

Object A is released from rest at a height of 14 m above the horizontal ground.
Object B is released with an initial upwards vertical velocity u at a height of 3.6 m 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.

(i) Calculate the time taken for object A to reach the ground.

time = ... s [2]

(ii) Use your answer in **(b)(i)** to calculate u.

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

(c) In a second experiment, object B is released from the same height and given the same initial speed as in **(b)** but at a release angle θ to the vertical, as shown in Fig. 1.2.

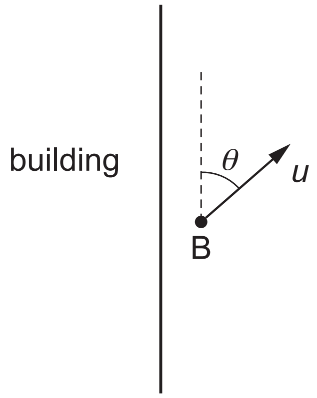


Fig. 1.2

(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 in **(b)(i)**.

....

....

.... [2]

(ii) By considering energy, state and explain the effect of the change in release angle on the speed at which B reaches the ground.

....

....

.... [2]

[Total: 9]

4 An aircraft, initially stationary on a runway, takes off with a speed of $85\,\text{km}\,\text{h}^{-1}$ in a distance of no more than 1.20 km.

What is the minimum constant acceleration necessary for the aircraft?

A $0.23\,\text{m}\,\text{s}^{-2}$ **B** $0.46\,\text{m}\,\text{s}^{-2}$ **C** $3.0\,\text{m}\,\text{s}^{-2}$ **D** $6.0\,\text{m}\,\text{s}^{-2}$

3 **(a)** A truck R of mass 9400 kg moves with constant acceleration in a straight line down a slope, as illustrated in Fig. 3.1.

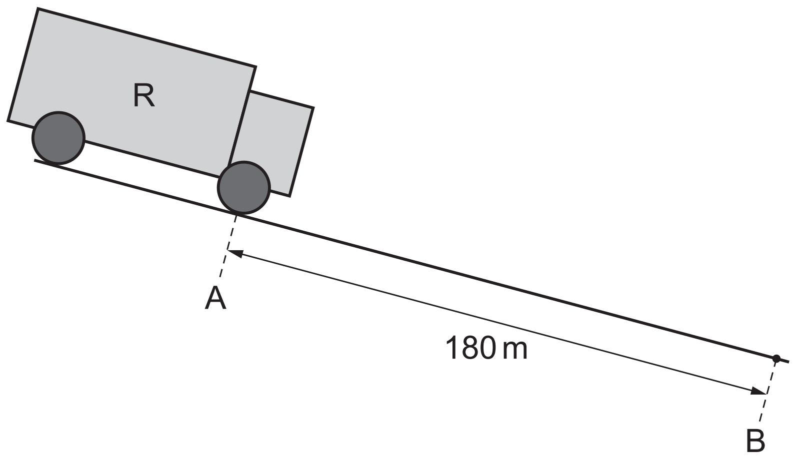


Fig. 3.1

At point A the speed of the truck is 13 m s^{-1} and at point B the speed of the truck is 22 m s^{-1}. A and B are a distance of 180 m apart.

(i) Calculate the acceleration of the truck between A and B.

acceleration = ... m s^{-2} [2]

(ii) Determine the gain in kinetic energy of the truck between A and B.

gain in kinetic energy = ... J [3]

(b) A short time after passing point B truck R moves in a straight line on horizontal ground. The driver of the truck applies the brakes. Fig. 3.2 shows the variation with time of the momentum of the truck.

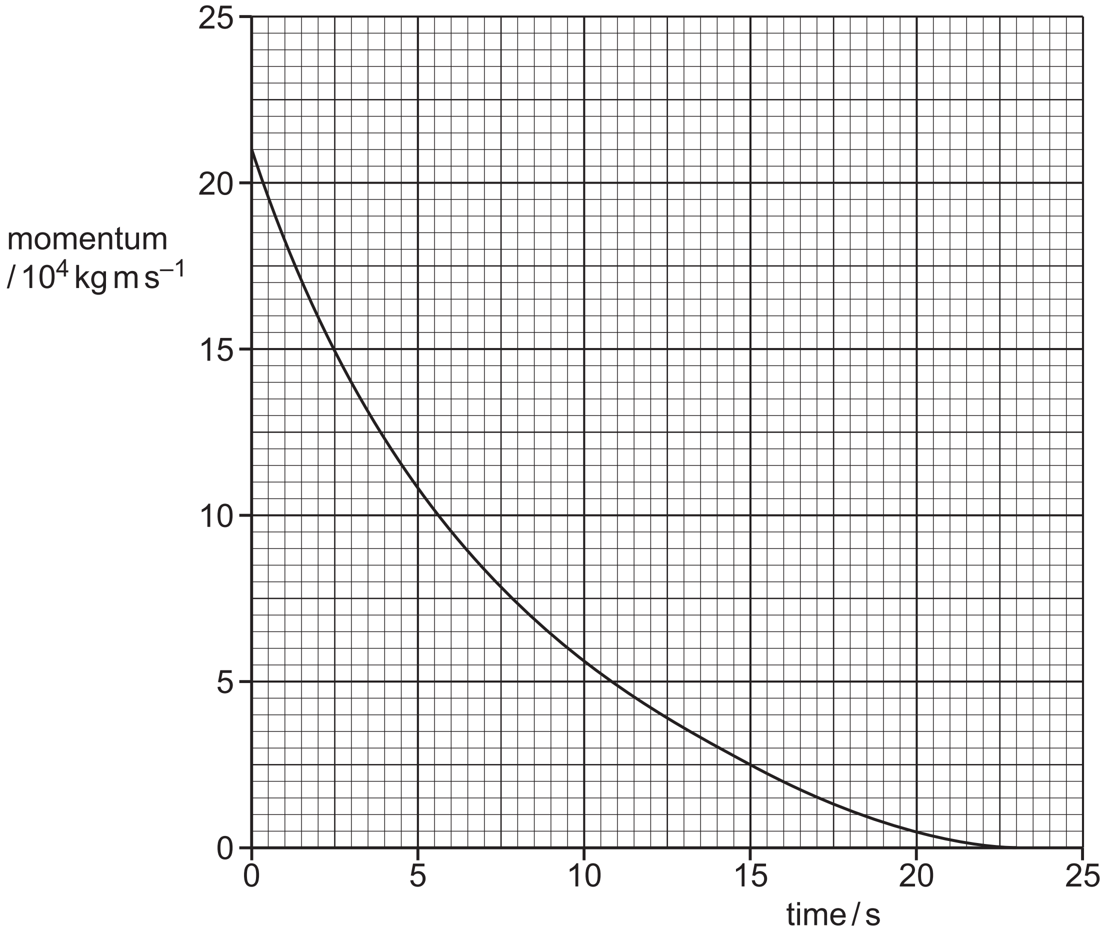


Fig. 3.2

(i) Define force.

....

.... [1]

(ii) Show that the average resultant force F acting on truck R between time t = 0 and t = 15 s is -1.2×10^4 N.

[1]

(iii) An identical truck S has the same initial momentum as truck R. Truck S experiences a constant force equal to the force *F* in **(b)(ii)**.

State and explain whether truck S will take more, less or the same amount of time to come to rest as truck R.

....

....

....

....

....

....

.... [3]

[Total: 10]