Past-paper walk-through

Equations of motion ▪ 2.1

eXercise

Questions in this set

- 9702/11 N25 Q5 ▪ 1 mark
- 9702/11 N25 Q6 ▪ 1 mark
- 9702/11 N25 Q7 ▪ 1 mark
- 9702/12 N25 Q5 ▪ 1 mark
- 9702/12 N25 Q6 ▪ 1 mark
- 9702/21 N25 Q1 ▪ 10 marks
- 9702/24 N25 Q1 ▪ 11 marks
- 9702/11 J25 Q7 ▪ 1 mark
- 9702/11 J25 Q8 ▪ 1 mark
- 9702/21 J25 Q1 ▪ 9 marks

Questions in this set

- 9702/12 M25 Q4 ▪ 1 mark
- 9702/22 M25 Q3 ▪ 10 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 5

9702/11 N25 ▪ Q5 ▪ 1 mark

A goods train passes through a station at a constant speed of $10\ \mathrm{m\,s^{-1}}$ at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of $0.5\ \mathrm{m\,s^{-2}}$ 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? **[1]**

A 6 s

B 10 s

C 20 s

D 40 s

Solution 5

A 6 s

B 10 s

C 20 s

D 40 s ✓

Why

- The goods train covers $10t$; the express covers $\frac{1}{2}(0.5)t^2 = 0.25t^2$.
- Overtaking means equal distances: $0.25t^2 = 10t$, so $t = 40$ s.
- C is only when the express matches the goods train's *speed*, which is not yet level with it.

Question 6

9702/11 N25 ▪ Q6 ▪ 1 mark

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? **[1]**

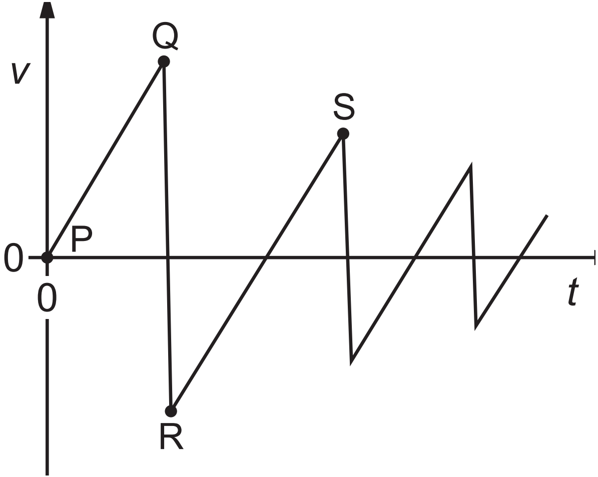
A The area under line PQ represents the initial height of the ball.

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.

Question 6



Solution 6

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. ✓

Why

- P is the moment of release, where the ball is momentarily at rest – its velocity there is zero.
- The greatest upward velocity comes immediately after the first bounce, not at P.
- A, B and C are all correct: the area under PQ is the drop height, the bounces get lower, and a free-flight gradient is g.

Question 7

9702/11 N25 ▪ Q7 ▪ 1 mark

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? **[1]**

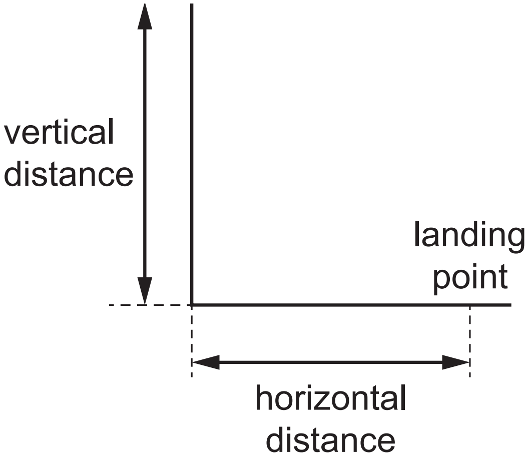
A x

B $2x$

C $4x$

D $16x$

Question 7



Solution 7

A x

B $2x$ ✓

C $4x$

D $16x$

Why

- The horizontal velocity never changes, so the distance depends only on the time of flight.
- From $y = \frac{1}{2}gt^2$, $t \propto \sqrt{y}$, so four times the drop doubles the time.
- Twice the time at the same horizontal speed gives $2x$.

Question 5

9702/12 N25 ▪ Q5 ▪ 1 mark

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? **[1]**

A $v - ad$

B $\sqrt{v^2 - 2ad}$

C $v + ad$

D $v - \frac{1}{2}ad^2$

Solution 5

A $v - ad$

B $\sqrt{v^2 - 2ad}$ ✓

C $v + ad$

D $v - \frac{1}{2}ad^2$

Why

- Start from $v^2 = u^2 + 2ad$ and make u the subject.
- $u^2 = v^2 - 2ad$, so $u = \sqrt{v^2 - 2ad}$.
- A and C treat the relation as if it were linear in v, which it is not.

Question 6

9702/12 N25 ▪ Q6 ▪ 1 mark

A bicycle brakes so that it undergoes uniform deceleration from a speed of 8 m s^{-1} to 6 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? **[1]**

A 7 m

B 9 m

C 16 m

D 21 m

Solution 6

A 7 m

B 9 m ✓

C 16 m

D 21 m

Why

- From $v^2 = u^2 + 2as$: $a = (6^2 - 8^2)/(2 \times 7) = -2$ m s^{-2}.
- Stopping from 6 m s^{-1} needs $s = 6^2/(2 \times 2) = 9$ m.
- The bicycle is slower now but still decelerating at the same rate, so it takes more than the first 7 m, not less.

Question 1

9702/21 N25 ▪ Q1 ▪ 10 marks

(a) Define acceleration. **[1]**

(b)(i) Determine the acceleration of the rocket. **[1]**

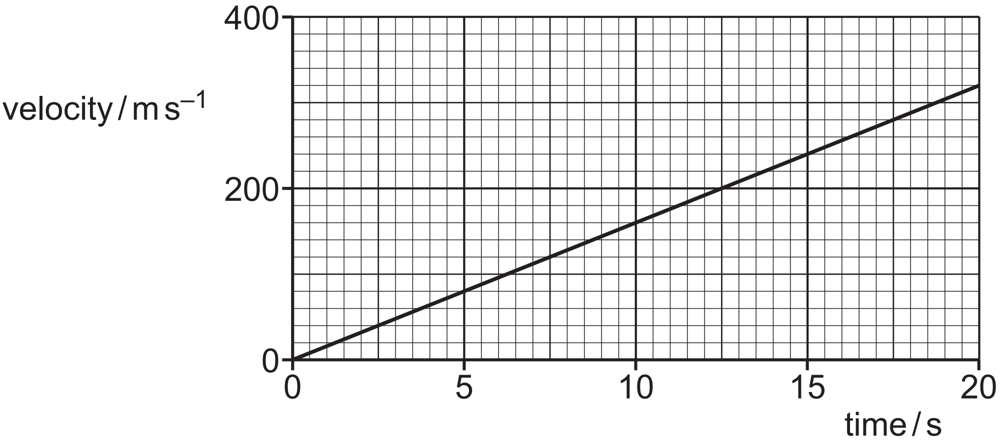
(b)(ii) Show that the height of the rocket above the surface of the Earth at a time of 20 s after launch is 3.2 km. **[2]**

(c)(i) calculate the gain in gravitational potential energy ΔE_P **[2]**

(c)(ii) calculate the gain in kinetic energy ΔE_K **[2]**

(c)(iii) determine the average power output of the rocket engines. Assume that resistive forces are negligible. **[2]**

Question 1



Solution 1

(a)

Mark scheme

- rate of change of velocity **B1**

Solution 1

(b)(i) Worked steps

The graph is a straight line from rest, so the acceleration is constant and equals the **gradient**.

- Read the two points off the graph: $v = 0$ at $t = 0$, and $v = 320$ m s^{-1} at $t = 20$ s.
- $a = \dfrac{\Delta v}{\Delta t} = \dfrac{320 - 0}{20}$
- $a = 16$ m s^{-2}

Solution 1

Mark scheme

- acceleration = 320 / 20
- = 16 m s–2 **A1**

Solution 1

(b)(ii) Worked steps

"Show that" means finish at the printed value, so quote it at the end.

- Constant acceleration from rest, so use $s = \frac{1}{2}(u + v)t$ — or, equivalently, the **area under the graph**, which is a triangle.
- $s = \frac{1}{2}(0 + 320)(20)$
- $s = 3200$ m $= 3.2$ km, as required.

Solution 1

Mark scheme

- $s = 1/2\ ((u) + v)t$ or distance = area under graph **C1**
- (height) $= 1/2 \times 20 \times 320 = 3200$ m or 3.2 km **A1**

Solution 1

(c)(i)

Worked steps

- Gain in gravitational potential energy: $\Delta E_\mathrm{P} = mg\,\Delta h$.
- Use the height just shown: $\Delta h = 3200$ m.
- $\Delta E_\mathrm{P} = 2.9 \times 10^6 \times 9.81 \times 3200$
- $\Delta E_\mathrm{P} = 9.1 \times 10^{10}$ J

Mark scheme

- $(\Delta\mathrm{EP}) = \mathrm{mg}\Delta\mathrm{h}$ **C1**
- $= 2.9 \times 106 \times 9.81 \times 3200$
- $= 9.1 \times 1010$ J **A1**

Solution 1

(c)(ii) Worked steps

- Gain in kinetic energy from rest: $\Delta E_{\mathsf{K}} = \frac{1}{2}mv^2$.
- $\Delta E_{\mathsf{K}} = \frac{1}{2} \times 2.9 \times 10^6 \times 320^2$
- $\Delta E_{\mathsf{K}} = 1.5 \times 10^{11}$ J

Solution 1

Mark scheme

- $(\Delta EK) = 1$
- $2\ m\Delta(v2)$ **C1**
- $= 1$
- $2 \times 2.9 \times 106 \times 3202$
- $= 1.5 \times 1011$ J **A1**

Solution 1

(c)(iii) Worked steps

Resistive forces are negligible, so **all** the work done by the engines becomes the two energy gains you have just found.

- Work done $= \Delta E_{\mathrm{P}} + \Delta E_{\mathrm{K}} = (0.91 + 1.5) \times 10^{11} = 2.4 \times 10^{11}$ J
- Average power $= \dfrac{\text{work done}}{\text{time}} = \dfrac{2.4 \times 10^{11}}{20}$
- $P = 1.2 \times 10^{10}$ W

Solution 1

Mark scheme

- (power $=$) work done / time C1
- power $=$ $((1.5 + 0.91) \times 1011)$ / 20
- $=$ 1.2×1010 W A1

Question 1

9702/24 N25 ▪ Q1 ▪ 11 marks

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

(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. **[2]**

(a)(ii) Show that the ball reaches its maximum height at time $t = 1.6$ s. **[1]**

(a)(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. **[1]**

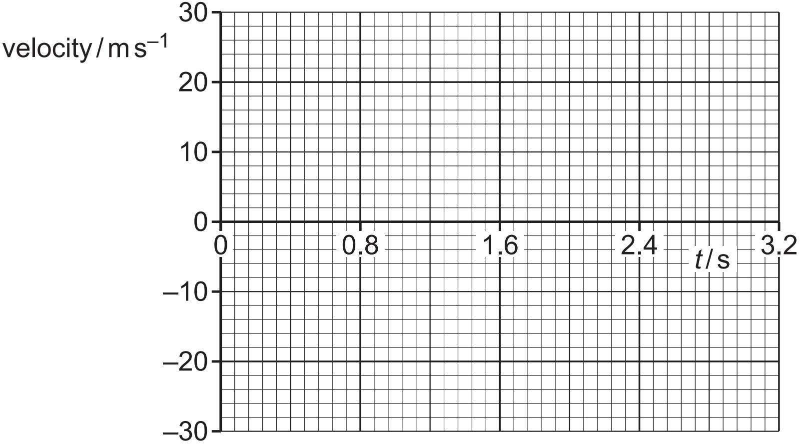
(a)(iv) On Fig. 1.2, sketch the variation of v_V with time t between $t = 0$ and $t = 3.2$ s. Assume that velocity in the upward direction is positive. Label your line V. **[3]**

(b)(i) Define momentum. **[1]**

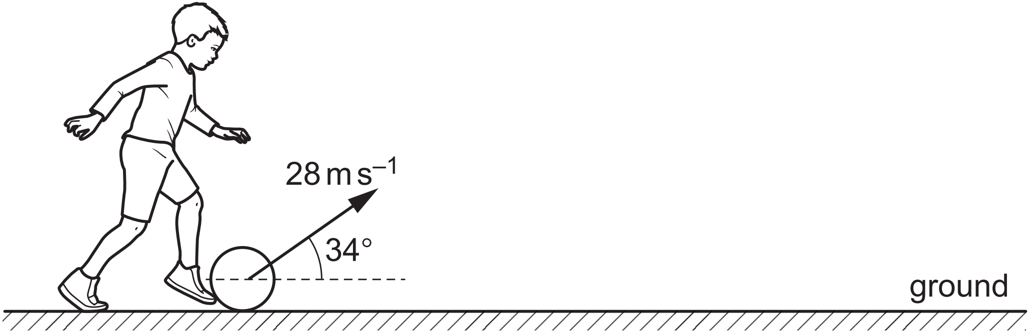
(b)(ii) Calculate the force that acts on the ball while it is in the air. **[2]**

(b)(iii) Determine the mass of the ball. **[1]**

Question 1



Question 1



Solution 1

(a)(i)

Worked steps

Resolve the launch velocity into two independent components.

- Horizontal: $v_\mathrm{H} = v\cos\theta = 28 \times \cos 34^\circ = 23$ m s^{-1}
- Vertical: $v_\mathrm{V} = v\sin\theta = 28 \times \sin 34^\circ = 16$ m s^{-1}

Check the sizes against the picture: the launch is nearer the ground than the vertical, so the horizontal component must be the larger one.

Mark scheme

- vH $=$ 28 $\times$ cos 34°
- $=$ 23 m s–1 **A1**
- vV $=$ 28 $\times$ sin 34°
- $=$ 16 m s–1 **A1**

Solution 1

(a)(ii) Worked steps

At maximum height the **vertical** velocity is momentarily zero; the horizontal one never changes and tells you nothing here.

- $v = u + at$ with $v = 0$, $u = 16$ m s^{-1}, $a = -9.81$ m s^{-2}
- $t = \dfrac{u}{g} = \dfrac{16}{9.81} = 1.6$ s, as required.

Solution 1

Mark scheme

- time $= 16 \;/\; 9.81 = 1.6$ s **A1**

Solution 1

(a)(iii)

Worked steps

Nothing acts horizontally (air resistance is ignored), so v_{H} never changes.

- Draw a **horizontal straight line** at $v = 23$ m s^{-1}, from $t = 0$ to $t = 3.2$ s.
- Label it **H**.

Mark scheme

- horizontal straight line at v = 23 m s–1 from t = 0 to t = 3.2 s **B1**

Solution 1

(a)(iv) Worked steps

Gravity is constant and downwards, so v_y falls at a steady rate: a straight line of gradient -9.81 m s^{-2}.

- Start at $v = +16$ m s^{-1} at $t = 0$.
- Cross the time axis at $t = 1.6$ s (the top of the flight, from part (a)(ii)).
- End at $v = -16$ m s^{-1} at $t = 3.2$ s — the same speed downwards as it left, because it lands at the height it started.
- Label it **V**.

Solution 1

Mark scheme

- straight diagonal line starting at a positive velocity from $t = 0$ to $t = 3.2$ s, crossing the time axis **B1**
- line starting at $v = 16$ m s–1 and ending at $v = –16$ m s–1 **B1**
- line passing through $v = 0$ at $t = 1.6$ s **B1**

Solution 1

(b)(i)

Mark scheme

- product of mass and velocity **B1**

Solution 1

(b)(ii)

Worked steps

Force is the rate of change of momentum, and the change of momentum is given.

- $F = \dfrac{\Delta p}{\Delta t} = \dfrac{13}{3.2}$
- $F = 4.1$ N

Mark scheme

- F = Δp / t **C1**
- = 13 / 3.2
- = 4.1 N **A1**

Solution 1

(b)(iii) Worked steps

Only weight acts on the ball in flight, so the force you just found **is** its weight.

- $m = \dfrac{F}{g} = \dfrac{4.1}{9.81} = 0.41$ kg
- Or from momentum: the vertical velocity reverses from $+16$ to -16 m s^{-1}, so $\Delta p = m(2 \times 16)$, giving $m = \dfrac{13}{32} = 0.41$ kg.

Solution 1

Mark scheme

- $m = \Delta p \ / \ v$
- $= 13 \ / \ (2 \times 16)$
- $= 0.41$ kg or $m = F \ / \ g$
- $= 4.06 \ / \ 9.81$
- $= 0.41$ kg **A1**

Question 7

9702/11 J25 ▪ Q7 ▪ 1 mark

Which equation of uniformly accelerated motion can be derived using only the gradient of a velocity–time graph? **[1]**

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

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

C $v = u + at$

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

Solution 7

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

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

C $v = u + at$ ✓

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

Why

- The gradient of a velocity–time graph is the acceleration: $a = (v - u)/t$.
- Rearranging that single statement gives $v = u + at$.
- A and B need the area under the graph, and D needs the area and the gradient together.

Question 8

9702/11 J25 ▪ Q8 ▪ 1 mark

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? **[1]**

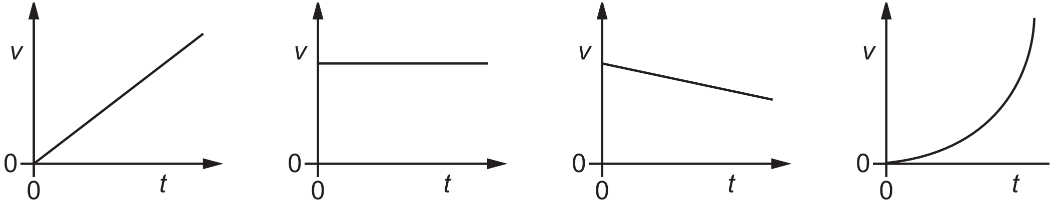
A horizontal: Q, vertical: P

B horizontal: Q, vertical: S

C horizontal: R, vertical: P

D horizontal: R, vertical: S

Question 8



Question 8

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

Solution 8

- **A** horizontal: Q, vertical: P ✓
- **B** horizontal: Q, vertical: S
- **C** horizontal: R, vertical: P
- **D** horizontal: R, vertical: S

Why

- With no air resistance nothing acts horizontally, so the horizontal velocity is constant – graph Q.
- Vertically the object starts at rest and gains speed at a steady g, so $v = gt$ – the straight line P.
- R has the horizontal speed decreasing (that needs drag) and S has the acceleration increasing.

Question 1

9702/21 J25 ▪ Q1 ▪ 9 marks

(a) Define acceleration. **[1]**

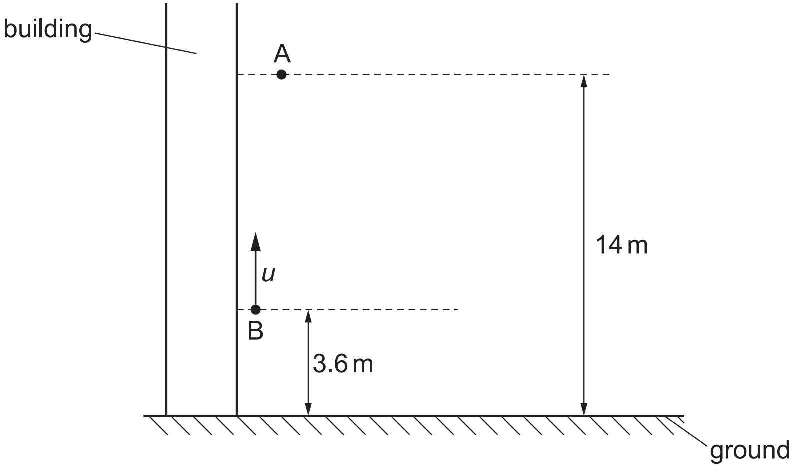
(b)(i) Calculate the time taken for object A to reach the ground. **[2]**

(b)(ii) Use your answer in (b)(i) to calculate u. **[2]**

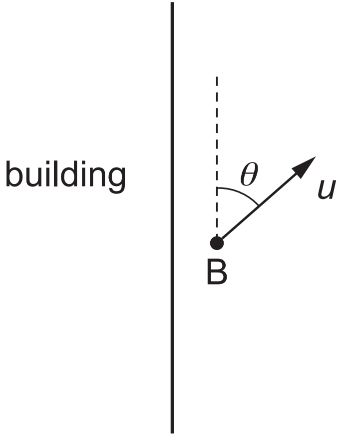
(c)(i) State and explain whether the time taken for object B to reach the ground is less than, the same as or greater than the time in (b)(i). **[2]**

(c)(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]**

Question 1



Question 1



Solution 1

(a)

Mark scheme

- rate of change of velocity **B1**

Solution 1

(b)(i) Worked steps

A is released from rest and falls freely, so $u = 0$ and $a = g$.

- $s = ut + \frac{1}{2}at^2$ becomes $s = \frac{1}{2}gt^2$
- $t = \sqrt{\frac{2s}{g}} = \sqrt{\frac{2 \times 14}{9.81}}$
- $t = 1.7$ s

Solution 1

Mark scheme

- $s = ut + ½at2$ and $u = 0$ or $s = ½at2$ $t = \sqrt{}(2 \times 14 / 9.81)$ **C1**
- $t = 1.7$ s **A1**
- OR $v = \sqrt{}(02 + 2 \times 9.81 \times 14)$ $v = 17$ (m s–1)
- $17 = (0 + 9.81) \times t$ or $17 = 9.81 \times t$ or $14 = ½ \times (0 + 17) \times t$ or $14 = ½ \times 17 \times t$
- (C1) $t = 1.7$ s
- (A1)

Solution 1

(b)(ii) Worked steps

B travels a different distance in the **same** time, so keep $t = 1.7$ s and solve for u. Take downwards as positive, matching the direction of s and g.

- $s = ut + \frac{1}{2}at^2$, with $s = 3.6$ m, $a = 9.81$ m s^{-2}, $t = 1.7$ s
- $3.6 = 1.7u + \frac{1}{2}(9.81)(1.7)^2$
- $u = \dfrac{3.6 - 14.2}{1.7} = -6.2$ m s^{-1}

Solution 1

The minus sign is the answer's meaning, not a slip: B was thrown **upwards** at 6.2 m s^{-1}.

Mark scheme

- s = ut + ½at2 u = (3.6 – ½ × 9.81 × 1.72) / 1.7 **C1**
- u = (–) 6.2 m s–1 **A1**
- OR v = (3.6 + ½ × 9.81 × 1.72) / 1.7 v = 10 (m s—1)
- 10 = u + 9.81 × 1.7 or 102 = u2 + (2 × 9.81 × 3.6) or 3.6 = ½ × (u + 10) × 1.7
- (C1) u = (—) 6.2 m s—1
- (A1)

Solution 1

(c)(i)

Mark scheme

- Less time (as it reaches a lower height) **B1**
- (because) the initial vertical (component of the) velocity is smaller (than in part (b)) **B1**

(c)(ii)

Mark scheme

- The (total) initial energy is the same (as in part (b)) **B1**
- change in gravitational potential energy is same, so speed is the same **B1**

Question 4

9702/12 M25 ▪ Q4 ▪ 1 mark

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

What is the minimum constant acceleration necessary for the aircraft?

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

Solution 4

Answer: **A**

Why

- Convert first: 85 km h^{-1} $= 85000/3600 = 23.6$ m s^{-1}, and 1.20 km $= 1200$ m.
- From rest, $v^2 = 2as$, so $a = v^2/2s = 23.6^2/2400 = 0.23$ m s^{-2}.
- B drops the factor of 2; C and D come from leaving the speed in km h^{-1}.

Question 3

9702/22 M25 ▪ Q3 ▪ 10 marks

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. A R B 180 m 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. 0 0 5 10 15 20 25 5 10 15 time / s 20 25 momentum / 104 kg m s–1 Fig. 3.2

Question 3

(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 × 104 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]

, ,
(a)(i) Calculate the acceleration of the truck between A and B. **[2]**
(a)(ii) (ii) Determine the gain in kinetic energy of the truck between A and B. gain in kinetic energy = ... J [3] , , **[3]**
(b)(i) Define force. **[1]**

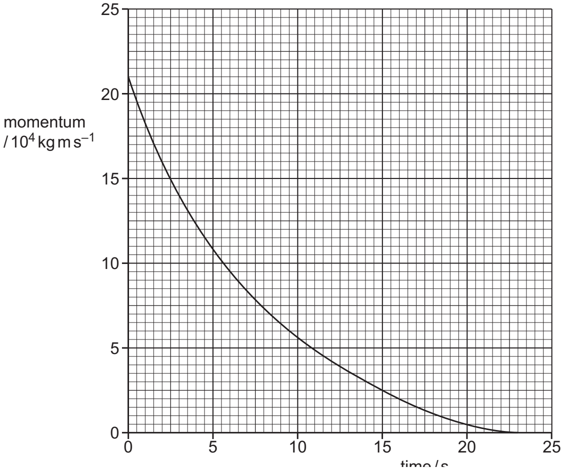
Question 3

(b)(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]**

(b)(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).

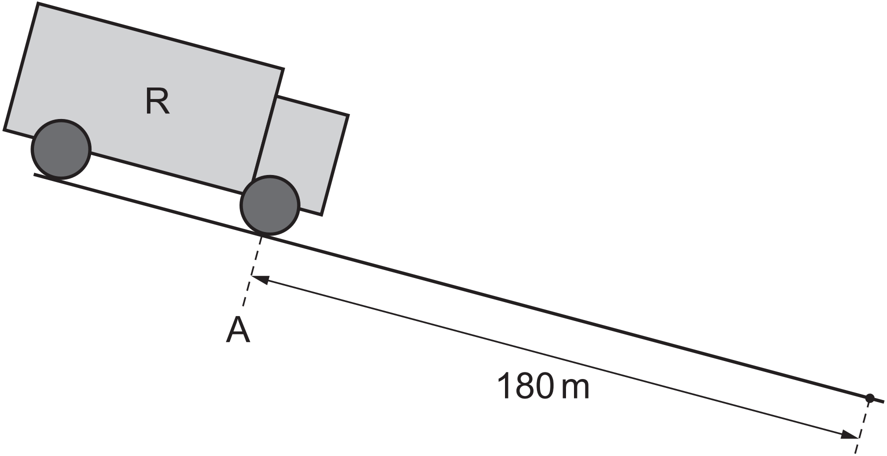
State and explain whether truck S will take more, less or the same amount of time to come to rest as truck R. **[3]**

Question 3



Question 3

Question 3



Solution 3

(a)(i) Worked steps

You know u, v and s but not t, so choose the SUVAT equation that leaves t out.

- $v^2 = u^2 + 2as$, so $a = \dfrac{v^2 - u^2}{2s}$
- $a = \dfrac{22^2 - 13^2}{2 \times 180} = \dfrac{484 - 169}{360}$
- $a = 0.88\ \text{m s}^{-2}$

Mark scheme

- a = (v2 – u2) / 2s

Solution 3

- $= (222 - 132) / (2 \times 180)$
- $= 0.88$ m s–2
- OR

3) $= 10.3$

- $180 = 13 \times 10.3 + ½\ a \times 10.32$ or
- $180 = 22 \times 10.3 - ½\ a \times 10.3\ 2$ or
- $22 = 13 + a \times 10.3$
- (C1)
- $a = 0.88$ m s–2
- (A1)

Solution 3

(a)(ii) Worked steps

Gain in kinetic energy is the difference between the two values, not $\frac{1}{2}mv^2$ of the difference in speed.

- $\Delta E_K = \frac{1}{2}m\left(v^2 - u^2\right)$
- $\Delta E_K = \frac{1}{2} \times 9400 \times (22^2 - 13^2)$
- $\Delta E_K = 1.5 \times 10^6$ J

Mark scheme

- (Δ)E = ½m(Δ)v2
- gain in KE = ½m(v2 – u2)

Solution 3

- $= ½ \times 9400 \times (222 – 132)$
- $= 1.5 \times 106$ J
- OR
- $W = Fs$
- $= ma \times d$
- (C1)
- gain in KE $= 9400 \times 0.88 \times 180$
- (C1)
- $= 1.5 \times 106$ J
- (A1)

Solution 3

(b)(i)

Mark scheme

- rate of change of momentum

Solution 3

(b)(ii) Worked steps

Force is the **gradient** of a momentum-time graph.

- Read both ends off the graph: $p = 21 \times 10^4$ kg m s^{-1} at $t = 0$, and $p = 2.5 \times 10^4$ kg m s^{-1} at $t = 15$ s.
- $F = \dfrac{\Delta p}{\Delta t} = \dfrac{(2.5 - 21) \times 10^4}{15}$
- $F = -1.2 \times 10^4$ N, as required. The sign says it opposes the motion.

Solution 3

Mark scheme

- (Force $=$) (2.5 $\times$ 104 – 21 $\times$ 104) / 15 $=$ – 1.2 $\times$ 104 (N)
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Solution 3

(b)(iii) Worked steps

Compare the two trucks on the quantity that is the same for both: the momentum each must lose is 21×10^4 kg m s^{-1}.

- R takes 23 s in total, so its **average** force is $\dfrac{21 \times 10^4}{23} = 0.91 \times 10^4$ N — smaller than F, because R's braking force grows over the 15 s shown.
- S feels the full 1.2×10^4 N the whole time: $t = \dfrac{21 \times 10^4}{1.2 \times 10^4} = 17.5$ s.
- The same change of momentum under a **larger** force takes **less time**, so S stops sooner.

Solution 3

Mark scheme

- The change of momentum (for S and R to come to rest) is the same
- (Average) force on R (to come to rest) is
- ($-21 \times 104 / 23 =$) 0.91×104 N or
- (Average) force on R (to come to rest) is less than the force on S / less than F
- (S will come to rest in) less time (than R).
- OR
- The change of momentum (for S and R to come to rest) is the same
- (B1)

Solution 3

- Time for S to come to rest is (-21×104 / $1.2 \times 104 =$) 17.5 s (and time for R to come to rest is 23 s)
- (B1)
- (S comes to rest in) less time (than R).
- (B1)