

AS Physics 9702

Unit 2 · Kinematics

Worked answers

Try the separate worksheet first. These worked answers explain methods as well as results. Equivalent valid reasoning and sensible rounding may also be correct. Suggested marks are RevisionTown practice guidance, not Cambridge marking instructions.

Scope: Cambridge International AS Physics 9702, 2025–2027 learning outcomes. The published 2028–2030 AS scope has been checked separately and is substantively unchanged. Version: 11 October 2026.

U2-Q1 · 6 marks

(a) Distance = $40 + 30 = 70$ m; displacement = $40 - 30 = 10$ m east. (b) Average speed = $70/14 = 5.0 \text{ m s}^{-1}$; average velocity = $10/14 = 0.714 \text{ m s}^{-1}$ east. (c) Eastward acceleration changes velocity towards the east; a westward-moving object initially slows until it stops, and may subsequently reverse.

U2-Q2 · 10 marks

(a) Gradients are $+3.0$, 0 and -3.0 m s^{-2} . (b) After $t = 10$ s, losing 12 m s^{-1} takes 4 s, so reversal is at $t = 14$ s. (c) Displacement = $\frac{1}{2}(4)(12) + (6)(12) + \frac{1}{2}(4)(12) - \frac{1}{2}(2)(6) = 24 + 72 + 24 - 6 = 114$ m. Distance = $24 + 72 + 24 + 6 = 126$ m. (d) Speed graph follows the positive parts of the velocity graph and reflects the final negative segment above the time axis. Acceleration graph has horizontal sections at $+3.0$, 0 and -3.0 , with ideal abrupt changes at 4 s and 10 s.

U2-Q3 · 6 marks

(a) Instantaneous velocity is tangent gradient = $(26.0 - 4.0)/(3.0 - 1.0) = 11 \text{ m s}^{-1}$. (b) Use the displacement difference between actual curve points divided by 2.0 s, which is the chord gradient; tangent points need not lie on the curve. (c) Horizontal means zero velocity; negative gradient means negative velocity. Accumulated distance cannot decrease, so its graph cannot have a negative gradient.

U2-Q4 · 7 marks

(a) From $a = (v - u)/t$, multiply by t and rearrange. (b) Constant acceleration makes velocity linear in time, so the velocity-time trapezium gives $s = \frac{1}{2}(u + v)t$. Substitute $v = u + at$ to obtain $s = ut + \frac{1}{2}at^2$. (c) Substitute $t = (v - u)/a$ into the trapezium equation: $2as = (u + v)(v - u) = v^2 - u^2$. For varying acceleration, the graph is generally curved and its mean velocity is not necessarily the average of the endpoint velocities.

U2-Q5 · 5 marks

Taking forwards as positive, $0 = 22.0 - 4.00t$ gives $t = 5.50$ s. From $0 = 22.0^2 + 2(-4.00)s$, $s = 60.5$ m. Braking usually brings the vehicle to rest rather than accelerating it backwards; the constant-acceleration model changes after stopping.

U2-Q6 · 7 marks

With upward positive, $a = -9.81 \text{ m s}^{-2}$. (a) $0 = 18.0^2 - 2(9.81)h$ gives $h = 16.5$ m. (b) Non-zero root of $0 = 18.0t - \frac{1}{2}(9.81)t^2$ is $t = 36.0/9.81 = 3.67$ s. (c) Velocity is zero at the top, but acceleration is -9.81 m s^{-2} , downward.

U2-Q7 · 5 marks

Taking downward positive, $45.0 = \frac{1}{2}(9.81)t^2$ gives $t = \sqrt{(90.0/9.81)} = 3.03$ s. Impact speed = $gt = 29.7 \text{ m s}^{-1}$, also $\sqrt{(2gh)}$. Air resistance produces an upward force, reducing downward acceleration below g and tending to increase the fall time and reduce impact speed compared with the ideal model.

U2-Q8 · 8 marks

Use a clamped electromagnet, dense steel ball, electronic timer and contact pad below it. Release starts timing and contact stops it. Measure the vertical fall distance of the same point on the ball; release without a push. Take several heights and repeat timings at each, calculating mean t and t^2 . Plot h against t^2 ; because $h = \frac{1}{2}gt^2$, g is twice the best-fit gradient. Repetition reduces random variation; electronic timing reduces reaction-time uncertainty; checking the distance zero and release delay addresses systematic error. Use a catch tray or cushioning and keep people clear of the falling ball.

U2-Q9 · 6 marks

(a) Since gradient = $g/2$, $g = (9.82 \pm 0.10) \text{ m s}^{-2}$. Multiplication by exact 2 doubles the absolute uncertainty. (b) Acceleration = gradient = $1.96/0.200 = 9.80 \text{ m s}^{-2}$. (c) Ideal release from rest with correct height and time origins predicts zero intercept. An offset may indicate a height zero error, timing delay, non-zero release velocity or another systematic problem; forcing the line through zero could bias g .

U2-Q10 · 8 marks

(a) Vertical initial velocity is zero, so $t = \sqrt{(2 \times 20.0/9.81)} = 2.02$ s. (b) $x = 8.00t = 16.2$ m. (c) Horizontal velocity remains 8.00 m s^{-1} ; downward velocity is $9.81t = 19.8 \text{ m s}^{-1}$. Speed = $\sqrt{(8.00^2 + 19.809^2)} = 21.4 \text{ m s}^{-1}$. Direction = $\tan^{-1}(19.809/8.00) = 68.0^\circ$ below horizontal. A ball dropped at the same instant has the same vertical initial conditions, so the same flight time.

U2-Q11 · 8 marks

$u_x = 20.0 \cos 30^\circ = 17.32 \text{ m s}^{-1}$; $u_y = 20.0 \sin 30^\circ = 10.0 \text{ m s}^{-1}$. The non-zero solution of $0 = 10.0t - 4.905t^2$ is $t = 2.04 \text{ s}$. Range = $17.32 \times 2.0387 = 35.3 \text{ m}$. Maximum height = $10.0^2 / (2 \times 9.81) = 5.10 \text{ m}$. At the top, velocity is 17.3 m s^{-1} horizontally and acceleration is 9.81 m s^{-2} downward.

U2-Q12 · 3 marks

Correct option: B. The vertical velocity becomes zero, but horizontal velocity remains non-zero and gravity continues to accelerate the projectile downward. A incorrectly removes both horizontal motion and gravity. C correctly retains horizontal motion but removes gravity. D removes the horizontal velocity and invents a horizontal force.

U2-Q13 · 3 marks

Correct option: C. Velocity reaches zero at 2 s. Each triangular area has magnitude $\frac{1}{2} \times 2 \times 4 = 4 \text{ m}$. Signed areas cancel, giving displacement 0 m; their magnitudes add to distance 8 m. A confuses returning to the initial position with no travel. B adds area magnitudes for displacement as well as distance. D uses a negative distance-related result and ignores the positive part of the graph.

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