

9	<p>C is the correct answer</p> <p>This is because $s = \frac{1}{2}gt^2$. So if in one unit of time the sphere has fallen one unit of distance, i.e. from image 1 to image 2, then in 2 units of time it will have fallen 4 units of distance, i.e. from image 1 to R.</p>	(1)
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2	<p>The only correct answer is C (initial acceleration is same for coin and feather, and time taken to reach the ground is less for coin)</p> <p>A is not correct because both objects have the same initial acceleration B is not correct because both objects have the same initial acceleration and object A has a greater terminal velocity D is not correct because object A has a greater terminal velocity</p>	1
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4	<p>The only correct answer is B as $s = vt$ and $s = 1.2 \times 0.9$</p> <p><i>A is not the correct answer as $s = vt$ and $s = 1.2 \times 0.9$</i> <i>C is not the correct answer as $s = vt$ and $s = 1.2 \times 0.9$</i> <i>D is not the correct answer as $s = vt$ and $s = 1.2 \times 0.9$</i></p>	(1)
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7	<p>A is the correct answer</p> <p>B is incorrect because the distance has not been doubled and the time has not been squared C is incorrect because the distance is in the wrong unit D is incorrect because the distance is in the wrong unit, has not been doubled and the time has not been squared</p>	1
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6	<p>The only correct answer is C (The initial horizontal velocity is equal to the final horizontal velocity)</p> <p>A is not correct because the horizontal component of velocity remains constant throughout the motion. A constant value does not have a minimum or maximum, so it is not appropriate to describe the horizontal velocity as minimum B is not correct because at maximum height the vertical velocity is 0 D is not correct because the final position is below the initial position</p>	1
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4	<p>B is the correct answer</p> <p>A is incorrect because the graph would have a gradient of $g/2$ C is incorrect because the graph would have a gradient of $2/g$ D is incorrect because the graph would have a gradient of $1/g$</p>	(1)
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Question Number	Answer	Mark
13(a)	<p>Method 1 – Calculate the vertical displacement at 102 m. See ($u_v =$) $33\sin 28$ Or 15 to 16 (m s^{-1}) Or ($u_h =$) $33\cos 28$ Or 29 (m s^{-1}) (1)</p> <p>Use of $v = s/t$ with $s = 102$ m for the time of flight needed (1) Or Use of $v = s/t$ with $s = 10$ m for the extra time of flight needed (1)</p> <p>Use of equation(s) to determine the vertical displacement at the time calculated (1)</p> <p>Vertical displacement = $(-)$ 5.8 to 6.0 m (1)</p> <p>Comparison with required height AND height is insufficient (1) (Allow correct conclusion based on the calculated height)</p> <p>Method 2 – Calculate the horizontal displacement for a height of 4.5 m. See ($u_v =$) $33\sin 28$ Or 15 to 16 (m s^{-1}) Or ($u_h =$) $33\cos 28$ Or 29 (m s^{-1}) (1)</p> <p>Use of vertical equation(s) with $s = (-)4.5$ m to determine the actual time of flight Or to determine the time beyond 92 m (1)</p> <p>Use of $v = s/t$ to determine the range (1) Or Use of $v = s/t$ for the extra displacement beyond 92 m (1)</p> <p>Horizontal displacement = 98 to 101 m Or extra displacement = 7.7 to 7.9 m (1)</p> <p>Comparison with required displacement AND height is insufficient (1) Or Comparison of extra displacement AND height is insufficient (1) (Allow correct conclusion based on the calculated distance)</p> <p>Method 3 – Calculate the actual time of flight and that needed for 102 m See ($u_v =$) $33\sin 28$ Or 15 to 16 (m s^{-1}) Or ($u_h =$) $33\cos 28$ Or 29 (m s^{-1}) (1)</p> <p>Use of $v = s/t$ with $s = 102$ m for the time of flight needed (1)</p> <p>Use of vertical equation(s) to determine the actual time of flight (1)</p> <p>Time of flight needed = 3.5 s AND actual time of flight = 3.4 s (1) (5)</p> <p>Time needed > actual time AND height is insufficient (1) (Allow correct conclusion based on the calculated times)</p> <p><u>Example of calculation</u> $u_v = (33 \text{ m s}^{-1}) \sin 28^\circ = 15.5 \text{ m s}^{-1}$ $u_h = (33 \text{ m s}^{-1}) \cos 28^\circ = 29.1 \text{ m s}^{-1}$ $t = \frac{102 \text{ m}}{29.1 \text{ m s}^{-1}}$ $t = 3.50 \text{ s}$ $s = (15.5 \text{ m s}^{-1} \times 3.50 \text{ s}) + (\frac{1}{2} \times (-9.81 \text{ N kg}^{-1}) \times (3.50 \text{ s})^2)$ $s = -5.87 \text{ m}$</p>	

***13(b)**

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content and lines of reasoning.

IC points	IC mark	Max linkage mark available	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

With air resistance:

Vertical motion

- When moving up weight and (vertical component of) air resistance are acting.
Or When moving up air resistance increases the resultant force.
- (When moving up,) downwards/vertical acceleration/deceleration increases
Or upward velocity decreases more quickly.
- (So maximum) height is lower.

Horizontal motion

- There is a horizontal deceleration/force (due to air resistance).
- (So the average) horizontal velocity is lower.
- The (ball travels a) shorter (total) distance.

(6)

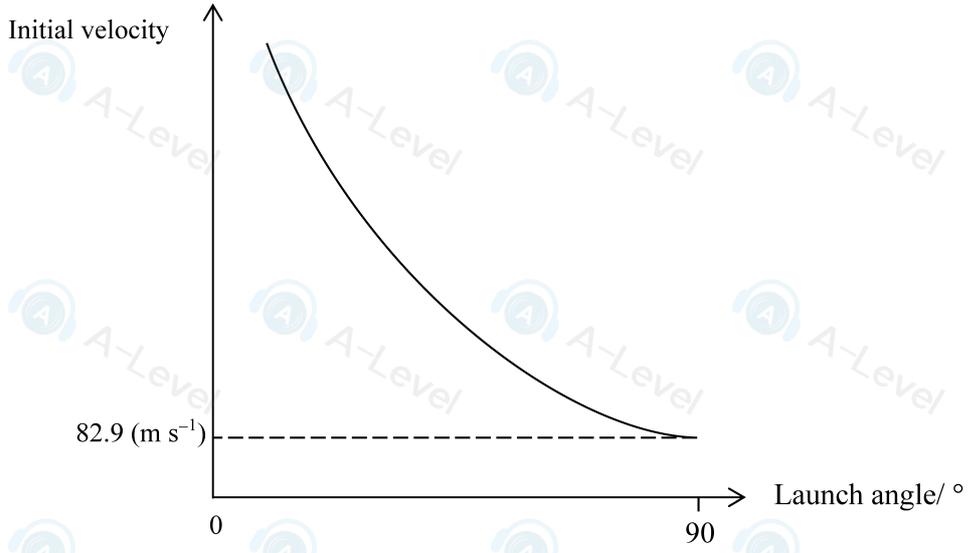
Total for question 13

11

Question Number	Answer	Mark
15(a)(i)	<p>(As horizontal distances are equal then) horizontal velocity of A = horizontal velocity of B (1)</p> <p>Resolve horizontally e.g. see horizontal velocity of A = $u_A \cos\theta$ and horizontal velocity of B = $u_B \cos 45$ (1)</p> <p>$u_A \cos\theta = u_B \cos 45$ (1)</p> <p>(MP3 dependent on MP1 or MP2)</p> <p><u>Example of calculation</u></p> <p>Horizontal velocity of A = $u_A \cos\theta$</p> <p>Horizontal velocity of B = $u_B \cos 45$</p> <p>$u_A \cos\theta = u_B \cos 45$</p> <p>$u_A \cos\theta = 0.707u_B$</p> <p>$u_A = \frac{0.707u_B}{\cos\theta}$</p>	<p>3</p>
15(a)(ii)	<p>Either</p> <p>(component of velocity method)</p> <p>θ must be greater than 45° (for the paths shown) (1)</p> <p>Or A is launched at a greater angle than B (to the horizontal) (1)</p> <p>Comparison of initial horizontal components to lead to $u_A > u_B$</p> <p>e.g.</p> <p>$\cos\theta < 0.707$ Or $\cos\theta < \cos 45$ Or $\frac{0.707}{\cos\theta} > 1$ leading to i.e. $u_A > u_B$ (1)</p> <p>Or</p> <p>(range method)</p> <p>The maximum range of a projectile is at 45° (1)</p> <p>To have a greater range at a greater launch angle, then the initial velocity must be greater (1)</p>	<p>2</p>

15(b)	Line for A: downward straight diagonal line, ending above 0 (at time t)	(1)	4
	Line for B: downward straight diagonal line crossing the time axis	(1)	
	Lines parallel (between 0 and $t/2$)	(1)	
	Line B passes through $(t/2, 0)$ with $t/2$ labelled on time axis	(1)	
	(MP4 conditional on MP3)		
	(Accept graphs where the positive direction is taken to be downwards, Only one line needs to be labelled. Max 3 for both lines unlabelled)		
Total for question 15			9

Question Number	Answer	Additional Guidance	Mark
19(a)	Acceleration of the shot is constant	(1)	2
	Because air resistance will be negligible Or the only force acting is weight	(1)	
19(b)(i)	Use of $s = ut + \frac{1}{2}at^2$ with $a = 0$	(1) <u>Example calculation</u> $14.2 \text{ m} = u_{\text{horizontal}} \times 1.61 \text{ s}$	2
	$u_{\text{horizontal}} = 8.82 \text{ (m s}^{-1}\text{)}$ (to at least 3 significant figures)	(1) $u_{\text{horizontal}} = \frac{14.2 \text{ m}}{1.61 \text{ s}} = 8.8199 \text{ m s}^{-1}$	
19(b)(ii)	Use of $s = ut + \frac{1}{2}at^2$ with $a = (-)9.81 \text{ m s}^{-2}$ and $s = (-)1.85 \text{ m}$	(1) <u>Example calculation</u> $u_{\text{vertical}} = \frac{\frac{1}{2} \times 9.81 \text{ m s}^{-2} \times (1.61 \text{ s})^2 - 1.85 \text{ m}}{1.61 \text{ s}} = 6.75 \text{ m s}^{-1}$	5
	Use of Pythagoras to determine u Or Use of appropriate trigonometry to determine u	(1) $u^2 = (8.82 \text{ m s}^{-1})^2 + (6.75 \text{ m s}^{-1})^2 = 123.4 \text{ m}^2 \text{ s}^{-2}$	
	$u = 11 \text{ m s}^{-1}$ [ecf from (b)(i)]	(1) $u = \sqrt{123.4 \text{ m}^2 \text{ s}^{-2}} = 11.1 \text{ m s}^{-1}$	
	Use of appropriate trigonometry to determine θ	(1) $\tan \theta = \frac{6.75 \text{ m s}^{-1}}{8.82 \text{ m s}^{-1}} = 0.765$	
	$\theta = 37^\circ$ [ecf from (b)(i)]	(1) $\theta = \tan^{-1}(0.765) = 37.4^\circ$	
Total for question 19			9

Question Number	Answer	Mark
14(a)(i)	<ul style="list-style-type: none"> Use of equation(s) of motion to determine u_v Or Use of $E_k = E_{\text{grav}}$ $u_v = 83 \text{ (m s}^{-1}\text{)}$ (for mp2 must have used $v = 0$ and $-g$) <p><u>Example of calculation</u> $0^2 = u^2 + 2(-9.81 \text{ m s}^{-2})(350 \text{ m})$ $u = 82.9 \text{ m s}^{-1}$</p>	(1) (1) 2
14(a)(ii)	<ul style="list-style-type: none"> Launch angle increasing as initial velocity decreases (i.e. negative gradient) Curve drawn Minimum initial velocity marked, and graph passes through (90, 82.9/80) Or other correct pair of points labelled and plotted Initial velocity axis asymptotic 	(1) (1) (1) (1) 4
14(b)	<p>(Perpendicular) distance to firework = time (counted) \times speed of sound</p> <p>Diameter of firework = $2 \times \text{distance} \times \tan(\phi/2)$ (allow Diameter of firework = distance $\times \tan(\phi/2)$)</p>	(1) (1) 2
Total for question 14		8

Question Number	Answer	Mark
*17(a)	<p>(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)</p> <p>Constant horizontal speed/velocity Or there is no horizontal acceleration (1)</p> <p>Bike same horizontal distance apart in each image Or measurements taken from photograph to demonstrate this (1)</p> <p>The vertical velocity is increasing/decreasing Or vertical/downwards acceleration/deceleration (1)</p> <p>Images of increasing/decreasing vertical distance Or measurements taken from photograph to demonstrate this (1)</p> <p>(treat as neutral any descriptions of the motion before the jump)</p>	4
17(b)(i)	<p>Use of trig to determine the initial vertical velocity component (1)</p> <p>Use of equation(s) of motion to calculate the height (1)</p> <p>height = 13 m (ignore any negative signs seen) (1)</p> <p><u>Example of calculation:</u> Initial vertical velocity = $9.5 \text{ m s}^{-1} \times \sin 10 = 1.65 \text{ m s}^{-1}$ $s = (1.65 \text{ m s}^{-1} \times 1.8 \text{ s}) + \frac{1}{2} (-9.81 \text{ m s}^{-2} \times (1.8 \text{ s})^2)$ $s = -12.9 \text{ m}$</p>	3
17(b)(ii)	<p>Use of trig to determine the initial horizontal velocity component (1)</p> <p>Use of $v = s/t$ (1)</p> <p>$s = 17 \text{ m}$ (1)</p> <p><u>Example of calculation:</u> Initial horizontal velocity = $9.5 \text{ m s}^{-1} \times \cos 10 = 9.36 \text{ m s}^{-1}$ $s = 9.36 \text{ m s}^{-1} \times 1.8 \text{ s} = 16.8 \text{ m}$</p>	3
17(c)	<p>There is no normal/contact/reaction/upwards force acting on him (from the bike) (1)</p> <p>The cyclist is falling with the same acceleration as the bike Or the acceleration of the bike (and the cyclist) is $g/9.81 \text{ (m s}^{-2}\text{)}$ Or The cyclist (and the bike are both) falling freely Or weight is the only force acting on him (1)</p>	2
Total for question 17		12