A Level OCR Physics

Chapter 5 Motion

Question	Answers	Extra information	Mark	AO	Spec reference
1(a)	Air resistance is much less on the Moon than on Earth The hammer and the feather are both accelerating for the whole fall and never reach terminal velocity		1 1	1	3.2.1 a and c
(b)	$36 \times \frac{1}{29.97} = 1.201$ s		1	2	M0.3
(c)	use of $s = ut + ½ at^2$ and $u = 0$ $g = 2\frac{s}{t^2}$ $g = 2 \times \frac{1.2}{1.201^2} = 1.66$ m s^{-2}		1 1	1 2	3.1.2a
(d)	vertical velocity = 50 sin 35° = 28.7 m s^{-1} AND horizontal velocity = 50 cos 35° = 41.0 m s^{-1}	both have to be correct for mark	1	2	2.1.3d
(e)	$u = -28.7$ m s^{-1}, $v = 0$, $a = 1.66$ m s^{-2} and use of $v = u + at$ $t = \frac{2.37}{1.66} = 17.3$ s total time = 2 × 17.3 = 35 s (34.6) OR 28.7 = −28.7 + (1.66 × t)	Intermediate units not required for the mark allow ecf for initial vertical velocity using 1.7 gives 34 s	1 1	2	3.1.3b
(f)	distance = 41.0 × 35 s = 1440 m which is less than one mile	allow ecf here	1 1	3	3.1.3b

Question	Answers	Extra information	Mark	AO	Spec reference
2(a)	use of $s = ut + ½at^2$ and $u = 0$ $g = 2\frac{s}{t^2}$ $g = 2 \times \frac{0.45}{0.32^2} = 8.8\ (8.79)\ \text{m s}^{-2}$		1 1	1 2	3.1.2a
(b)	any one from can identify anomalies/check if results repeatable/check precision of data shows that g constant for different heights	not simply more accurate	1	1	1.1.1c
(c)	suitable line of best fit drawn large triangle or coordinates seen on graph gradient = 5.2 ± 0.1		1 1 1	2	1.1.3d
(d)	use of $s = ut + ½at^2$ and $u = 0$ or $s = ½gt^2$ gradient = ½ g $g = 2 \times 5.2 = 10.4\ \text{m s}^{-2}$	must use the gradient to gain marks allow ecf from answer to 2(c) range = 9.6 to 10	1 1	1 2	3.1.2a
(e)	ball not released quickly/centre of ball not falling through light gates/parallax errors when measuring distance between light gates/ball falling before reaching first light gate so u not equal to 0	any sensible suggestion	1	3	1.1.4c
3(a)	points plotted correctly (within ± ½ square) smooth curve line of best fit drawn	lose mark for one mistake	1 1	2	1.1.3d
(b)	tangent on slope within first 3 seconds gradient = $\frac{25-0}{15-018} = 1.7\ \text{m s}^{-2}$	no marks if values from table used Allow answers from 1.2 to 2.3	1 1	2	3.1.1d

Question	Answers	Extra information	Mark	AO	Spec reference
(c)	thrust = $ma + mg$ = 140 000$(a + g)$ = 1.6 × 10^6 N OR $W = mg$ = 140 000 kg × 9.81 = 1373 400 N $F = ma$ = 238 000 N thrust = 1373 400 N + 238 000 N = 1.6 × 10^6 N	allow e.c.f. from answer to 3(b)	1 1	2	3.2.1
(d)	attempt to measure area beneath graph counting squares and conversion distance = 104 m ± 5 m	approximating area with shapes 2 marks max	1 1	3	3.1.1d
(e)	acceleration increasing mass decreasing as fuel burnt		1 1	3	3.2.1
4(a)	$t = \frac{d}{s} = \frac{20}{30}$ = 0.67 s		1	2	3.1.1a 3.1.2c
(b)	if distance proportional to speed^2 then $\frac{d}{\text{speed}^2}$ = constant at least two data points selected for example $\frac{8}{10^2}$ = 0.08 $\frac{32}{20.5^2}$ = 0.08		1 1	2	1.1.3b

Question	Answers	Extra information	Mark	AO	Spec reference
(c)	either use of $v^2 = u^2 + 2as$ and $v = 0$ assuming constant deceleration $v^2 \propto s$ OR ½ $mv^2 = Fs$ assuming constant braking force $v^2 \propto s$		1 1	3	3.1.2a
(d)	stopping distance = 13 + 30 = 43 m assumes good tyres and good/dry road surface and driver not distracted any of these could increase stopping distance	Allow answers from 42 to 44	1 1	3	3.1.2c
(e)	use of $F = ma$ or $v^2 = u^2 + 2as$ and $v = 0$ $a = \frac{u^2}{2s} = \frac{20^2}{2 \times 30} = 6.7\ \text{m s}^{-2}$ $F = 1500 \times 6.7 = 10$ kN		1 1 1	2	3.1.2a 3.2.1a
5(a)	path of projectile drawn		1	2	3.1.3
(b)	acceleration is constant/or 9.81 downwards		1 1	2	3.1.3a
(c)	use of $s = ut + ½at^2$ and $u = 0$ $250 = 0 + ½ \times 9.81 \times t^2$ $t = 7.14$ s distance = $s \times t = 70 \times 7.14$ s = 500 m		1 1 1	1 2	3.1.2a 3.1.3
(d)	$v^2 = u^2 + 2as$ or $v = u + at$ to find vertical component of velocity $v = \sqrt{2 \times 9.81 \times 250} = 70\ \text{m s}^{-1}$		1 1	3	3.1.3 2.1.3d

Question	Answers	Extra information	Mark	AO	Spec reference
	horizontal velocity = 70 m s^{-1} therefore final velocity = $\sqrt{70^2 + 70^2}$ = 99 m s^{-1}		1		
6(a)	the vertical velocity is independent of the horizontal velocity vertical velocity accelerated downwards by g horizontal velocity constant		1 1 1	2	3.1.3a
(b)	use of $s = ut + ½at^2$ and $u = 0$ $a = 2\frac{s}{t^2} = 2 \times \frac{1.50}{4.20^2}$ = 0.17 m s^{-2}		1 1	1 2	3.1.3b
(c)	$F = ma$ = 0.180 × 0.17 = 0.031 N	if 0.2 used get 0.036	1	2	3.2.1a
(d)	resultant force = $F = mg$ – lift lift = $mg - F$ = (0.180 × 9.81) – 0.031 N lift = 1.73 N		1 1	3	3.2.1
7(a)	**Level 3 (5–6 marks)** Clear procedure, a sketch **and** analysis. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Some procedure, a sketch and some analysis. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited procedure and sketch **or** limited analysis and sketch *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**Indicative scientific points may include:** **Procedure** • grid/scale as backdrop • filming ball falling with stopwatch in frame • camera placed perpendicular to ball drop so that whole fall in shot • watching film back to extract time and displacement readings **Sketch** • displacement time graph	max 6	2	3.1.1 1.1.1a

Question	Answers	Extra information	Mark	AO	Spec reference
		starting from zero and showing a curve with an increasing gradient **Analysis** • plot displacement time graph • draw tangent on curve • tangent should be near the beginning when ball still accelerating • find velocity using tangent • calculate acceleration using gradient and time from start			
(b)	$\% \text{ difference} = \frac{\text{actual} - \text{result}}{\text{result}} \times 100\% = \frac{9.81 - 8.2}{9.81}$ = 16%		1 1	2	2.2.1d
(c)	If the tangent was drawn after too much time the object may have been slowed by drag/air resistance/or reached terminal velocity		1	3	
(d)	Use of $s = ut + ½ at^2$ and $u = 0$ where t = 0.2 s (0.4 s, 0.6 s etc) first stone tied at s = ½ × 9.81 × 0.2^2 = 0.20 m second stone tied at s = ½ × 9.81 × 0.4^2 = 0.78 m third stone tied at s = ½ × 9.81 × 0.6^2 = 1.77 m forth stone would be at 3.14m and so can't fit on the string		1 1	3	3.1.2a
8(a)	distance is a scalar quantity and has magnitude only displacement is a vector and has both magnitude and direction	need definition of vector/scalar stated or implied by description	1	1	2.3.1
(b)	125 m north of original position		1 1	2	3.1.1b

Question	Answers	Extra information	Mark	AO	Spec reference
(c)	horizontal line for 25 seconds and negative horizontal line for further 45 seconds appropriate scale e.g. velocity for first 25 seconds = $\frac{325}{25}$ = 13 m s^{-1} velocity for remaining 45 seconds = $\frac{450}{45}$ = −10 m s^{-1}		1 1 1	3	3.1.1c
(d)	vertical line when the velocity changed direction suggests infinite acceleration which is impossible	Allow wtte	1	3	3.1.1b and d