# Projectiles - Answers

June 2015 Mathematics Advanced Paper 1: Mechanics 1

1.

| Question Number | Scheme | Marks |
|---|---|---|
| 2(a) | $$0^2 = 19.6^2 - 2 \times gH$$ $$H = 19.6\text{m } (20)$$ | M1 <br> A1 (2) |
| (b) | $$14.7 = 19.6t - \tfrac{1}{2}gt^2$$ $$t^2 - 4t + 3 = 0$$ $$(t-1)(t-3) = 0$$ $$t = 1 \text{ or } 3; \quad \text{Answer 2 s}$$ | M1 A1 <br><br> DM1 <br><br> A1; A1 (5) |
| | | 7 |
| 2(b) <br><br> ALT 1 | (their $h$ - 14.7) = ½ g $t^2$     **OR**     $v^2 = 19.6^2 - 2g \times 14.7 \Rightarrow v = (\pm) 9.8$ <br> $t = 1$               and 0 9.8 – 9.8 $t \Rightarrow t = 1$ <br> Total = 2 x their 1 <br> = 2 s | M1 A1 <br> A1 <br> DM 1 <br> A1 |
| 2(b) <br><br><br> ALT 2/3 | $v^2 = 19.6^2 - 2g \times 14.7$ <br> $v = \pm 9.8$ <br><br> **EITHER:**      $-9.8 = 9.8 - gT$ <br>                $T = 2$ <br><br> **OR:**      $0 = 9.8t - \tfrac{1}{2}g t^2$ <br>         $t = (0)$ or 2 | M1 <br> A1 <br><br> DM1 A1 <br> A1 <br><br> DM1 A1 <br> A1 |
| | **Notes** | |
| 2(a) | M1 is for a complete method (which could involve use of two *suvat* equations) for finding $H$ i.e. for an equation in $H$ *only*, condone sign errors <br> A1 for 19.6 or 20 <u>correctly obtained</u> (2g is A0) | |
| 2(b) | First M1 is for a quadratic equation in $t$ only (where $t$ is time at 14.7 above $O$) <br> First A1 for a correct equation <br> Second DM1, dependent on first M1, for solving for $t$ <br> Second A1 for <u>both</u> values of $t$, 1 and 3. <br> **N.B.** If answer(s) are wrong or have come from an incorrect quadratic, and the quadratic formula has been used, M1 can only be awarded if there is clear evidence that the correct formula has been used. If their expression is not correct for their quadratic, allow a slip but only if <u>we see an attempt to substitute into a stated correct formula.</u> <br> Third A1 for 2 s <br> **N.B.** Obtaining $t = 1$ at $s = 14.7$ (above $O$) only, can score max M1 A1 | |

2.

| Question Number | Scheme | Marks |
|---|---|---|
| **5.** | (a) $\quad v^2 = u^2 + 2as \;\Rightarrow\; 28^2 = u^2 + 2\times9.8\times17.5$ <br> $\qquad$ Leading to $u = 21$ ✱ $\qquad\qquad$ cso | M1 A1 <br> A1 $\qquad$ **(3)** |
| | (b) $\quad s = ut + \dfrac{1}{2}at^2 \;\Rightarrow\; 19 = 21t - 4.9t^2$ <br><br> $\qquad\qquad 4.9t^2 - 21t + 19 = 0$ <br><br> $\qquad\qquad t = \dfrac{21 \pm \sqrt{21^2 - 4\times4.9\times19}}{9.8}$ <br><br> $\qquad\qquad t = 2.99$ or $3.0$ <br> $\qquad\qquad t = 1.30$ or $1.3$ | M1 A1 <br><br><br><br> DM1 A1 A1 <br> **(5)** |
| | (c) $\quad$ N2L $\qquad\qquad 4g - 5000 = 4a$ <br> $\qquad\qquad\qquad (a = -1240.2)$ <br> $\qquad v^2 = u^2 + 2as \;\Rightarrow\; 0^2 = 28^2 - 2\times1240.2\times s$ <br> $\qquad\qquad$ Leading to $s = 0.316$ (m) $\qquad$ or 0.32 | M1 A1 <br><br><br> M1 A1 $\qquad$ **(4)** <br> **[12]** |
| | **OR** <br><br> $\qquad\qquad \frac{1}{2} \times 4 \times 28^2 + 4gs = 5000s$ <br> Work-Energy: $\qquad\qquad s = 0.316$ or $0.32$ | <br><br> M1 A1 <br> M1 A1 |

**Question 5(a)**
First M1 for a complete method for finding $u$ e.g.
$\qquad 28^2 = u^2 + 2g \text{x} 17.5$

or $28^2 = u^2 + 2(\text{-}g)\text{x}(\text{-}17.5)$
or $28^2 = 2gs \Rightarrow s = 40$ then $0^2 = u^2 + 2(\text{-}g)\text{x}(22.5)$
condone sign errors
First A1 for a correct equation(s) <u>with g = 9.8</u>
Second A1 for "$u = 21$" PRINTED ANSWER
N.B. Allow a verification method, but they must state, as a conclusion, that "$u = 21$", to score the final A1.

**Question 5(b)**
First M1 for a complete method for finding at least one $t$ value i.e. for producing an equation in $t$ only.
(condone sign errors but not missing terms)
First A1 for a correct quadratic equation in $t$ only or TWO correct linear equations in $t$ only.
Second DM1, dependent on first M1, for attempt to solve the quadratic or one of the linear equations.
Second A1 for 3.0 or 3 or 2.99
Third A1 for 1.3 or 1.30

**Question 5(c)**
First M1 for resolving vertically with usual rules.
First A1 for a correct equation
Second M1 for use of $v^2 = u^2 + 2as$, with $v = 0$, $u = 28$ or $u = 0$ and $v = 28$ and their $a$, (or any other complete method which produces an equation in $s$, which could be negative)
M0 if they haven't *calculated* a value of $a$.
Second A1 for 0.32 or 0.316. (must be positive since it's a distance)

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3.

| Question Number | Scheme | Marks |
|---|---|---|
| 5 (a) | $v = u + at(\uparrow) \Rightarrow 0 = u - g(\dfrac{25}{14})$ <br><br> $u = 17\frac{1}{2}$ ✱ | M1 M(A)1 <br><br> A1 <br> (3) |
| (b) | $v^2 = u^2 + 2as(\uparrow) \Rightarrow 0^2 = 17.5^2 - 2gs$ <br><br> $s = 15.6$ (m) or 16 (m) | M1 <br><br> A1 <br> (2) |
| (c) | $s = ut + \frac{1}{2}at^2(\uparrow) \Rightarrow 6.6 = 17.5t - \frac{1}{2}gt^2$ <br><br> $4.9t^2 - 17.5t + 6.6 = 0$ <br><br> $t = \dfrac{17.5 \pm \sqrt{(17.5^2 - 129.36)}}{9.8} = \dfrac{17.5 \pm 13.3}{9.8}$ <br><br> $t = 3.142.. \ (22/7)$ or $0.428...(3/7)$ <br><br> $T = t_2 - t_1 = 2.71 \ (2.7)$ | M1 <br><br> A1 <br><br> DM1 <br><br> A1 <br><br> DM1 A1 (6) |

**OR**

$$v^2 = u^2 + 2as(\uparrow) => v^2 = 17.5^2 - 2gx6.6$$

$$v = \pm13.3$$

$$v = u + at(\uparrow) => \pm13.3 = 17.5 - gt \qquad \text{M1A1}$$

$$\text{DM1}$$

$$t = \frac{17.5 \pm 13.3}{9.8} \qquad \text{A1}$$

$$= 3.14.. \ (22/7) \text{ or } 0.428..(3/7)$$

$$T = 3.14.. - 0.428.. = 2.71 \text{ or } 2.7 \qquad \text{DM1 A1 \quad (6)}$$

**OR**

$$v^2 = u^2 + 2as(\uparrow) => v^2 = 17.5^2 - 2gx6.6 \quad \text{or} \quad 0^2 = u^2 - 2gx(15.625 - 6.6)$$

$$v = 13.3 \qquad\qquad\qquad u = 13.3$$

$$v = u + at(\uparrow) => 0 = 13.3 - gt \qquad \text{M1 A1}$$

$$t = \frac{13.3}{g} \qquad \text{DM1 A1}$$

$$T = 2 \text{ x } \frac{13.3}{g} = 2.7 \text{ or } 2.71 \qquad \text{DM1 A1 \quad (6)}$$

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4.

| Question Number | Scheme | Marks |
|---|---|---|
| **1.** | | |
| **(a)** | $0^2 = u^2 - 2x9.8x40$ | M1 A1 |
| | $u = 28 \text{ m s}^{-1}$ ** GIVEN ANSWER | A1 |
| | | (3) |
| **(b)** | $33.6 = 28t - \frac{1}{2}9.8t^2$ | M1 A1 |
| | $4.9t^2 - 28t + 33.6 = 0$ | |
| | $t = \dfrac{28 \pm \sqrt{28^2 - 4x4.9x33.6}}{9.8}$ | |
| | $= 4 \text{ s or } (1.7 \text{ s or } 1.71 \text{ s})$ | M1 A1 A1 |
| | | (5) |
| | | **8** |

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5.

| Question Number | Scheme | Marks |
|---|---|---|
| **2.** | | |
| (a) | $-6.45 = u - 9.8 \times 0.75$ | M1 A1 |
| | $0.9 = u$ ** | A1 |
| | | (3) |
| (b) | $0 = 0.81 - 2 \times 9.8 \times s$ | M1 |
| | $s = 0.041$ or $0.0413$ | A1 |
| | | (2) |
| (c) | $h = -0.9 \times 0.75 + 4.9 \times 0.75^2$ | M1 A1 |
| | $h = 2.1$ or $2.08$ | A1 |
| | | (3) |
| | | **[8]** |

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6.

| Question Number | Scheme | Marks |
|---|---|---|
| **Q6** (a) | $(\uparrow) v^2 = u^2 + 2as$ | |
| | $0 = 14.7^2 - 2 \times 9.8 \times s$ | M1A1 |
| | $s = 11.025$ (or $11$ or $11.0$ or $11.03$) m | A1 |
| | Height is 60 m or 60.0 m   **ft** | A1ft (4) |
| (b) | $(\downarrow) v^2 = u^2 + 2as$ | |
| | $v^2 = (-14.7)^2 + 2 \times 9.8 \times 49$ | M1 A1 |
| | $v = 34.3$ or $34$  m s$^{-1}$ | A1 (3) |
| (c) | $(\downarrow) v = u + at$         **OR**      $(\downarrow) s = ut + \frac{1}{2}at^2$ | |
| | $34.3 = -14.7 + 9.8t$                $49 = -14.7t + 4.9t^2$ | M1 A1 |
| | $t = 5$                                    $t = 5$ | A1 (3) |
| | | **[10]** |