Godalming College

Mechanics 7 – Projectiles 1: Solutions

Section 1

1. (a) $\sqrt{5^2+12^2} = 13$ (b) $\sqrt{3^2+5^2} = \sqrt{34} = 5.83$ (3 sf)

2. $a = \frac{39-0}{20} = 1.95ms^{-2}$ distance $= 39 \times \frac{80+60}{2} = 2730\ m\ or\ 2.73\ km$

3. $s = ?\ \ u = 6\ \ v = ?\ \ a = -9.8\ \ t = 2$ $v = u + at = 6 - 2 \times -9.8 = 13.6$ ms^{-1}

   $s = ut + \frac{1}{2}at^2 = 6 \times 2 + 2 \times -9.8 = -7.6$ so stone was thrown 7.6 m above the water

4. $s = 3\ \ u = 25\ \ v = ?\ \ a = -9.8\ \ t = ?$ $s = ut + \frac{1}{2}at^2$ so $3 = 25t - 4.9t^2$
   So times the ball is at 3 m are $t_1 = 0.123$ and $t_2 = 4.979$ so above 3m for t_2-t_1 = 4.86 seconds

5. (a) 6.6277 would represent hours of sunshine on day 0 while the -0.0153 indicates that sunshine hours drop by around 55 seconds per day
   (b) x = 32 y = 6.14 hours
   (c) Not reliable - the data has very weak correlation so a linear model is not appropriate.

Section 2

1. **(a)** $\sqrt{3^2+4^2} = 5$ ms^{-1} at an angle of arctan $(\frac{3}{4})$= 36.9^0 to the **i** vector
(b) $\sqrt{2^2+(-1)^2} = \sqrt{5}$ ms-1 at an angle of arctan $(\frac{1}{2})$= (-)26.6^0 to the **i** vector

(4 marks)

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2. $39\ sin\ \theta = 39 \times \frac{12}{13} = 36$ $39\ cos\ \theta = 39 \times \frac{5}{13} = 15$
So v = 15i + 36j ms^{-1}

(4 marks)

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3. (a) For vertical motion, $s = 25, u = 0\ v = ?, a = g, t = ?$
Using $s = ut + \frac{1}{2}at^2$ we get $25 = 4.9 \times t^2$ giving $t = 2.26$ s (3sf)
(b) No acceleration horizontally so $s = ut$ giving $15 \times t = 33.9$ m (3sf)
(c) The distance is likely to be an overestimate as air resistance will reduce this.

(6 marks)

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4. For horizontal motion, $s = 15 \times 1 = 15$
For vertical motion, $s = ?, u = 0\ v = ?, a = g, t = 1$
Using $s = ut + \frac{1}{2}at^2$ we get $s = 4.9 \times 1^2 = 4.9$
The distance from start is $\sqrt{15^2 + 4.9^2} = 15.8$ m (3sf)

(6 marks)

5. For vertical motion, $s = 0.04, u = 0\ v = ?, a = g, t = T$
For horizontal motion, $s = 80, u = ?\ v = ?, a = 0, t = T$

Using $s = ut + \frac{1}{2}at^2$ vertically we get $0.04 = 4.9 \times T^2$ giving $T = \sqrt{\frac{0.04}{4.9}}$ s (oe)

Using $s = ut + \frac{1}{2}at^2$ horizonally we get $80 = uT + 0 \times T^2$ giving $u = \frac{80}{T}$

So $u = 885$ ms^{-1} (3sf)

(6 marks)

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6. (a) For initial motion across the table, using $F = ma$ gives $-\frac{1}{4}mg = ma$ so $a = -\frac{1}{4}g$

So $s = 0.8, u = \frac{7\sqrt{3}}{5}\ v = ?, a = -\frac{g}{4}, t = T_1$

Using $v^2 = u^2 + 2as$ we get $v^2 = (\frac{7\sqrt{3}}{5})^2 + 2(-\frac{g}{4}) \times 0.8$ giving $v = 1.4$ ms^{-1}

(b) For vertical motion under gravity, $s = 1.2, u = 0\ v = ?, a = g, t = T_2$

Using $s = ut + \frac{1}{2}at^2$ vertically we get $1.2 = 4.9 \times T_2^2$ so $T_2 = \frac{2\sqrt{3}}{7}$

No acceleration horizontally, so distance $= u \times T_2 = 1.4 \times \frac{2\sqrt{3}}{7}$

Total distance travelled horizontally $= 0.8 + 1.4 \times \frac{2\sqrt{3}}{7} = 1.49$ m (3sf)

(c) $T_1 = \frac{v-u}{a} = \frac{1.4-\frac{7\sqrt{3}}{5}}{-\frac{g}{4}} = 0.4183 \ldots$

Total time $= T_1 + T_2 = 0.913$ seconds (3sf)

(14marks)

(Total 40 Marks)