

1. (a) Vertical motion: $v^2 = u^2 + 2as$ M1
 $(40 \sin \theta)^2 = 2 \times g \times 12$ A1
 $(\sin \theta)^2 = \frac{2 \times g \times 12}{40^2}$
 $\theta = 22.54 = 22.5^\circ$ (accept 23) A1 3
- (b) Vert motion $P \rightarrow R$: $s = ut + \frac{1}{2}at^2$
 $-36 = 40 \sin \theta t - \frac{g}{2}t^2$ M1
 $\frac{g}{2}t^2 - 40 \sin \theta t - 36 = 0$ A1 A1
 $t = \frac{40 \sin 22.54 + \sqrt{(40 \sin 22.54)^2 + 4 \times 4.9 \times 36}}{9.8}$
 $t = 4.694...$ A1
Horizontal P to R: $s = 40 \cos \theta t$ M1
 $= 173 \text{ m (or 170 m)}$ A1 6
- (c) Using Energy:
 $\frac{1}{2}mv^2 - \frac{1}{2}m \times 40^2 = m \times g \times 36$ M1 A1
 $v^2 = 2(9.8 \times 36 + \frac{1}{2} \times 40^2)$
 $v = 48.0.....$
 $v = 48 \text{ m s}^{-1}$ (accept 48.0) A1 3

[12]

2 (a) $x_A = 28t$

$x_B = 35 \cos \alpha t$

B1 B1

Meet $\Rightarrow 28t = 35 \cos \alpha t \Rightarrow \cos \alpha = 28 / 35 = 4 / 5 *$

M1 A1

4

(b) $y_A = 73.5 - \frac{1}{2}gt^2$ $y_B = 21t - \frac{1}{2}gt^2$ Meet $\Rightarrow 73.5 = 21t$

B1 B1

$\Rightarrow t = \underline{3.5 \text{ s}}$

M1 A1

4

[8]

3. (a) $\rightarrow x = u \cos \alpha t = 10$

M1A1

$$\uparrow y = u \sin \alpha t - \frac{1}{2}gt^2 = 2$$

M1A1

$\Rightarrow t =$

$$\frac{10}{u \cos \alpha}$$

$$2 = u \sin \alpha \times \frac{10}{u \cos \alpha} - \frac{g}{2} \times \frac{100}{u^2 \cos^2 \alpha}$$

M1

$$= 10 \tan \alpha - \frac{50g}{u^2 \cos^2 \alpha} \quad (\text{given answer})$$

A1

6

(b) $2 = 10 \times 1 - \frac{100g \times 2}{2u^2 \times 1}$

M1A1

$$u^2 = \frac{100g}{8}, u = 8 \sqrt{\frac{100g}{8}} = 11.1 (\text{ms}^{-1})$$

A1

$$\frac{1}{2}mu^2 = m \times 9.8 \times \frac{1}{2} \times 2$$

M1A1

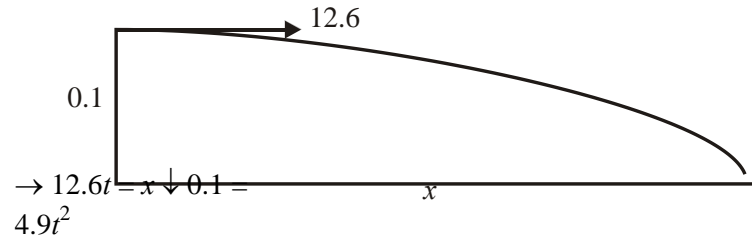
$$v = 9.1 \text{ms}^{-1}$$

A1

6

[12]

4 (a)



$$\Rightarrow 0.1 = 4.9 \times$$

$$\Rightarrow x = 1.8 \text{ m} \quad \frac{x^2}{12.6}$$

B1

B1

M1

(b)



$$\uparrow u \sin \alpha.t = \frac{1}{2} g t^2$$

$$u \cdot \frac{24}{25} t = 2.5$$

$$\Rightarrow u \approx 6.75 \text{ or } 6.8 \text{ m s}^{-1}$$

$$u \cdot \frac{2.5}{25} = 4.9 \cdot \frac{2.5}{24u}$$

$$u^2 = \frac{4.9 \times 2.5 \times 25^2}{7 \times 24}$$

A1

4

M1 A1

M1 A1

M1 A1

6

[10]

5.

(a) \rightarrow : $u \cos \alpha \times T = 8$

$u \times \frac{4}{5} \times T = 8$

$uT = 10$ (*)

M1

A1 2

(b) \uparrow : $-4 = u \sin \alpha T - \frac{1}{2}gT^2$

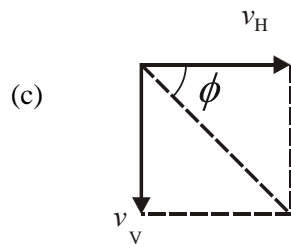
$u = 7$

M1 A1

$$-4 = u \times \frac{3}{5} \left(\frac{10}{u} \right) - \frac{1}{2} \times 9.8 \left(\frac{10}{u} \right)^2$$

M1

M1 A1 7



$v_H = u \cos \alpha = \frac{28}{5}$

B1 ft

$v_v^2 = (-u \sin \alpha)^2 + 2g \times 4$

M1

$\Rightarrow v_v = 9.8 (= \frac{49}{5})$

A1 ft

$\tan \phi = \frac{49/5}{28/5} = \frac{7}{4}$

M1 A1 cao 5

[12]

6. (a) $\uparrow \{ -52.5 = 14t - \frac{1}{2} \times 9.8t^2$

M1 A2

$$7t^2 - 20t - 75 = 0 \quad (7t + 15)(t - 5) = 0 \quad t = 5 \quad (\text{or } t = -\frac{15}{7})$$

M1 A1 A1

(\rightarrow): $S = 28 \cos 30^\circ \times 5$

M1

(b) $v_{\text{horizontal}} : 28 \cos 30^\circ = 14\sqrt{3} \approx 24.25 \text{ m (3 s.f.)}$

A1

8

$v_{\text{vertical}} : 28 \sin 30^\circ - 5g = -35$

$\therefore \text{speed} = \sqrt{(14\sqrt{3})^2 + 35^2} = \sqrt{1813} = 42.6 \text{ m s}^{-1} \text{ OR}$

KE gain = PE loss

$\frac{1}{2} m (v^2 - 28^2) = mg \times 52.5$

2

M1 A1

$\Rightarrow v = \sqrt{1813} = 42.6 \text{ m s}^{-1}$

M1 A1

5

M1 A2

M1 A1

5

[13]

7. (a) $2ut = 735$

$$0 = 3ut - \frac{1}{2}gt^2$$

$u = 24.5^*$
eliminating t

M1 A1

M1 A1

dep. M1

A1 6

(b) $t = \frac{735}{49} = 15$

M1 A1 2

(c) Initially: $v^2 = (2u)^2 + (3u)^2$ (7803.25)

$$\frac{1}{2}mv^2 - \frac{1}{2}m65^2 = mgh$$

$$h = 180 \text{ m (183 m)}$$

OR $v_y^2 = 65^2 - (2u)^2$ (1824)

$$v_y^2 = (3u)^2 - 2gh \quad h = 180 \text{ m (183 m)}$$

M1

M1 A1

A1 4

M1

M1 A1

A1 (4)

[12]

$$8 \quad \text{(a)} \quad 7 - 5t^2 \quad (6)$$

$$\text{(b) (i)} \quad Vt \cos \theta \quad (4)$$

$$\text{(ii)} \quad Vt \sin \theta - 5t^2$$

$$\text{(c)} \quad \tan \theta = \frac{7}{24}, \quad VT = 25 \quad (6)$$

$$\text{(d)} \quad 7V^2 > 3125 \quad (4)$$