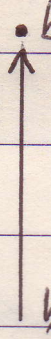
BOARD OF STUDIES
NEW SOUTH WALES

Centre Number: ..... Student Number: .....

Projectile Motion – Worksheet 1

1.



(a) At max. ht. $V = 0$ (vertically):

$V^2 = u^2 + 2as$

$0 = (24.5)^2 - 2 \times 9.8 \times s$

$\therefore s = \underline{30.6m}$

(b) $V = u + at$

$0 = 24.5 - 9.8t$

$\therefore t = \underline{2.5s}$

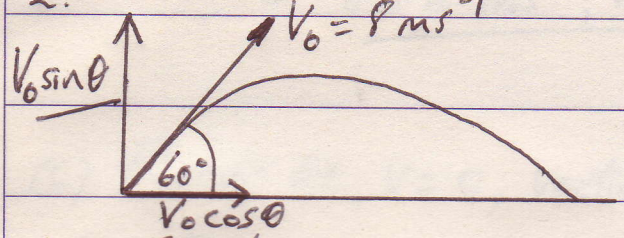
(c) Speed will be same as initial speed $= 24.5\,ms^{-1}$

(since the motion is symmetrical – and energy is conserved.)

(d) Total time of flight = 2 x time to max. ht.

$= \underline{5.0s}$

2.



(a) $x = V_0 \cos\theta . t$

$= 8 \cos 60° \times 0.5$

$= \underline{2.0m}$

(b) Time to max. ht. $\Rightarrow V = 0$ (vertically)

$0 = 8 \sin 60° - 9.8t$

$\therefore t = \underline{0.7s}$

$\therefore$ Time of flight $= 2 \times 0.7$

$= \underline{1.4s}$

$y = V_0 \sin\theta . t - \frac{1}{2} g t^2$

$= 8 \sin 60° . 0.5 - \frac{1}{2} \times 9.8 \times (0.5)^2$

$= \underline{2.2m}$

(Note: for those not sure – we use $V = u + at$ vertically, with $V = 0$.
u vertically is $8 \sin 60°$)

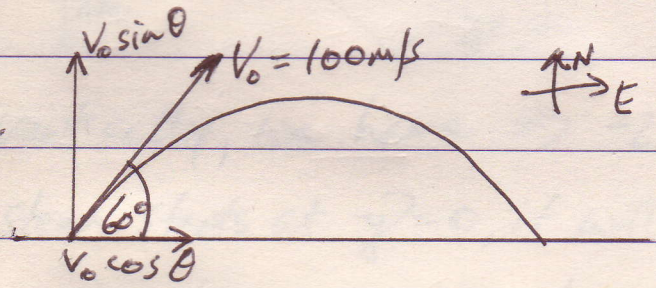
2. (c) Horizontally $\Rightarrow x = V_0 \cos\theta . t$, t = time of flight

$\therefore x = 8\cos 60° \times 1.4$

$= \underline{5.6\ m}$

(d) Max range is achieved with $\theta = \underline{45°}$. (Ignoring air resistance)

3.



(a) $V_x = V_0 \cos\theta$

$= 100\cos 60°$

$= \underline{50\ m/s\ East}$

(b) $V_y = V_0 \sin\theta$

$= 100 \sin 60°$

$= \underline{86.6\ ms^{-1},\ vertically\ upward}$

(c) At max. ht., $V = 0$, vertically.

Using $V = u + at$ vertically, we have:

$0 = 86.6 - 9.8t$

$\therefore t = \underline{8.84s} \Rightarrow$ time to max. ht.

So, total time of flight $= 2 \times 8.84 = \underline{17.7s}$

(d) For max. ht. $\Rightarrow y = V_0 \sin\theta . t - \frac{1}{2} g t^2$ (from $s = ut + \frac{1}{2}at^2$)

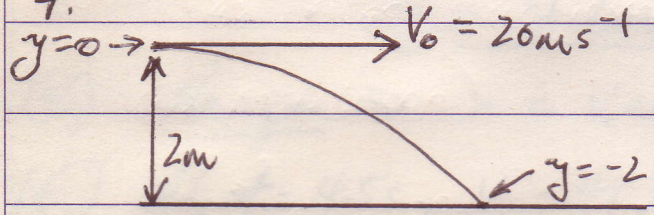
$y = (86.6 \times 8.84) - (\frac{1}{2} \times 9.8 \times 8.84^2) = \underline{382.6\ m}$

3. (c) Range $\Rightarrow x = V_0 \cos\theta \cdot t$

$= 50 \times 17.7$

$= 885\ m$

4.



(a) Stone has zero vertical velocity initially. So, using $s = ut + \frac{1}{2}at^2$ vertically, we have $\Rightarrow -2 = 0 - \frac{1}{2}gt^2$ (assuming here stone starts at $y=0$, it will reach ground at $y=-2$).

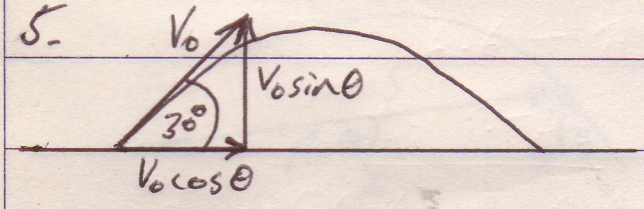
$\therefore t = 0.64s \Rightarrow$ time for stone to hit ground.

(b) $V_y = 0 - gt$ (from $v = u + at$) and $t = 0.64s$

$\therefore V_y = -6.27 m/s$ or $6.27 ms^{-1}$ vertically downward

(c) Range $\Rightarrow x = V_0 \cos\theta \cdot t = V_0 \cdot t$, since $\theta = 0°$ and $\cos\theta = 1$. So, $x = 20 \times 0.64 = 12.8m$

5.



(a) $V_x = V_0 \cos\theta = 50 \cos 30°$

$= 43.3 m/s$, horizontally

(b) $V_y = V_0 \sin\theta = 50 \times \sin 30°$

$= 25.0 ms^{-1}$, vertically up

5. (c) Time to max. ht. $\Rightarrow V = 0$, vertically

$0 = 25 - gt$ and $t = 2.55\text{s}$ to max. ht.

$\therefore$ Total time of flight $= 2 \times 2.55 = 5.1\text{s}$

(d) Max. ht. $\Rightarrow y = 25t - \frac{1}{2}gt^2$ and $t = 2.55\text{s}$

$\therefore y = 31.9\text{m}$

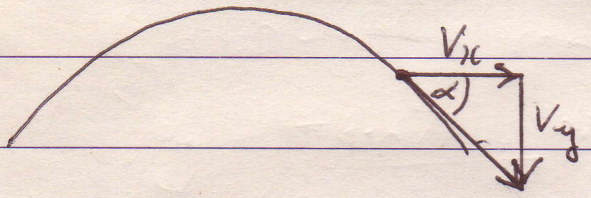
(e) Range $\Rightarrow x = V_0 \cos\theta \cdot t = 43.3 \times 5.1 = 220.8\text{m}$

(f) At $t = 4.5\text{s}$, $V_x = 43.3\text{ms}^{-1}$, $V_y = V_0 \sin\theta - gt$

$\therefore V_y = 25 - (9.8 \times 4.5)$

$= -19.1\text{ms}^{-1}$.

Total velocity $\Rightarrow V_T = \sqrt{V_x^2 + V_y^2} = \sqrt{43.3^2 + (-19.1)^2} = 47.3\text{ m/s}$



$\tan\alpha = \frac{V_y}{V_x} = \frac{19.1}{43.3} = 0.4411$

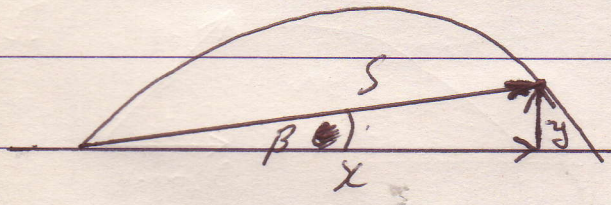
$\therefore \alpha = 23.8°$ below

$\therefore V_T = 47.3\text{ms}^{-1}$ at $23.8°$ below horizontal.

(g) At $t = 4.5\text{s}$, $x = 43.3 \times 4.5 = 194.9\text{m}$

and $y = V_0 \sin\theta \cdot t - \frac{1}{2}gt^2 = (25 \times 4.5) - (\frac{1}{2} \times 9.8 \times 4.5^2) = 13.3\text{m}$

Total Displacement $\Rightarrow S_T = \sqrt{x^2 + y^2} = \sqrt{194.9^2 + 13.3^2} = 195.4\text{m}$

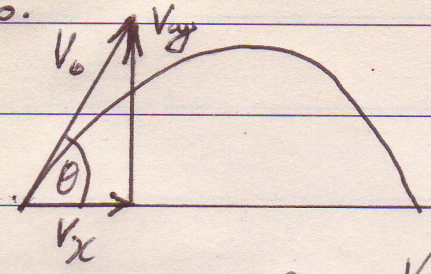


$\tan\beta = \frac{y}{x} = \frac{13.3}{194.9} = 0.0682$

$\therefore \beta = 3.9°$

$\therefore S_T = 195.4\text{m}$ at an angle of $3.9°$ above the horizontal.

6.



At max. ht. $V = 0$, vertically.

From $V = u + at$, vertically $\Rightarrow$

$0 = V_0 \sin\theta - gt$

$0 = 20 \sin 45° - 1.6 \times t$

$\therefore t = 8.8$ s is time to max ht.

$\therefore$ Max. ht. $\Rightarrow$ $y = V_0 \sin\theta . t - \frac{1}{2} g t^2$

$= 20 \sin 45° \times 8.8 - \frac{1}{2} \times 1.6 \times 8.8^2$

$= 62.5$ m

Time to complete flight $= 2 \times 8.8 = 17.6$ s

$\therefore$ Range $\Rightarrow$ $x = V_0 \cos\theta . t$, where $t = 17.6$ s

$\therefore x = 20 \cos 45° \times 17.6$

$= 249$ m

$\therefore$ Max. height is 62.5m and range is 249m.