Chapter 4 Homework.

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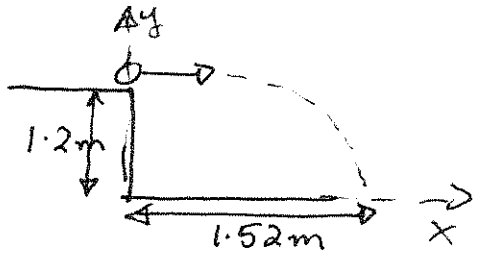


(a) How long in the air? – analyze vertical (ie y) motion:

$y_0 = 1.2 \quad y_f = 0 \quad v_{yi} = 0 \quad v_{yf} = ? \quad a = -9.8\ m/s^2 \quad t = ?$

$$y_f - y_0 = \cancel{v_{yi} t}^{\,0} + \frac{1}{2} a t^2$$

$$-1.2 = -\frac{1}{2} 9.8 t^2$$

$$t = \sqrt{\frac{2(y_f - y_0)}{a}} = \sqrt{\frac{2(0-1.2)}{-9.8}} = \boxed{0.49\ s.}$$

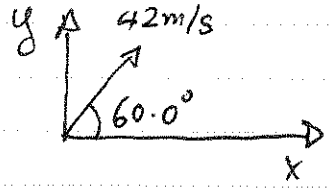
(b) What is initial speed off table? Initial speed is all in x-direction. There is no acceleration in the x-direction.

$v_x = ? \quad x_f = 1.52 \quad x_0 = 0 \quad a = 0 \quad t = 0.49\ s$

$$x_f - x_0 = v_x t \quad \Rightarrow \quad v_x = \frac{x_f - x_0}{t} = \frac{1.52}{0.49}$$

$$= \boxed{3.1\ m/s}$$

26 y direction:



$y_0 = 0 \quad y = h \quad v_{0y} = 42 \sin 60°$

$v_{yf} = ? \quad a = -9.8\ m/s^2$

$t = 5.5\ s$

$$y - y_0 = v_{0y} t + \frac{1}{2} a t^2$$

$$h = v_{0y} t + \frac{1}{2} a t^2$$

$$= 42 \sin 60\ 5.5 - \frac{1}{2}\ 9.8\ 5.5^2$$

$$= 200 - 148$$

$$h = 52\ m$$

(b) Speed just before impact. Work out x & y components of velocity and find the magnitude to get the speed.

$V_x = 42\cos 60^\circ = 21 \text{ m/s}$ (no a_x so V_x does not change).

$V_y = V_{y0} + at = 42\sin 60 - 9.8 \times 5.5$

$= -17.5 \text{ m/s}.$

$|V| = \sqrt{V_x^2 + V_y^2} = \sqrt{21^2 + (-17.5)^2} = \boxed{27.3 \text{ m/s}}$

(c) To get the maximum height we need to reset the endpoint to the maximum height where (of course!) $V_y = 0$.

$y_0 = 0 \quad y_f = H \quad V_{y0} = 42\sin 60 \quad V_{yf} = 0 \quad a = -9.8 \text{ m/s}^2$

$t = ?$

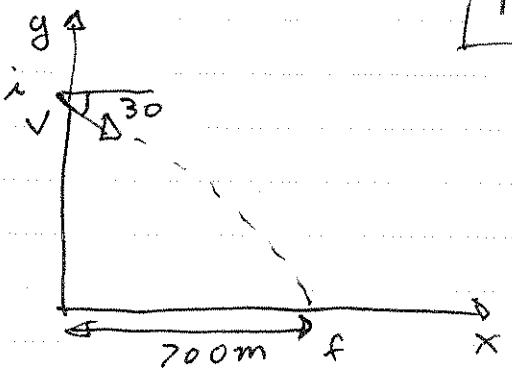
$$V_{yf}^2 - V_{y0}^2 = 2a(y_f - y_0)$$

$$\frac{V_{yf}^2 - V_{y0}^2}{2a} + y_0 = H$$

$$\frac{0 - (42\sin 60)^2}{-2\times 9.8} + 0 = H$$

$$\boxed{H = 67.5 \text{ m}}$$

27.



(a) use x direction to find the time:

$x_0 = 0 \quad x_f = 700 \text{ m}$

$V_x = V\cos 30^\circ \quad t = ?$

$V = 290.0 \frac{\text{km}}{\text{hr}} = \frac{290\,000}{3600} \frac{\text{m}}{\text{s}}$

$= 80.6 \text{ m/s}$

10s

$$V_x = \frac{x_f - x_0}{t} \Rightarrow t = \frac{V_x}{x_f - x_0} = \frac{80.6\cos 30}{700 - 0} =$$

(b) How high was the release point?
Set up y-direction

$y_0 = ?$ $y_f = 0$ $V_{y_0} = -V\sin 30°$ $V_{y_f} = ?$ $a = -9.8 m/s^2$
$t = 0.1 s$.

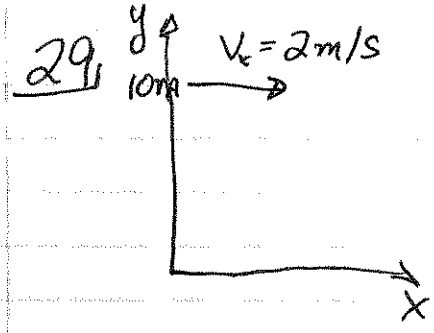
$$y_f - y_0 = V_{y_0} t + \frac{1}{2} a t^2$$

$$y_f - V_{y_0} t - \frac{1}{2} a t^2 = y_0$$

$$0 + V\sin 30 \times t + \frac{1}{2} 9.8 t^2 = y_0$$

$$80.6 \sin 30 \times 10 + \frac{1}{2} 9.8 \times 10^2 = y_0 = 893 m.$$

29.



$x_0 = 0$ $x_f = ?$ $t = 0.8$ $V_x = 2 m/s$

(a) $x_f - x_0 = V_x t$

$$x_f = 2 \times 0.8 = 1.6 m.$$

(b) $y = ?$ $y_0 = 10m$ $V_{y_0} = 0$ $V_{y_f} = ?$ $a = -9.8$
$t = 0.8$

$$y - y_0 = V_{y_0} t + \frac{1}{2} a t^2$$

$$y - 10 = \frac{1}{2} a t^2 \Rightarrow y = \frac{1}{2} a t^2 + 10 = -\frac{1}{2} 9.8 \, 0.8^2 + 10$$
$$= \boxed{6.86 m.}$$

(c) time to travel 10m is $y_0 = 10$ $y = 0$ $V_{y_0} = 0$ $V_{y_f} = ?$
$a = -9.8 m/s^2$ $t = ?$

$$y - y_0 = V_{y_0} t + \frac{1}{2} a t^2$$

$$t = \sqrt{\frac{2(y - y_0)}{a}} = \sqrt{\frac{2(-10)}{-9.8}} = 1.43 s$$

$$x_f = x_0 + v_x t = 0 + 2 \times 1.43 = \boxed{2.85\text{m}}$$

34) $v = 19.5$ at $45°$

Range of the ball. $x_f = ?$ Find time of flight first.

$y_0 = 0$ $y_f = 0$ $v_{y_0} = v \sin 45°$ $v_{y_f} = ?$ $a = -9.8$ $t = ?$

$$y_f - y_0 = v_{y_0} t + \frac{1}{2} a t^2$$

$$0 = v \sin 45 \times t + \frac{1}{2} a t^2$$

$$t = \frac{2 v \sin 45}{-a} = \frac{2 \times 19.5 \sin 45}{9.8}$$

$$= 2.81\text{s}.$$

$$x_f = x_0 + v_x t = 0 + 19.5 \cos 45 \times 2.81 = 38.7\text{m}$$

Player must move $55 - 38.7\text{m}$ in 2.81s to meet the ball. $\Rightarrow$ 5.8m/s.

38) Time to travel 22m in the x direction.

$x_0 = 0$ $x_f = 22\text{m}$ $v_x = 25.0 \cos 40°$ $t = ?$

$$t = \frac{x_f - x_0}{v} = \frac{22\text{m}}{25.0 \cos 40} = 1.15\text{s}.$$

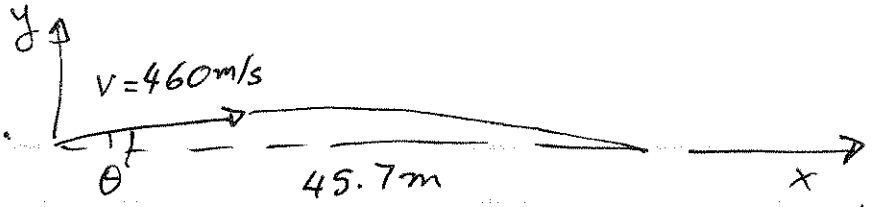
Horizontal velocity component $v_x = v \cos 40 = 19.2\text{m/s}$

Vertical velocity — use $v_f = v_0 + at$ where $v_0 = v \sin 40°$ and $a = -9.8\text{m/s}^2$ $t = 1.15\text{s}$

$$v_f = (25.0 \sin 40°) - 9.8 \times 1.15 = 4.8\text{m/s}.$$

The vertical compont is still positive so the ball is still rising when it's hits the wall. ie it has not reached the highest point

39.



Set up the x and y motion equations.

In x direction $x_0 = 0$ $x_f = 45.7\,m$ $V_x = V\cos\theta$ $t = ?$

$$t = \frac{x_f - x_0}{V_x} = \frac{45.7}{460\cos\theta}$$

In the y-direction

$y_0 = 0$ $y_f = 0$ $V_{y_0} = V\sin\theta$ $a = -9.8\,m/s^2$ $t = ?$

$V_{y_f} = ?$

$$y_f - y_0 = V_{y_0}t + \frac{1}{2}at^2$$

$$0 = V\sin\theta\, t + \frac{1}{2}at^2$$

$$t = \frac{-2V\sin\theta}{a}$$

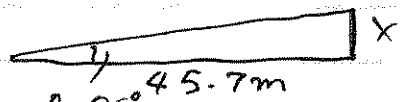
The t values must be equal.

$$\frac{45.7}{460\cos\theta} = -\frac{2V\sin\theta}{a}$$

$$-\frac{45.7\times(-9.8)}{(460)^2} = 2\sin\theta\cos\theta = \sin 2\theta$$

$$2\theta = \sin^{-1}(\quad) = 0.12^\circ$$

$$\Rightarrow \underline{\theta = 0.06^\circ}.$$



$$\tan(0.06) = \frac{x}{45.7} \Rightarrow x = 45.7\tan(0.06)$$

$$= 0.048\,m$$

ie 4.8 cm above center

57. (a) Period = time for 1 revolution = 12 s

(b) $\frac{v^2}{R} = \left(\frac{2\pi 15}{12}\right)^2/15 =$ ~~4.2 m/s²~~ $4.1\,m/s^2$

(c) down (towards center of motion).

(d) $4.1\,m/s^2$ (e) up

62. (a) Distance moved in 1 revolution $= 2\pi r$

$= 2\pi\, 0.15\,m$

$= 0.940\,m$

(b) Tip speed $= \dfrac{\text{distance}}{\text{time for 1 rev}} = \dfrac{0.94}{(60s/1200)}$

$= 18.8\,m/s$

(c) $a = \dfrac{V^2}{R} = \dfrac{(18.8)^2}{0.15} = 2360\,m/s^2$

(d) Period $= \dfrac{60s}{1200} = 0.05s.$