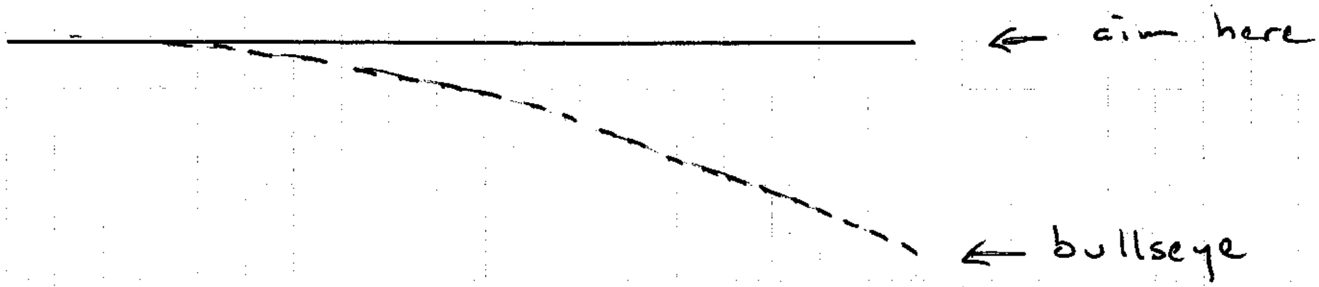
Projectiles + Circular Motion Review

1



Horizontal

$v_x = 90$ m/s
$d_x = 40$ m

$t = \frac{d_x}{v_x}$

$= \frac{40}{90}$

$t = 0.44$ s

Vertical

$v_i = 0$
$a = -9.8$ m/s^2
$t = 0.44$ s

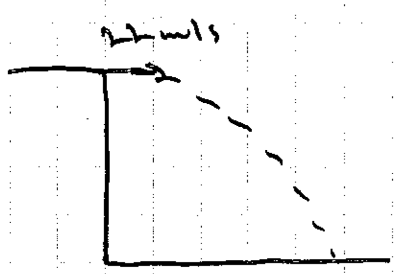
$d = v_i t + \frac{1}{2}at^2$

$= (0)(0.44) + \frac{1}{2}(-9.8)(0.44)^2$

$d = -0.968$ m

He must aim $\boxed{0.97 \text{ m}}$ above the bullseye.

2



Vertical

$d = -176.4$ m
$a = -9.8$ m/s^2
$v_i = 0$

$d = v_i t + \frac{1}{2}at^2$
$-176.4 = \frac{1}{2}(-9.8)t^2$

$t = 6$ s

Horizontal

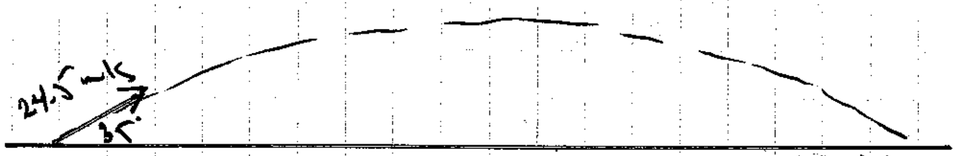
$v_x = 22$ m/s
$t = 6$ s

$d_x = v_x \cdot t$

$= 22(6)$

$d_x = \boxed{132 \text{ m}}$

(8)



a) Vertical

$d = 0$
$a = -9.8 \text{ m/s}^2$
$v_i = 24.5 \sin 35 = 14.053 \text{ m/s}$

$d = v_i t + \frac{1}{2} a t^2$

$0 = 14.053\, t + \frac{1}{2}(-9.8) t^2$

$0 = t\,(14.053 - 4.9t)$

$\therefore\ t = 0 \quad \text{or} \quad 14.053 - 4.9t = 0$

$t = 2.868 \text{ s}$

Horizontal

$t = 2.868 \text{ s}$
$v_x = 24.5 \cos 35$
$= 20.069 \text{ m/s}$

$d_x = v_x \cdot t$

$= (20.069)(2.868)$

$d_x = \boxed{57.6 \text{ m}}$

b) Vertical (to middle)

$v_i = 14.053 \text{ m/s}$
$v_f = 0$
$a = -9.8 \text{ m/s}^2$

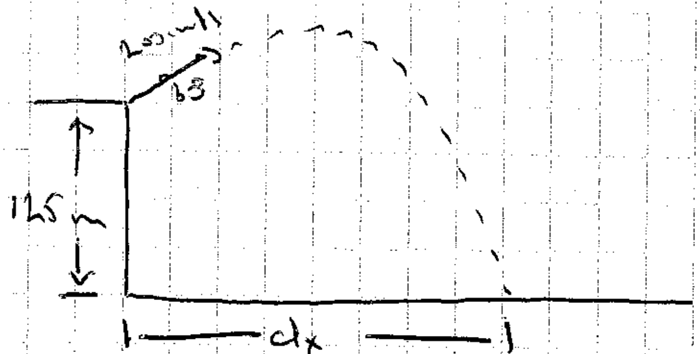
$v_f^2 = v_i^2 + 2ad$

$0 = (14.053)^2 + 2(-9.8)\,d$

$d = \frac{(14.053)^2}{19.6}$

$d = \boxed{10.1 \text{ m}}$

4



Vertical

$v_i = 200 \sin 30 = 100$ m/s
$a = -9.8$ m/s^2
$d = -125$ m
$t = ?$

$v_f^2 = v_i^2 + 2ad$

$= 100^2 + 2(-9.8)(-125)$

$v_f = -111.58$ m/s

$v_f = v_i + at$

$-111.58 = 100 - 9.8t$

$t = 21.59$ s

Horizontal

$v_x = 200 \cos 30 = 173.205$ m/s

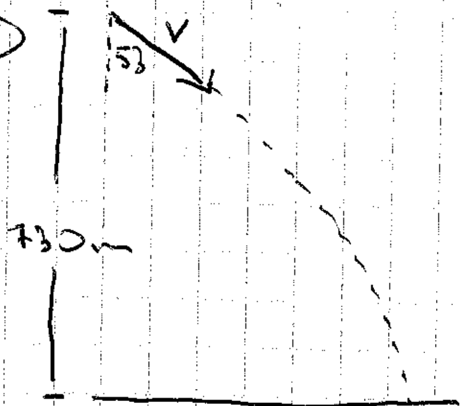
$t = 21.59$ s

$d_x = v_x \cdot t$

$= (173.205)(21.59)$

$d_x = \boxed{3739 \text{ m}}$

5



a) Vertical

$v_i = -v\cos 53$
$a = -9.8\ m/s^2$
$t = 5s$
$d = -730\ m$

$d = v_i t + \frac{1}{2}at^2$

$-730 = (-v\cos 53)5 + \frac{1}{2}(-9.8)(5)^2$

$-730 = -3.009\,v - 122.5$

$v = \dfrac{730 - 122.5}{3.009}$

$v = \boxed{202\ m/s}$

b) Horizontal

$v_x = v\sin 53$
$= 202\sin 53$
$v_x = 161.236\ m/s$
$t = 5s$

$d_x = v_x \cdot t$

$= (161.236)(5)$

$d_x = \boxed{806\ m}$

c) Vertical

$v_f = v_i + at$

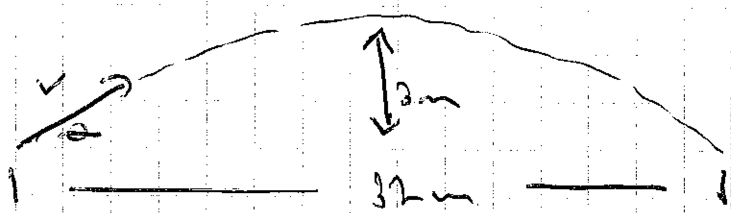
$= -202\cos 53 + (-9.8)(5)$

$v_f = \boxed{-171\ m/s}$

Horizontal

$v_x = \boxed{161\ m/s}$

⑥



Vertical (to the middle)

v_i
$a = -9.8$
$d = 3\ m$
$v_f = 0$

$v_f^2 = v_i^2 + 2ad$

$0 = v_i^2 + 2(-9.8)(3)$

$v_i = 7.668\ m/s$

$v_f = v_i + at$

$0 = 7.668 - 9.8t$

$t = 0.782\ s$

Horizontal

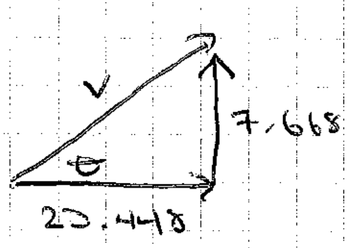
v_x
$d_x = 32\ m$
$t = 1.565\ s$

$v_x = \dfrac{d_x}{t}$

$= \dfrac{32}{1.565}$

$v_x = 20.448\ m/s$

doubled for the whole trip $= 1.565\ s$

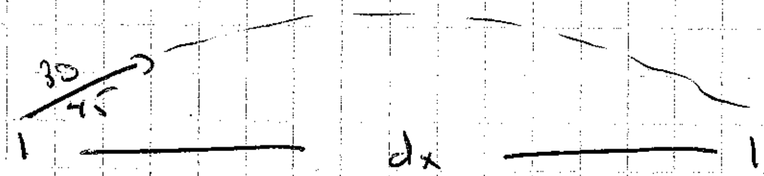


$\theta = \tan^{-1}\left(\dfrac{7.668}{20.448}\right) = 20.6^\circ$

$v = \sqrt{7.668^2 + 20.448^2}$

$v = \boxed{21.8\ m/s\ [20.6^\circ\ ATH]}$

(7) * With no air resistance, max distance is achieved at a 45° angle.



Vertical

$v_i = 30 \sin 45$
$a = -9.8 \text{ m/s}^2$
$v_f = 0$ (at midpoint)

$v_f = v_i + at$

$0 = 30 \sin 45 - 9.8t$

$t = 2.165$ s (to midpoint)

total time $= 4.329$ s

Horizontal

$v_x = 30 \cos 45$
$t = 4.329$ s

$d_x = v_x \cdot t$

$= 30 \cos 45 (4.329)$

$d_x = \boxed{91.8 \text{ m}}$

(8) $v = \dfrac{2\pi r}{T}$

$277.8 = \dfrac{2\pi r}{160}$

$r = 7073.6$ m

$a = \dfrac{v^2}{r}$

$= \dfrac{(277.8)^2}{7073.6}$

$a = \boxed{10.9 \text{ m/s}^2}$

(9) $a = \dfrac{v^2}{r}$

$8.3 = \dfrac{25^2}{r}$

$r = \dfrac{25^2}{8.3} = \boxed{75.3 \text{ m}}$

(10) a) $a = \frac{v^2}{r} = \frac{(1.25)^2}{11} = \boxed{0.14 \ m/s^2}$

b) $\Sigma F = ma$

$= (25)(0.14)$

$\Sigma F = \boxed{3.55 \ N}$

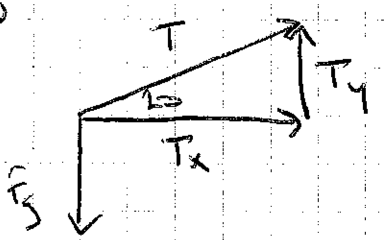
(11) $\Sigma F = \frac{mv^2}{r}$

$26 = \frac{0.8 v^2}{0.5}$

$v = \sqrt{\frac{26(0.5)}{0.8}}$

$v = \boxed{4.03 \ m/s}$

(12)



a) $T_y = F_g$

$= mg$

$= (4)(9.8)$

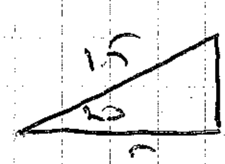
$T_y = 39.2 \ N$

$\sin 20 = \frac{T_y}{T}$

$T = \frac{T_y}{\sin 20}$

$= \frac{39.2}{\sin 20}$

$T = \boxed{114.6 \ N}$



b) $\Sigma F = F_x$

$\frac{mv^2}{r} = T \cos 20$

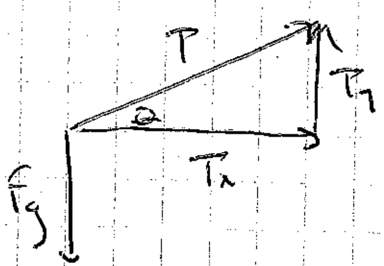
$r = 1.5 \cos 20$

$r = 1.41 \ m$

$v = \sqrt{\frac{(114.6 \cos 20)(1.41)}{4}}$

$v = \boxed{6.2 \ m/s}$

(13)



$$v = \frac{2\pi r}{T} = \frac{2\pi(0.625)}{1.3}$$

$$v = 2.945 \text{ m/s}$$

a) $T_y = F_g$

$= mg$

$= (0.875)(9.8)$

$T_y = 8.575 \text{ N}$

$T_x = \Sigma F$

$= \frac{mv^2}{r}$

$= \frac{(0.875)(2.945)^2}{(0.625)}$

$T_x = 12.144 \text{ N}$

$T^2 = T_x^2 + T_y^2$

$= (8.575)^2 + 12.144^2$

$T = \boxed{14.9 \text{ N}}$

b) $\theta = \tan^{-1}\left(\frac{T_y}{T_x}\right)$

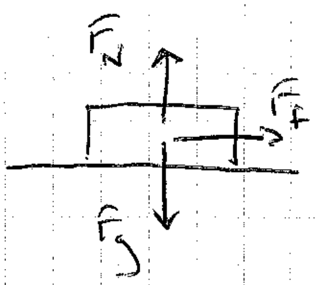
$= \tan^{-1}\left(\frac{8.575}{12.144}\right)$

$\theta = 35^\circ$ to horizontal

or

$\boxed{55^\circ}$ to vertical

(14)



$$\Sigma F = F_f$$

$$\frac{\cancel{m}v^2}{r} = \mu \cdot \cancel{m}g$$

$$v = \sqrt{\mu r g}$$

$$= \sqrt{(0.6)(85)(9.8)}$$

$$v = \boxed{22.4 \text{ m/s}}$$

(15) 55 km/h = 15.278 m/s

$$\Sigma F = F_f$$

$$\frac{\cancel{m}v^2}{r} = \mu \cancel{m}g$$

$$\mu = \frac{v^2}{rg} = \frac{(15.278)^2}{(68)(9.8)} = \boxed{0.35}$$

(16)

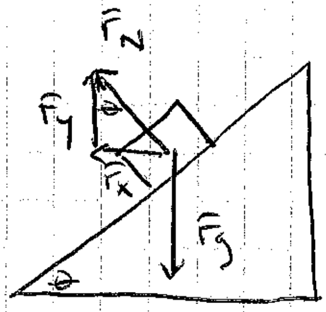
$$F_f = \Sigma F$$

$$= \frac{mv^2}{r}$$

$$= \frac{(60)(18)^2}{20}$$

$$F_f = \boxed{972 \text{ N}}$$

(17)



$F_x = \Sigma F$

$F_y = F_g$

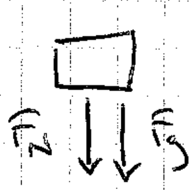
$$\tan\theta = \frac{F_x}{F_y} = \frac{\frac{\cancel{m}v^2}{r}}{\cancel{m}g}$$

$$\tan\theta = \frac{v^2}{rg}$$

$$\theta = \tan^{-1}\left(\frac{66.7^2}{(975)(9.8)}\right)$$

$$\theta = \boxed{25^\circ}$$

(18)



$F_N = 0$

$\Sigma F = F_g$

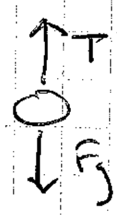
$$\frac{\cancel{m}v^2}{r} = \cancel{m}g$$

$$v = \sqrt{rg}$$

$$= \sqrt{(18)(9.8)}$$

$$v = \boxed{13.3 \text{ m/s}}$$

(19) a)



$$\Sigma F = T - F_g$$

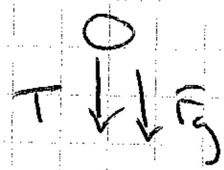
$$\frac{mv^2}{r} = T - mg$$

$$T = \frac{mv^2}{r} + mg$$

$$= \frac{(2)(12)^2}{1.5} + (2)(9.8)$$

$$T = \boxed{211.6 \text{ N}}$$

b)



$$\Sigma F = T + F_g$$

$$\frac{mv^2}{r} = T + mg$$

$$T = \frac{mv^2}{r} - mg$$

$$= \frac{(2)(12)^2}{1.5} - (2)(9.8)$$

$$T = \boxed{172.4 \text{ N}}$$

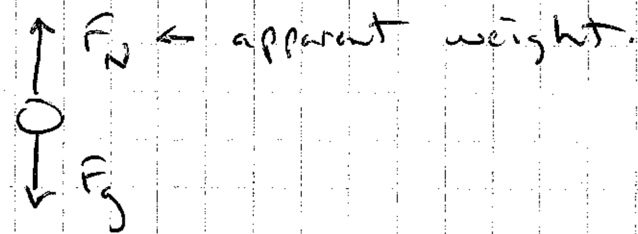
(20) $700\ km/h = 194.4\ m/s$

a) $a = 6g = 6(9.8) = 58.8\ m/s^2$

$$a = \frac{v^2}{r}$$

$$r = \frac{v^2}{a} = \frac{(194.4)^2}{58.8} = \boxed{643\ m}$$

b)



$$\Sigma F = F_N - F_g$$

$$ma = F_N - mg$$

$$F_N = ma + mg$$

$$= (80)(58.8) + (80)(9.8)$$

$$F_N = \boxed{5488\ N}$$