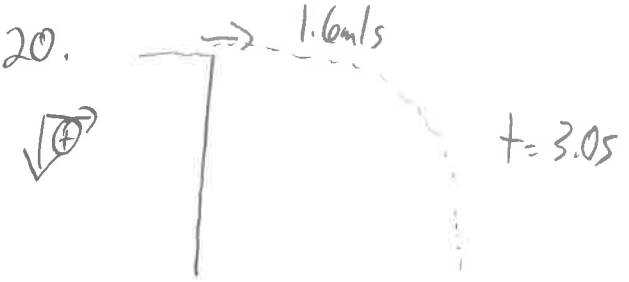
Projective Motion

20.



x-dir	y-dir
$V_x = 1.6\,m/s$	$V_{oy} = 0\,m/s$
$t_x = 3.0s$	$V_y = ?$
$d_x = ?$	$d_y = ?$
	$a_y = 9.80\,m/s^2$
	$t_y = 3.0s$

$V_x = \frac{d_x}{t_x} \quad \therefore \quad d_x = V_x t_x$

$= (1.6\,m/s)(3.0s)$

$= 4.8\,m$

$d_y = \cancel{V_{oy}t} + \frac{1}{2} a t_y^2$

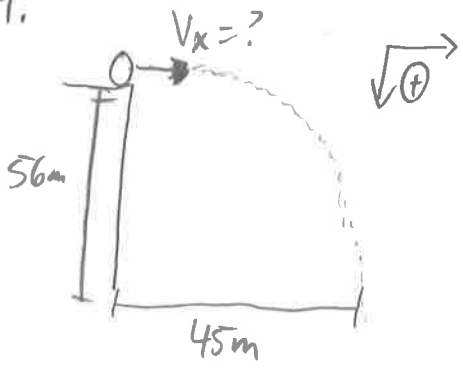
$d_y = \frac{1}{2} a t_y^2$

$= \frac{1}{2}(9.80\,m/s^2)(3.0s)^2$

$= 44.1\,m$

$= 44\,m$

24.



x-dir	y-dir
$V_x = ?$	$V_{oy} = 0\,m/s$
$t_x = t_y$	$V_y = ?$
$d_x = 45m$	$d_y = 56m$
	$a_y = 9.80\,m/s^2$
	$t_y = t$

$d_y = \cancel{V_{oy}t_y} + \frac{1}{2} a_y t$

$d_y = \frac{1}{2} a_y t^2$

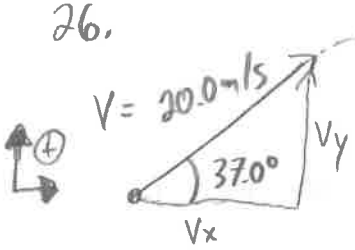
$\therefore \quad t = \sqrt{\frac{2d_y}{a_y}} = \sqrt{\frac{2(56m)}{9.8\,m/s^2}} = 3.3806s$

$V_x = \frac{d_x}{t_x} = \frac{45m}{3.3806s}$

$V_x = 13.311\,m/s$

$V_x = 13\,m/s$

26.



x-dir	y-dir
$V_x = V\cos 37°$	$V_y = V\sin 37°$
$t_x = t_y$	$a_y = -9.80\ m/s^2$
$d_x = ?$	$d_y = 0\ m$
	$t_y = ?$

$$d = V_0 t + \tfrac{1}{2} a t^2$$

$$d_y = V\sin 37° \, t + \tfrac{1}{2} a_y t^2$$

$$0 = t\left(V\sin 37° + \tfrac{1}{2} a t\right)$$

So $t = 0$

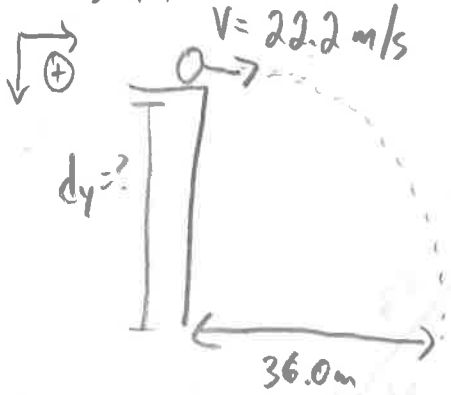
OR $t = \dfrac{-2V\sin 37°}{a}$

$$= \frac{-2(20.0\ m/s)\sin 37°}{-9.80\ m/s^2}$$

$$t = 2.4563$$

$$\boxed{t = 2.46\ s}$$

27.



x-dir	y-dir
$V_x = 22.2\ m/s$	$d_y = ?$
$d_x = 36.0\ m$	$V_{0y} = 0\ m/s$
$t_x = ?$	$t_y = t_x$
	$a_y = 9.80\ m/s^2$

$$V_x = \frac{d_x}{t_x} \quad \therefore \quad t_x = \frac{d_x}{V_x}$$

$$= \frac{36.0\ m}{22.2\ s}$$

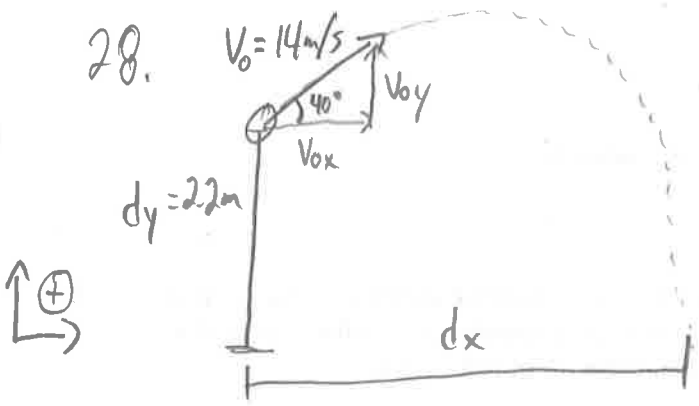
$$= 1.6216\ s$$

$$d = \cancel{V_0 t} + \tfrac{1}{2} a t^2$$

$$d_y = \tfrac{1}{2}(9.80\ m/s^2)(1.6216\ s)^2$$

$$= 12.8853 = \boxed{12.9\ m}$$

28.



x-dir	y-dir
$V_{ox} = V_0 \cos 40°$	$V_{oy} = V_0 \sin 40°$
$d_x = ?$	$a_y = -9.80 m/s^2$
$t_x = t_y$	$t_y = ?$
	$d_y = -2.2m$

$$d_y = V_{oy}t + \frac{1}{2}a_y t^2$$

$$-2.2 = 14 \sin 40° t - \frac{1}{2}(9.8)t^2$$

$$\therefore \; 4.9t^2 - 8.999t - 2.2 = 0$$

$$t = \frac{8.999 \pm \sqrt{(-8.999)^2 - 4(4.9)(-2.2)}}{2(4.9)}$$

$$t = -0.2184 \, s$$

OR

$$2.0550 s$$

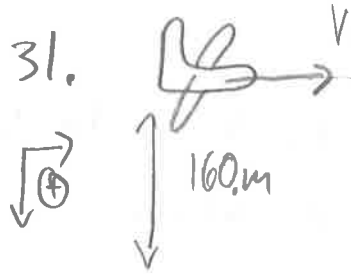
So $V = \frac{d}{t} \; \therefore \; d_x = V_x t_x$

$$= (14 m/s)(\cos 40°)(2.0550 s)$$

$$= 22.0392 m$$

$$\boxed{= 22 m}$$

31.



x-dir	y-dir
$V_x = 160\text{ km/h}$	$V_{oy} = 0\text{ m/s}$
$= 44.\bar{4}\text{ m/s}$	$d_y = 160\text{ m}$
$t_x = t_y$	$a_y = 9.80\text{ m/s}^2$
$d_x = ?$	$t_y = ?$

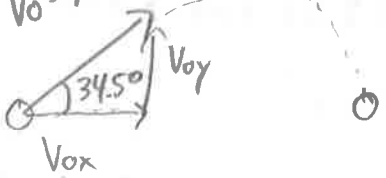
$$d_y = V_{oy}t + \tfrac{1}{2}a_y t^2$$

$$d_y = \tfrac{1}{2}a_y t^2 \quad \therefore \quad t_y = \sqrt{\frac{2d_y}{a_y}}$$

$$= \sqrt{\frac{2(160\text{ m})}{9.80\text{ m/s}^2}} = 5.71428$$

$$= 5.71\text{ s}$$

35.



x-dir	y-dir
$V_{ox} = V_0 \cos 34.5°$	$V_{oy} = V_0 \sin 34.5°$
$t_x = t_y = t$	$a_y = -9.80\text{ m/s}^2$
	$t_y = t_x = t$

a) max height $V_y = 0$

$$V_y^2 = V_{oy}^2 + 2ad$$

$$\therefore d_y = \frac{-V_{oy}^2}{2a} = \frac{-(75.2\text{ m/s} \cdot \sin 34.5°)^2}{2(-9.80\text{ m/s}^2)}$$

$$d_y = 92.56262$$

$$d_y = 92.6\text{ m}$$

b) total time $d_y = 0$

$$d_y = V_{oy}t + \frac{1}{2}at^2$$

$$0 = (75.2 \cdot \sin 34.5^\circ)t + \frac{1}{2}(-9.80 m/s^2)t^2$$

$$= t\,(42.594 - 4.90t)$$

$t = 0$ s OR $t = \frac{42.594}{4.90} = 8.6927$ s

$= 8.69$ s

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c) $V = \frac{d}{t}$ $\therefore$ $d_x = V_x t_x$

$= (75.2 m/s \cdot \cos 34.5^\circ)(8.6927 s)$

$= 538.72$ m

$= 539$ m

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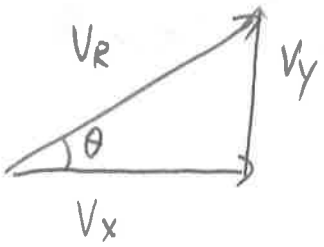
d) $V_x = V_0 \cos 34.5^\circ = 75.2\,m/s \cdot \cos 34.5^\circ = 61.9742\,m/s$

@ $t = 1.50s$

$V_y = V_{oy} + a_y t$

$= 75.2\,m/s \cdot \sin 34.5^\circ - (9.8\,m/s^2)(1.50s)$

$= 27.89374\ m/s$



$V_R = \sqrt{V_x^2 + V_y^2}$

$= \sqrt{(61.9742\,m/s)^2 + (27.89374\,m/s)^2}$

$V_R = 67.9620\ m/s$

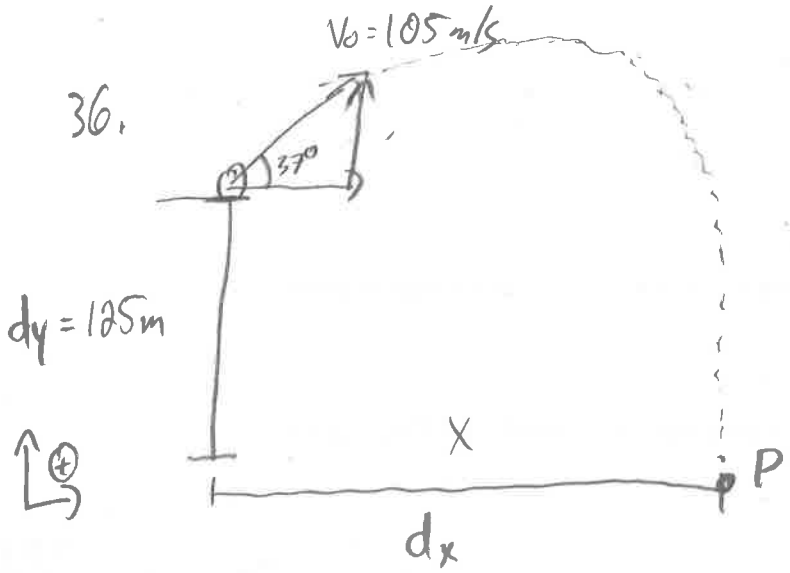
$\tan\theta = \frac{V_y}{V_x}$

$\therefore \theta = \tan^{-1}\left(\frac{27.894}{61.9742}\right)$

$= 24.232^\circ$

$V_R = 68.0\,m/s$, 24.2° above the horizontal

36.



x-dir	y-dir
$V_x = V_0 \cos 37°$	$V_{oy} = V_0 \sin 37°$
$t_x = t_y = t$	$d_y = -125\ m$
	$a_y = -9.80\ m/s^2$
	$t_y = t_x = t$

a) time

$$d_y = V_{y0}t + \frac{1}{2}a_y t^2$$

$$-125 = (105\ m/s)(\sin 37°)t + \frac{1}{2}(-9.80)t^2$$

$$\therefore\ 4.90t^2 - 63.191t - 125 = 0$$

$$t = \frac{63.191 \pm \sqrt{(-63.191)^2 - 4(4.90)(-125)}}{2(4.90)}$$

$$t = -1.7426\ s \quad \text{or} \quad 14.639\ s$$

$$\boxed{t = 14.6\ s}$$

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b) $v = \frac{d}{t}$ $\therefore\ d_x = V_x t$

$$d_x = (105\ m/s)(\cos 37°)(14.639\ s)$$

$$= 1227.58\ m$$

$$\boxed{= 1230\ m}$$

c) at impact $t = 14.639\,s$

$$V_x = (105\,m/s)(\cos 37°) = 83.857\,m/s = \boxed{83.9\,m/s\ (\text{RIGHT})}$$

$$V_y = V_{oy} + at$$

$$= (105\,m/s)(\sin 37°) + (-9.80\,m/s^2)(14.639\,s)$$

$$= -80.271\,m/s = \boxed{80.3\,m/s\ (\text{down})}$$

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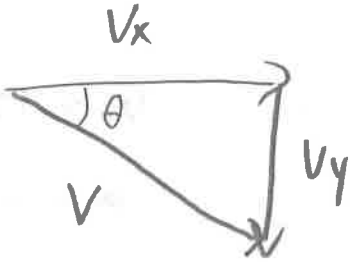
d)



$$V = \sqrt{V_x^2 + V_y^2}$$

$$V = \sqrt{(83.857\,m/s)^2 + (80.271\,m/s)^2}$$

$$= 116.08\,m/s$$

$$\boxed{116\,m/s}$$

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e) $\tan\theta = \dfrac{V_y}{V_x}$

$$\theta = \tan^{-1}\left(\frac{80.271}{83.857}\right) = 43.748°$$

$$\boxed{43.7° \text{ Below the horizontal}}$$