Solutions: Projectile Motion W.S. #2

1) Horizontal

$\Delta d_x = ?$

$v_x = 10.0\ m/s$

$\Delta t = 0.71\ s$

$\Delta d_x = v_x \Delta t$

$= 10.0\ \frac{m}{s} \times 0.71\ s$

$= \underline{\underline{7.1\ m}}$

Vertical

$\Delta d_y = -2.5\ m$

$a_y = -9.8\ m/s^2$

$\Delta t = ?$

$v_{iy} = 0$

$\Delta d_y = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$

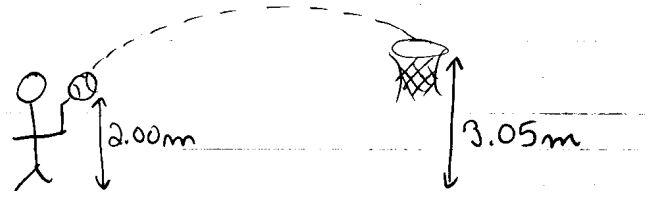
$(\Delta t)^2 = \frac{2\Delta d_y}{a}$

$= \frac{2(-2.5\ m)}{-9.8\ m/s^2}$

$= 0.51020\ s^2$

$\Delta t = 0.71\ s$

a)



17.1 m/s
40°

$v_x = v\cos\theta$
$= 17.1\,m/s \cos 40°$
$= 13.1\,m/s$

$v_y = v\sin\theta$
$= 17.1\,m/s \sin 40°$
$= 11.0\,m/s$

Horizontal

$\Delta d_x = ?$
$\Delta t = 2.14\,s$
$v_x = 13.1\,m/s$

$\Delta d_x = v_x \Delta t$
$= (13.1\,m/s)(2.14\,s)$
$= \underline{\underline{28.0\,m}}$

Vertical

$\Delta d_y = 3.05\,m - 2.00\,m$
$= 1.05\,m$
$a = -9.8\,m/s^2$
$v_{iy} = 11.0\,m/s$

$\Delta d_y = v_{iy}\Delta t + \frac{1}{2}a(\Delta t)^2$

quadratic

$1.05\,m = 11\,m/s\,\Delta t + \frac{1}{2}(-9.8\,m/s^2)(\Delta t)^2$

$0 = -4.9(\Delta t)^2 + 11\Delta t - 1.05\,m$

...

$\Delta t = 0.10\,s$ or $\Delta t = 2.14\,s$

$\Delta t = 0.10\,s$: way up

$\Delta t = 2.14\,s$: way down

3) **Horizontal**

$\Delta d_x = 10.0\,m$

$v_x = ?$

$\Delta t = 2.67\,s$

$$v_x = \frac{\Delta d_x}{\Delta t} = \frac{10.0\,m}{2.67\,s} = 3.75\,m/s$$

Vertical

$\Delta d_y = -35.0\,m$

$a = -9.8\,m/s^2$

$\Delta t = ?$

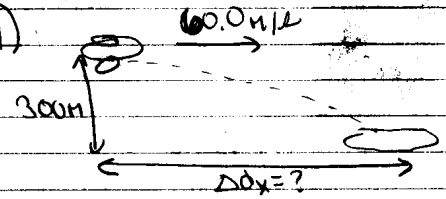
$v_{iy} = 0$

$$\Delta d_y = \cancel{v_{iy}}^{0}\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$(\Delta t)^2 = \frac{2\Delta d_y}{a} = \frac{2(-35\,m)}{-9.8\,m/s^2} = 7.14\,s^2$$

$\Delta t = 2.67\,s$

4)



Horizontal

$v_x = 60.0\,m/s$

$\Delta t = 7.82\,s$

$\Delta d_x = ?$

$$\Delta d_x = v_x \Delta t = 60\frac{1}{s}(7.82\,s) = 469\,m$$

Vertical

$\Delta d_y = -300\,m$

$a = -9.8\,m/s^2$

$\Delta t = ?$

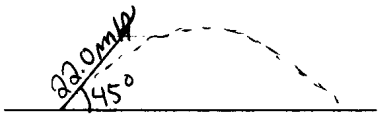
$v_{iy} = 0$

$$\Delta d_y = \cancel{v_{iy}}^{0}\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$(\Delta t)^2 = \frac{2\Delta d_y}{a} = \frac{2(-300\,m)}{-9.8\,m/s^2} = 61.22\,s^2$$

$\Delta t = 7.82\,s$

5)



$v_x = v\cos\theta$
$= 22\frac{m}{s}\cos 45°$
$= 15.6\ m/s$

$v_x = v\sin\theta$
$= 22\frac{m}{s}\sin 45°$
$= 15.6\ m/s$

Horizontal

$\Delta d_x = ?$
$v_x = 15.6\ m/s$
$\Delta t = 3.18\ s$

b) continued

$\Delta d_x = v_x \Delta t$
$= 15.6\frac{m}{s}(3.18\ s)$
$= \underline{\underline{49.6\ m}}$

Vertical

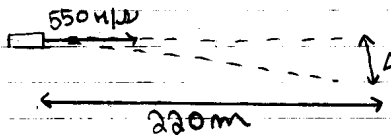
$\Delta d_y = ?$
$a_y = -9.8\ m/s^2$
$v_f = 0$
$v_{iy} = 15.6\ m/s$

a) $\cancel{v_f^2}^{0} = v_{iy}^2 + 2a_y\Delta d_y$
$-v_i^2 = 2a\Delta d$
$\Delta d_y = \frac{-v_i^2}{2a}$
$= \frac{-(15.6\ m/s)^2}{2(-9.8\ m/s^2)}$
$= \underline{\underline{12.4\ m}}$

b) $\Delta d_y = 0$
$a_y = -9.8\ m/s^2$
$\Delta t = ?$
$v_{iy} = 15.6\ m/s$

$\cancel{\Delta d_y}^{0} = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$
$\frac{1}{2}a(\Delta t)^2 = -v_i\Delta t$
$\Delta t = \frac{-2v_i}{a}$
$= \frac{-2(15.6\ m/s)}{-9.8\ m/s^2}$
$= 3.18\ s$

(b)



Horizontal

$\Delta d_x = 220\,m$

$v_x = 550\,m/s$

$\Delta t = ?$

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

$$= \frac{220\,m}{550\,m/s}$$

$$= 0.400\,s$$

Vertical

$v_{iy} = 0$

$a_y = -9.8\,m/s^2$

$\Delta t = 0.40\,s$

$\Delta d_y = ?$

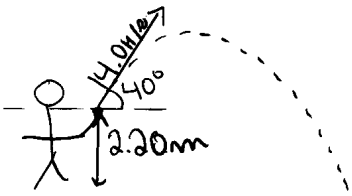
$$\Delta d_y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$= \frac{1}{2}\left(-9.8\,\frac{m}{s^2}\right)(0.4\,s)^2$$

$$= -0.784\,m$$

Ans: 0.784 m

7)



$v_x = v\cos\theta$
$= 14\frac{m}{s}\cos 40°$
$= 10.7 m/s$

$v_y = v\sin\theta$
$= 14\frac{m}{s}\sin 40°$
$= 9.00 m/s$

Horizontal

$v_x = 10.7 m/s$
$\Delta t = 2.06 s$
$\Delta d_x = ?$

$\Delta d_x = v_x \Delta t$
$= 10.7\frac{m}{s}(2.06 s)$
$= \underline{22.0 m}$

Vertical

$\Delta d_y = -2.20 m$
$v_{iy} = 9.00 m/s$
$a = -9.8 m/s^2$
$\Delta t = ?$

$\Delta d_y = v_i \Delta t + \frac{1}{2} a(\Delta t)^2$

quadratic!

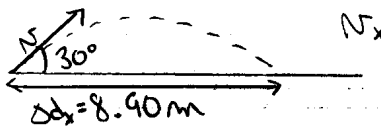
$-2.20 m = 9.00\frac{m}{s}\Delta t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)(\Delta t)^2$

$0 = -4.9(\Delta t)^2 + 9\Delta t + 2.2$

$\Delta t = \frac{-9 \pm \sqrt{9^2 - 4(-4.9)(2.2)}}{2(-4.9)}$

$\Delta t = -0.218 s$ or $\Delta t = 2.06 s$

8)



$v_x = v\cos\theta = v\cos 30° = 0.87v$

$v_y = v\sin\theta = v\sin 30° = 0.5v$

Horizontal	Vertical
$\Delta d_x = 8.90\,m$	$\Delta d_y = 0$
$v_x = ? = 0.87v$	$a = -9.8\,m/s^2$
$\Delta t = ?$	$\Delta t = ?$
	$v_y = ? = 0.5v$

2 equations, 2 unknown! (v and Δt)

$\Delta d_x = v_x \Delta t$

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

$\Delta d_y = v_{iy}\Delta t + \frac{1}{2}a(\Delta t)^2$

$-v_{iy}\Delta t = \frac{1}{2}a(\Delta t)^2$

$\boxed{\Delta t = -\frac{2v_{iy}}{a_y}}$

$$\frac{\Delta d_x}{v_x} = -\frac{2v_{iy}}{a_y}$$

$$\frac{8.90\,m}{0.87v} = -\frac{2(0.5v)}{-9.8\,m/s^2}$$

$$(8.90\,m)(-9.8\,m/s^2) = (0.87v)(-2(0.5)v)$$

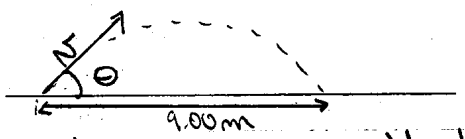
$$87.22\,m^2/s^2 = 0.87v^2$$

$$\frac{87.22}{(0.87)}\,m^2/s^2 = v^2$$

$$100\,m^2/s^2 = v^2$$

$$\underline{10\,m/s = v}$$

9)



Horizontal

$\Delta d_x = 9.00\,m$

$\Delta t = 1.14\,s$

$v_x = ?$

$$v_x = \frac{\Delta d_x}{\Delta t} = \frac{9.00\,m}{1.14\,s}$$

$v_x = 7.89\,m/s$

Vertical

$\Delta d_y = 0$

$v_{iy} = ?$

$a = -9.8\,m/s^2$

$\Delta t = 1.14\,s$

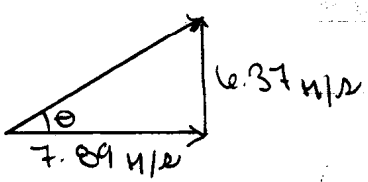
$$\Delta d_y = v_{iy}\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$v_{iy}\Delta t = -\frac{1}{2}a(\Delta t)^2$$

$$v_{iy} = -\frac{1}{2}a\Delta t$$

$$= -\frac{1}{2}(-9.8\,m/s^2)(1.14\,s)^2$$

$v_{iy} = 6.37\,m/s$



$$\tan\theta = \frac{6.37\,m/s}{7.89\,m/s}$$

$$\theta = \tan^{-1}\left(\frac{6.37}{7.89}\right)$$

$$= 38.9^\circ$$