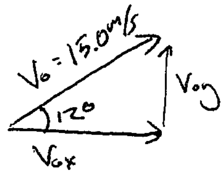
SOH CAH TOA

Name:_______________________

AP Phys: Projectile motion problem set 1

1. A ball is thrown with an angle of 12.0 ° to the horizon with a speed of 15.0 m/s. What are its horizontal and vertical components?



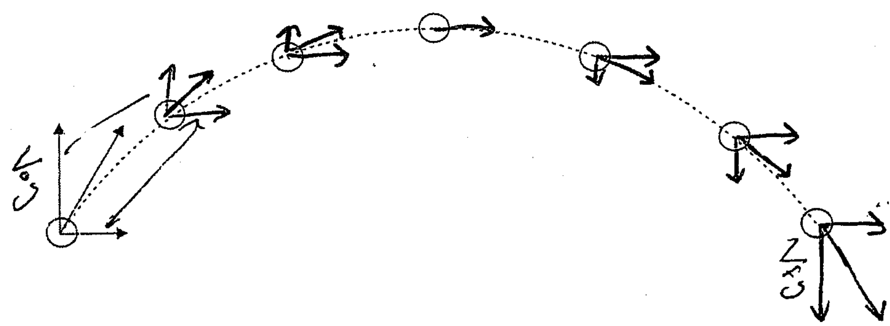
$\cos\theta = \frac{V_{ox}}{V_o}$ $\sin\theta = \frac{V_{oy}}{V_o}$

$V_{ox} = V_o \cos\theta$ $V_{oy} = V_o \sin\theta$

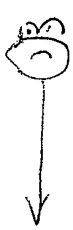
$= 15.0 \cos(12.0)$ $= 15.0 \sin(12.0)$

$= 14.7$ m/s $= 3.12$ m/s

2. Draw the velocity vectors onto the balls below:



3. A frog falls from its rainforest tree. If we ignore wind resistance, (a) how much time does it take the frog to fall a distance of 12.0 m? (b) how fast is the frog falling at this point?



(A) $d = 12.0$ m
$a = +9.8$ m/s²
$V_o = 0$
$t = ?$
$V_f = ?$

$d = \cancel{V_o t}^{\,0} + \frac{1}{2} a t^2$

$t = \sqrt{\frac{d\,2}{a}}$

$= \sqrt{\frac{12.0\,\text{m} \cdot 2}{9.8\,\text{m/s}^2}}$

$= 8.57$ 1/s $= \boxed{8.57\text{s}}$

(b) $V_f = V_o + at$

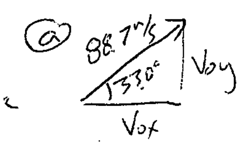
$V_f = 0 + (9.8\,\text{m/s}^2)(8.57\text{s})$

$\boxed{V_f = 83.995\,\text{m/s}}$

4. An arrow is launched with a velocity of 88.7 m/s at an angle of 33.0° to the horizontal. (a) What are the horizontal and vertical components of the velocity? (b) How long does it take for the arrow to reach its highest position? (c) How long does it take to fall back down? (d) How far does the arrow travel?

X	Y
$a_x = 0$	$a_y = -9.81$ m/s²
V_{ox}	$V_{py} = 0$
t_T	V_{oy}
	$t_p = ?$

(a)



$V_{ox} = 88.7\,\text{m/s} \cos(33.0°) = 74.39$ m/s

$V_{oy} = 88.7\,\text{m/s} \sin(33.0°) = 48.31$ m/s

(b) $V_{py} = V_{oy} + a t_p$

$t_p = \frac{V_{py} - V_{oy}}{a}$

$= \frac{0 - 48.31}{-9.8\,\text{m/s}^2}$

$\boxed{= 4.930\text{s}}$

(c) $\boxed{\text{same as } t_p}$

(d) $d_x = V_{ox} t_T + \frac{1}{2} \cancel{a_x} t_T^2$

$d_x = V_{ox} \cdot t_T$

$d_x = V_{ox} \cdot 2 t_p$

$d_x = (74.4\,\text{m/s})(2 \cdot 4.93)$

$d_x = 734$ m

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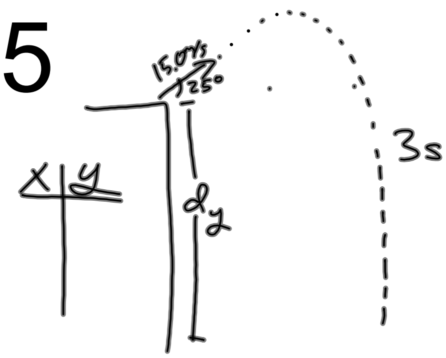

X	y
$V_{ox} = 13.6\,m/s$	$V_{oy} = 6.34\,m/s$
$a_x = 0$	$a_y = -9.8\,m/s^2$
	$V_{py} = 0$

$$\cos\Theta = \frac{V_{ox}}{V_o}$$
$$V_{ox} = V_o \cos\Theta$$
$$V_{ox} = (15.0\,m/s)(\cos(25))$$
$$V_{ox} = 13.6\,m/s$$
$$\sin\Theta = \frac{V_{oy}}{V_o}$$
$$V_{oy} = V_o \sin\Theta = 6.34\,m/s$$

Time to peak:

$$V_{py} = V_{oy} + a_y t_p$$
$$t_p = \frac{V_{py} - V_{oy}}{a_y}$$
$$t_p = \frac{0 - 6.34\,m/s}{-9.8\,m/s^2}$$
$$t_p = 0.647\,s$$

Time for Arc:

$$t_{arc} = 2(t_p)$$
$$t_{arc} = 2(.647\,s)$$
$$t_{arc} = 1.29\,s$$

$d_y = ?$

$V_o = -6.34\,m/s$

$t = 3.00\,s - 1.29\,s = 1.71\,s = t_{fall}$

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

$$d_y = V_{oy} t_{fall} + \frac{1}{2} a_y t_{fall}^2$$
$$d_y = (-6.34\,m/s)(1.71\,s) + \frac{1}{2}(-9.8\,m/s)(1.71\,s)^2$$
$$d_y = -25\,m$$

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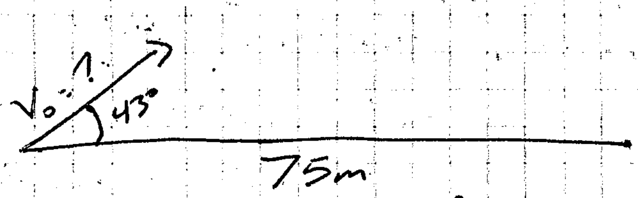

$\cos\theta = \frac{V_{ox}}{V_o}$

$V_{ox} = V_o \cos\theta$

$V_{ox} = $

(a) $d_x = V_{ox}t + \cancel{\frac{1}{2}a_x t^2}^{\,0}$

$V_{ox} = \frac{d_x}{t}$

$V_{ox} = \frac{75m}{2.3s}$

$V_{ox} = 32.6 m/s$

$\cos\theta = \frac{V_{ox}}{V_o}$

$V_o = \frac{V_{ox}}{\cos\theta}$

$V_o = \frac{32.6 m/s}{\cos(43°)}$

$V_o = 44.59 m/s = \boxed{44.6 m/s}$

$\boxed{45 m/s}$

(b) $\tan\theta = \frac{V_{oy}}{V_{ox}}$

$V_{oy} = V_{ox}\tan\theta$

$V_{oy} = (32.6 m/s)\tan(43)$

$V_{oy} = 30.4 m/s$

$V_{py} = V_{oy} + a_y t_p$

$t_p = \frac{V_{py} - V_{oy}}{a_y}$

$t_p = \frac{0 - 30.4 m/s}{(-9.8 m/s)}$

$t_p = 3.1s$

$\cancel{V_{py}^2}^{\,0} = V_{oy}^2 + 2a_y d_y$

$d_y = \frac{-V_{oy}^2}{2a_y} = \frac{-(30.4 m/s)^2}{2(-9.8 m/s)} = \boxed{47.2m} = \boxed{d_y = 47m}$

~~7 (a) slope = 1 m/s²~~

~~$a = \frac{V}{t}$ =~~

~~$V = at = 1 m/s^2 \cdot 2.5s$~~

~~$\boxed{V = 2.5 m/s}$~~

~~(b) $\frac{Rise}{Run} = \frac{-6 m/s}{7s} = -\frac{6}{7} m/s^2$ ... $= -1.4 m/s$ +2~~

~~eyeball it~~

~~(c) a-b, f-g~~

~~(d) $8 + 20 + 2 + 8 + 1.5 = 40m$ 39.5m~~

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x	y
$V_o = V$	$d_y = h$
$a_x = 0$	$a_y = -9.8 m/s$
$d_x = ?$	$V_{oy} = 0$

$d_y = \cancel{V_{oy}t}^{\,0} + \frac{1}{2}a_y t^2$

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

$h = \frac{1}{2}g t^2$

$t = \sqrt{\frac{2h}{g}}$

$d_x = V_{ox}t + \cancel{\frac{1}{2}a_x t^2}^{\,0}$

$\boxed{d_x = V\sqrt{\frac{2h}{g}}}$

you must only use the variables Provided

7 a) slope = $1\,m/s^2$

$a = \frac{v}{t}$

$V = at$

$V = 1\,m/s^2 \cdot 2.5\,s$

$V = 2.5\,m/s$

b) eyeball it, -2

c) a to b and f to g

d) Area under the curve

$8m + 20m + 2m + 8m = \boxed{38\,m}$

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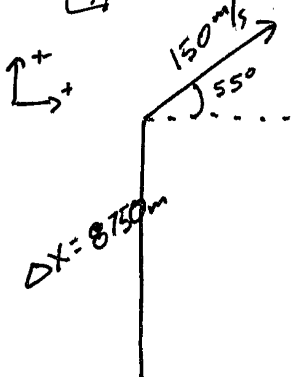

X	Y
$a_x = 0$	$a_y = -9.8\,m/s^2$
$V_{ox} = 86.04\,m/s$	$V_{oy} = 122.87\,m/s$
	$V_{peak\,y} = 0$
	$X_{oy} = 8750m$
	$X_{fy} = 0$

Initial Velocities

$\cos\theta = \frac{V_{ox}}{V_o}$

$V_{ox} = V_o \cos(\theta)$

$V_{ox} = 150 \cos(55)$

$\boxed{V_{ox} = 86.04\,m/s}$

$\sin\theta = \frac{V_{oy}}{V_o}$

$V_{oy} = V_o \sin\theta$

$= 150 \sin(55)$

$= 122.87\,m/s$

a) displacement to peak (y)

$\cancel{V_{peak\,y}}^2 = V_{oy}^2 + 2a_y \Delta X_{y\,peak}$

$\Delta X_{y\,peak} = \frac{-V_{oy}^2}{2a_y}$

$\Delta X_{y\,peak} = \frac{-(122.87\,m/s)^2}{2(-9.8\,m/s^2)}$

$\boxed{\Delta X_{y\,peak} = 769.5\,m}$

b) Time until it hits:

Time to peak:

$V_{y\,peak} = V_{oy} + a_y t_{peak}$

$t_{peak} = \frac{-V_{oy}}{a_y}$

$t_{peak} = \frac{-122.8\,m/s}{(-9.8\,m/s^2)}$

$t_{peak} = 12.54\,s$

c) ΔX_x:

$\Delta X_x = V_{ox} t_{Total} + \cancel{\frac{1}{2} a_x t_{total}^2}$

$\Delta X_x = V_{ox} t_{Total}$

$\Delta X_x = (86.04\,m/s)(56.62\,s)$

$\boxed{\Delta X_x = 4871.3\,m}$

Time to fall (only falling)

$\Delta X_{Total\,y} = \cancel{V_{peak\,y} t_{down}} + \frac{1}{2} a_y t_{down}^2$

$t_{down} = \sqrt{\frac{2\,\Delta X_{Total\,y}}{a_y}}$

$t_{down} = \sqrt{\frac{2(769.5m + 8750m)}{+9.8\,m/s^2}}$

$t_{down} = 44.08\,s$

Total Time: $12.54\,s + 44.08\,s = \boxed{56.62\,s}$

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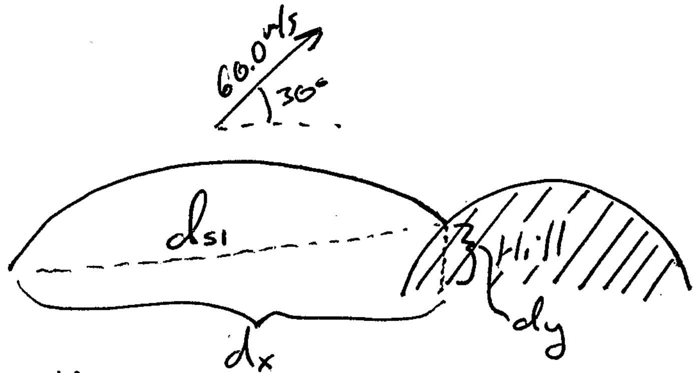


$V_{ox} = V_o \cos\theta$

$V_{ox} = 60.0\,m/s \cos(30°)$

$V_{ox} = 51.96\,m/s$

$V_{oy} = V_o \sin\theta$

$V_{oy} = 60.0\,m/s \sin(30)$

$V_{oy} = 30.0\,m/s$

X	y
$a_x = 0$	$a_y = -9.8\,m/s^2$
$V_{ox} = 51.96\,m/s$	$V_{oy} = 30.0\,m/s$
$t_{Total} = 4s$	$V_{Py} = 0$

(a) The velocity in the y direction is zero so the only velocity is in the x direction.

$V_x = 51.96\,m/s = \boxed{52.0\,m/s}$

b find d_x and d_y

d_x: $d_x = V_{ox} t_{Total} + \cancel{\frac{1}{2} a_x t_{Total}^2}$

$d_x = (51.96\,m/s)(4s)$

$d_x = 207.846\,m$

$d_x = 208\,m$

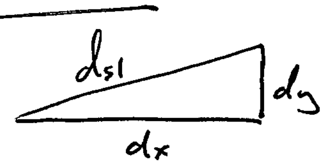
d_y: $d_y = V_{oy} t_{Total} + \frac{1}{2} a_y t_{Total}^2$

$d_y = (30.0\,m/s)(4s) + \frac{1}{2}(-9.8\,m/s^2)(4s)^2$

$d_y = 120\,m - 78.4\,m$

$d_y = 41.6\,m$

d_{s1}:



$a^2 + b^2 = c^2$

$d_{s1} = \sqrt{d_x^2 + d_y^2}$

$d_{s1} = \sqrt{(207.846\,m)^2 + (41.6\,m)^2}$

$d_{s1} = 211.968\,m$

$\boxed{d_{s1} = 212\,m}$