Projectiles

Horizontally - the velocity is constant

Vertically - the acceleration is constant $(a = -9.81 m/s^2)$

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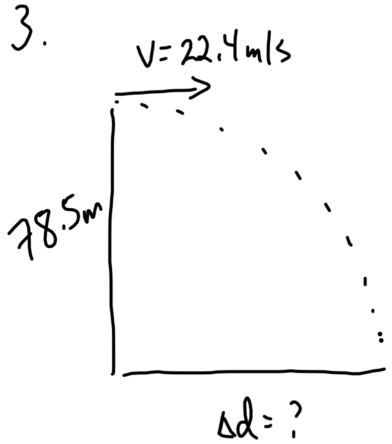
3.



Vertically

$v_1 = 0$

$\Delta d = -78.5m$

$a = -9.81 m/s^2$

$\Delta t = ?$

$$\Delta d = \cancel{v_1 t}^{\,0} + \frac{1}{2} a t^2$$

$$-78.5m = \frac{-9.81 m/s^2}{2} t^2$$

$$t^2 = \frac{2(-78.5m)}{-9.81 m/s^2}$$

$$t = 4.00 s$$

Horizontally

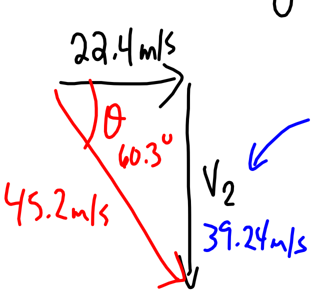
$$v = \frac{\Delta d}{\Delta t}$$

$$\Delta d = v \Delta t$$

$$\Delta d = (22.4 m/s)(4.00s)$$

$$\Delta d = 89.6 m$$

When landing:



vertically

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

$$a = \frac{v_2 - \cancel{v_1}^{\,0}}{\Delta t}$$

$$v_2 = a \Delta t$$

$$v_2 = (-9.81 m/s^2)(4.00s)$$

$$v_2 = -39.24 m/s$$

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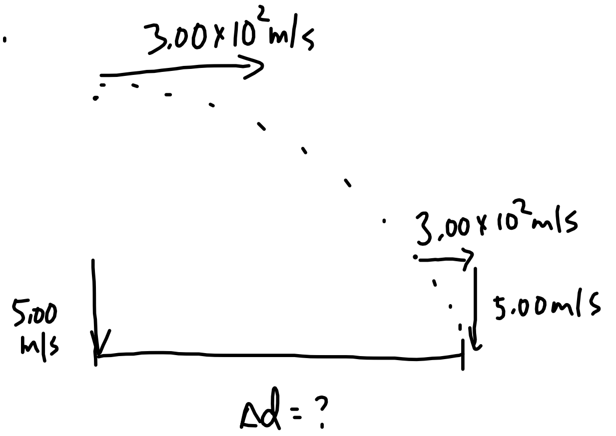
8.



Horizontally (constant velocity)

$V = \frac{\Delta d}{\Delta t}$

$\Delta d = v \Delta t$

$\Delta d = (3.00 \times 10^2 m/s)(0.510 s)$

a) $\Delta d = 153 m$

Bullet casing → Vertically

$V_1 = 0$

$V_2 = -5.00 m/s$

$a = -9.8 m/s^2$

$\Delta t =$

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

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

$\Delta t = \frac{-5.00 m/s - 0}{-9.81 m/s^2}$

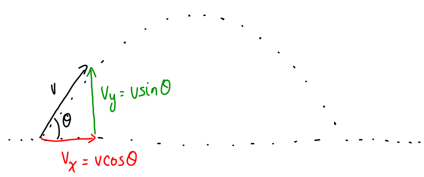
$\Delta t = 0.510 s$

Time for the casing to fall which is the same time the bullet is in the air.

b) Since both the bullet and the bullet casing are in the air for the same time, they both hit the ground at the same vertical velocity (i.e. 5.00m/s)

Symmetrical Trajectories

When a projectile returns to the same level that it was launched from it has a symmetrical trajectory (no air resistance).



Time in the air (vertically, $\Delta d = 0$ since the projectile returns to same level)

vertically:
$v_1 = v\sin\theta$
$\Delta d = 0$
$a = -g$
$\Delta t = ??$

$$\Delta d = v_1 t + \frac{1}{2}at^2$$
$$0 = (v\sin\theta)t - \frac{g}{2}t^2$$
$$0 = t\left(v\sin\theta - \frac{g}{2}t\right)$$

$\cancel{t=0}$ OR $v\sin\theta - \frac{g}{2}t = 0$

$$v\sin\theta = \frac{g}{2}t$$
$$t = \frac{2v\sin\theta}{g}$$

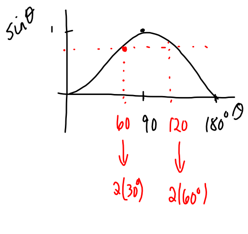
How far horizontally?

$v_x = v\cos\theta$
$\Delta t = \frac{2v\sin\theta}{g}$
$\Delta d_x = ?$

$$v_x = \frac{\Delta d_x}{\Delta t}$$
$$\Delta d_x = v_x \Delta t$$
$$\Delta d_x = (v\cos\theta)\left(\frac{2v\sin\theta}{g}\right)$$
$$\Delta d_x = \frac{v^2 \, 2\cos\theta\sin\theta}{g} \quad \rightarrow \sin 2\theta$$

Range
$$R = \frac{v^2\sin 2\theta}{g}$$

The maximum range is when $\theta = 45°$ (i.e. $\sin 2(45°) = 1$)



A launch angle of 30° and 60° will have the same range

Complementary angles have the same range.

Maximum height: (vertically)

$v_1 = v\sin\theta$
$t = \frac{1}{2}\left(\frac{2v\sin\theta}{g}\right) = \frac{v\sin\theta}{g}$
$a = -g$
$\Delta d = ??$
$v_2 = 0$

$$v_2^2 = v_1^2 + 2a\Delta d$$
$$\Delta d = \frac{\cancel{v_2^2}^{\,0} - v_1^2}{2a}$$
$$\Delta d = \frac{-(v\sin\theta)^2}{2(-g)}$$

max height.
$$H = \frac{v^2\sin^2\theta}{2g}$$

TO DO:

1. Look over MP|547