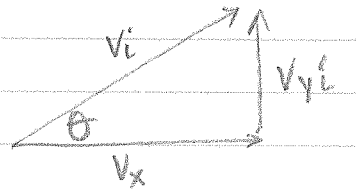
Projectile Motion WS - Answers

1. C - Only gravity acts in the downwards direction. Both have $v_{iy} = 0$; v_x has no effect.

2. D - v_{yi} changes with launch angle; greater v_{yi} = greater time in the air

3. $v_i = 80.0\ m/s$
$\theta = 40°$
$\Delta t = 1.63\ s$
$\Delta d_y = 0$
$g = a_y = -9.8\ m/s^2$
$\Delta d_x = ?$



$v_x = v_i \cos\theta$
$= (80.0\ m/s) \cos 40°$
$= 61.3\ m/s$

$v_{yi} = v_i \sin\theta$
$= (80.0\ m/s) \sin 40°$
$= 51.4\ m/s$

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

$\Delta d_x = (61.3\ m/s)(1.63\ s)$
$\Delta d_x = 99.9\ m$
$= 1.0 \times 10^2\ m$

∴ the target is 1.0×10^2 m from the archer.

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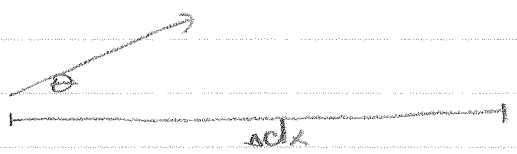
4. $\theta = 30.0°$
$\Delta d_x = 86.9\,m$
$\Delta t = 3.20\,s$



a) $v_i = ?$

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

$$= \frac{86.9\,m}{3.20\,s}$$

$$= 27.16\,m/s$$

$$\cos\theta = \frac{v_x}{v_i} \Rightarrow v_i = \frac{v_x}{\cos\theta}$$

$$v_i = \frac{27.16\,m/s}{\cos(30.0°)}$$

$$v_i = 31.4\,m/s$$

b) $\Delta d_{ymax} = ?$

Δd_{ymax} occurs at $t = \frac{\Delta t}{2} = \frac{3.20\,s}{2} = 1.60\,s$

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

$v_{yi} = v_i \sin\theta$
$= (31.4\,m/s)\sin(30.0°)$
$= 15.70\,m/s$

$\Delta d_{ymax} = v_{yi}\Delta t + \frac{1}{2}a\Delta t^2$
$= (15.70\,m/s)(1.60\,s) + \frac{1}{2}(-9.8\,m/s^2)(1.60\,s)^2$
$= 12.6\,m$

∴ the maximum height is 12.6 m

Projectile Motion WS - Answers

5. $v_i = 19.6\ m/s$
$\Delta d_y = 0$
$a_y = -9.81\ m/s^2$
$\theta = 45.8$
$\Delta d_x = ?$

An angle of 45° results in the best launch angle ($\cos\theta = \sin\theta$).

$v_{iy} = v_i \sin\theta$
$= (19.6\ m/s)\sin 45.0$
$= 13.86\ m/s$

$v_x = v_i \cos\theta$
$= (19.6\ m/s)\cos 45.0°$
$= 13.86\ m/s$

$$\Delta d_y = v_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2$$
$$0 = (13.86\ m/s)\Delta t + \frac{1}{2}(-9.81\ m/s^2)\Delta t^2$$
$$0 = 13.86 - 4.905\Delta t$$
$$\Delta t = \frac{13.86}{4.905}$$
$$= 2.826\ s$$

$$\Delta d_x = v_x \Delta t$$
$$= (13.86\ m/s)(2.826\ s)$$
$$= 39.2\ m$$

PROJECTILE MOTION WS- ANSWERS

6. $v_i = 25.2\ m/s$
$\Delta d_y = 0\ m$
$\Delta d_{x1} = 60.0\ m$
$\Delta d_{x2} = 65.0\ m$
$\Delta d_x = ?$
$a_y = -9.81\ m/s^2$

* The answer depends on the launch angle, θ. Assume $\theta = 45.0°$

$v_{yi} = v_x = v_i \cos\theta$
$= (25.2\ m/s)\cos(45.0°)$
$= 17.82\ m/s$

1. Find Δt $\quad \Delta d_y = v_{yi}\Delta t + \frac{1}{2}a_y \Delta t^2$

$0 = (17.82)\Delta t + \frac{1}{2}(-9.81\ m/s^2)\Delta t^2$
$0 = 17.82 - 4.905\Delta t$
$\Delta t = \frac{17.82}{4.905} = 3.633\ s$

2. Find Δd_x - $\quad \Delta d_x = v_x \Delta t$
$= (17.82\ m/s)(3.633\ s)$
$= 64.7\ m$

$\therefore$ Christy was correct.

EXTRA CHALLENGE: What launch angle for George to be correct? $\theta = ?$ $\quad \Delta d_x = 60.0\ m$

$v_x = \frac{\Delta d_x}{\Delta t} = v_i \cos\theta \qquad v_{yi} = v_i \sin\theta$

$\Rightarrow \Delta t = \frac{\Delta d_x}{v_i \cos\theta}$

$\therefore \quad \Delta d_y = v_{yi}\Delta t + \frac{1}{2}a_y \Delta t^2$

$0 = v_i \sin\theta \left(\frac{\Delta d_x}{v_i \cos\theta}\right) + \frac{1}{2}(-9.81\ m/s^2)\left(\frac{\Delta d_x}{v_i \cos\theta}\right)^2$

* Multiply by $\cos\theta$

$0 = \Delta d_x \sin\theta - 4.9\ m/s^2 \frac{\Delta d_x^2}{v_i \cos\theta}$

Projectile Motion WS - Answer

7. $v_i = 5.00\ m/s$
$\theta = 50.0°$
$\Delta d_x = 10.0\ m$
$\Delta d_y = ?$
$a_y = -9.81\ m/s^2$

$v_x = v_i \cos\theta$
$= (5.00\ m/s)\cos(50.0°)$
$= 3.214\ m/s$

$v_{yi} = v_i \sin\theta$
$= (5.00\ m/s)\sin(50.0°)$
$= 3.830\ m/s$

$$\Delta t = \frac{\Delta d_x}{v_x}$$
$$= \frac{10.0\ m}{3.214\ m/s}$$
$$= 3.111\ s$$

$$\Delta d_y = v_{yi}\Delta t + \frac{1}{2}a_y \Delta t^2$$
$$= (3.830\ m/s)(3.111\ s) + \frac{1}{2}(-9.8\ m/s^2)(3.111\ s)^2$$
$$= -35.6\ m$$