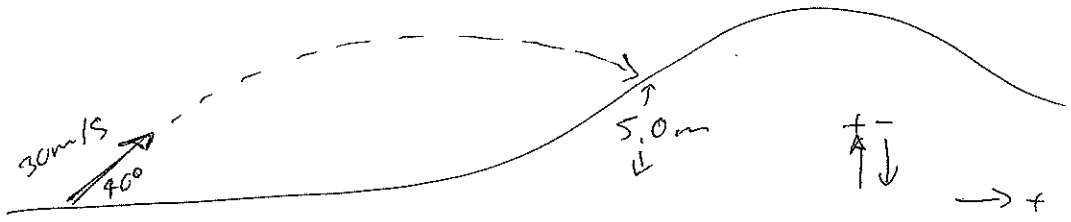
Physics 12 Practice Quiz – Projectiles in 2-D

Name: KEY

A golf player hits a ball, giving an initial speed of 30.0 m/s, at an angle of 40.0° above the horizontal. The golf course is on a hill, so when the ball hits the ground on its way down from its flight, it lands on the hill 5.0 m above the height from which it was launched.

1. Draw a sketch of the situation. Show the sign convention.



2. Complete the chart listing the information given in the question statement. In cases where a variable is unknown, fill in the space with a question mark "?" *(at this stage, do not calculate the unknowns – this is where you just state the info given in the question statement)*

Horizontal (x) component	Vertical (y) component
$v_x =$ $30\cos 40^\circ$	$v_{iy} =$ $30\sin 40^\circ$
$d_x =$?	$v_{fy} =$?
$t =$?	$\Delta d_y =$ 5.0m
	$a_y =$ $-9.80 m/s^2$
	$t =$?

3. To what maximum height above the ground does the ball fly before it starts to fall back down?

$v_{fy} = 0$ $\quad \Delta d_y = \dfrac{v_{fy}^2 - v_{iy}^2}{2a_y} = \dfrac{0 - (30\sin 40^\circ)^2}{2(-9.8)}$

$\Delta d_y = 19.0m$

4. Determine the speed of the ball when it is at its maximum height.

~~$v_x = 30\cos 40^\circ$~~ $v_x = 30\cos 40^\circ$

$v_x = 23.0 m/s$

5. How much time passes between the instant after the ball is hit by the golfer until the instant before it lands on the ground?

$$\Delta d_y = \tfrac{1}{2} a_y t^2 + v_{iy} t$$

$$0 = \tfrac{1}{2} a_y t^2 + v_{iy} t - \Delta d_y$$

$$0 = \tfrac{1}{2}(-9.8) t^2 + (30\sin 40^\circ) t - 5$$

$$0 = -4.9 t^2 + (30\sin 40^\circ) t - 5$$

$$t = \frac{-(30\sin 40^\circ) \pm \sqrt{(30\sin 40^\circ)^2 - 4(-4.9)(-5)}}{2(-4.9)} = \frac{-(30\sin 40^\circ) \pm 16.548665}{-9.8}$$

$t = 0.279078$ or 3.656

0.279078: on the way up; 3.656: on the way down

$$\boxed{t = 3.7\text{s}}$$

6. Determine the ***range*** of the ball.

$$d_x = v_x t = (30\cos 40^\circ)(3.656)$$

$$= (30\cos 40^\circ)(3.656)$$

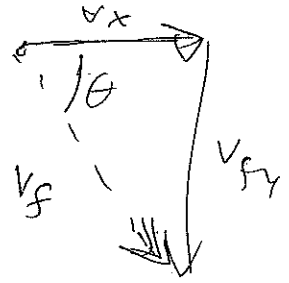
$$\boxed{d_x = 84\text{m}}$$

7. Determine the velocity of the ball the instant before it hits the ground (magnitude and direction).

$$v_{fy}^2 = 2 a_y \Delta d_y + v_{iy}^2$$

$$v_{fy} = \sqrt{2(-9.8)(5) + (30\sin 40^\circ)^2}$$

$$= -16.548665$$



$$v_f = \sqrt{v_x^2 + v_y^2} = \sqrt{(30\cos 40^\circ)^2 + (16.548665)^2}$$

$$= 28.3196$$

$$\theta = \tan^{-1}\left[\frac{v_{fy}}{v_x}\right] = \tan^{-1}\left[\frac{16.548665}{30\cos 40^\circ}\right] = 35.76^\circ$$

$$\boxed{v_f = 28\text{m/s}\ [36^\circ \text{ below the horizontal}]}$$