

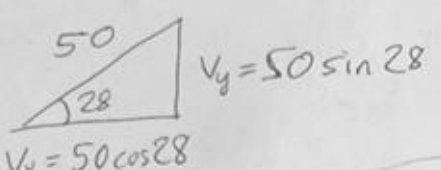
### Quiz 4 - Projectile Motion (Due midnight, Thursday Feb 19)

A golf ball is hit from the edge of a cliff 75 m high. The golf ball's initial speed is 50 m/sec, at an angle of 28 degrees relative to the horizontal.

1. Given  $\mathbf{a}(t) = \langle 0, -9.8 \rangle$ , create vectors for velocity,  $\mathbf{v}(t)$ , and position,  $\mathbf{r}(t)$ . Assume that the origin is at the base of the cliff. (4 pts)
2. What is the highest that the golf ball gets? (2 pts)
3. How far down range (horizontally) does the golf ball travel when it impacts the ground for the first time? (2 pts)
4. At what speed does the golf ball impact the ground for the first time? (2 pts)

Quiz 4 Key

1.  $\vec{a}(t) = \langle 0, -9.8 \rangle$   
 $\vec{v}(t) = \int \vec{a}(t) dt = \langle v_x, -9.8t + v_y \rangle$



$v_x = 50 \cos 28$   
 $v_y = 50 \sin 28$

$\therefore \vec{v}(t) = \langle 50 \cos 28, -9.8t + 50 \sin 28 \rangle$   
or  $\langle 44.1474, -9.8t + 23.4736 \rangle$

$\vec{r}(t) = \int \vec{v}(t) dt = \langle 44.1474t + v_x, -4.9t^2 + 23.4736t + v_y \rangle$   
initial position:  $(0, 75)$   
 $\therefore \vec{r}(t) = \langle 44.1474t, -4.9t^2 + 23.4736t + 75 \rangle$

2. Max height is when the vertical component of velocity = 0:

$$-9.8t + 23.4736 \Rightarrow t = \frac{23.4736}{9.8} = 2.395 \text{ sec}$$

so max ht = vertical component of position at  $t = 2.395 \text{ sec}$ :

$$-4.9(2.395)^2 + 23.4736(2.395) + 75 = \boxed{103.113 \text{ m}}$$

3. Ball lands when vertical component of position is zero:

$$-4.9t^2 + 23.4736t + 75 = 0 \Rightarrow t = 6.983 \text{ sec}$$

(use QF or graph)

so horizontal distance is  $44.1474(6.983) = \boxed{308.281 \text{ m}}$

4. Speed at impact =  $|\vec{v}(6.983)| = |\langle 44.1474, -44.9598 \rangle|$

$$= \sqrt{(44.1474)^2 + (-44.9598)^2}$$

$$\approx \boxed{63.01 \text{ m/sec}}$$