

Projectile motion  
Angular motion: Vertical and horizontal motion

Proficiency:

- What are the individual X/Y components of velocity and acceleration (level 1)
- How much time will the object be in the air? (level 2)
- What is the maximum height? (level 3)
- What is the maximum distance traveled? (level 3)



1. A rock is launched at  $20^\circ$  at  $30\text{m/s}$ . (level 1)

Determine the initial Velocity and Acceleration in each plain.

Acceleration (x): 0      Acceleration (y): -9.8

$\cos(20) \cdot 30 = 28.1$   
 $\sin(20) \cdot 30 = 10.2$   
 Velocity (x): 28.1      Velocity (y): 10.2

2. How much time is the rock in the air? (level 2)

$$y_t = y_0 + at \quad 0 = 10.2 + -9.8(t)$$

$$= 1.04\text{sec} \times 2 = \boxed{2.08}$$

3. What is the maximum height of the rock? (level 3)

$$y_t = y_0 + v_0t + \frac{1}{2}at^2$$

$$= 0 + 10.2(1.04) + -4.9(1.04)^2$$

$$10.6 - 5.29 = \boxed{5.3\text{m}}$$

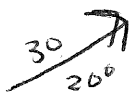
4. What is the maximum distance the ball will travel along the ground? (level 3)

$$x_t = x_0 + v_0t + \frac{1}{2}at^2$$

$$= 0 + 28.1(2.08) = \boxed{58.4\text{m}}$$

5. If the object is launched from a vehicle traveling  $5\text{m/s}$  at  $20^\circ$  at  $30\text{m/s}$  relative to the truck. Determine the initial Velocity and Acceleration in each plain.

Acceleration (x): 0      Acceleration (y): -9.8



$\cos(20) \cdot 30 = 28.1$        $\sin(20) \cdot 30 = 10.2$

Velocity (x):  $28.1 + 5 = 33.2$       Velocity (y):  $10.2\text{m/s}$

Car moving  $\rightarrow$

6. How much time is the rock in the air? (level 2)

$$y_t = y_0 + at$$

$$0 = 10.2 + -9.8t \quad t = 1.04 \times 2 = \boxed{2.08\text{sec}}$$

7. What is the maximum height of the rock? (level 3)

$$y_t = y_0 + v_0t + \frac{1}{2}at^2$$

$$= 0 + 10.2(1.04) + \frac{1}{2}(-9.8)(1.04)^2$$

$$10.6 - 5.29 = \underline{5.3\text{m}}$$

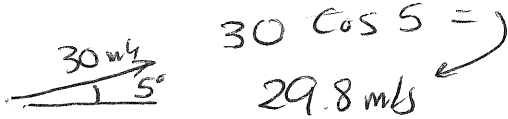
8. What is the maximum distance the ball will travel along the ground? (level 3)

$$x_t = x_0 + v_0t + \frac{1}{2}at^2$$

$$= 0 + 33.2(2.08) + 0 = \boxed{X_t = 69\text{m}}$$

4. A ball is kicked  $5^\circ$  at  $30\text{m/s}$ .

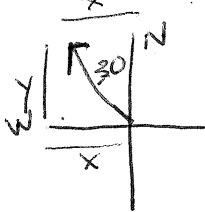
a. What is the component of velocity moving in the X direction?



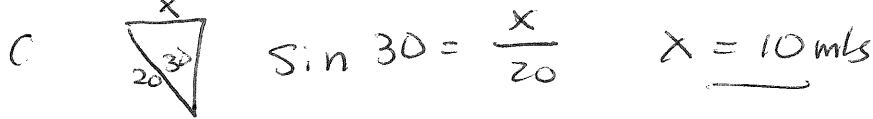
b. What is the component of velocity moving in the Y direction?

$30 \sin 5 = 2.6 \text{ m/s}$

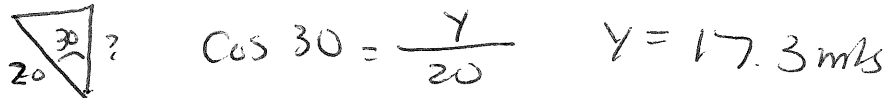
5. A soccer ball is kicked at  $30^\circ$  W of N at  $20\text{m/s}$ .



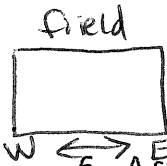
a. What is the component of velocity moving in the X direction?



b. What is the component of velocity moving in the Y direction?



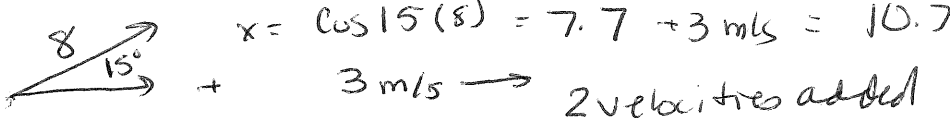
c. How long will it take for the ball to roll 20m down the field?



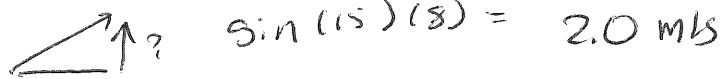
$X_f = X_i + v_i t + \frac{1}{2} a t^2$   
 $20 = 0 + 10(t) + 0 \quad t = 2 \text{ sec}$

6. A soccer ball is rolling at  $3\text{m/s}$  and is kicked with a foot traveling causing the ball to move with an additional velocity at  $8\text{m/s}$   $15^\circ$ .

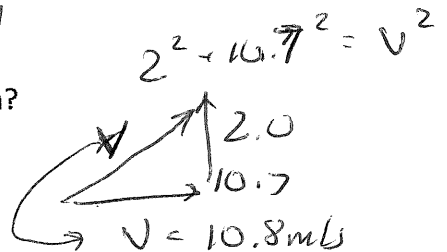
a. What is the component of velocity moving in the X direction?



b. What is the component of velocity moving in the Y direction?



c. What is the new velocity of the ball?



7. A quarterback is running horizontal to the field at  $3\text{m/s}$  and throws a ball horizontally at  $7\text{m/s}$ .

a. What is the component of velocity moving in the X direction?

$3 + 7 = 10 \text{ m/s}$

b. What is the component of velocity moving in the Y direction?

0

c. What is the new velocity of the ball?

10 m/s

