# Projectile Motion

Physics – Mr. Hall

**PARTNER TEST**

Name: _____

**1.** Your flux capacitor powered Delorean cruises at a constant speed of 36.0 m/s. How long does it take to travel 9.0 m?

$d = v \cdot t$

$t = d/v = 9.0\ m / 36.0\ m/s =$ **0.25 s**

**2.** You throw a rock into the air at a speed of 20.0 m/s and at an angle of 41.4°. At the top of the rock's path, what is the rock's
a) horizontal velocity?

$v_{horiz} = 20.0\ m/s \cdot \cos(41.4°) =$ **15.0 m/s**

b) vertical velocity?

$v_{vert} =$ **0.00 m/s** (at the top of the arc, there is no vertical velocity)

c) horizontal acceleration?

$a_{horiz} =$ **0.00 m/s²**

d) vertical acceleration?

$a_{vert} =$ **- 9.8 m/s²**

**3.** You walk 16.0 m east, turn left, and then walk 9.0 m north. What is your displacement (both distance and angle)?

$c^2 = a^2 + b^2 = (16.0\ m)^2 + (9.0\ m)^2 = 337\ m^2$

$c =$ **18.4 m** (mistake on key from class on this one)

$\theta = \tan^{-1}(9/16) =$ **29.4°**

**4.** A football is kicked toward the goal posts at a speed of 25.0 m/s and an angle of 32.5°. Find the horizontal and vertical components of the football's speed.

$v_{horiz} = 25.0\ m/s \cos(32.5°) = 21.08478615\ m/s =$ **21.1 m/s**

$v_{vert} = 25.0\ m/s \sin(32.5°) = 13.4324902\ m/s =$ **13.4 m/s**

**5.** How long is the football from question #4 in the air?

$v = v_i + at$

$t = (v - v_i)/a = (-13.4324902\ m/s - 13.4324902\ m/s) / 9.8\ m/s^2 = 2.7413245\ s =$ **2.74 s**

**6.** How high does the football from question #4 reach at its highest point? What is its speed at that highest point?

$v^2 = v_i^2 + 2ad$

$d = (v^2 - v_i^2) / 2a = ((0\ m/s)^2 - (13.4324902\ m/s)^2) / 2(-9.8\ m/s^2) = 9.2057037\ m =$ **9.21 m**

$v_{highest\ point} = v_{horiz} =$ **21.1 m/s**

**7.** How far away from the kicker does the football from problem #4 land?

$d = d_i + v_i t + \frac{1}{2} at^2$

$d = 0\ m + 21.08478615\ m/s \cdot 2.7413245\ s = 57.80024085\ m =$ **57.8 m**

**8.** You are in charge of the stunts for the newest James Bond movie. In one scene, a car drives off a cliff and lands on a boat. If the car is going 35.0 m/s, and the cliff is 25.0 m above the water, how far from the base of the cliff should the boat be?

(hint: do #9 first)

$d = v_i t = (35.0\ m/s)(2.258769757\ s) = 79.0569415\ m =$ **79.1 m**

**9.** How long would the car from problem #8 be in the air before hitting the boat?

$d = d_i + v_i t + \frac{1}{2} at^2$

$25.0\ m = 0\ m + (0\ m/s)\ t + \frac{1}{2} (9.8\ m/s^2)\ t^2$

$25.0\ m = (4.9\ m/s^2)\ t^2$

$t^2 = 25.0\ m / 4.9\ m/s^2 = 5.1020408\ s^2$

$t = 2.258769757\ s =$ **2.26 s**

**10.** (a) What would be the car's vertical speed when it hits the boat? (b) What would be the car's horizontal speed when it hits the boat? (c) What would be the car's total speed when it hits the boat?

a) $v = v_i + at$

$v_{vert} = 0\ m/s + (9.8\ m/s^2)(2.258769757\ s) = 22.1359436\ m/s =$ **22.1 m/s**

b) $v_{horiz} =$ **35.0 m/s**

c) $v_{total}^2 = v_{vert}^2 + v_{horiz}^2$

$v_{total}^2 = (22.1359436\ m/s)^2 + (35.0\ m/s)^2$

$v_{total}^2 = 1714.99999988\ m^2/s^2$

$v_{total} = 41.412558\ m/s =$ **41.4 m/s**

**11.** You shoot a basketball at a hoop which is 3.5 meters above the floor. You shoot the ball at an angle of 60.0° at a speed of 15.0 m/s. (a) How high does the basketball go at its highest point? (b) How long until the basketball goes through the hoop? (c) How far back do you stand from the basket to make this shot?

$v_{vert} = 15.0\ m/s \sin(60.0°) = 12.990381057\ m/s$
$v_{horiz} = 15.0\ m/s \cos(60.0°) = 7.50\ m/s$

a) $v^2 = v_i^2 + 2ad$
$d = (v^2 - v_i^2)/2a$
$d = ((0\ m/s)^2 - (12.990381057\ m/s)^2) / 2(-9.8\ m/s^2) = 8.60969387755\ m =$ **8.61 m**

b) $v = v_i + at_{up}$
$0\ m/s = 12.990381057 + (-9.8\ m/s^s)\ t_{up}$
$t_{up} = -12.990381057\ m/s / -9.8\ m/s^2 = 1.325549\ s = 1.33\ s$

$d_{down} = 8.60969387755\ m - 3.5\ m = 5.10969387755\ m = 5.11\ m$
$d_{down} = d_i + v_i t + \frac{1}{2}\ a t_{down}^2$
$5.11\ m = 0\ m + (0\ m/s)\ t + \frac{1}{2}\ (9.8\ m/s^2)\ t_{down}^2$
$t_{down}^2 = 5.10969387755\ m / 4.9\ m/s^2 = 1.04279467\ s^2$
$t_{down} = 1.02117318\ s = 1.02\ s$

$t_{total} = t_{up} + t_{down} = 1.325549\ s + 1.02117318\ s = 2.346722\ s =$ **2.35 s**

c) $d = v_{horiz}\ t_{total} = 17.600416\ m =$ **17.6 m**

$x = x_o + v_o t + \frac{1}{2} a t^2$

$v = v_o + a t$

$v^2 = v_o^2 + 2ad$