Lesson 6 Worksheet

1. A base ball is thrown with an initial speed of 20 m/s at an angle of 10° above the horizontal. Determine:
a. How long it is in the air for. (t = 0.71s)
b. What its maximum height will be. (0.61 m)
c. How long the range (horizontal displacement) is. (14 m)

a. v_i = 20m/s v_x = 20m/scos10° = 19.7m/s v_{iy} = (20m/s)sin10° = 3.47m/s v_{fy} = -3.47m/s a_y = -9.80m/s^2 t = ?	$a_y = \frac{v_{fy} - v_{iy}}{t}$ $t = \frac{v_{fy} - v_{iy}}{a_y}$ $t = \frac{(-3.47m/s) - (3.47m/s)}{(-9.80m/s^2)} = 0.71s$
b. v_{iy} = 3.47m/s v_{fy} = 0m/s a_y = -9.80m/s^2 d_y = ?	$v_f^2 = v_i^2 + 2ad$ $v_f^2 - v_i^2 = 2ad$ $\frac{v_f^2 - v_i^2}{2a} = d$ $d = \frac{v_f^2 - v_i^2}{2a} = \frac{(0m/s)^2 - (3.47m/s)^2}{2(-9.80m/s^2)}$ $d_y = 0.61m$
c. $v_{ix} = v_{fx} = v_x$ = 19.7m/s t = 0.71s d_x = ?	$d_x = \left(\frac{v_{fx} + v_{ix}}{2}\right)t = \left(\frac{19.7m/s + 19.7m/s}{2}\right)(0.71s)$ $d_x = 14m$

2. An artillery shell is launched at an unknown angle. It strikes the ground (at the height that it was fired) 250 m away and has a maximum height of 100 m. Determine:
a. The initial vertical velocity. (44.3 m/s)
b. The time the shell is in the air. (9.04 s)
c. The horizontal velocity. (27.7 m/s)
d. The initial speed. (52.2 m/s)
e. The angle the projectile was launched at. (58.0°)
f. What is the velocity 2.00 seconds after launch?
g. What is the velocity on impact?

a. Let's start by writing down all the information we can about the half way point of the projectile's flight. d_{ymax} = 100m a_y = -9.80m/s^2 v_{iy} = ? v_{fy} = 0m/s	$v_{fy}^2 = v_{iy}^2 + 2a_y d_{y\max}$ $v_{fy}^2 - 2a_y d_{y\max} = v_{iy}^2$ $v_{iy}^2 = v_{fy}^2 - 2a_y d_{y\max}$ $\sqrt{v_{iy}^2} = v_{iy} = \sqrt{v_{fy}^2 - 2a_y d_{y\max}}$ $v_{iy} = \sqrt{(0m/s)^2 - 2(-9.80m/s^2)(100m)}$ $v_{iy} = 44.3m/s$
b. v_{iy} = 44.3m/s v_{fy} = -44.3m/s t = ?	$a_y = \frac{v_{fy} - v_{iy}}{t}$ $t = \frac{v_{fy} - v_{iy}}{a_y} = \frac{-44.3m/s - 44.3m/s}{-9.80m/s^2} = 9.04s$
c. t = 9.04s d_x = 250m $v_{ix} = v_{fx} = v_x$ = ?	$v_x = \frac{d_x}{t} = \frac{250m}{9.04s} = 27.7m/s$
d. v_{ix} = 27.7m/s v_{iy} = 44.3m/s	$v_i^2 = v_{ix}^2 + v_{iy}^2$ $v_i = \sqrt{v_{ix}^2 + v_{iy}^2}$ $v_i = \sqrt{(27.7m/s)^2 + (44.3m/s)^2} = 52.2m/s$
e. Draw a triangle with the vectors v_{ix}, v_{iy}, and v_i and then use sin, cos, or tan to solve. I'll use tan.  *** For some reason the computer messed up the inverse tan part. All I did was take the inverse tan of both sides, so inverse tan of 1.60 = 58.0°	$\tan\theta = \frac{opp}{adj} = \frac{v_{iy}}{v_{ix}} = \frac{44.3m/s}{27.7m/s}$ $\tan\theta = 1.60$ $\tan^{-1}(\tan\theta) = \tan^{-1}(1.60)$ $\theta = 58.0°$

f. v_{iy} = 44.3m/s v_{fy} = ? a_y = -9.80m/s^2 t = 2.00s v_x = 27.7m/s (it never changes) So the velocity when t = 2.00s is: v_x = 27.7m/s v_y = 24.7m/s	$a_y = \frac{v_{fy} - v_{iy}}{t}$ $a_y t = v_{fy} - v_{iy}$ $a_y t + v_{iy} = v_{fy}$ $v_{fy} = a_y t + v_{iy}$ $v_{fy} = (-9.80m/s^2)(2.00s) + 44.3m/s = 24.7m/s$
g. We could do a whole bunch of calculations, but why bother? The easiest way to answer this question is to understand that v_x will not change, and v_{fy} is the opposite of v_{iy}. v_{fx} = 27.7m/s v_{fy} = -44.3m/s	