Angle-Launched Projectiles

The Equations:
Kinematic equations used for 1-dimensional motion can be used for projectile motion as well. The two perpendicular motions – falling and horizontal - are independent of each other. As such, separate sets of equations are needed for these two independent motions. Finally, one assumes negligible air resistance and an acceleration of gravity of 9.8 m/s^2, down(-). Thus, $a_x = 0$ m/s/s and $a_y = -9.8$ m/s/s.

1-Dim.	$v_f = v_o + a \bullet t$	$d = v_o \bullet t + ½ \bullet a \bullet t^2$	$v_f^2 = v_o^2 + 2 \bullet a \bullet d$	$d = \frac{v_o + v_f}{2} \bullet t$
x-comp.	$v_{fx} = v_{ox} + a_x \bullet t$	$d_x = v_{ox} \bullet t + ½ \bullet a_x \bullet t^2$	$v_{fx}^2 = v_{ox}^2 + 2 \bullet a_x \bullet d_x$	$d_x = \frac{v_{ox} + v_{fx}}{2} \bullet t$
y-comp.	$v_{fy} = v_{oy} + a_y \bullet t$	$d_y = v_{oy} \bullet t + ½ \bullet a_y \bullet t^2$	$v_{fy}^2 = v_{oy}^2 + 2 \bullet a_y \bullet d_y$	$d_y = \frac{v_{oy} + v_{fy}}{2} \bullet t$

1. Use trigonometric functions to resolve the following velocity vectors into horizontal and vertical components. Then utilize kinematic equations to calculate the other motion parameters. Be careful with the equations; be guided by the principle that "perpendicular components of motion are independent of each other."

A long jumper leaps with an initial velocity of 9.5 m/s at an angle of 40° to the horizontal.	Megan Progress, GBS golf standout, hits a nine-iron with a velocity of 25 m/s at an angle of 60° to the horizontal.	A place kicker launches a kickoff at an angle of 30° to the horizontal and a velocity of 30 m/s.
v_{ox} = ____________ m/s	v_{ox} = ____________ m/s	v_{ox} = ____________ m/s
v_{oy} = ____________ m/s	v_{oy} = ____________ m/s	v_{oy} = ____________ m/s
t_{up} = ____________ s	t_{up} = ____________ s	t_{up} = ____________ s
t_{total} = ____________ s	t_{total} = ____________ s	t_{total} = ____________ s
d_x = ____________ m	d_x = ____________ m	d_x = ____________ m
d_y @ peak = ________ m	d_y @ peak = ________ m	d_y @ peak = ________ m
PSYW:	**PSYW:**	**PSYW:**

2. Generalize the calculations performed in question #1 above by writing the equations used to calculate each of the quantities requested in the problem.

v_{ox} = ______________________ v_{oy} = ______________________

t_{up} = ______________________ t_{total} = ______________________

d_x = ______________________ d_y @ peak = ______________________

3. Determine the hang time, the peak height, and the range of a ball launched at <u>a speed of 40.0 m/s</u> at angles of (a) 40.0 degrees, (b) 45.0 degrees, and (c) 50.0 degrees from ground level.

40.0 degrees	**45.0 degrees**	**50.0 degrees**
v_{ox} = ________________	v_{ox} = ________________	v_{ox} = ________________
v_{oy} = ________________	v_{oy} = ________________	v_{oy} = ________________
t_{up} = ________________	t_{up} = ________________	t_{up} = ________________
t_{total} = ________________	t_{total} = ________________	t_{total} = ________________
d_x = ________________	d_x = ________________	d_x = ________________
$d_{y\text{-peak}}$ = ________________	$d_{y\text{-peak}}$ = ________________	$d_{y\text{-peak}}$ = ________________

4. Dennis launches a water balloon from the top of his 42-meter high dorm building with a speed of 31 m/s at an angle of 22 degrees. Determine how far from the base of the building that the balloon will land.

5. Using his pitching wedge, Eddie launches a golf ball with an initial velocity of 80 m/s at 60 degrees above the horizontal from a position 24 meters from the edge of a building. At what height will the ball strike the building?

6. A tennis ball is lobbed high in the air and has a hang time of 3.0 seconds. To what height will the ball rise above the striking location?

7. A golf ball is hit at an angle of 40 degrees and has a total hang time of 6.0 seconds. Determine the horizontal displacement of the ball.

8. A biker projects off a ramp inclined at 22° above the horizontal and lands on the ground at the same vertical height a distance of 3.6 meters away from the launch location. Determine the launch speed of the bike.