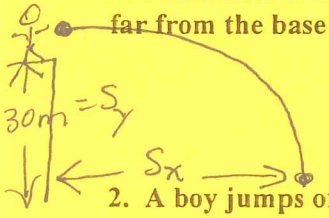
KEY

TRAJECTORY PROBLEMS

1. A baseball is thrown horizontally at 22 m/s from the roof of a 10 story building (one story = 3m). How far from the base of the building will the ball strike the ground?



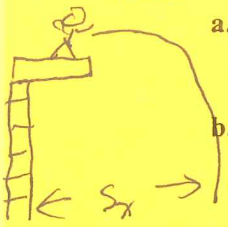
Given: $S_y = 30m$, $V_x = 22 m/s$, $a = g = 9.8 m/s^2$

PLAN: Use The height To calc. The Time Use V_x and Time from above To get $S_x = V_x t = (22 m/s)(2.47s)$

$S_y = \frac{1}{2} g t^2$ so $t = \sqrt{\frac{2S_y}{g}} = \sqrt{\frac{2(30m)}{9.8 m/s^2}} = 2.47s$

$S_x = 54.4m$

2. A boy jumps off a high dive platform with a horizontal velocity of 2.5 m/s and lands in the water 1.1 s later.



a. How high is the platform?

Fab Five #4 $S_y = \frac{1}{2} g t^2 = \frac{1}{2}(9.8 m/s^2)(1.1s)^2 = 5.93m$

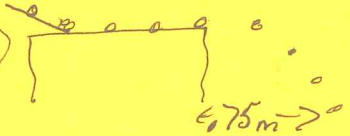
b. How far from the base of the platform does he land?

Fab Five #1 $S_x = V_x t = (2.5 m/s)(1.1s) = 2.75m$

3. A ball rolls off a horizontal surface and lands 0.50 s later at a horizontal distance of 75 cm. Bulls Eye Lab

a. How tall is the surface?

$S_y = \frac{1}{2} g t^2 = \frac{1}{2}(9.8 m/s^2)(\frac{1}{2}s)^2 = 1.225m$



b. Calculate the ball's velocity as it leaves the surface.

$V_x = \frac{S_x}{t} = \frac{.75m}{(\frac{1}{2})s} = 1.50 m/s$

c. If horizontal velocity is doubled, what happens to horizontal distance traveled?

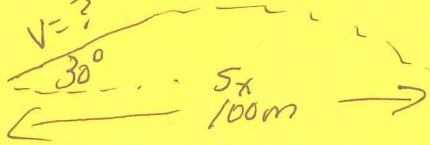
$S_x = V_x t$ originally $(1m) = (1m/s)(1s)$ example

Now $(?m) = (2m/s)(1s) = 2m$ was 1m so doubled

d. If vertical distance fallen is doubled, what happens to time to fall?

$t = \sqrt{\frac{2S_y}{g}}$ means $t \propto \sqrt{S_y}$ so $t \propto \sqrt{2}$ Thus $\sqrt{2}$ Times as much

4. A batter hits a baseball into the outfield where it lands between outfielders 100 m from home plate. If the ball was hit at an angle of 30° above the ground, what was the velocity with which it was hit?



Range Equation we derived with our Turkey hand (on back)

$S_x = V^2 \sin 2\theta / g$ so $V = \sqrt{\frac{S_x g}{\sin 2\theta}} = \sqrt{\frac{(100m)(9.8 m/s^2)}{\sin 60°}}$

$V = 33.6 m/s$

5. A ship fires shells from its guns with an initial velocity of 400 m/s and an angle of 35°.

a. Find the horizontal and vertical components of initial velocity.

Turkey #1 $V_x = V\cos\theta = (400 m/s)\cos 35° = 327.7 m/s$

#2 $V_y = V \sin\theta = (400 m/s) \sin 35° = 229.4 m/s$

b. Find the range of the gun for this setting.

#5 $S_x = \frac{V^2 \sin 2\theta}{g} = \frac{(400 m/s)^2 \sin 70°}{9.8 m/s^2} = 15,341.9m$

c. How long will it take for the projectile to hit the target?

#4 (2×#3) $Time_{Total} = 2T_{up} = \frac{2V_y}{g} = \frac{2(229.4 m/s)}{(9.8 m/s^2)} = 46.8s$

Notes: finger 3 = ½ finger 4

d. What is the maximum range for this gun?

#6 e. $S_{yMAX} = \frac{1}{2} g (T_{up})^2$ OR $\frac{finger\ 2 \times finger\ 3}{2} = \frac{(229.4 m/s)(23.4s)}{2} = 2684.9m$

e. What maximum height did the shell reach?

d. Max range is a 45° angle so $S_x = \frac{V^2 \sin 90°}{g} = \frac{(400 m/s)^2 (1)}{(9.8 m/s^2)} = 16,327 m$

UNIT 4: MOTION IN TWO DIMENSIONS

Upon completion of this unit, the student should be able to:

1. Use the equations of motion in two dimensions to calculate range, time of flight, and vertical distance fallen for type 1 trajectory problems.

2. Use the equations of motion in two dimensions to calculate range, time of flight, and maximum height of a projectile for type 2 trajectory problems.

3. Describe the shape of the path followed by a projectile in Earth's gravitational field.

4. Differentiate between horizontal and vertical components of projectile motion.

5. Explain what is meant by independence of vectors and why it is important.

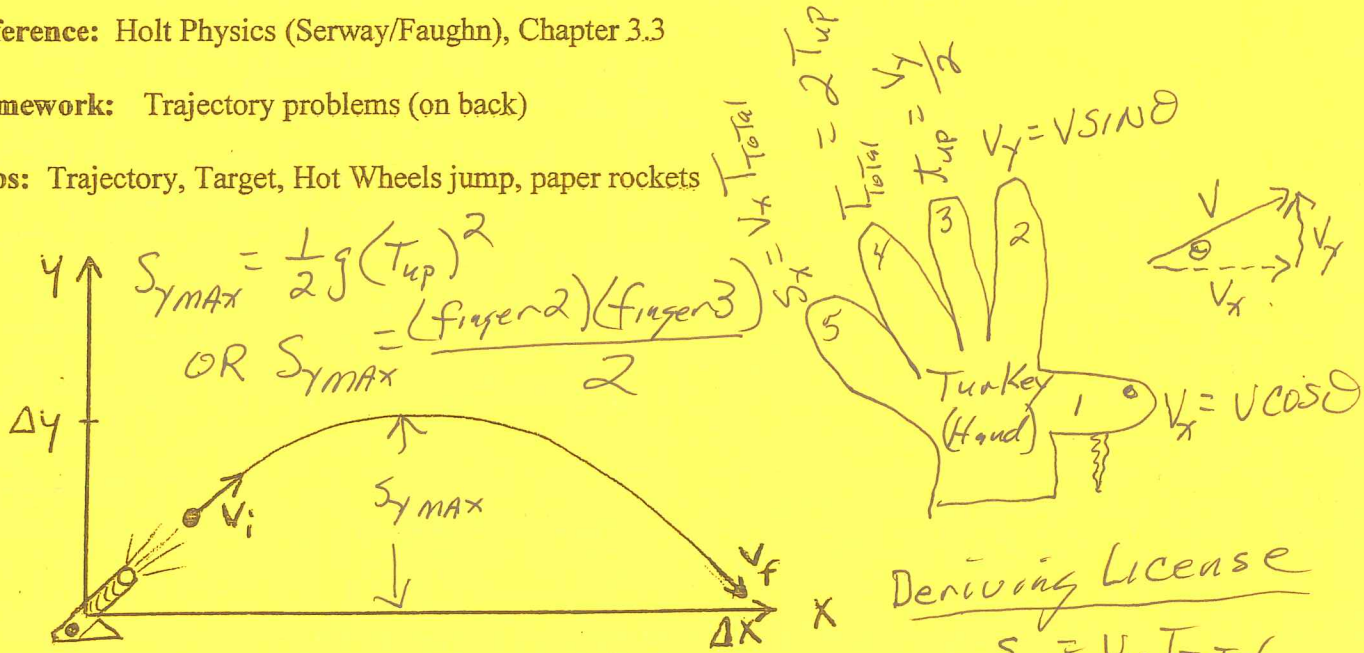
6. Explain the difference between enfilade and defilade fire.

7. Construct position-time and velocity-time graphs from given data and use to analyze the motion of a projectile.

Reference: Holt Physics (Serway/Faughn), Chapter 3.3

Homework: Trajectory problems (on back)

Labs: Trajectory, Target, Hot Wheels jump, paper rockets



Deriving License

$S_x = V_x T_{Total}$

substituting $S_x = V\cos\theta(2)(V\sin\theta)/g$

$S_x = V^2 \sin 2\theta / g$