PROJECTILES

A **projectile** is an object given an initial velocity and is free falling in gravity. Free fall means nothing is holding you up against gravity. (eg. a diver, an arrow, bullet shot, cannonball fired, a baseball hit, a tennis, squash or golf ball hit, or even a satellite) Drop unequal masses from the same height to see which hits first.

Answer: _____

The text on page 42 shows a strobe photograph of a device designed to drop one ball at the same time that another is projected horizontally. Grid lines have been drawn on the photo. Remember that the strobe light flashes at equal time intervals marking out equal times.

Two things are immediately obvious from the photo:

1. both balls accelerate downward at the same rate **(accelerated** motion).
2. the projected ball keeps its constant horizontal velocity **(uniform** motion).

Projectiles can therefore be treated as two separate motions since the uniform acceleration due to gravity only affects the vertical component of the motion! **Vertical and horizontal motions are independent of each other.** To crudely prove this we can flick a penny into another one that is just teetering on the edge of the table and hear them hit at the same time.

Demonstrating your understanding.

1. An arrow is aimed and fired at 8.0 m/s horizontally directly at the bulls-eye of a target 22 m away.

   a) How far below the centre of the bulls-eye will the arrow hit?

   b) If the target becomes unfastened at the very instant the arrow leaves the bow and falls straight down, where will the arrow strike the target? Explain.

   c) Would this same thing happen if, instead, a bullet were fired? a tennis ball?

2. Ignoring the curvature of the Earth and air resistance, how far would the following objects each fired horizontally from a height of 2.0 m above the ground travel before hitting the ground:

   a) a baseball thrown by a throwing machine at 5.0 m/s?

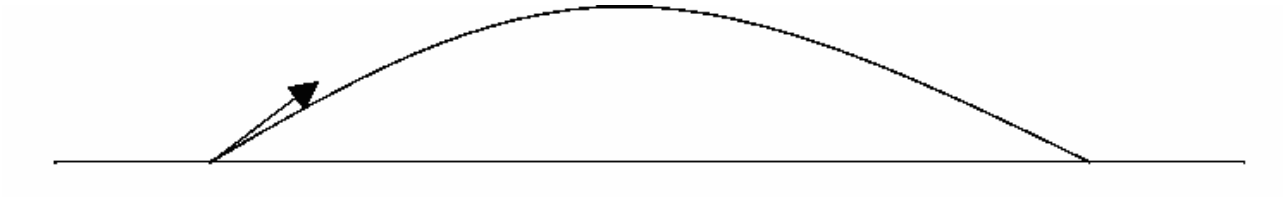
   b) a baseball thrown by a throwing machine at 20. m/s?

   c) a bullet fired from a gun at 300. m/s?

3. How far would the same bullet travel on the Moon (assuming it is a perfect glassy sphere as Aristotle claimed)? The acceleration due to gravity on the moon is 1/6 of what it is on Earth.

More complex motions. Questions:

4. A punter kicks the football down the field. The ball leaves the ground at a $30°$ angle with a velocity of 20. m/s.



a) How long is the football in the air?

b) how far from the kicker will the ball first hit the ground?

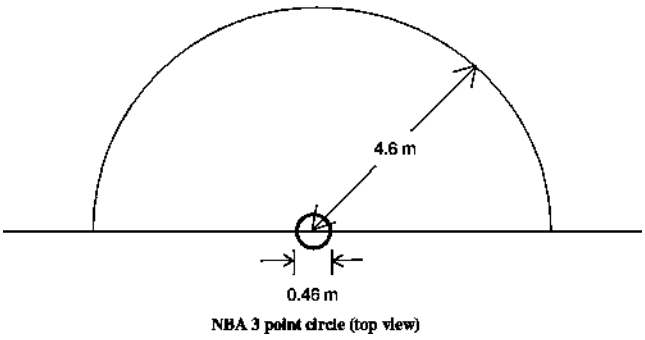
c) How high does the ball rise?

d) How long would the ball be in the air if the angle of trajectory was $45°$ or $60°$?

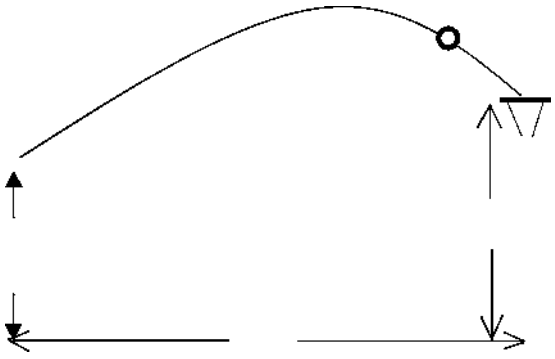
Practice problems (as hard as they get!):

1. A golf ball lies in a sand trap 2.4 m below the level of the green and an horizontal distance of 8.2 m from the pin. If the golfer hits the ball at a $60°$ angle, at a speed of 10. m/s, how far from the pin will it land?

2. A regulation basketball net is 3.05 m above the floor. It is 46 cm in diameter. The three point circle is about 4.6 metres from the basket. (allow the player 5.0 m) At what speed should the player shoot if the ball is released at a height of 2.25 m at 45 above the horizontal to score three points?



NBA 3 point circle (top view)


side view