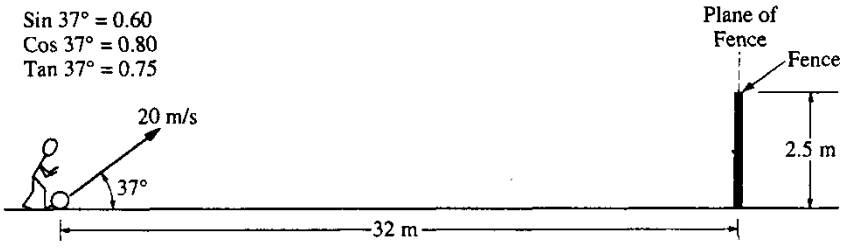
1. A ship makes three displacements in the following order:

1) 76 mi, 48º
2) 50 mi, 124º
3) 47 mi, 270º

(a) Draw a clear diagram showing all three displacement vectors with respect to horizontal points (north, east, south, and west).
(b) Find the X and Y components of displacement $D_1$.
(c) Find the X and Y components of displacement $D_2$.
(d) Find the X and Y components of displacement $D_3$.
(e) Find the magnitude of the resultant vector.
(f) Find the direction of the resultant vector.
(g) What is the distance traveled by the ship?

2. A torpedo leaves a ship at 2.1m/s initially aimed at a target 85 meters north. The current of the ocean flows perpendicular to this motion at 0.9m/s east.

(a) How far off course will the torpedo be when it reaches 85 meters in the direction of the torpedo's initial velocity?
(b) With what speed will the torpedo travel as seen from above?
(c) At what angle will be the torpedo's initial velocity?
(d) At what angle should the torpedo be aimed to compensate for the current?
(e) Without equations, explain conceptually what happens to the answer to (a) if the target is farther away.



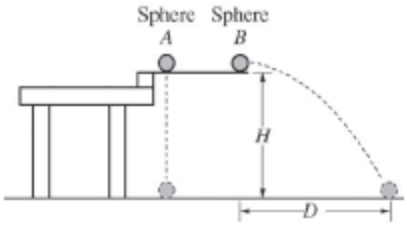

Note: Diagram not drawn to scale.

3. A ball of mass 0.5 kilogram, initially at rest, is kicked directly toward a fence from a point 32 meters away, as shown above. The velocity of the ball as it leaves the kicker's foot is 20 meters per second at an angle of 37° above the horizontal. The top of the fence is 2.5 meters high. The kicker's foot is in contact with the ball for 0.05 second. The ball hits nothing while in flight and air resistance is negligible.

a. Determine the magnitude of the average net force exerted on the ball during the kick.
b. Determine the time it takes for the ball to reach the plane of the fence.
c. Will the ball hit the fence? If so, how far below the top of the fence will it hit? If not, how far above the top of the fence will it pass?
d. Sketch the horizontal and vertical components of the position, velocity, and acceleration of the ball as functions of time until the ball reaches the plane of the fence.
e. How would the velocity and acceleration graphs change in (d) if the ball was kicked on the Earth's moon?

4. Two planetary explorers land on an uncharted planet and decide to test the range of a cannon they brought along. When they fire a cannonball with a speed of 100m/s at an angle of 25º from the horizontal ground, they find that the cannonball follows a parabolic path and takes 10 seconds to return to the ground.

(a) Determine the acceleration due to gravity on this uncharted planet.
(b) Determine the maximum height above the level ground the cannonball reaches.
(c) One of the astronauts claims the cannonball landed over a mile away. Are they correct if 1 mile is approximately 1600m?
(d) The astronauts then fire another identical cannonball at 100m/s at an angle of 75º to the horizontal ground. Will the cannonball travel a horizontal range x' which is less than, greater than, or equal to the horizontal range for a 25º launch angle?




5. Two identical sphere are released from a device at time t=0 from the same height *H*, as shown above. Sphere A has no initial veloicty and falls straight down. Sphere B is given an initial horizontal velocity of magnitude $v_0$ and travels a horizontal distance *D* before it reaches the ground. The spheres reach the ground at the same time $t_f$ even though sphere B has more distance to cover before landing. Air resistance is negligible.

(a) Sketch a graph of the vertical component of velocity versus time for each sphere.
(b) Sketch a graph of the horizontal component of velocity versus time for each sphere.
(c) In a clear, coherent, paragraph-length response, explain why the spheres reach the ground at the same time even though they travel difference distances. Include references to either or both parts (a) and (b).

6. On an air hockey table, a series of miniature bowling pins have been set at one end. A child pushes the air hockey puck and it glides smoothly towards the pins. The puck only manages to hit one pin on the far right side and kicks it back and to the left.
a. What is an example of Newton's first law in this situation?
b. What is an example of Newton's second law in this situation?
c. What is an example of Newton's third law in this situation?