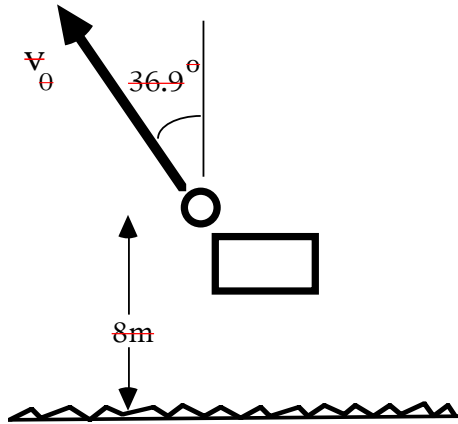


### Problem 1

~~A sprinter running a 100 meter race starts at rest, accelerates at constant acceleration with magnitude  $A$  for 2 seconds, and then runs at constant speed until the end.~~

- ~~Find the position (relative to the start position) and speed of the runner at the end of the 2 seconds in terms of  $A$ .~~
- ~~Assume that the runner takes a total of 10 seconds to run the 100 meters. Find the value of the acceleration  $A$ . You can leave your answer in terms of a fraction but clearly indicate the units.~~

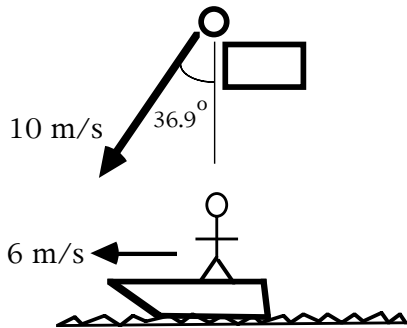
### Problem 2



~~A rock is thrown upward from a bridge at an initial height of 8 meters above the water at an initial speed of  $v_0$  and an angle of  $36.9^\circ$  from the vertical as shown. Use  $g=10 \text{ m/s}^2$  to solve this problem. See note on formula sheet about the values of trigonometric functions for this angle.~~

- ~~Write a set of equations for the horizontal and vertical positions and velocities of the rock as a function of time. Clearly indicate on your drawing your choice of axes and what point you are using as your origin.~~
- ~~The rock reaches its highest point in 2 seconds. How high is the rock above the water at that instant? (Hint: First you need to find  $v_0$ ).~~

### Problem 3



A rock is thrown downward from a bridge at an initial speed of 10 m/s and an angle of  $36.9^\circ$  from the vertical as shown. At the same instant a boat is passing under the bridge traveling 6 m/s in the direction shown. See note on formula sheet about the values of trigonometric functions for this angle.

- Find the vertical and horizontal components of the initial velocity of the rock as seen by a person on the bridge. Clearly indicate on your drawing your choice of axes.
  - Find the vertical and horizontal components of the initial velocity of the rock as seen by the person on the boat. Clearly indicate on your drawing your choice of axes.
- c) Draw a clear vector diagram showing how to relate the velocity the rock appears to be moving as seen from the bridge, the velocity the rock appears to be moving as seen by the person in the boat, and the velocity of the boat with respect to the bridge.

### Problem 4

~~The position of a particle of mass  $M$  is given by the following equations:~~

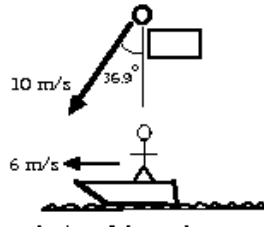
$$X = A + Bt - Ct^2 \quad Y = D + Et - F\cos(Gt) \quad Z = H + F\sin(Gt)$$

~~where  $A, B, C, D, E, F, G,$  and  $H$  are all constants.~~

- ~~Find the three components of the acceleration as a function of time.~~
- ~~Are the direction and magnitude of the acceleration independent of time? Explain your answer.~~

### Problem 3

a)



$$v_x = 10 \sin(36.9^\circ) = 6 \text{ m/s}$$

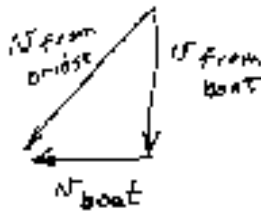
$$v_y = -10 \cos(36.9^\circ) = -8 \text{ m/s}$$

b)

$$v_x = 6 - 6 = 0 \text{ m/s}$$

$$v_y = -8 - 0 = -8 \text{ m/s}$$

c)



### Problem 4

a)

$$v_x = B - 2Ct \quad a_x = -2C$$

$$v_y = E + FG \sin(Gt) \quad a_y = FG^2 \cos(Gt)$$

$$v_z = FG \cos(Gt) \quad a_z = -FG^2 \sin(Gt)$$

b)

$$|a| = \sqrt{4C^2 + F^2G^4}$$

Magnitude constant, direction changes.

### Problem 5

