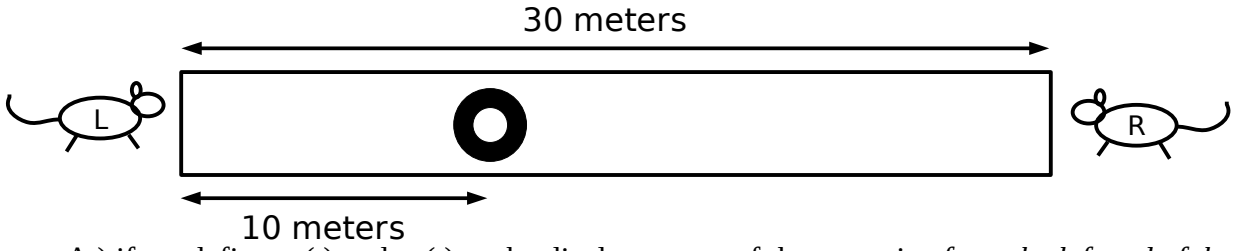
Physics 10310
Discussion Section Questions

Set 3

Directions: This is designed as a review for Thursday's exam. You should work together as a group to set up these problems, and then the groups will be asked to present their strategies for the solutions. A completed answer sheet is not necessary this week, but each of you may want to write down some work so that you can use this as a study tool.

1. A 30-meter long pipe has a donut placed at a point 10 meters from the left end. At time t=0, two very athletic mice are placed at rest at either end of the pipe (see picture) and both begin to run toward the donut. Mouse L on the left accelerates at 3.0 m/s^2 toward the donut, and mouse R on the right accelerates at 5.0 m/s^2 toward the donut from the other side. Each maintains constant acceleration. Assume all motion is one-dimensional along the pipe.

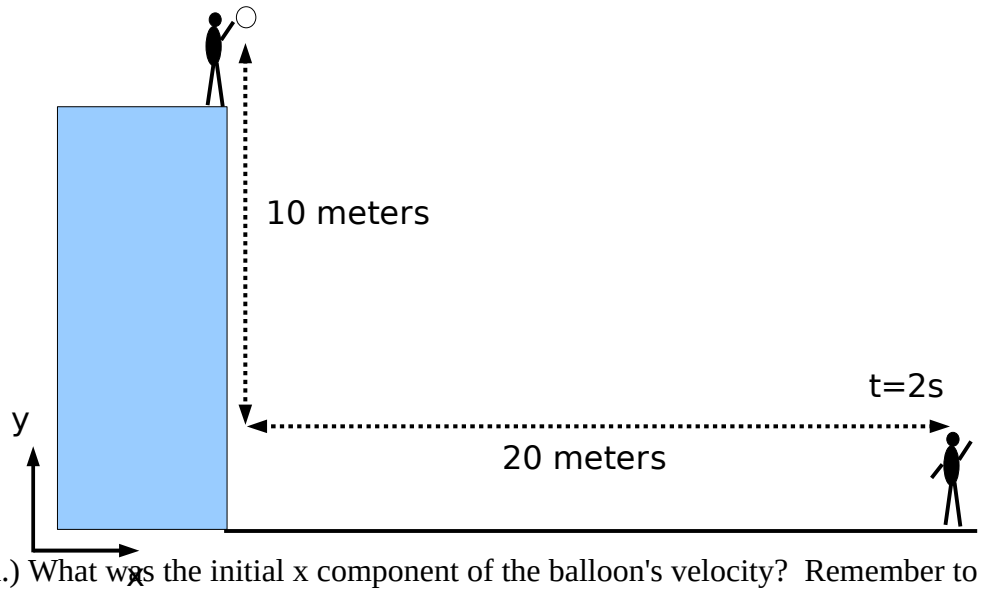


   A.) if we define $x_L(t)$ and $x_R(t)$ as the displacements of the two mice *from the left end of the pipe* as a function of time, write algebraic expressions for $x_L(t)$ and $x_R(t)$. Take the positive x direction to be to the right.
   B.) At what time will the mice be 14 meters apart in the pipe?
   C.) Which mouse gets to the donut first, and how fast is it running when it gets there?

2. Only three seconds are left in the game and ND trails by a score of 23-21 (ok, it's optimistic, but just bear with us...). The ND kicker comes out to attempt a 39-yard field goal from the center of the field. His aim is perfect dead-center with the football leaving the ground at an angle of 53º and a speed of 66 ft/s. Neglect air resistance
   A.) But will the football make it over the crossbar of the goal post, which is 10 ft high? How far above or below will it sail?
   B.) What is the total time of flight of the ball until the instant the game is decided? Assume the game is decided when the ball reaches the goalpost.
   C.) What is the magnitude and direction of the ball's velocity at this point?
3. An object moving in the x-y plane is tracked on radar. The position vector as a function of time *t* is found to be:
   $\mathbf{r} = 3.0t\,\mathbf{i} + (2.0t - 1.0t^2)\mathbf{j}$ (km)
   where **i** and **j** are the usual unit vectors in the x and y directions, respectively.
   A.) what is the instantaneous velocity vector **v** as a function of time?
   B.) what is the instantaneous acceleration vector **a** as a function of time?

C.) what is the instantaneous velocity when t=2s and
D.)what is the average velocity in the interval from t=0 to t=2 sec?

4. A student stands on the roof of her dorm and throws a water balloon at some angle, hitting the head of her professor located 10 meters lower than the student and 20 meters away horizontally. The balloon spends 2 sec in the air; neglect air resistance and choose the x and y direction as shown in the drawing.



A.) What was the initial x component of the balloon's velocity? Remember to show whether or not it was positive or negative.
B.) What was the initial y component of the balloon's velocity? Remember to show whether it was positive or negative.
C.) At what speed does the balloon hit the professor's head?