# Physics Exploration Homework Supplement P110-1.pdf

## Air track Introduction to Graphs

Go to the Physics Exploration Center. Enter through the resource room 311/312 Thaw Hall. This week you will play with an "air track". When the air track is turned on, objects can slide with negligible friction. You can incline the horizontal air track by placing a small metal cylinder under the front leg of the air track. Attached to the air track is a sonar displacement sensor which in conjunction with the computer can measure the position of an object at a particular time. When triggered, the computer sonar system will track and plot the displacement, velocity and acceleration of the slider on our air track. Try out the air track by turning on the blower (under the table) and giving the slider various initial conditions.

(a) Predict and draw graphs for the displacement, velocity and acceleration of a slider when you launch it up an incline plane and then let it slide down (the graph should show both up and down motion). Choose the origin to be the place where you launched the slider. After you write down your prediction, use the sonar system on the air track to measure and plot the displacement, velocity and acceleration of the slider on the air track, when you release it from rest at the top of the inclined track. Print the computer generated plot of the motion of the slider.

(b) Predict and draw graphs for the displacement, velocity and acceleration of the slider when you push it on a horizontal air track. Now do the experiment on the air track. In this latter case give the slider an initial velocity somewhere between zero and the final velocity in case (a). Again, have the computer and sonar system record the motion of the air cart (slider) and then print out the plot.

(c) From the two graphs, determine the time(s) when the displacement was the same in both the inclined plane and the horizontal plane cases ("displacement crossing time"). Ignore the time on the graph when you are pushing the slider and your hand was in front of the sonar.

(d) Do the same for the velocity and acceleration (identify from the graph at what time, if any, the velocities and accelerations are same in cases (a) and (b)).

(e) Is the displacement crossing time the same as the velocity crossing time (that is, are the displacements in cases (a) and (b) same at the same time when the velocities are the same)? Justify your answer.

(f) Is the acceleration ever the same in cases (a) and (b)? Justify your answer.

Now consider this problem: You and your friend are driving in adjacent lanes on a straight highway. At time $t = 0$, you and your friend were adjacent to each other. At that time $t = 0$, your friend's car starts from rest and moves with a constant acceleration of $1 m/s^2$ while your car has a constant velocity of 30 *m/s.*

(g) Does your friend ever catch up with you for time $t > 0$? At what time?

(h) Which of the following physical quantities are the same for your friend and you when you catch up with each other: (i) displacement, (ii) velocity, (iii) acceleration? Justify your answer in each case.

(i) Is there some time when your velocity is the same as your friends? Is it before or after you two catch up with each other? Justify your answer.

(j) Clearly describe in your own words the similarity between this problem and the exploration problem that you did in part (a)-(f).