

# Physics 20 Lesson 6

## Graphical Analysis Activities

### I. Motion Up and Down an Incline

#### **Objective:**

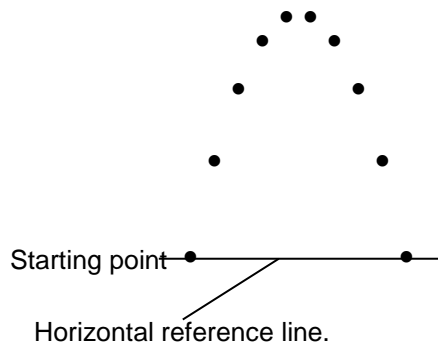
To analyse the motion of an object that moves up and then down an inclined plane (an air table).

#### **Materials:**

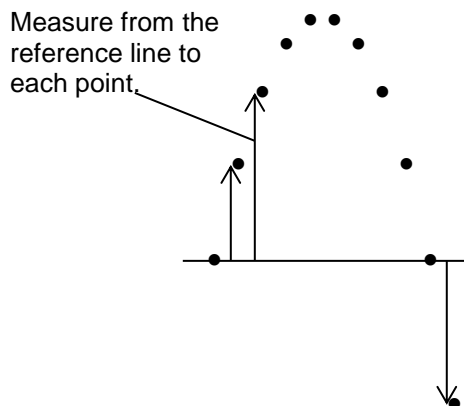
air table, air table paper, graph paper, rulers

#### **Procedure:**

1. Set the spark timer to 0.040 s (i.e. – 25 Hz)
2. Tilt the air table up by using two biology text books under the single leg.
3. Project the puck up the table so that it goes up about 30 cm and returns almost straight down.
3. For this activity we are interested in the puck's motion after it was released. Choose a starting point when the puck was in motion after it was released. Draw a horizontal reference line parallel with the edge of the paper. For example:



4. Measure the total vertical distance from the reference line to each point. Use every available point. (You may want to check what you are doing with your teacher.)
5. Record your measurements in a suitable position/time data table.



#### **Table of Observations:**

Create a suitable data table for your results.

### **Graphs of Observations:**

1. Plot and draw a position–time graph.
2. Using the position–time graph and the tangent technique that you learned in Lesson 5 (pages 5-2 and 5-3), calculate the instantaneous velocity for at least five points.
3. Make a suitable velocity/time data table.
4. Plot a velocity–time graph. (The method for doing this is described in Lesson 5 and on pages 24 and 25 Pearson.)
5. Calculate and plot an acceleration–time graph from the velocity–time graph.

### **Analysis and Interpretation:**

1. Describe the velocity of the puck from beginning to end.
2. When is the velocity of the air puck zero? Indicate where it occurs on the position–time and velocity–time graphs.
3. What physical quantity does the slope of the velocity–time graph represent?
4. What is the sign of the acceleration (+ or –)? Explain.
5. Does the acceleration change or is it constant? Explain.

Your write-up should include:

- ⇒ a statement of the purpose of this activity
- ⇒ data tables and observations
- ⇒ graphs
- ⇒ slope calculations including units
- ⇒ answers to the analysis and interpretation questions

## II. Moving Man – Computer simulation

### Objective:

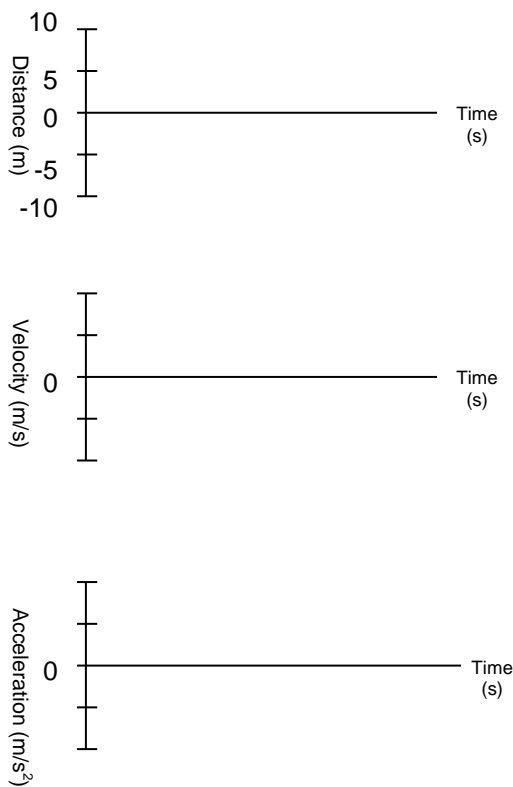
You will be able to accurately interpret and draw position, velocity and acceleration graphs for common situations and explain their reasoning.

### Procedure:

Go to <http://www.colorado.edu/physics/phet> and find “The Moving Man” simulation under the category of “motion.”

1. Investigate *Moving Man* by dragging the dude around with your mouse. This will give you very jumpy data, especially in the acceleration graph – why? Now try making the man move using the slider arrows. Use the playback features to look at the graphs. While you make observations, **discuss in your group** the reasons the graphs look the way they do.
2. Making predictions: Make a chart like the one below on your own paper. Without using *Moving Man*, sketch what you think the graphs would look like for the following scenario and explain your reasoning.

**Scenario A: The man starts at the tree and moves toward the house with constant velocity.**



Explain your reasoning for the graphs' appearance:

3. Now, use the *Moving Man* simulation to verify or correct your predicted graphs and reasoning with a different color pen. Be sure to use the sliders to enter  $d$ ,  $v$ , or  $a$ ; if you try to move the man by hand, the results will not be good.
4. Make new charts like the ones above for each of the scenarios A – H. **Predict** what you think the distance, velocity, and acceleration graphs will look like.
5. Use the *Moving Man* simulation to verify or correct your predicted graphs with a different coloured pen.
  - B. A man moving from 0 to the house at a fast pace then moving back to 0 at a slower pace.
  - C. A man moving from 0 to the house, speeding up as he walks.
  - D. The man stands still while he talks on his cell phone at the middle of the sidewalk, then walks toward the house at a constant rate trying to get better cell reception. He comes to a sudden stop when the coverage is good (about a meter before the house) and stands still to finish his conversation.
  - E. The man starts close to the tree, stands still for a little while, then walks toward the house at a constant rate for a while, then slows gradually to a stop.
  - F. The man starts three meters from the house and speeds up as he walks towards the tree.
  - G. A man wakes up from his nap under the tree and speeds up toward the house. He stops because he is worried that he dropped his keys. He stands still as he searches his pockets for his keys. Once he finds them, he continues calmly to walk toward the house and then slows to a stop as he nears the door.
  - H. The man starts with some velocity towards the tree, slows to a stop, and turns to accelerate back towards the house.
6. Look at your graphs, reasoning's, and the corrections from questions 2 – 5. Discuss (with your group, and then write down your discussion) why some of your predictions were wrong and how your ideas about motion have changed.

### **Lab Write-up:**

Title, Data (i.e. all of your graphs, *with* explanations, predictions in one color and correct graph in another), and an answer to question 6.

