Lab 2-7: **Up and Down**

Purpose: 1. To make and interpret motion graphs for the following situations:
   a. A ball tossed up in the air.
   b. A cart given an initial push up a ramp.
2. To show that an object can have zero velocity, yet be constantly accelerating.

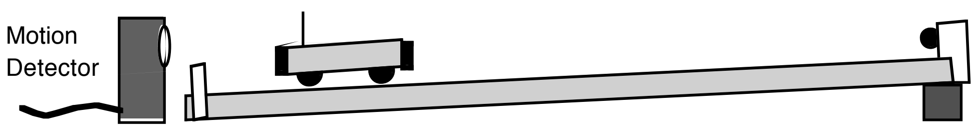
Procedure:

Part I: Tossing a ball in the air

1. Place the Motion Detector in on a stool pointing straight up.
2. Start Logger Pro and open up the file "06 Ball Toss."
3. Hold the ball directly above the Motion Detector.
4. Start timing. After you hear the Motion Detector clicking, toss the ball straight up in the air a few times. Obviously, make sure you catch it and don't let it crash into the Motion Detector. The goal is to get the ball to record the ball going up and down. (Try a few times in a row – this may be difficult. Call your teacher if you are not having any luck.)
5. Make sure your graph shows the ball going up and down. There will definitely be some "weirdness" in the graphs on either side of this motion and we will end up ignoring this.
6. Put in the regression line for the linear part of the velocity graph and put in the statistics for the horizontal part of the acceleration graph. Make sure the correct part of the graph is highlighted!
7. After checking with the teacher, title the graphs and print them.
8. Look at the data values by clicking on the "Examine" button and answer questions 2-4 on this set of graphs.

Part II: Cart pushed up a ramp

1. Raise one end of the ramp by placing a book or something under it, or by using a stand and a clamp.
2. Place the Motion Detector at the base of the ramp so that it is pointing up the ramp.
3. Put the cart on the ramp. Make sure that the wheels of the cart are in the grooves on the ramp. *See diagram.*



5. Start timing. After you hear the Motion Detector clicking, give the cart a quick push so that it gets to within 10 cm of the raised end. Don't let the cart slam into the bottom of the ramp! (This may take a few trials.)
6. Make sure your graph shows the cart going up and down the ramp. There will definitely be some "weirdness" in the graphs on either side of this motion and we will end up ignoring this. Sketch the position, velocity and acceleration graphs in the space below. Make sure you label the graphs, and include the slope of the velocity graph.

slope = _________

Questions:

1. Since you put the motion detector on the ground, what are the directions of each of the following:

   positive velocity:____________ negative velocity:____________

   positive acceleration:____________ negative acceleration:____________

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Answer the following right on the printed out graph:

2. Identify the region where the ball was being pushed/tossed, but still in your hands. Label this region on the velocity and the acceleration graphs.
3. Identify the regions where the ball was "in free fall." (This means that the cart/ball was moving under the influence of gravity only and you were not touching it.)
   a. On each of the three graphs, label where the ball was moving upwards.
   b. On each of the three graphs, label where the ball was moving downward.
4. Determine the position, velocity and acceleration at the following points:
   a. On the velocity graph, locate the maximum velocity just as the ball was released. Mark and record its value on the graph.
   b. On the position graph, locate the maximum height of the ball. Mark the spot on the graph and record its value on the graph.
   c. On the velocity graph, locate where the ball was at its maximum height. Mark the spot on the graph and record the velocity on the graph.
   d. On the acceleration graph, locate where the ball was at its maximum height. Mark the spot on the graph and record the acceleration on the graph.

Conclusions:

1. Was the acceleration of the ball constant while it was in the air? How do you know? If it was constant, what was the value?

2. Was the acceleration of the cart constant while it was moving on the track after it left your hand? How do you know? If it was constant, what was the value?

3. If you have a constant acceleration, yet have a zero velocity, what must you be doing?

4. When you toss something into the air, it goes up and down. At its maximum height, what is its velocity and its acceleration. Give the numbers and also state the direction.

5. Can something have a constant acceleration, yet be going in one direction first and then in the opposite direction later?

6. Both sets of graphs show an object going up and then coming down – so the cart or ball had to be at the same height twice (once going up and once going down.) What is true about the velocities of the cart or ball when it is at the same height? What about the speeds?

7. If you throw a ball up in the air, it will take a certain amount of time to reach its maximum height. How long would it take to fall back down to its original position?