SPH3U: Freefall

Recorder: _____
Manager: _____
Speaker: _____
0 1 2 3 4 5

One of the most important examples of motion is that of falling objects. How does an object move when it is falling? Let's find out!

A: Observing Falling Motions

1. **Observe.** You need a ball. Describe the motion of the falling ball (ignore the bounces). Offer some reasons for the observed motion.

2. **Observe.** You need a piece of paper. Describe the motion of the falling paper. Offer some reasons for the observed motion.

3. **Predict.** Describe how the paper might fall if it is crumpled into a little ball (don't do it yet!) Explain the reasons for your predictions.

4. **Test.** Drop the crumpled paper ball. Describe your observations. Drop it with the ball as a comparison. Offer some reasons for the observed motions.

In grade 11 and 12 we will focus on a simplified type of freefall where the effect of air resistance is small enough compared to the effect of gravity that it can be ignored. Our definition of freefall is vertical motion near Earth's surface that is influenced by gravity alone.

B: Analyzing Falling Motion

Your teacher has a motion detector set up which we will observe as a class. We will drop a bean-bag to avoid confusion from any bounces of a ball. We choose the origin to be the floor and the upward direction as positive *y*-direction. When we analyze freefall we will replace the *x* symbols for position and displacement with *y* symbols to indicate the vertical direction.

1. **Observe.** Sketch the position and velocity-time graphs from the computer for the falling bean-bag.

2. **Interpret.** What can we conclude about the motion of the object while it is falling (freefalling)?

3. **Reason.** At what moment in time does freefall begin? What should our first event be?

4. **Reason.** At what moment does freefall end? What should our second event be?

C: Freefalling Up?

1. **Observe.** Toss the ball straight up a couple of times and then describe its motion while it is travelling upwards. Offer some reasons for the observed motion.

2. **Speculate.** Do you think the acceleration when the ball is rising is different in some way than the acceleration when the ball is falling? Why or why not?

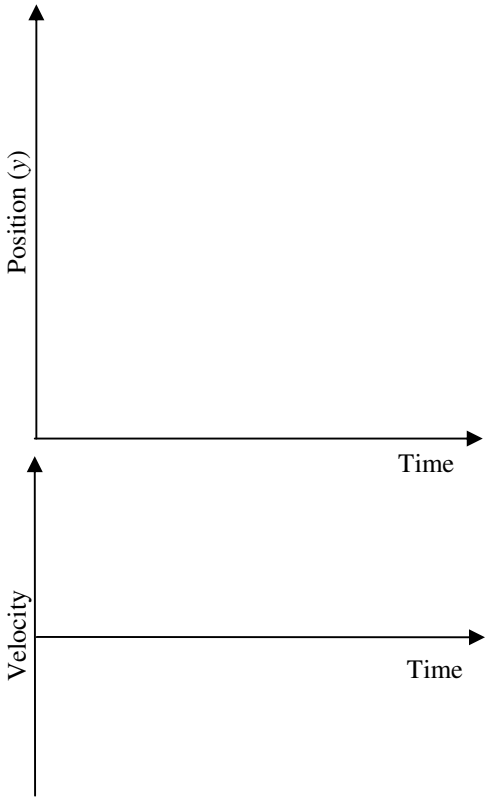
3. **Speculate.** What do you think the acceleration will be at the moment when the ball is at its highest point? Why?

D: Analyzing the Motion of a Tossed Ball

As a class, observe the results from the motion detector for a ball's complete trip up and back down.

1. **Observe.** (*as a class*) Sketch the results from the computer in the two graphs to the right. Be sure to line up the features of the graphs vertically (same moments in time.)

2. **Interpret.** (*as a group*) Explain which graph is easiest to use to decide when the ball leaves contact with your teacher's hand and returns into contact.



3. **Interpret.** Label three events on each graph (1): the ball leaves the hand, (2) the ball at its highest position, and (3) the ball returns to the hand. Label the portion of each graph that represents upwards motion, downwards motion. Indicate in which portions the velocity positive, negative, or equal to zero.

4. **Reason.** How does the acceleration of the ball during the upwards part of its trip compare with the downwards part?

5. **Reason.** Many people are interested in what happened when the ball "turns around" at the top of its trip. Some students argue that the acceleration at the top is zero; others think not. What do you think happens to the acceleration at this point? Use the v-t graph to help explain.

6. **Interpret.** On the two graphs above, label the interval of time during which the ball experiences freefall. Justify your interpretation.