Position, Velocity, and Acceleration

Required Equipment:

- Laptop (with LoggerPro software)
- Motion detector
- Rolling object (toy car, pencil, etc.)
- Ramp

Pre-Lab Lecture Key Points:

➔ *Position* = the location of an object

➔ *Velocity* = the rate at which the location of an object changes

➔ *Acceleration* = the rate at which the velocity of an object changes

➔ The emphasis in this lesson should be on the distinction between position, velocity, and acceleration

➔ Any long, flat object can be substituted for the ramp

➔ Students should also be able to see that even though position, velocity, and acceleration represent different quantities, they are fundamentally related (i.e. velocity tells us how fast or slow an object's position is changing)

Gravity = a force that pulls objects towards Earth's surface

➔ The second experiment demonstrates the fact that gravity causes objects to accelerate downwards (towards Earth's surface)

➔ If desired, you can ask students what they think gravity is or if they have ever heard of it before

➔ Don't go into detail about what a force is unless students are curious (this will be covered in detail next week); they should be able to understand that is essentially an invisible hand pulling an object towards the Earth

Student Lab Procedure:

1. Open the LoggerPro software on a laptop.

*The next few (2-3) steps can be somewhat confusing so it may be necessary to connect the motion detector for the students

2. Plug in the motion detector into the Dig/Sonic 1 port in the LabPro device, which should be connected to the laptop.

3. In LoggerPro, go to the Experiment tab, highlight Set Up Sensors, and then choose Show All Interfaces.

4. Drag the Motion Detector icon to the Dig/Sonic 1 field.

5. Test the detector by pressing the large green play button near the top of the LoggerPro window; you should be able to hear a clicking sound coming from the detector.

*When the green button is pressed, the motion detector will measure position, velocity, and acceleration for 10 seconds; at first you may have to play around with the software but the output graph can be tuned to position, velocity, or acceleration by right-clicking on the y-axis of the active graph, which is especially important for the next part

6. Using your knowledge of position, velocity, and acceleration, spend the next 15-20 minutes using the motion detector to try and match the graphs in the Observations below.

7. When necessary, ask your teacher how to switch the graph between position, velocity, and acceleration. It is very important that the type of graph on your worksheet match the one in LoggerPro!

*Students may have trouble perfectly matching the graphs on their worksheet due to limitations in the motion detector; if this is the case, the students should be able to describe what motion should occur in order to produce a certain graph

8. Now take a ramp and place the motion detector at the top.

*Make sure students face the motion detector at an angle so it detects along the flat surface/slope of the ramp

9. Set up the LoggerPro graph to show acceleration.

10. Now put the rolling object at the top of the ramp. Press the green play button and let go of the rolling object at the same time.

11. Note down any interesting features of the graph on your worksheet and try to explain them.

*The graph of acceleration should, for the most part, be flat; there may or may not be some distortions in the beginning of the graph but the rest of it should be flat (some trigonometric multiple of g = 9.8 m/s^2)

Wrap-Up:

- ➔ One last time, ask students the difference between position, velocity, and acceleration
- ➔ Depending on how long it takes to set up the LoggerPro software and motion detector, it might be wise to skip the second experiment or describe to students how it would play out
- ➔ The take-away point for the gravity experiment is to show that gravity imparts some nonzero acceleration onto any object within Earth's vicinity
- ➔ The fact that the acceleration of the object down the ramp is constant will come up again in next week's experiment when gravity is discussed!