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Ninja Physics Lab Guide

Misconceptions

- Acceleration cannot be zero if you are moving.
- Acceleration has nothing to do with direction, only motion in a straight line.

Guiding Questions

1. What are the three ways an object can accelerate? **There are three ways an object can accelerate: a change in speed, a change in direction, or a change in both speed and direction.**
2. Can you be moving at a high rate of speed and have zero acceleration? **Yes, as long as there is no change in speed or direction, acceleration is zero.**
3. Is it possible to have acceleration if I maintain my speed at an exact rate? **Yes, a change in direction would still equal a change in acceleration, even if your speed was constant.**

Overview Questions Key

1. What topics will be covered in this lab? **Acceleration, Acceleration, due to gravity, Balanced and Unbalanced Forces, Cartesian Coordinates - X, Y, and Z Axes**
2. Make a prediction: Is it possible to move with zero acceleration while remaining perfectly level? **Answers will vary**
3. How well do you think you currently understand acceleration and gravity? What do you want to learn? Be specific. **Answers will vary, but students should reference specific parts of definitions and/or application and/or examples that are unclear.**

Background Questions Key

1. What is gravity? **Gravity is an invisible force that attracts all objects to each other.**
2. Describe how the mass of an object affects its gravitational “pull” on other objects. **The more mass an object has, the greater its gravitational force (how much it pulls) will be on other objects. Therefore, larger/heavier objects will exert a greater gravitational force than smaller/lighter objects.**
3. Why is the acceleration due to gravity different on the Moon than it is here on Earth? **Since the Moon has less mass than the Earth, it exerts a smaller gravitational force on other objects (it doesn’t “pull” as hard as the Earth). Therefore, the rate at which objects accelerate on the Moon (due to gravity) is slower.**
4. Describe two sets of conditions where an object has no (zero) acceleration. **Two sets of conditions that would result in an object having no/zero acceleration would be, 1) The object is at rest, or 2) The object is moving at a constant speed in the same direction.**
5. You will be using the Cartesian Coordinate system in this set of activities. What will the Y and Z axes represent (be sure to indicate which is which)? **In the Cartesian Coordinate system, the Y axis will represent acceleration in one direction, and the Z axis will represent acceleration due to gravity.**
6. Define balanced forces AND include an example (different from the one provided in the text). **Balanced forces describes a set of conditions where all the forces acting upon an object are equal (such as when there is no change in speed or direction and acceleration is at zero). An example of this would be a tug of war game with equally balanced team strength (the rope isn’t moving because it is being pulled with the same amount of force in opposite directions).**

Objectives

The following learning objectives are emphasized in this exploration:

- Visualize, collect and analyze data
- Use Cartesian Coordinates - x, y, and z axes
- Measure and record acceleration
- Measure & record acceleration due to gravity
- Visualize balanced forces in action

Additional Resources

Phet:

Gravity Force Lab

https://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_en.html

Khan Academy:

<https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration-tutorial/v/acceleration>

Next Generation Science Standards (NGSS)

Science and Engineering Practices

- **Analyzing and interpreting data.** Students read and interpret accelerometer data in the activities.
- **Using math and computational thinking.** Students learn about and use Cartesian Coordinates in the activities.

Disciplinary Core Ideas

- **K-PS2-1.** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- **3-PS2-1.** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **MS-PS2-4.** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Cross Cutting Concepts

- **Cause and effect:** Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
- **Scale, proportion, and quantity.** In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.