Activity 5 - Run and Jump

Activity/Demo

In this activity we'll be working to understand Newton's Third Law of Motion: For every applied force, there is an equal and opposite force. There will be a demonstration on a skateboard, a "thought experiment", and you will build a "balloon rocket" to examine the effects of Newton's Third Law of Motion.

Activity/Demo:

1. A person is standing on a skateboard near a wall. Touching only the wall, and not the floor, this person moves away from the wall and "coasts" across the floor. Use words and diagrams to answer the following questions.

a) When does the person on the skateboard "accelerate"? In which direction does he or she accelerate?

b) When does the person travel at a constant speed? If there were no friction, how far would this person travel?

c) Newton's Second Law of Motion ($F = ma$) says that a force must be present if acceleration occurs. What is the ***source*** of the force, the push or pull, that causes the person on the skateboard to accelerate in this case? Identify the *object* that does the pushing on the skateboarder's mass. Also, identify the direction of the push that would cause the skateboarder to accelerate.

d) Obviously, the skateboarder does some pushing too. On what object did the skateboarder push? In which direction did the skateboarder push?

e) How do you think the following two forces compare? (Consider both the amount of force and the direction of the force)

- The force exerted by the skateboarder on the wall
- The force exerted by the wall on the skateboarder

Draw a sketch showing these two forces at work.

2. Do a "thought experiment" about the forces involved when you are running or walking on a horizontal surface. Use words and sketches to answer the following questions in your notebook.

a) With each step you push the bottom surface of your shoe, the sole, horizontally backward. The force acts parallel to the surface of the ground, trying to scrape the ground in the direction opposite your motion. Usually, friction is enough to prevent your shoe from sliding across the ground. Since you move forward, not rearward, there must be a force in the forward direction that causes you to accelerate. Draw a sketch and describe what is happening during a single step when someone walking or running is pushing against the surface of the ground as given in this example.

b) Would it be possible to walk or run on an extremely slippery skating rink when wearing ordinary shoes? Discuss why or why not in terms of forces.

3. You will now construct a balloon rocket using fishing line, a straw, a balloon and some tape. We'll also be using a stopwatch, meter stick, some pennies, and some chairs or tables to anchor our balloon rocket's guide line (the fishing line).

a) Copy the table below into your notebook (use a ruler):

Cargo	Trial 1 time (s)	Trial 2 time (s)	Trial 3 time (s)	Average time (s)	distance (m)	Average velocity (m/s)
2 pennies						
6 pennies						

b) Cut a piece of fishing line long enough to reach between two chairs that are three or more meters apart. Tie the line to one chair. Insert the other end of the line through the straw, then tie off the other end of the line to the other chair and pull the chairs apart until the line is taut. *Make sure the line is level*.

c) Measure the distance between the chairs and record it in the data table in your notebook.

d) Have one partner blow up the balloon and hold the balloon's opening closed. Use a piece of string or yarn around the balloon to find the circumference of the balloon. Then measure how long the yarn or string is (in centimeters) using a meter stick. Record this value just below your data table in your notebook. ***The balloon needs to be the same size for each trial!***

e) Describe in your notebook what is happening to the sides of the balloon when you blow air into the balloon (in terms of force).

f) Attach 2 pennies to the balloon using tape. This is to stabilize the balloon rocket on the fishing line.

g) Have your partner attach the balloon to the straw using tape. Make sure the opening of the balloon is pointing toward the end of the line you're starting the rocket from.

h) Have one partner ready to record the time it takes the balloon to travel the length of the string. Release the balloon. Record the travel time in the data table. Repeat this two more times with the two penny cargo.

i) Repeat the experiment (again, three trials) with a cargo of 6 pennies taped to the balloon. Again, record the times in the data table.

j) Calculate the average times for the 2 penny balloon jet and the 6 penny balloon rocket. Using this average time and the distance you measured, find the average velocity for both rockets. (If you've forgotten how to find the average velocity, look on your formula page in the front of the notebook!)

k) If the force from the balloon is pushing the air out, what is supplying the force to push the balloon along the string?

l) Looking at your data, describe the difference between the average velocity from the 2 penny rocket and the 6 penny rocket.

m) Explain why there is a difference in the average velocities between the 2 and 6 penny balloon rockets (refer to Newton's Second Law of Motion, $F = ma$).