ACTIVITY 4: MATHEMATICALLY MODELING CONSTANT SPEED

In this activity, students will complete a graphing exercise to mathematically model the motion of an object moving at a constant speed.

Materials Needed:

- graph paper
- dry ice data in tabular form from Activity 3

Begin by having students partner up and obtain one of the data sets from the dry ice speed experiment. Ensure that different pairs of students are working with different data sets. This will be important later to drive home the point that the block was moving at a constant speed no matter how fast it was moving when pushed with different amounts of force.

First, have students construct a position vs. time graph and plot their data points from the table. They will need to scale the axes with position in cm on the y-axis and time in seconds on the x-axis. The intervals of each axis will depend on the ranges for the data in their measurements. They should draw a best-fit line for their graph.

Next, have the students determine the amount of distance traveled from second to second by finding the difference between the positions at each time. Have them list those differences (e.g., calculated distances) out in a separate table that shows time and distance. Ask them to discuss what they notice about the distance vs. time data compared to the position vs. time data. They should jot down some observations to share later during the discussion.

Then, have students average their distances and divide it by the time interval (e.g., 1 second) that was associated with each. This is the average speed of the dry ice block in cm/s.

Last, have students find the slope of their best-fit line with units of the slope in the calculation (e.g., cm/s), and also determine the y-intercept value (with units) for their best fit line. Using these two calculated values, students should write a linear equation (e.g., y=mx+b) that represents the line of best fit (including units).

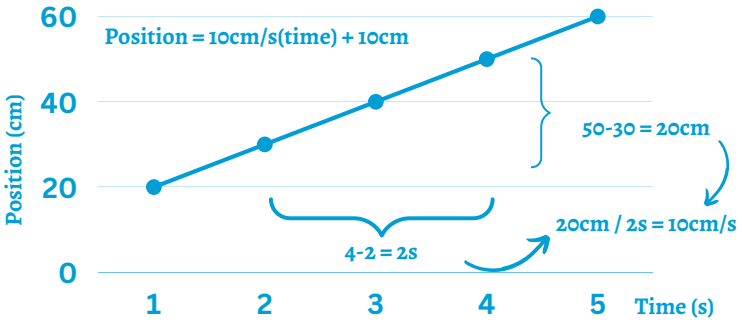

Image Credit: Gary Abud, Jr.

Discussion

Using large dry erase boards or chart paper, have students summarize their analysis of the data by displaying their data table, graph, and linear equation to be able to show the class.

Display all the groups' summary boards for everyone to see and engage the whole group in a discussion about the data. Elicit a few select groups to answer each question based on the features of their summary board that you see. Help students to use the information on their board to support their claims as they answer and discuss the following questions:

- **How does the slope value from your best-fit line compare to the average speed calculated earlier?** *(these values should be very close to one another)*
- **What does the y-intercept value from the graph tell us about the block of dry ice during the experiment?** *(it tells us the position of the block at the 0s point in time)*
- **What conclusions can we all draw about the motion of the block in each experiment?** *(It was moving with a constant speed every time)*
- **Where would the block be after 30sec?**

Conclude this discussion by revisiting the force diagrams of the dry ice from earlier in the lesson. Be sure to name the object that is doing the pushing or pulling for each of the forces on the diagram and note which forces are balanced out by any others. Help students to see that the forces are balanced on the block of dry ice. Tie this to the motion of the dry ice to help students make the connection that **when forces are balanced, objects move with a constant speed in a straight path.**