A Model for Constant Velocity

A Carolina Essentials™ Activity

Student Worksheet

Overview

Early in the history of physics, study and experimentation focused on modeling and understanding motion of all types. Johannes Kepler proposed his laws of planetary motion and Isaac Newton proposed his laws of motion and motion due to gravity in the 1600s. These renowned scientists began with data and developed mathematical models from their analyses.

You'll do the same in this activity on constant velocity. First, a check of some vocabulary:

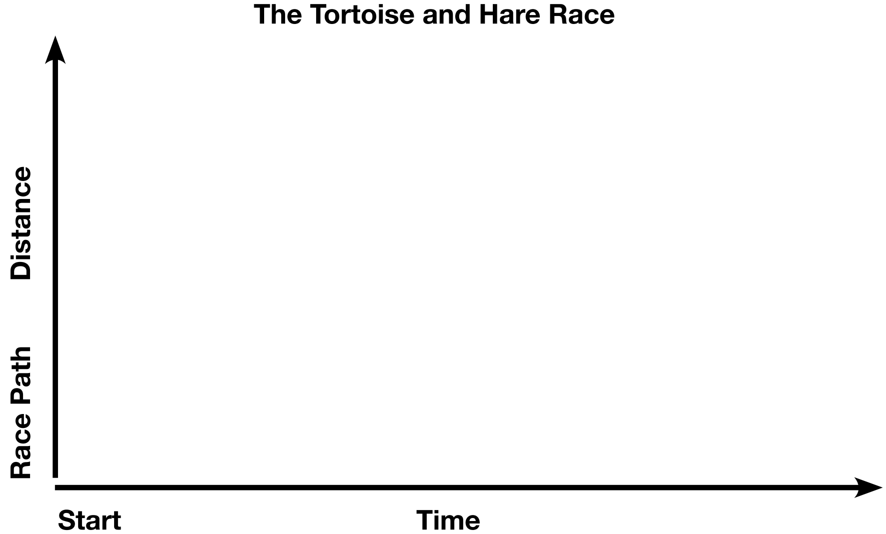
- Position: a place where something is located at a moment in time
- Speed: distance traveled per unit of time
- Velocity: speed with direction

When you study speed, you're observing a body's change in position over a certain amount of time. That data can then be used to calculate speed directly with a formula or through graphical analysis. When you make observations on the direction at which the body is moving and its speed, you're measuring velocity.

Phenomenon

Remember the fable of the tortoise and the hare? They started a race at the same time, but the "slower" tortoise won the race. See if you can graphically represent the fable below. Remember that the tortoise and hare start at the same time and place, and end at the same place, but the tortoise finishes first.

The Tortoise and Hare Race



Essential Question

How is motion modeled both graphically and mathematically?

Activity Objectives

1. Collect and analyze data for an object moving at constant velocity.
2. Develop a predictive mathematical model that describes the motion of an object moving with a constant velocity.

Disposal

Dispose of the aluminum foil in the classroom trash or recycle. Do not discard the dowels as they can be reused.

SAFETY REQUIREMENTS

No PPE is required for the activity.

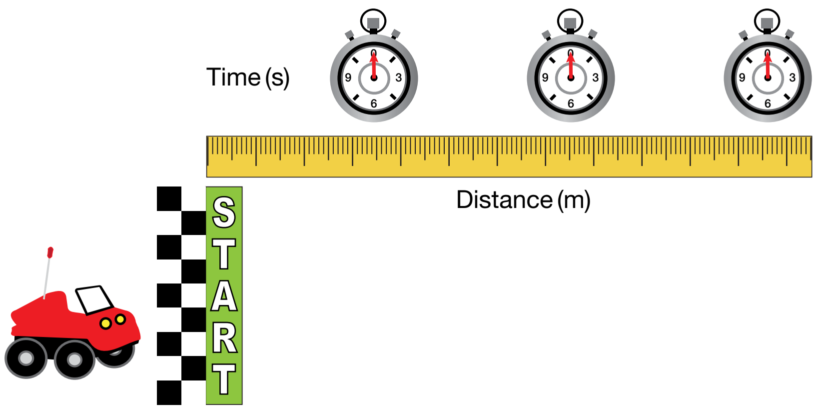
MATERIALS

- Constant velocity vehicle
- Wood dowel, 7/8 × 1-7/8 in
- Square of aluminum foil, 10 × 10 cm
- Tape measure or meter stick
- 3 stopwatches or smartphones
- Graph paper
- Calculator
- 2 batteries, size C

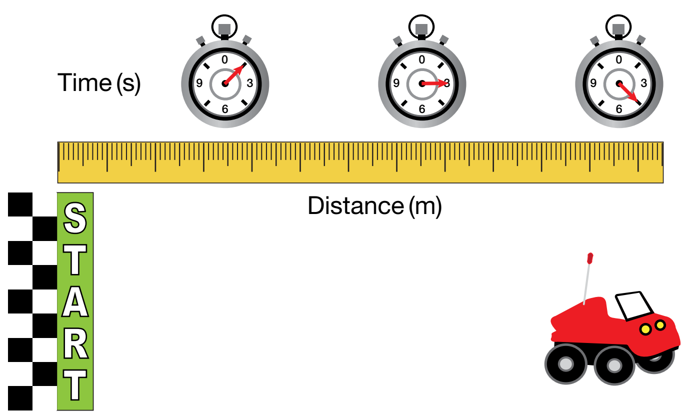
Activity Procedure

Procedure A: Vehicle with 2 Batteries

1. Prepare a straight, level track/path at least 3 meters long, where you can operate the constant velocity vehicle.
2. Prepare the vehicle by installing the batteries and closing the battery compartment.
3. Test the vehicle. Place it on the track you prepared in step 1, and switch on the power. Allow the car to run the length of the track. If the car veers to the left or the right (more than twice the width of the car, or over 3 meters) modify the track to correct the path.
4. Once your test track is prepared, set the car on the floor at least a car length behind the start point.
5. One group member needs to be behind the start point to activate the car. A second member stands at the start point to signal the timers to start. Three students stand at designated meter points to take times. One student should be located behind the finish line to recover the car.
6. Record the position of each student with a timer from the start position. Mark this position on the track with a piece of tape.
7. Start the car by switching on the power and release the car to travel the track.
8. When the car crosses the start point, the student at that position signals the timers to start. On the starter's signal, all timers start their stopwatches/timers.



9. As the vehicle crosses the position on the track next to each timer, that student will stop his/her stopwatch.



10. Repeat the experiment 2 more times. Record the time for each trial at each position.

11. Average the 3 times for each position.

Procedure B: Vehicle with 1 Batteries

12. Remove 1 battery from the constant velocity vehicle. Wrap the wooden dowel completely with aluminum foil to make a battery jumper. Place it in the battery compartment so the jumper is in the negative end of the battery compartment, near the spring. Switch on the car to make sure it works.

13. Repeat Procedure A with the modified vehicle.

Data and Observations

Construct data tables for procedures A and B. Be sure to record your units of measure.

Analysis and Discussion

1. Construct a graph for both sets of data. Color code the data. Consider these questions as you construct the graphs:
    1. What variable should be recorded on the y-axis?
    2. What variable should be recorded on the x-axis?
    3. What units of measure should you assign to each variable?
    4. What should you label each axis?
    5. What title should you assign your graph?
    6. How will you scale your graph?

2. What does the shape of the line indicate about the motion of the vehicle?

3. What is the effect of removing a battery on the velocity of the vehicle? What graphical evidence supports your claim?

4. How can you determine the speed of the car from the graph of the data?

5. Scientific models must be predictive. Does the graph of the car's motion meet this definition? How could you use the graph to predict the position of the car at a future time?

6. Use what you have learned to interpret the graph you drew of the race between the tortoise and the hare. Identify the type of motion, constant velocity or rest, and relative speed (slope of the line).