Investigating Motion

Strand Force, Motion, and Energy
Topic Investigating motion
Primary SOL 4.2 The student will investigate and understand characteristics and interactions of moving objects. Key concepts include
a) motion is described by an object's direction and speed.
Related SOL 4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units;
e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources;
i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs.

Background Information

Motion is described by an object's position relative to another object over time. Its speed is defined by the distance it travels over time.

Materials

Activity A:

- Five meter length of string
- Five stopwatches
- Attached "On Your Mark!" data sheet
- Graph paper

Activity B:

- 11 meter sticks
- Small toy car
- Five stopwatches
- Attached "Start Your Engines!" data sheet
- Piece of stiff cardboard or wooden board for a ramp
- Overhead projector (optional)

Follow-up/extension:

- Copies of the attached worksheets on "The Trip"

Vocabulary

position, motion, distance

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Activity A: Student Races

Introduction

1. Ask students how they could determine which student in the class is the fastest runner. Ask the students how they would collect the data and use that data to compare each of the students to determine the fastest runner in the class. Guide students to collect data using distance and time in order to calculate speed. Ask the students what tools they will use to collect the needed data.
2. Ask the students what needs to be held constant for the race.
3. Explain to the students that the class will be conducting timed races outside. Ask for students that would like to volunteer to be runners. Some students will need to be timers while others will be recording time.

Procedure

1. Demonstrate the proper operation of the stopwatch then have students practice using a stopwatch.
2. Take students outside to a place in the schoolyard where you can conduct a footrace.
3. Choose five student volunteers to be the timers, and instruct them to use the five meter length of string to position themselves five meters apart. Have them mark their positions so they can find them again without measuring.
4. Give each of the five students a stopwatch.
5. Choose a student volunteer to be the runner, and position the runner five meters before the first stopwatch.
6. Direct the timers to start their stopwatches as soon as you give the "Go" command. ("On your mark, get set! Go!") As the runner passes each timer, the timer should stop his/her stopwatch. When the runner has completed the 25-meter race, ask each timer to call out the time on his/her stopwatch, and have each student record the times on his/her data sheet to the nearest tenth of a second.
7. Allow all students the chance to be a runner or a timer.
8. Return to the classroom, and give each student a sheet of graph paper. Have students write the name of the activity at the top of the sheet. Instruct them to label the x-axis with the 5-meter intervals (i.e., 5 m, 10 m, 15 m, 20 m, 25 m) and the y-axis with seconds (1 through 10 should be enough).
9. Have each student graph either his or her time or the time of one of the runners.

Conclusion

1. Discuss the results of each run.

Activity B: Toy Car Races

Introduction

1. Set up a racetrack by laying two rows of meter sticks end to end for five meters. Between the two rows leave about 15 cm for the track. The meter sticks should be an equal distance apart for all five meters.
2. At one end of the track, place the ramp so that it is raised 10 cm from the floor. Place one student timer with stopwatch at each meter interval.

Procedure

1. Choose a student to be the "driver," and have the "driver" hold the car at the top of the ramp.
2. Direct the students who are timing to start their stopwatches as the car is released; direct the "driver" to release the car when you say, "Go." As the car passes in front of each timer, the timer should stop his/her stopwatch.
3. Ask each timer to call out the time on his/her stopwatch, and have each student record the times on his/her data sheet to the nearest tenth of a second.
4. Allow all students the chance to be a "driver" and/or a timer.
5. Have students graph and discuss the data of one of the car's runs on graph paper as described in Step 8 of the activity above.

Conclusion

1. Review the data from the trials with the students. Ask students to make a conclusion about the graph.
2. It may be helpful to the students if the teacher completed one or two runners' data on a graph on the overhead projector.

As an alternative, "Start Your Engines!" is an indoor activity that measures the number of seconds a toy car rolls along a track when released from different ramp heights.

Assessment

- **Questions**
  - What is motion?
  - What can the position of an object be described by?
  - What did you measure today?
- **Journal/writing prompts**
  - Your little brother and you are at the beach. When your brother gets in the water, you notice he gets swept far down the beach and doesn't seem to notice. Using what you learned today, write about why he has no idea he is moving away from his place on the beach.
  - When viewing the sunrise or sunset, it appears that the sun moves. Explain why we see this and where we would have to be to view what is really happening.
- **Other**
  - As students prepare their graphs, circulate among the students to check for understanding.

- Give the students additional data sheets, and have them not only graph the results but also write a short paragraph explaining what the graph represents.

Extensions and Connections (for all students)

- Have students complete the activity called "The Trip," dealing with speed (see attachments).
- Have students make a multiple line graph by graphing the times of several students on the same graph, using a different line color for each data set.
- Have students determine who the three fastest runners were by calculating their total times. This activity may be repeated throughout the year to see if the times of the top three students change over time.
- Have students enter their data in a graphing program and experiment with the data being interpreted in several different types of graphs.
- Have advanced students calculate actual speed by using the formula: speed = distance ÷ time

Strategies for Differentiation

- Create mixed ability groups for collecting and recording data. Assign responsibilities to each student in the group depending on ability. Responsibilities could include runner, time keeper, and start "caller."
- Color-code the graphs for your students. Allow students to create another type of graph such as a bar graph.
- Allow students to slide down a playground slide or move on a scooter board to experience speed.
- Students could make a multiple line graph using contrasting colors to represent subjects' data. Students could compare and contrast the speed of the two experiences.

On Your Mark!

Runner: ____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Runner:____

Distance	5 meters	10 meters	15 meters	20 meters	25 meters
Time					

Start Your Engines!

Driver:_____

Height of ramp	10 cm	20 cm	30 cm	40 cm	50 cm
Time car rolled					

Driver:_____

Height of ramp	10 cm	20 cm	30 cm	40 cm	50 cm
Time car rolled					

Driver:_____

Height of ramp	10 cm	20 cm	30 cm	40 cm	50 cm
Time car rolled					

Driver:_____

Height of ramp	10 cm	20 cm	30 cm	40 cm	50 cm
Time car rolled					

The Trip

Read the story below carefully. As you read, write the data from the story onto "The Trip Data Table." Once you have all of the information on the data table, use that information to make a graph.

Ronnie and his family were finally taking off for their annual vacation. Everyone was excited because the cabin at the lake was theirs for two whole weeks. Ronnie and his sister sat in the back seat watching and waiting for the long trip to be over and the lake fun to begin. Here is a record of the average speeds Ronnie's car drove over the entire 10 hour drive.

The first hour was all in-town driving, and the traffic was awful. They only averaged 30 mph. Once they got on the interstate, they were able to drive for 3 hours at an average speed of 60 mph, so hours 2, 3, and 4 were driven at 60 mph.

By the time they got to Plainville, everyone was starving, so they decided to stop and eat lunch. The lunch took up all of hour 5; average speed, 0 mph.

Back on the road again — slowly. Getting out of town was tedious. Average speed for hour 6 was only 40 mph. Hours 7 and 8 found the family picking up speed at an average of 65 mph.

Once they got to the mountains, their speed slowed down. Hours 9 and 10 only had an average speed of 40 mph.

At the cabin at last!

The Trip

Data Table

	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8	Hour 9	Hour 10
Average Speed (in mph)