2.6 Distance–Time Graphs

Strand:
Linear Relations

Student Text Pages
88 to 94

Suggested Timing
80 min

Tools
- large ball (such as a basketball or volleyball)
- grid paper

Technology Tools
- graphing calculators
- CBR™ (calculator-based rangefinder)
- link cables

Related Resources
BLM 2.6.1 Practice: Distance-Time Graphs
BLM A9 Communication General Scoring Rubric
BLM G10 Grid Paper

Mathematical Process Expectations Emphasis

- ☐ Problem Solving
- ☐ Reasoning and Proving
- ☑ Reflecting
- ☑ Selecting Tools and Computational Strategies
- ☑ Connecting
- ☑ Representing
- ☑ Communicating

Specific Expectations

Using Data Management to Investigate Relationships

RE1.01 interpret the meanings of points on scatter plots or graphs that represent linear relations, including scatter plots or graphs in more than one quadrant (e.g., on a scatter plot of height versus age, interpret the point (13, 150) as representing a student who is 13 years old and 150 cm tall; identify points on the graph that represent students who are taller and younger than this student);
RE1.02 pose problems, identify variables, and formulate hypotheses associated with relationships between two variables;
RE1.03 design and carry out an investigation or experiment involving relationships between two variables, including the collection and organization of data, using appropriate methods, equipment, and/or technology (e.g., surveying; using measuring tools, scientific probes, the Internet) and techniques (e.g., making tables, drawing graphs);
RE1.04 describe trends and relationships observed in data, make inferences from data, compare the inferences with hypotheses about the data, and explain any differences between the inferences and the hypotheses (e.g., describe the trend observed in the data. Does a relationship seem to exist? Of what sort? Is the outcome consistent with your hypothesis? Identify and explain any outlying pieces of data. Suggest a formula that relates the variables. How might you vary this experiment to examine other relationships?);

Understanding Characteristics of Linear Relations

RE2.01 construct tables of values, graphs, and equations, using a variety of tools (e.g., graphing calculators, spreadsheets, graphing software, paper and pencil), to represent linear relations derived from descriptions of realistic situations;
RE2.02 construct tables of values, scatter plots, and lines or curves of best fit as appropriate, using a variety of tools (e.g., spreadsheets, graphing software, graphing calculators, paper and pencil), for linearly related and non-linearly related data collected from a variety of sources (e.g., experiments, electronic secondary sources, patterning with concrete materials);

Connecting Various Representations of Linear Relations

RE3.02 describe a situation that would explain the events illustrated by a given graph of a relationship between two variables;
RE3.03 determine other representations of a linear relation, given one representation (e.g., given a numeric model, determine a graphical model and an algebraic model; given a graph, determine some points on the graph and determine an algebraic model).

Teaching Suggestions

- Read the opening paragraph as a class. This is a good introduction to the CBR™ (calculator-based rangefinder) for graphing calculators. The CBR™ is to be used as a data collection tool so that analysis of the data can follow. (2 min)
- Investigates A and B are excellent exercises in understanding distance-time graphs. Ideal group sizes are two or three students. Allow students to experiment with the CBRs™ until they have a good sample. (40 min)

Common Errors

- Some students may have difficulty describing motion or matching graphs.

R_x This type of concept takes time to understand. Have students investigate what happens to the distance–time graph when they stand still, walk at a slow steady pace, walk at a faster steady pace, speed up, slow down, and walk backwards. Have them copy their graphs onto a piece of paper or **BLM G10 Grid Paper** and write a full description of their actions.

Ongoing Assessment

Communicate Your Understanding questions can be used as quizzes to assess student Communication skills.

- At the end of the activities, have a class discussion on the importance of distance-time graphs and the speed relationships they show. This will help students' understanding later in the course when they learn about rates of change and slope. Stress that the steepness of the graph represents the speed of the object. Also, stress the importance of using time as the independent variable. (10 min)

Tips on using the CBR™:

a) The CBR™ works best at distances of 1 m to 3 m. Measurements of distances less than 1 m or more than 3 m can be inaccurate. CBR2s™ have a better range, approximately 15 cm to 6 m.

b) Soft clothing absorbs the ultrasonic pulses from the ranger. The target student can improve the reflection of the pulses by carrying a piece of stiff cardboard.

c) Hard surfaces, such as desks and chalkboards, can reflect the ultrasonic pulses and cause erroneous readings. A wide hallway is a good place to conduct these investigations.

- If you do not have access to CBRs™, discuss the graphs in question 7 of Investigate A. Create a few more simple graphs so the students can act out and describe the motion implied by the graph. Have the students act out some simple motions toward a wall, while their partner(s) draw the appropriate graphs.
- For Investigate B, have students roll a ball slowly down a ramp with a metre stick or tape measure fastened to the side. Have one student tap off the seconds from a stopwatch, while a second student calls out the distances every 2 s. A third student can record them on a chart. Steps 5, 6, and 8 can be answered for this activity as well.
- Assign and discuss questions C1 and C2. (10 min)
- You may wish to use **BLM 2.6.1 Practice: Distance-Time Graphs** for remediation or extra practice.

Investigate Answers (page 88)

A. 5. The horizontal axis represents time and the vertical axis represents distance. Time is the independent variable because distance is being measured relative to time.

6. Answers will vary.

a) The graph shows the distance decreasing in a straight line for the first 2 s when approaching the wall.

b) The graph shows the distance increasing at an increasing pace (non-linear).

c) The graph shows a horizontal line when I was standing still.

d) The parts of the graph that represent the motion towards the wall and standing still are straight lines while the motion away from the wall is a curved line. The straight part represents motion at a constant speed and the curved part represent motion at an increasing speed (non-constant).

7. a) The graph represents motion toward a wall at a constant speed and then, standing still.

b) The graph represents motion toward a wall at an increasing speed and then, slowing down to a complete stop and standing still for a while.

8. Motion at a constant speed is represented by straight lines on a distance-time graph and motion at an increasing or decreasing speed is represented by a curved line.

B. 5. The horizontal axis represents time and the vertical axis represents distance. Time is the independent variable because distance is being measured relative to time.

6. The point on the graph where the distance stops increasing (where the graph peaks) is the point where the ball hit the floor and bounced back.

7. The coordinates of this point represent how far the ball was from the rangefinder when the ball hit the floor.

8. Answers will vary. The relationship between distance and time is not linear because the graph shows their relationship as a curve not a straight line. We can conclude that the speed of the ball is increasing.

Communicate Your Understanding Responses (page 91)

C1. AB: slowest movement, BC: fastest movement, CD: no movement, DE: backward movement

C2. a) Person 1 walks towards the CBR™ at a steady pace and then, stops in front of it.

b) Person 2 walks at a faster pace than Person 1.

c) Person 3 has a running start towards the CBR™ but then gradually slows down.

Accommodations

Gifted and Enrichment—Give students opportunities to create their own distance-time graphs.

Visual—Provide students with opportunities to orally describe the graphs in this section.

Motor—Encourage students to work in groups when using technology.

Memory—Allow students to create and use "sequential cue card" instructions to remember the steps required to use technology in this section.

Practise

These questions should not pose difficulties for the students.

Connect and Apply

Most questions support the basic concepts taught in the Investigate activities. Question 5 is a key question to consolidate the students' understanding of distance–time graphs. Question 9 is an excellent activity for making students think about appropriate motion for a given graph and to communicate their ideas. You may wish to use **BLM A9 Communication General Scoring Rubric** to assist you in assessing your students. You may wish to use **BLM G10 Grid Paper** for questions 6 to 9.

Extend

In question 12, the Ball Bounce program shows the distance of the ball from the floor, rather than from the CBR™. This way, it provides what looks like a ball bouncing along a floor. Remind students that the independent axis represents time.

Exercise Guide

Category	Question Number
Minimum (essential questions for all students to cover the expectations)	1–3, 5
Typical	1–9
Extension	11–14