5.4 Slope as a Rate of Change

Strand:
Linear Relations

Strand:
Analytic Geometry

Student Text Pages
264 to 271

Suggested Timing
80 min

Tools
- grid paper

Technology Tools
- *Fathom*™
- computers
- graphing calculators

Related Resources
BLM A12 Group Work Assessment Rubric
BLM T6 *Fathom*™
BLM 5.4.1 Practice: Slope as a Rate of Change
BLM G10 Grid Paper
BLM 5.4.2 Achievement Check Rubric

Mathematical Process Expectations Emphasis

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

Specific Expectations

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;

Investigating the Properties of Slope

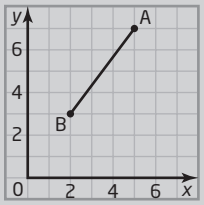
AG2.01 determine, through investigation, various formulas for the slope of a line segment or to determine the slope of a line segment or a line;

AG2.03 determine, through investigation, connections among the representations of a constant rate of change of a linear relation (e.g., the cost of producing a book of photographs is $50, plus $5 per book, so, an equation is $C = 50 + 5p$; a table of values provides the first difference of 5; the rate of change has a value of 5, which is also the slope of the corresponding line; and 5 is the coefficient of the independent variable, p, in this equation);

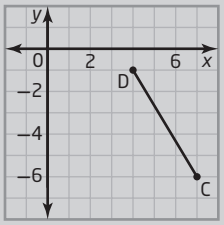
Warm-Up

1. Calculate the slope of each line segment.

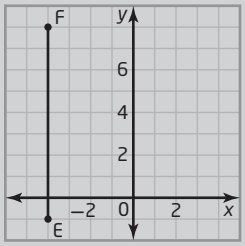
a)



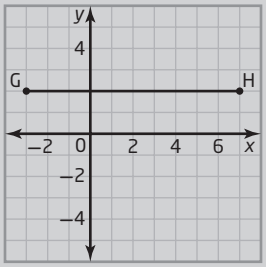
b)



c)



d)



Warm-Up Answers

1. a) rise $= 5 - 2$, or 3, run $= 7 - 3$, or 4, slope $= \frac{3}{4}$

b) rise $= -6 - (-1)$, or -5, run $= 9 - 4$, or 5, slope $= -\frac{5}{5}$, or -1

c) rise $= 8 - (-1)$, or 9, run $= -4 - (-4)$, or 0, slope $= \frac{9}{0}$ or undefined

d) rise $= 2 - 2$, or 0, run $= 7 - (-4)$, or 10, slope $= \frac{0}{10}$, or 0

Teaching Suggestions

- Read the opening paragraph aloud, and have a short class discussion on the meaning of rate of change. Some examples include: speed, temperature change per hour, and change in volume of gasoline per kilometre travelled. (5 min)

Common Errors

- Some students may divide by the *x*-value instead of the change in *x*.

R_x Remind students that, since it is a rate of *change*, both the numerator and denominator need to represent change.

- Some students may invert the slope/rate of change formula

R_x Discuss the meaning of the term *per* and how it is frequently represented by a slash, meaning, "divided by."

Ongoing Assessment

- Use Achievement Check question 18 to monitor student success. See Achievement Check Answers and **BLM 5.4.2 Achievement Check Rubric**.
- Chapter Problem question 9 also can be used as an assessment tool.
- Communicate Your Understanding questions can be used as quizzes to assess students' Communication skills.

Accommodations

Visual—Allow students to work in groups to complete specific questions in this section and do group presentations of their solutions to their classmates.

Perceptual—Encourage students to use visual cues to relate rate of change to the slope of a line.

Memory—Encourage students to use cue cards to remember the formulas for slope and rate of change.

- Have students work with a partner or in small groups on the Investigate. You may wish to use **BLM A12 Group Work Assessment Rubric** to assist you in assessing your students. Extend the earlier discussion on rate of change to include slope of a graph. (5 min)
- Discuss Examples 1 and 2, or similar examples that show multiple representations of rates of change and slope, numerically, graphically, verbally, and with the slope formula. Stress to students that, although most rates of change are relative to time, this is not always the case. (15 min)
- Discuss Communicate Your Understanding C1 and C2. Question C2 will provide a good indicator of a student's level of understanding of rates of change. (15 min)
- If students will be using technology for the graphing in this section, you may wish to use **BLM T6 *Fathom*™** and/or refer them to the Technology Appendix in their textbook to support these activities.
- Assign and take up Practise questions 1 to 5. (15 min)
- You may wish to use **BLM 5.4.1 Practice: Slope as a Rate of Change** for remediation or extra practice.

Investigate Answers (page 264)

1. The distance travelled by the person or animal in a given time.

2. sprinter 10.2, polar bear 11.1, alligator 15.5, cyclist 16.5, cheetah 31.1

3. sprinter 10.2 m/s, polar bear 11.1 m/s, alligator 15.5 m/s, cyclist 16.5 m/s, cheetah 31.1 m/s

4. The slope represents the rate of change. The greater, or faster, a rate of change is, the steeper the graph of the relation will be.

Communicate Your Understanding Responses (page 267)

C1. He divided the run by the rise ($5 \div 400$). He should have divided the rise by the run ($400 \div 5$).

C2. a) C **b)** A **c)** D **d)** B

Practise

The Practise questions are straightforward and consolidate the examples. Students may have difficulties using appropriate words in their interpretations.

Connect and Apply

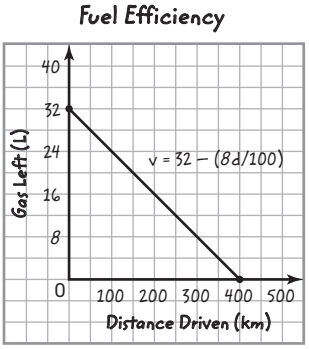
The questions provide interesting contexts for rate of change and are accessible to most students. Question 8 should provide some interesting discussion. Level 4 students may convert to a percent rate of change before discussing whether it was a popular piece of software.

Question 9 refers to the Chapter Problem. You may wish to assign this problem, but not take it up until the end of the chapter.

Students may find question 18 challenging because the rate is per 100 km, rather than a unit rate. Question 18, the Achievement Check, is a good communication question. You may wish to use **BLM G10 Grid Paper** for these activities.

Achievement Check Answers (page 271)

18. a)



Distance (km)	0	100	200	300	400
Volume of Gasoline Remaining (L)	32	24	16	8	0

b) slope $= \frac{\text{rise}}{\text{run}}$

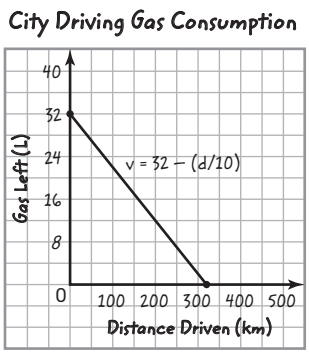
$= \frac{-8}{100}$

$= -0.08$

This means that Kim's car uses 0.08 L of gas for each 1 km driven on the highway. The negative sign means that there is less gas in the fuel tank.

c) Since Kim's car uses 25% more gas in city driving, it will use 25% of 8 L, or 2 L more for each 100 km driven in the city.

Distance (km)	0	100	200	300	320
Volume of Gasoline Remaining (L)	32	22	12	2	0



slope $= \frac{\text{rise}}{\text{run}}$

$= \frac{-10}{100}$

$= -0.10$

This means that Kim's car uses 0.10 L of gas for each 1 km driven on the highway. Again, the negative sign means that there is less gas in the fuel tank.

Extend

Question 19 is a challenging problem as it uses percent change. This creates a non-linear (exponential) graph. Encourage students to explore other graphs created through percent decline or growth.

Question 20 shows different rates of change in a piecewise graph.

Exercise Guide

Category	Question Number
Minimum (essential questions for all students to cover the expectations)	1–8
Typical	1–8, 10, 13–16
Extension	19, 20