Name _____

Date _____

Linear Functions: Slope as Rate of Change   Student Worksheet

Overview

The **Overview** introduces the topics covered in **Observations** and **Activities**. Scroll through the **Overview** using ▶ (◀ to review, if necessary). Read each screen carefully. Look for new terms, definitions, and concepts.

Observations

The **Observations** illustrate mathematical concepts relating to finding the slope using graph coordinates. Scroll through the **Observations** using ▶ (◀ to review, if necessary). Read each screen carefully. When you come to a **Write an Observation** screen, stop and write the answers to the questions on your worksheet.

What kinds of graphs have a nonconstant rate of change?

_____

_____

_____

Activities

The **Activities** section helps you practice finding a slope as rate of change. You can select from two activities—**Balloon Speed** or **Dive**. Follow these steps to play the activity and complete your worksheet.

1. Make sure you are in the **Activities** for this section.

2. Highlight an activity using ▲ or ▼, and press ENTER.

Scoring: You get two attempts to solve each problem. You earn 2 points for a correct answer on the first try, 1 point for a correct answer on the second try.

You can earn up to 10 points.

Balloon Speed

1. Highlight a level (bronze = least difficult; gold = most difficult), and press ENTER to select it.

2. Select whether you want to play during **Nighttime** or **Daytime**.

3. Take a trip in the balloon. Record the times and positions in the table.

4. Calculate the rate of change (the slope) of each trip, showing all work, including the correct units. Enter the rate and press ENTER. If the answer is incorrect, the correct answer is displayed; press any key to resume play.

5. What level did you play? _____

6. What was your score? _____

Trip	Start Time	Start Position	Stop Time	Stop Position	Speed (include units)
1					
2					
3					
4					
5					

Name _____

Date _____

Activities (continued)

```
┌─────────────────────┐
│ SELECT AN ACTIVITY  │
│ ┌1┐  FIND THE CONSTANT│
│ ┌2┐  RATE OF CHANGE  │
│      OF THE SUBMARINE│
│      ON EACH SEGMENT │
│    ┌DIVE!┐   🚢      │
│ SELECT & PRESS [ENTER] ✛│
└─────────────────────┘
```

Scoring: You get one attempt to select the correct row. If you select an incorrect row, the correct row is identified.

Dive

1. Take a dive in the submarine. Record the times and positions in the table below.

2. Calculate the rate of change (slope) of each segment in the table below. Show all your work. Include the correct units.

3. After the third segment, the next screen displays three rows of three rates. Use your rate answers from the table to determine the correct row. To select a row, press ▾ or ▴ to move the submarine cursor, and then press [ENTER].

4. Did you select the correct row? _____

Segment	Start Time	Start Position	Stop Time	Stop Position	Speed (include units)
1					
2					
3					

Car Trip Word Problem

A car takes a 20-minute trip. The car starts at home, (0,0). It travels 6 miles in 10 minutes. The car stops in traffic for 5 minutes. The driver forgot something at home so the car returns in 5 minutes. Draw a straight-line graph of the trip. Write the rate of change for each leg of the trip on the graph to the right.

```
MI ┤ ·  ·  ·  ·  ·
   │ ·  ·  ·  ·  ·
 8 ┤ ·  ·  ·  ·  ·
   │ ·  ·  ·  ·  ·
 2 ┤ ·  ·  ·  ·  ·
   └─┼──┼──┼──┼──
     5  10 15  MIN
```
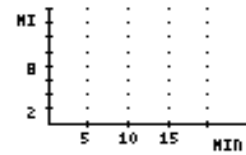
🖩 Try-It!™ on Your TI‑83 Plus

See the section on *Slope Using Coordinates* to find out how to use your graphing calculator to find the slope of a line containing two given points. Review the keystrokes. Use these keystrokes to compute the rate of change for each pair of data points given. Include the correct units with your answer.

1.

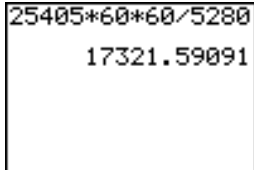| x (seconds)	y (feet)
10	6.72
20	8.05

2.

x (hour)	y (phone calls)
2	18
4	25

Rate of Change _____

Rate of Change _____

3. A space shuttle has an average velocity of 25,405 ft/sec. The velocity of a car on a highway can be 60 mi/hr. To find out how many times faster the space shuttle travels compared to the car, you must convert the speed of the space shuttle to miles per hour. First, look at the conversion by hand, and then do it on the graphing calculator. When set to **Float**, the graphing calculator shows the answer to five decimal places.

$$25{,}405\,\frac{\text{ft}}{\text{sec}} \times \frac{60\text{ sec}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{1\text{ mi}}{5280\text{ ft}} = 17321.59091\,\frac{\text{mi}}{\text{hr}}$$

To Do This	Press	Display (TI-83 Plus shown)
1. If necessary, exit the Topics in Algebra 1 application and clear the Home screen.	[2nd] [QUIT] ⟨**EXIT**⟩ [CLEAR]	
2. Calculate 25,405 × 60 × 60 / 5,280.	**25405**[×]**60**[×]**60**[÷] **5280**[ENTER]	```25405*60*60/5280
17321.59091```

3. How many times faster does the space shuttle travel compared to the car? _____

Additional Problems

Try these by hand, and show your work below. Then check the answers on your graphing calculator.

5280 feet = 1 mile   1000 meters = 1 kilometer
60 seconds = 1 minute   60 minutes = 1 hour

1. 55 miles/hour → feet/second

2. 35 meters/second → kilometers/hour

Name _____

Date _____

▦ Try-It!™ on Your TI‑73

See the section on *Slope Using Coordinates* to find out how to use your graphing calculator to find the slope of a line containing two given points. Review the keystrokes. Use these keystrokes to compute the rate of change for each pair of data points given. Include the correct units with your answer.

1.

x (seconds)	y (feet)
10	6.72
20	8.05

2.

x (hour)	y (phone calls)
2	18
4	25

Rate of Change _____

Rate of Change _____

3. A space shuttle has an average velocity of 25,405 ft/sec. The velocity of a car on a highway can be 60 mi/hr. To find out how many times faster the space shuttle travels compared to the car, you must convert the speed of the space shuttle to miles per hour. First, look at the conversion by hand, and then do it on the graphing calculator. When set to **Float**, the graphing calculator shows the answer to five decimal places.

$$25{,}405 \, \frac{\text{ft}}{\text{sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{1 \text{ mi}}{5280 \text{ ft}} = 17321.59091 \, \frac{\text{mi}}{\text{hr}}$$

To Do This	Press	Display (TI-73 shown)
1. Exit the Topics in Algebra 1 application and clear the Home Screen.	[2nd] [QUIT] ⟨**EXIT**⟩ [CLEAR]	
2. Enter the velocity, 25,405 on the Home Screen.	**25405**	25405
3. Open the **CONVERSIONS** menu, and select the category, **Speed**.	[2nd] [CONVERT] **7:Speed**	CONVERSIONS 1:Length… 2:Area… 3:Volume… 4:Time… 5:Temp… 6:Mass/Weight… 7Speed…
4. Select the units you are converting *from*, **ft/sec**.	**1:ft/sec**	SPEED ft/s▸ 1ft/s 2:m/s 3:mi/hr 4:km/hr 5:knot
5. Select the units you are converting *to*, **mi/hr**. 25,405 ft/s rounded to tenths is **17321.6 mi/hr**.	**3:mi/hr** [ENTER]	25405 ft/s▸mi/hr 17321.59091

How many times faster does the space shuttle travel compared to the car? _____

▦ Try-It!™ on Your TI-73 (continued)

Additional Problems

Try these by hand, and show your work below. Then check the answers on your graphing calculator.

5280 feet = 1 mile	1000 meters = 1 kilometer
60 seconds = 1 minute	60 minutes = 1 hour

1. 55 miles/hour → feet/second

2. 35 meters/second → kilometers/hour

Linear Functions: Slope as Rate of Change   Teacher Notes

Objectives

- To associate the slope of a straight line with a constant rate of change.

- To calculate the rate of change from data points on a line, using the correct units.

- To read from a linear graph: the rate of change, the scale of the axes, and the correct units.

Math Highlights

This section highlights the use of the slope formula to find the rate of change from graphs and data. Students may need to review the slope formula; see previous sections on the graphing calculator.

$$\text{rate of change} = m = \frac{y_2 - y_1}{x_2 - x_1} \text{ units}$$

Emphasize the use of appropriate units. For example, in the **Fill the Pool** example in the **Overview**, the students see a pool filling at a constant rate of change. Two data points from the growth graph or table shown are (4,2) and (6,3). To find the slope, students should calculate:

$$\text{rate of change} = m = \frac{3-2}{6-4}\frac{\text{ft}}{\text{hr}} = \frac{1}{2}\frac{\text{ft}}{\text{hr}} = .5\frac{\text{ft}}{\text{hr}}$$

Mention to students that if the graph of a real problem were nonlinear, the calculation of the rate of change using two data points gives the *average* rate of change over the interval chosen.

Common Student Errors

- Neglecting to write the appropriate units.

- Misunderstanding how to use the *position* with respect to a starting place rather than distance. In the slope formula, $y_2 - y_1$ gives the *signed distance* traveled.

- Specifying which point is (x_1, y_1) and which point is (x_2, y_2). Show students that both calculations give the same answer. Some students are confused when they see a division by two negative numbers that results in a positive growth. Discuss this with the students. Watch for an incorrect substitution where students switch the order in the numerator or denominator. For example, if the data points (0,0) and (10,2) give the growth of a plant in cm per day, the rate of change is calculated:

Correct: $\dfrac{2-0}{10-0}\dfrac{\text{cm}}{\text{day}} = \dfrac{1}{5}\dfrac{\text{cm}}{\text{day}}$ *or* $\dfrac{0-2}{0-10}\dfrac{\text{cm}}{\text{day}} = \dfrac{^-1}{^-5}\dfrac{\text{cm}}{\text{day}}$

Incorrect: $\dfrac{0-2}{10-0}\dfrac{\text{cm}}{\text{day}}$

- Students need to be exposed to other variables besides x and y. For example, it is useful to use t for time and d for distance.

Student Worksheet Notes with Answers

Overview

Tell students:

1. How to find the **Overview** or tell them to review the instructions on the worksheet.

2. How to navigate the application, if they are not yet familiar with the application.

3. To scroll through the **Overview** on the graphing calculator. Point out new terms, definitions, and concepts, and tell students to look for them as they go through the **Overview**.

Observations

The **Observations** help students understand mathematical concepts relating to finding the slope using graph coordinates.

If necessary, tell students how to find the **Observations** for this section.
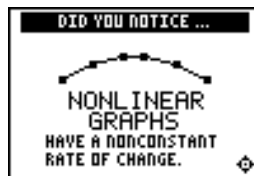
Observation 1

What kinds of graphs have a nonconstant rate of change?
Students write their answer on their worksheet.

Nonlinear graphs have a nonconstant rate of change.

Students see the answer
on the screen at the right.

Activities

Balloon Speed

Tell students to:

1. Highlight a level (bronze = least difficult; gold = most difficult), and press ENTER to select it.

2. Select whether they want to play during **Nighttime** or **Daytime**.

3. Take a trip in the balloon. Record the times and positions in the table.

4. Calculate the rate of change (the slope) of each trip, showing all work, including the correct units. Enter the rate and press ENTER. If the answer is incorrect, the correct answer is displayed; press any key to resume play.

5. Record the level they played.

6. Record their score.

Scoring: Students get two attempts to solve each problem. They earn 2 points for a correct answer on the first try, 1 point for a correct answer on the second try.

Students can earn up to 10 points.

Dive

Tell students to:

1. Take a dive in the submarine. Record the times and positions in the table below.

2. Calculate the rate of change (slope) of each segment in the table on the worksheet, showing all their work, including the correct units.

3. After the third segment, the next screen displays three rows of three rates. Students use their rate answers from the table to determine the correct row. To select a row, press ▾ or ▴ to move the submarine cursor, and then press ENTER.

4. Record whether they selected the correct row.

Scoring: You get one attempt to select the correct row. If you select an incorrect row, the correct row is identified.

Activities (continued)

Car Trip Word Problem

Distance	Rate
(0,0) to (10,6)	.6 mi/min
(10,6) to (15,6)	0 mi/min
(15,6) to (20,0)	-1.2 mi/min
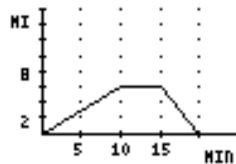
Notice that the rate is positive going away from home. The rate is negative on the return part of the trip indicating the direction of going back home.

▦ Try-It!™ on Your TI-83 Plus or TI-73

Note: There is a ▦ Try-It for the TI-83 Plus and one for the TI-73; they are on separate pages.

Students review using the graphing calculator to compute the slope of a line containing two points. They also see how to use the graphing calculator to do conversions. The TI-73 has conversion functionality whereas users of the TI-83 Plus have to know how to set up the conversion. See the Student Worksheet for instructions.

1. *0.133 ft per sec*

2. *3.5 phone calls per hour*

Have students discuss the meaning of the rates and their choice of representation. For example, is 3.5 phone calls per hour the most meaningful way of communicating the rate of change or is 7 phone calls every two hours a better way of describing the rate? Have students justify their reasoning.

3. (TI-83 Plus) or 6. (TI-73)
The space shuttle travels 288.7 times faster than a car (17321.59091 m∕hr ÷ 60 mi∕hr).

Graphing Calculator Problems

Tell students to follow the steps exactly on the graphing calculators. Example screens are displayed on the worksheets for students to compare with the graphing calculator screens.

Additional Problems

Students work problems by hand and check on graphing calculator.

1. $80\frac{2}{3}\ \frac{ft}{sec} = 80.\overline{6}\ \frac{ft}{sec}$

2. $126\ \frac{km}{hr}$