1. Do you think a car will roll farther when the ramp is set up on a higher step? Explain why you think so.

Jackie and Derrick did an experiment to find out how far a car rolled when the ramp was put on steps of different heights. First, they talked about how to be sure that the experiment was fair. Derrick suggested that the starting line on the ramp should stay the same.

2. What other variables should not change during the experiment? Why?
3. Jackie's neighbor said they should keep the height of the ramp the same for the entire experiment and that the distance traveled (D) should be measured from the bottom of the ramp to the back wheels of the car. Do you agree? Why or why not?
4. Jackie and Derrick decided to run three trials for each different height. Why was this a good idea?
5. On the first trial, Jackie determined the car traveled past one meter and stopped at 24 cm on the second meterstick. How many meters did the car travel?

Use the TIMS Laboratory Method to design and do an experiment like Jackie and Derrick's. Use a car, a ramp, and some blocks or books to study the relationship between the height of the ramp (*H*) and the distance your car will roll on the ground (*D*). Use blocks or books to change the height of the ramp. The height (*H*) is the height of the blocks (or books).

6. What is the manipulated variable?
7. What is the responding variable?

8. **A.** Draw a picture of the lab. Be sure to show the two main variables, Height (*H*) and Distance (*D*), and identify other variables that should not change.

   B. Write a paragraph that describes any special or specific setup notes so that later you can set up the experiment again in exactly the same way. (Hint: Look at your answer to Question 2 and your picture.) You will make and check predictions about how far your car rolls. Unless you are careful now, you may not be able to check your predictions later.

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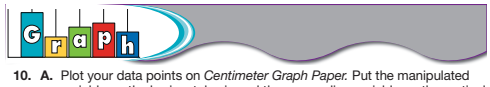
9. **A.** Work with your group to collect data for the experiment you designed.
   - Discuss what values you will use for the height (*H*).
   - Measure the height in centimeters.
   - Measure the distance (*D*) the car rolls to the nearest hundredth of a meter. Use decimals to record your measurements of this distance.
   - Do three trials for each height. Average the three distances for each height by finding the median distance.
   - Keep track of your data on the *Downhill Racer Data Table* from the *Student Activity Book*. Use the Ramp Height and the Average Distance Rolled for the ordered pairs.

Ramp Height vs. Distance Rolled

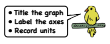
H Ramp Height (in cm)	*D* Distance Rolled (in m)				Ordered Pairs (H, D)
	Trial 1	Trial 2	Trial 3	Average	

   B. Why is it a good idea to find the average distance?



10. **A.** Plot your data points on *Centimeter Graph Paper.* Put the manipulated variable on the horizontal axis and the responding variable on the vertical axis. Before you scale your axes, discuss with your group how much room you need on your graph for extrapolation. (Hint: Look at Questions 11–14.)

    B. Look at your points on the graph. Do the points lie close to a straight line? If so, use a ruler to draw a best-fit line. Extend the line in both directions.



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Questions 1–21 (SG pp. 475–479)

1. Answers will vary.
2.* See the list of fixed variables in Lesson 5 (car, ramp surface, floor surface, starting line, measuring points, etc.).
3. Responses will vary, but students should not agree with this method as no variable is being changed.
4. Three or more trials for each height is a good idea since experimental and measurement errors as well as mistakes are inevitable. Gross errors can be checked. If the distance for one trial is very different from the other trials, that data should be thrown out and the trial should be repeated.
5.* 1.24 m
6.* the height (*H*) of the ramp
7.* the distance (*D*) the car rolls
8. **A.*** Pictures will vary.

   B.* Answers will vary, but paragraphs should include all the variables students hold fixed in order to make the experiment fair. For example, each group should describe the car they use, the starting line on their ramp, etc.
9. **A.*** See Figure 5 in Lesson 5.

   B.* It is a good idea to find the average distance to average out any experimental and measurement error.
10.* See Figure 6 in Lesson 5.

***Answers and/or discussion are included in the lesson.**

Answers to ***Questions 11–15*** are based on the sample data and graph in Figures 5 and 6 of Lesson 5. Students' answers will vary based on their data.

11. A. Predicted $D = 3.15$ m

B. interpolate

C. Answers will vary.

D.* Answers will vary.

12. A. 5 m

B. extrapolate

C. Answers will vary.

D.* Answers will vary.

13. A. 5 cm. Find 1.5 m on the vertical axis of the graph; draw a line horizontally until it reaches the best-fit line; draw a vertical line down until it reaches the horizontal axis. The point (5 cm) at which the vertical line touches the horizontal axis is the predicted height of the ramp.

B.* Answers will vary.

14. A. Yes

B. Yes

C. The distance increases.

15.* Line A; Possible response: If the starting point were lower on the ramp, the car would not travel as far and the line would not be as steep as the line for the experiment.

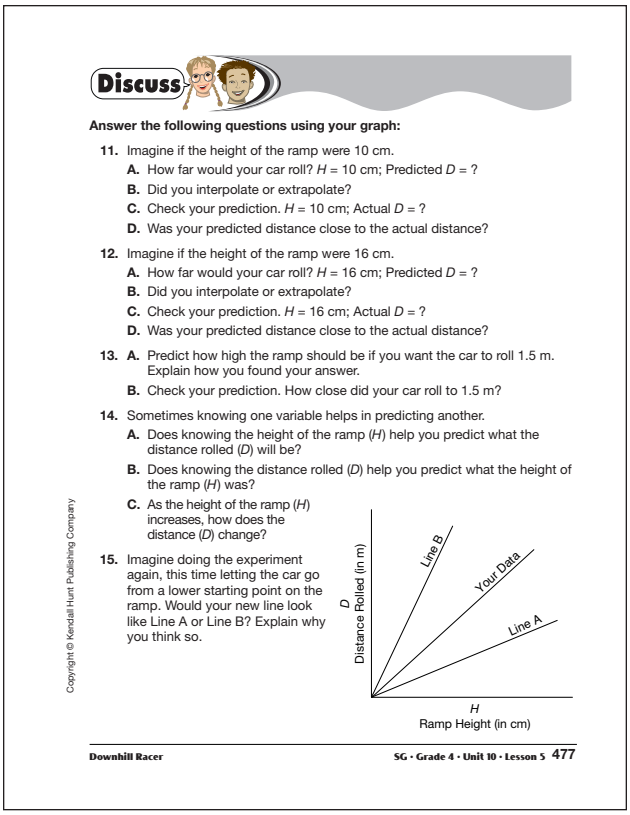
16. A.* Starting Distance (*S*)

B.* Distance the car rolls (*D*)

C.* Height of the ramp, car

D.* numerical

17. 84 cm



Discuss

Answer the following questions using your graph:

11. Imagine if the height of the ramp were 10 cm.
- **A.** How far would your car roll? $H = 10$ cm; Predicted D = ?
- **B.** Did you interpolate or extrapolate?
- **C.** Check your prediction. $H = 10$ cm; Actual D = ?
- **D.** Was your predicted distance close to the actual distance?

12. Imagine if the height of the ramp were 16 cm.
- **A.** How far would your car roll? $H = 16$ cm; Predicted D = ?
- **B.** Did you interpolate or extrapolate?
- **C.** Check your prediction. $H = 16$ cm; Actual D = ?
- **D.** Was your predicted distance close to the actual distance?

13. A. Predict how high the ramp should be if you want the car to roll 1.5 m. Explain how you found your answer.

B. Check your prediction. How close did your car roll to 1.5 m?

14. Sometimes knowing one variable helps in predicting another.
- **A.** Does knowing the height of the ramp (*H*) help you predict what the distance rolled (*D*) will be?
- **B.** Does knowing the distance rolled (*D*) help you predict what the height of the ramp (*H*) was?
- **C.** As the height of the ramp (*H*) increases, how does the distance (*D*) change?

15. Imagine doing the experiment again, this time letting the car go from a lower starting point on the ramp. Would your new line look like Line A or Line B? Explain why you think so.

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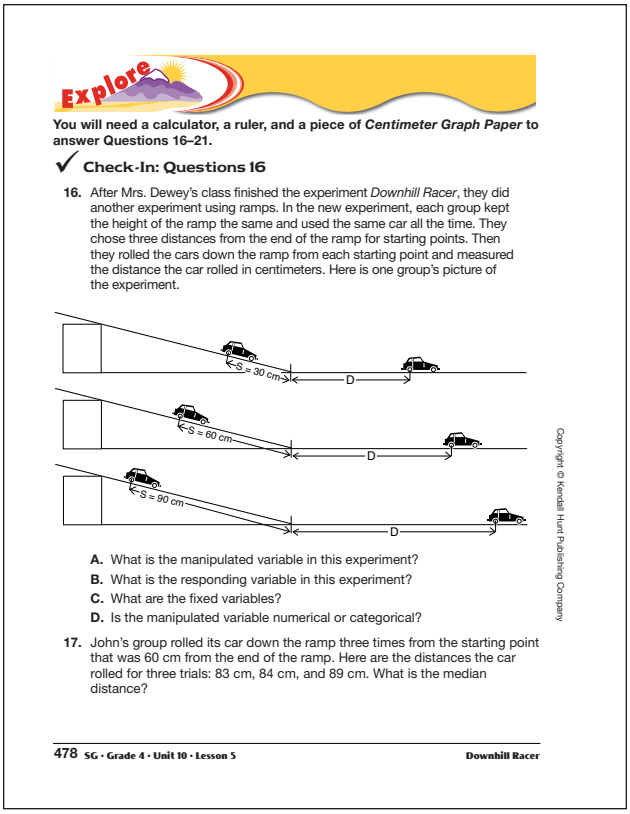

Explore

You will need a calculator, a ruler, and a piece of *Centimeter Graph Paper* to answer Questions 16–21.

✓ **Check-In: Questions 16**

16. After Mrs. Dewey's class finished the experiment *Downhill Racer*, they did another experiment using ramps. In the new experiment, each group kept the height of the ramp the same and used the same car all the time. They chose three distances from the end of the ramp for starting points. Then they rolled the cars down the ramp from each starting point and measured the distance the car rolled in centimeters. Here is one group's picture of the experiment.

- **A.** What is the manipulated variable in this experiment?
- **B.** What is the responding variable in this experiment?
- **C.** What are the fixed variables?
- **D.** Is the manipulated variable numerical or categorical?

17. John's group rolled its car down the ramp three times from the starting point that was 60 cm from the end of the ramp. Here are the distances the car rolled for three trials: 83 cm, 84 cm, and 89 cm. What is the median distance?

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***Answers and/or discussion are included in the lesson.**

18. Nila's group chose to do four trials. Here are the distances the car rolled from a starting point that was 120 cm from the end of the ramp: 189 cm, 177 cm, 186 cm, and 188 cm. What is the median distance?

19. Here is Shannon's data. Make a graph of the data on *Centimeter Graph Paper.*

Start Distance vs. Distance Rolled

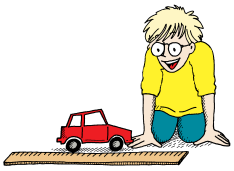
S Starting Distance From End of Ramp (in cm)	*D* Distance Rolled (in cm)				Ordered Pairs (H, D)
	Trial 1	Trial 2	Trial 3	Average	
30	48	47	47	47	(30, 47)
60	87	84	86	86	(60, 86)
90	144	142	145	144	(90, 144)

20. **A.** Use your graph to predict the distance the car will roll if Shannon uses the same lab setup and she starts to roll the car down the ramp 45 cm from the end of the ramp. Show your thinking on your graph.

B. Did you use interpolation or extrapolation to find your answer?

21. **A.** Use your graph to predict the distance the car will roll if Shannon uses the same lab setup and she starts to roll the car down the ramp 120 cm from the end of the ramp. Show your thinking on your graph.

B. Did you use interpolation or extrapolation to find your answer?



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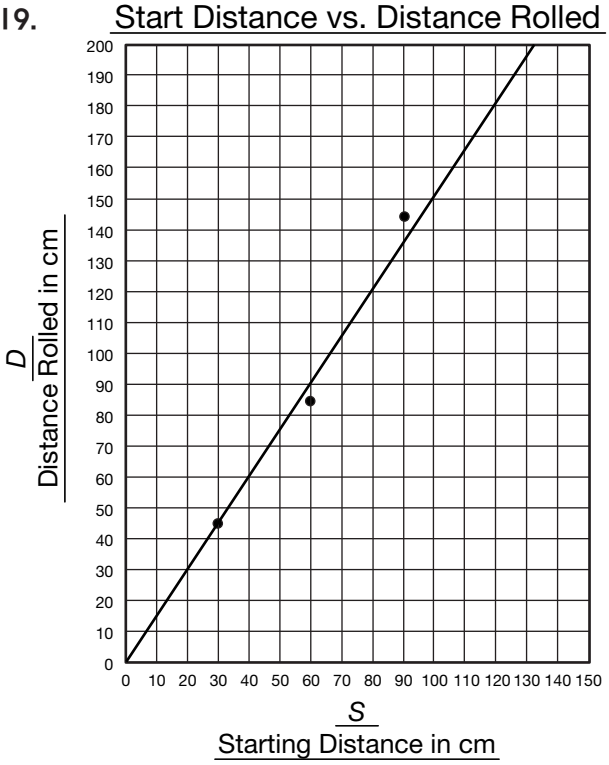
18. 187 cm

19.



20. A. About 70 cm. (Answers may vary slightly due to differences in best-fit lines and scales.)

B. interpolation

21. A. About 180 cm. (Answers may vary somewhat due to differences in best-fit lines and scales.)

B. extrapolation

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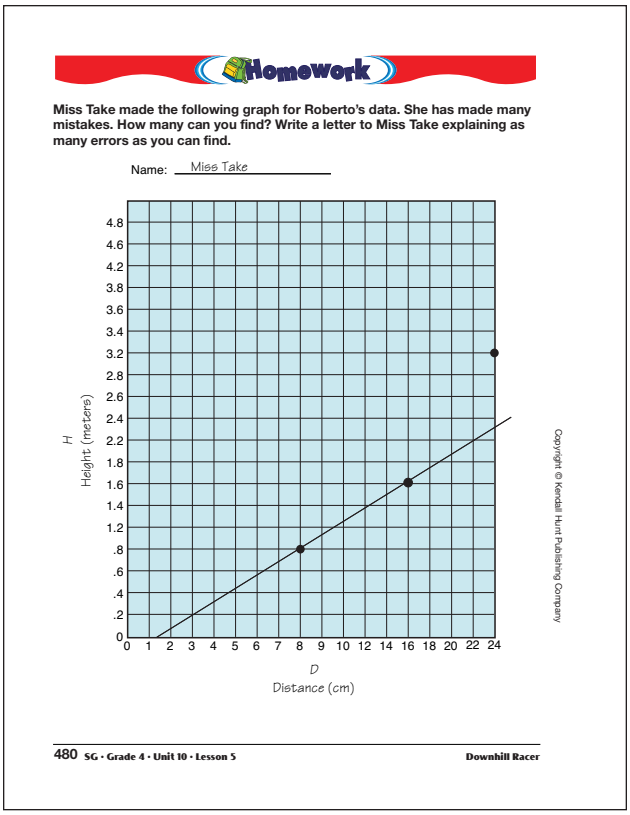
Homework (SG p. 480)

Student paragraphs should include descriptions of the following mistakes:

- The horizontal axis should be labeled with Height (H), not Distance (D).
- The vertical axis should be labeled with Distance (D).
- Height was measured in cm, distance was measure in meters.
- There is no title.
- The points from Roberto's data are plotted incorrectly.
- The best-fit line is incorrect. It should take into account the point for $H = 24$ cm. The line should go above the two lower points and below the third point.
- The best-fit line should go through the point (0, 0). At a height of 0, the car should go a distance of 0 cm.
- The horizontal axis is scaled by ones to 10, then is scaled by twos.
- The vertical axis scale is missing 1.0, 2.0, 3.0, 4.0, and 4.4.



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