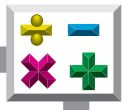


Lesson Four Purpose

- Understand and explain the effects of addition, subtraction, multiplication, and division on real numbers, including square roots, exponents, and appropriate inverse relationships. (MA.A.3.4.1)
- Add, subtract, multiply, and divide real numbers, including square roots and exponents, using appropriate methods of computing, such as mental mathematics, paper and pencil, and calculator. (MA.A.3.4.3)
- Use concrete and graphic models to derive formulas for finding rate, distance, time, and angle measures. (MA.B.1.4.2)
- Solve real-world problems involving rated measures (miles per hour, feet per second). (MA.B.2.4.2)
- Describe, analyze, and generalize relationships, patterns, and functions using words, symbols, variables, tables, and graphs. (MA.D.1.4.1)
- Interpret data that has been collected, organized, and displayed in charts, tables, and plots. (MA.E.1.4.1)
- Design and perform real-world statistical experiments, then analyze results and report findings. (MA.E.3.4.1)

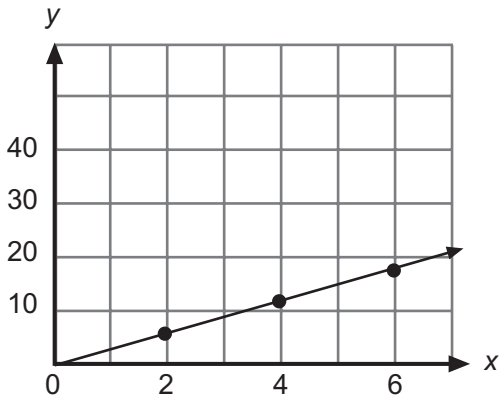
Graphing to Interpret Relationships

Equations:

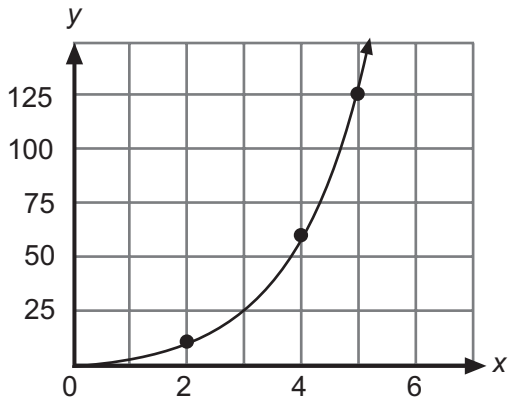
- can be simple or complex
- can have one *variable* or many
- can have one **solution** or many
- can be graphed
- can be solved in different ways.

A graph is a drawing used to represent data. A graph can be a picture of an equation. The graphs of some equations are straight lines. Equations whose graphs are straight lines are called **linear equations**.

Graphs of other equations can be curves or other shapes. Equations whose graphs are not straight lines but are curves or other shapes are called **nonlinear equations**.



linear equation



nonlinear equation

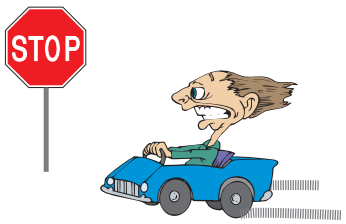
Practice

Consider the following.

The *speed* at which you are driving *impacts the stopping distance*. Therefore, *reaction distance*, as well as the *braking distance*, must be considered when determining stopping distance.

Given a certain speed, over an hour

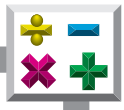
- the reaction distance is s
- the braking distance is $\frac{s^2}{20}$, and
- the stopping distance is $s + \left(\frac{s^2}{20}\right)$.



Complete the following table.

1. **Reaction, Braking, and Stopping Distances after One Hour**

Speed (in mph)	Reaction Distance (in feet) s	Braking Distance (in feet) $\frac{s^2}{20}$	Stopping Distance (in feet) $s + \frac{s^2}{20}$
10	10		
15			26.25
20		20	
25			
30			75
35	35		
40			
45		125	
50			
55			
60			
65			
70			
75			



Refer to your answers in the **table in number 1** *to answer numbers 2-5.*

2. If the typical car length is 15 feet, how many car lengths are represented in the stopping distance at a speed of

   30 mph? _____

   40 mph? _____

   60 mph? _____

   70 mph? _____

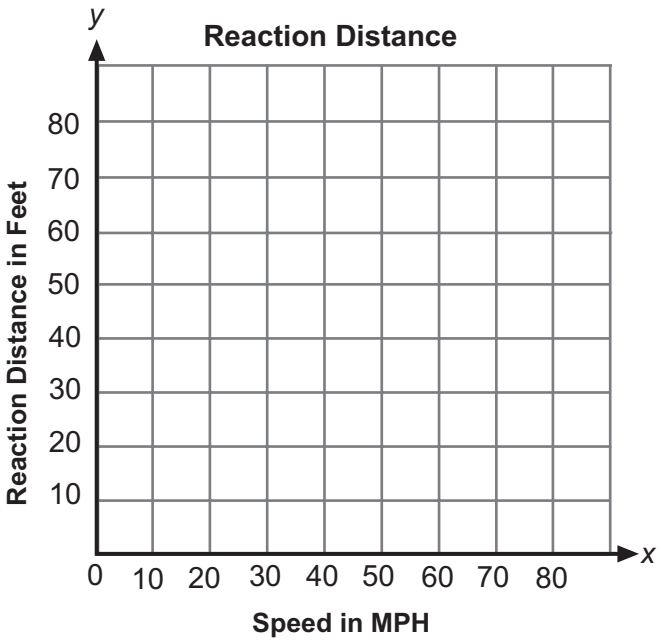
3. As the speed increases by 10, the *reaction distance* _____ (does, does not) increase by a constant amount.

4. As the speed increases by 10, the *braking distance* _____ (does, does not) increase by a constant amount.

5. As the speed increases by 10, the *stopping distance* _____ (does, does not) increase by a constant amount.

Graph the **data in the table in number 1** *on the grids below.*

6.



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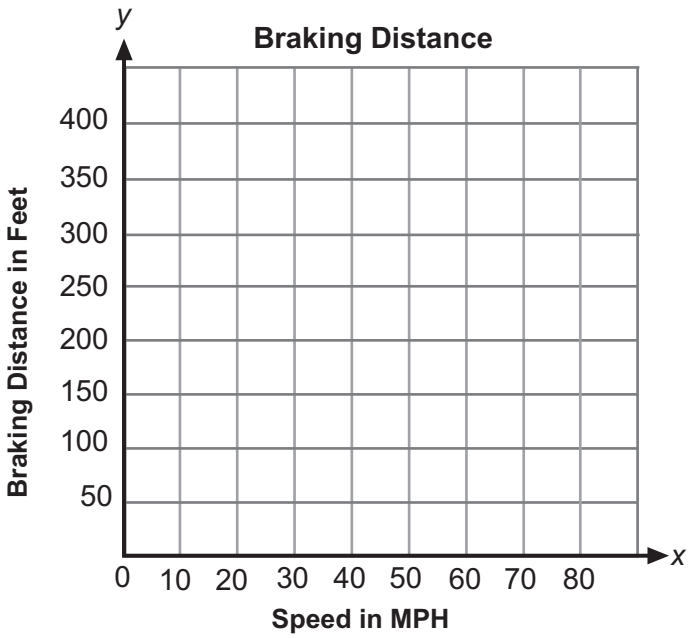

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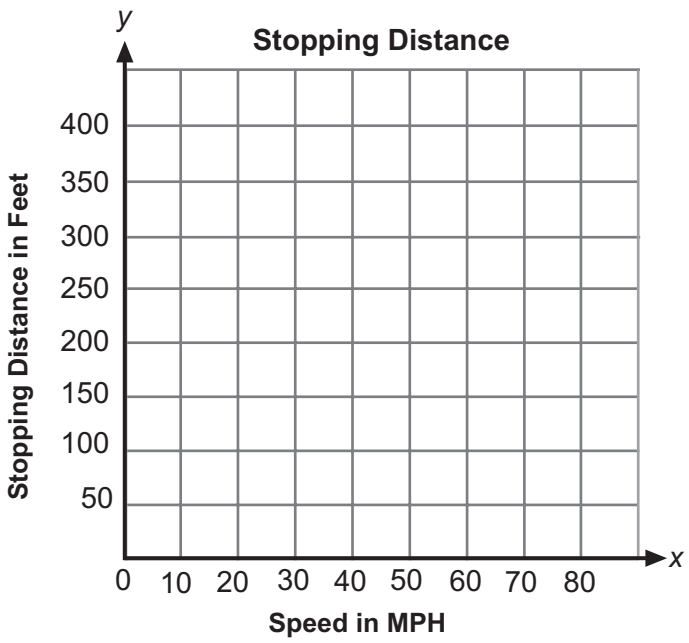

9. Which of the graphs appear to be linear?

_____

Explain why this is true. _____

_____

_____

10. Which of the graphs appear *not* to be linear?

_____

Explain why this is true. _____

_____

_____

Think about This!

If a graphing calculator was used to produce the table and graphs produced in questions 1 and 4, the following equations would be entered as follows:

a. $y_1 = x$

b. $y_2 = \frac{x^2}{20}$

c. $y_3 = \frac{x^2}{20} + x$

- The first equation indicates that y and x have the same values.

  When the speed is 10 mph, the reaction distance is 10 feet. When the speed is 50 mph, the reaction distance is 50 feet.

- All values that make the equation true lie on a straight line that passes through the origin (0, 0).

  The variable, x, is to the first power. As x increases by 10, y increases by 10, so the rate of increase is constant.

- The variable, x, in the second equation is raised to the second power.

  The values for x and y that make the equation true do *not* lie in a straight line. As x increases by 10, the amount of increase in y varies. The amount of increase is *not* constant.

When we see all three graphs on the same coordinate grid, we see that equation **a** yields a line and that equations **b** and **c** yield curves. The curve for equation **c** lies above the one for equation **b**.

11. Explain why this occurs.

_____

_____

_____

Practice

Answer the following.

In May 2003, a *USA Today* newspaper featured a story on Allyson Felix, a 17-year-old high school student from North Hills, California. She was described as having "jaw-dropping natural athleticism, uncommon work ethic, and laser focus." Her father was quoted as saying, "Allyson puts herself into what she *wants* to put herself into. I'd love to see her put herself into cleaning her room. It's a disaster." The article also noted that she was 5'6" tall.

At the time of the article, she was the fastest woman in the world in the 200-meter race. At a meet with world-class sprinters in Mexico City, she set a time of 22.11 seconds for 200 meters.

1. What was her rate in meters per second (mps) **rounded to the nearest hundredth of a meter**? _____ mps

2. Place some **meter sticks** end to end or **measure and mark** a convenient **distance in meters**. Then determine **your rate** when **walking** and when **running**.

   your walking rate: _____ mps

   your running rate: _____ mps

3. Florence Griffith Joyner set the world record in the 1988 Olympics, which was still standing at the time this problem was written in 2003. She ran 200 meters in 21.34 seconds.

   What was her rate in meters per second **rounded to the nearest hundredth of a meter**? _____ mps

4. Write a sentence comparing the rates of Felix and Joyner.

   _____

   _____

Practice

Answer the following.

An article in *USA Today* on February 23, 2004 reported the results of their analysis of 1.2 million speeding tickets issued in 2002 on interstate highways in 18 states.

Use the following **data from zones** *where* **speed limit was 65 mph** *to respond to answer number 1 on the following page.*

Percent of Tickets in 65 MPH Zones on Interstate Highways in 18 States in 2002

Speed Limit	Speed When Ticketed in 2002	Percentage of Tickets
65 mph	Up to 69 mph	0%
65 mph	Up to 74 mph	2%
65 mph	Up to 79 mph	25%
65 mph	Up to 84 mph	73%
65 mph	Up to 89 mph	93%
65 mph	Up to 94 mph	98%

1. a. Few, if any, tickets were written when speed exceeded the limit by 1 to _____ mph.

   b. _____ % of the tickets were written for speeds exceeding the limit by 5 to 9 mph.

   c. 23% of the tickets were written for speeds exceeding the limit by 10 to _____ mph.

   Note: Although 25% of the tickets were written for speed limits up to 79 mph, you must subtract 2% to take out the tickets *already* written for speed limits up to 74 mph.

   d. _____ % of the tickets were written for speeds exceeding the limit by 15 to 19 mph.

   e. True *or* not enough information given to answer:

   No tickets were written for speeds exceeding the limit by 30 mph or more. _____

Use the following **data** *from the* **analysis** *to answer number 2.*

Percent of Tickets in 75 MPH Zones on Interstate Highways in 18 States in 2002

Speed Limit	Speed When Ticketed in 2002	Percentage of Tickets
75 mph	Up to 79 mph	0%
75 mph	Up to 84 mph	18%
75 mph	Up to 89 mph	71%
75 mph	Up to 94 mph	91%
75 mph	Up to 99 mph	97%

2. a. For each 100 tickets written, _____ went to drivers exceeding the limit by 5 to 9 mph.

b. For each 100 tickets written, _____ went to drivers exceeding the limit by 10 to 14 mph.

c. For each 100 tickets written, 20 went to drivers exceeding the limit by _____ to _____ mph.

d. When the speed limit was 75 mph, the percentage of tickets written for drivers exceeding the limit by 5 to 9 mph was _____ (greater than, less than, the same as) the percentage under the same circumstances for a speed limit of 65 mph.

Use the following **data** *from the* **analysis** *to answer number 3.*

Percent of Tickets for Speeds of 100 MPH or Greater in 2000

Speed When Ticketed in 2002	Amount over the Speed Limit	Percentage of Tickets
100 mph or greater	25 mph over	14%
100 mph or greater	30 mph over	28%
100 mph or greater	35 mph over	49%
100 mph or greater	40 mph over	9%

3. a. Nearly half of these tickets went to drivers with speed exceeding the speed limit by _____ mph.

b. If the speed limit was 65 mph and a driver exceeded it by 40 mph, the driver's speed would be _____ mph.

c. If a driver exceeded the speed limit by 40 mph and the driver's speed was 115 mph, then the speed limit was _____ mph.

Use the following **data** *from the* **analysis** *to answer number 4.*

Percent of Tickets for Speeds of 80, 90, and 100 MPH or Greater in 1991 and 2002

Speed When Ticketed	Percentage of Tickets in 1991	Percentage of Tickets in 2002
80 mph or greater	20%	66%
90 mph or greater	2%	10%
100 mph or greater	0.3%	1.0%

4. a. The percentage of tickets written for drivers with speeds of 80 mph or greater _____ (increased, decreased) from 1991 to 2002.

b. The report indicates 1.2 million tickets were analyzed. Write 1.2 million in **standard form**. _____

Remember: *Standard form* is a method of writing the common symbol for a numeral. Example: The standard numeral for eight is 8.

c. Of the 1.2 million tickets analyzed in 2002, _____ (number, not percent) were written for drivers at speeds of 90 mph or greater.

d. Of the 1.2 million tickets analyzed in 2002, _____ (number, not percent) were written for drivers at speeds of 80 mph or greater.

e. Explain how the calculation to answer question 4b can be easily done without the use of paper and pencil or a calculator.

_____

_____

Read the following.

The newspaper provided reasons drivers give for speeding which included the following:

a. "Because everyone else does, especially our leaders."

b. "Because we think we have a good excuse."

c. "Because we think we have a right to."

d. "Because we're sure we won't crash—or get hurt."

e. "Because no one's gonna stop us."

Answer the following. Then on your own paper, write a short **news article** *in* **response to one of the reasons** *above.*

5. What facts can you find to support or deny reason **a** above?

_____

_____

6. Conduct a survey to determine what excuses people give for speeding. Strive for a representative sample. Write a conclusion on how "good" you think these reasons are.

_____

_____

7. Consider what rights Americans have and conclude whether or not speeding is one of them. Explain.

8. What research can you find to support or deny reason **e** on the previous page?

9. The following data from the news article may contribute to an article supporting or denying reason **d** on the previous page.

Speed at Time of Crash	Fatality
30 mph or less	
35 or 40 mph	
45 or 50 mph	
55 mph	
60 mph or more	

Speed of a 4,000-pound Vehicle	F
40 mph	
60 mph	

Estimated Number of Deaths in Speed-related Crashes in 2000
Estimated Number of Injuries in Speed-related Crashes in 2000

10. On your own paper, write a short news article.