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Graphing Proportional Relationships

Two values are proportional if they maintain the same ratio and their graph will always be a straight line that goes through the origin (0,0). In this lesson we'll explore how to draw proportional graphs and use them to solve desperate situations!

Save the Merchant Ship!

It was a race against time. The Serendipity, a large, slow merchant ship, sailed toward South America. The passengers were all enjoying the voyage, but what they didn't know was that just off the tip of Florida, three small, fast, heavily-armed pirate ships were eagerly awaiting the merchant's approach. The happy vessel was now only 70 miles from disaster.

At that point, the Avenger, a fast Yankee warship, received a telegram about the Serendipity's danger, and sailed from St. Augustine, Florida. Bristling with cannons and marines, the warship could handle the pirates but was 250 miles away from the ambush point. Is there enough time to catch up? Can the Avenger sail 250 miles before the Serendipity covers 70? It's a question of proportions.

Many situations in life involve proportional relationships, and sometimes the best way to understand those relationships is to draw a graph. Two values have a **proportional relationship** if their ratio (the fraction formed when one is divided by the other) is always the same. If one doubles, so does the other.

A **graph** is a picture of a mathematical relationship that helps us visualize how the numbers work together. It can help us look up the information we need when we have a problem involving proportions.

In our example, the distance each ship has moved is proportional to how much long it has been sailing. Figure 1 will tell us if the Avenger can travel 250 miles before the Serendipity travels 70. Let's take a look.

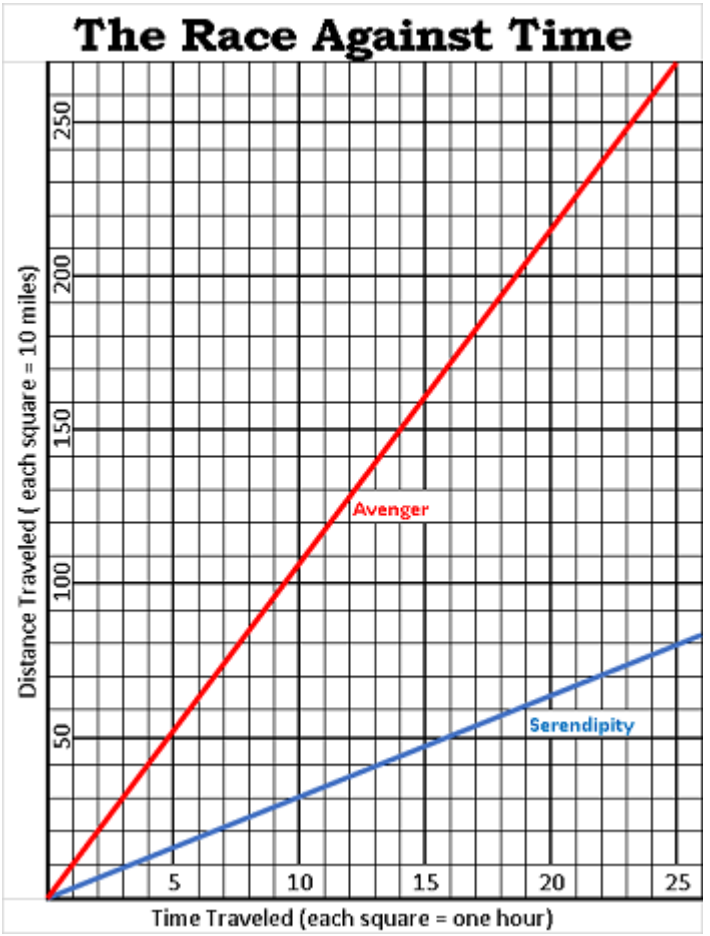

Figure 1. Graph showing distance versus time of the two ships

If you follow the blue line, which is the voyage of the Serendipity, you'll see when the ship goes 70 miles it encountered the pirates after 22 hours. What about the Avenger? Well, follow the red line to the same 22-hour point. Did the Avenger travel 250 miles by that time? No, at 22 hours the Avenger had only covered about 236 miles. It was 14 miles away when the merchant was attacked.

So what happened? The Avenger was too late to save the Serendipity, arriving at the scene just over an hour after the merchant vessel arrived. The Serendipity had been sunk, her cargo plundered and all passengers lost. The pirates were gone.

Drawing a Proportional Graph

When you're drawing a graph for a proportional relationship, keep two things in mind:

1. Proportional graphs are always a straight line.
2. Proportional graphs always start at the origin, or (0, 0) point.

So now let's see if we can save the Serendipity. The Avenger averaged just over 10 miles per hour, and the Serendipity averaged about 3. What if the Americans sent a newer, faster warship to catch the Serendipity?

The Aggressor, a fast clipper ship, was also anchored at St. Augustine. Lighter and slimmer than the bulky Avenger, the Aggressor averaged 13.5 miles per hour. Would it be able to catch the Serendipity before the slow merchant reached the Bahamas? Was it able to cover 250 miles from St. Augustine to the Bahamas in less than 22 hours? Let's draw the graph and find out.

When you're graphing a proportional relationship, you place the output (in this case, how far the ships have sailed) on the *y* axis. Remember, the *y* axis is on the left side and is vertical. The input value (how long the ships have sailed) is placed on the *x* axis, horizontally at the bottom of the graph. Notice that our 'Race Against Time' graph is divided into 10-mile segments on the *y* axis and one-hour segments on the *x* axis. When you're graphing, it's up to you how you label your axes, but you want to make sure that you include all values of interest (such as the 70 miles that the merchant ship will travel).

Since a proportional graph is a straight line, all you need are two accurate points, and since all proportional graphs intersect the (0, 0) point, that will be one of them. To get the other point, we'll do a little arithmetic. Since the Aggressor travels 13.5 miles per hour, we can find another point by multiplying a number of hours times the sailing speed. Since it's an easy number, we'll use 10 hours.

10 hours x 13.5 miles per hour = 135 miles traveled.

Ten hours into the trip the Aggressor will have traveled 13.5 miles per hour times 10 hours, or 135 miles. There's our second point! 10 hours, 135 miles.

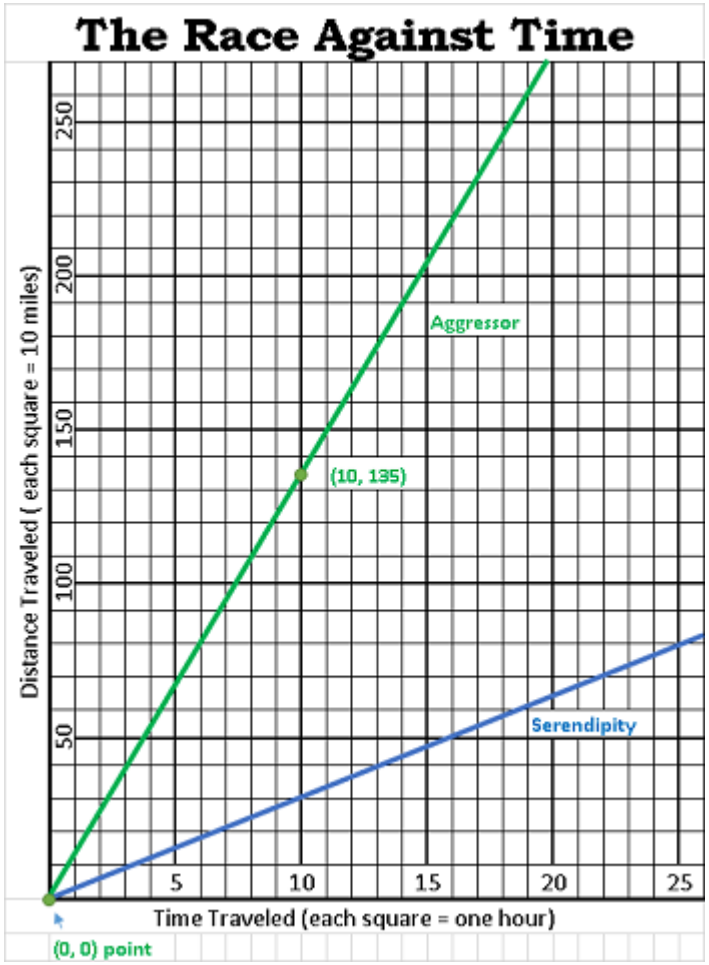

Figure 2. The newly plotted path of the Avenger compared to the Serendipity.

In Figure 2, the two dots are placed and a green line has been drawn to connect the dots. Following the line, you can see that it will reach 250 miles (and the pirates) after just 18 hours of sailing, which gives it plenty of time to catch up with the Serendipity. We saved the day!

Lesson Summary

When two values are in a **proportional relationship**, that means that the ratio, or fraction you get when you divide one by the other, will always be the same. A **graph** is a picture that shows a mathematical relationship. It allows you to track the change in one value by following a change in the other.

Graphs of a proportional relationship always start at the (0, 0) point and are always a straight line. Calculate a second point, draw a straight line through the two points, and you have the graph. It's a useful tool for using math to predict the future!