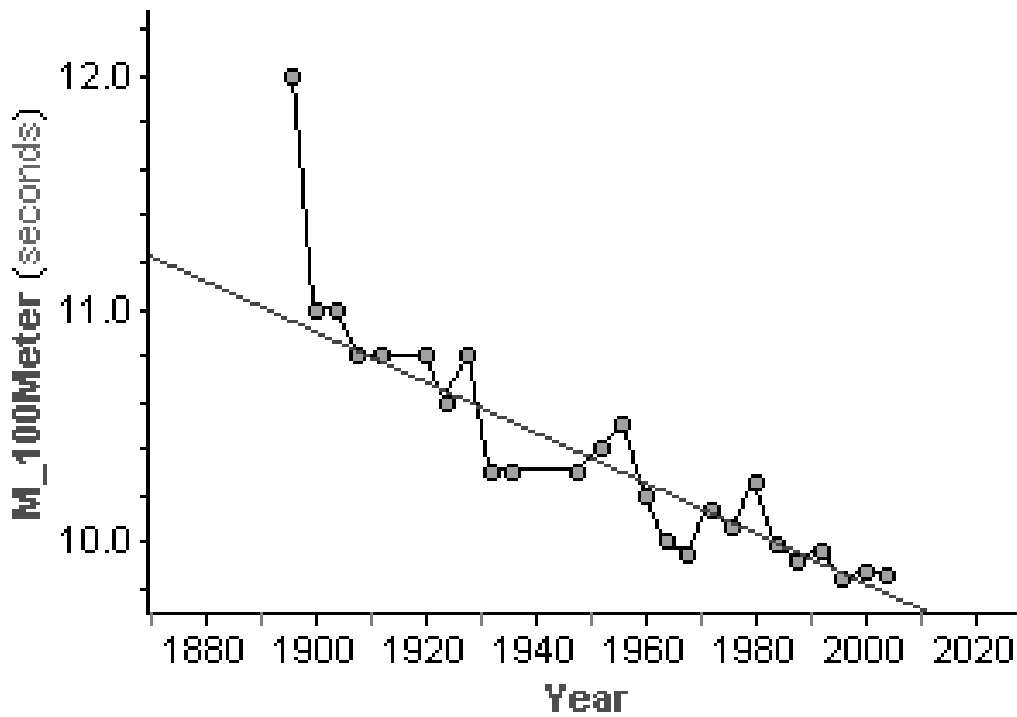


# Algebra 1



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# Mammals' Brains

In this activity, you'll study the brain sizes of 62 mammals. You'll use Fathom to find the mammals with the largest and smallest brains. You'll see that your answers depend on how you define "largest" and "smallest."

## MAKE A CONJECTURE

Before looking at the data, think about what you expect to see.

- Q1** Assume that you could weigh the brains of the African elephant, mountain beaver, human, and rat. Predict their order from largest to smallest brain, based on brain weight. Explain your reasoning.
- Q2** Assume that you could weigh these mammals' bodies, too. Would the four body weights go in the same order as the brain weights?
- Q3** Assume that you calculate the ratio of brain weight to body weight for these four mammals. Predict their order from largest to smallest brain, based on brain-to-body ratio. Explain your reasoning.

## INVESTIGATE

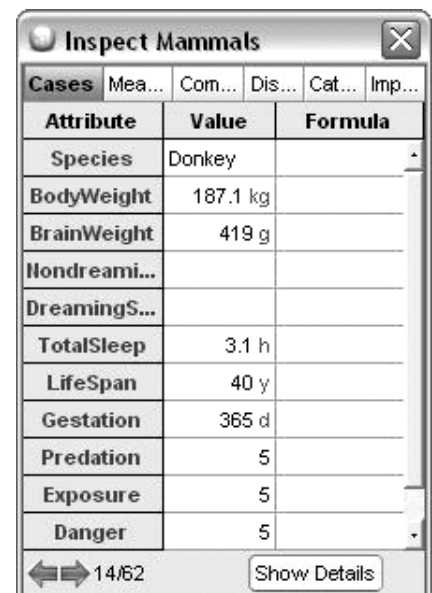
Now you'll use Fathom to look at the actual data.



- 1.** Open the document **Mammals.ftm**. A box of gold balls appears. This is a *collection*. It stores the data.
- 2.** Double-click the collection. The collection *inspector* opens. Click the **Cases** tab to show the data about one mammal. Each mammal is a *case*. Each piece of data, such as *Species*, *BodyWeight*, or *BrainWeight*, is an *attribute*. Use the arrows at the bottom to browse through the cases.
- Q4** Find the brain weight (with units) of a human.
- Q5** Find the body weight (with units) of a rat.

A *case table* is a good way to look at all of the data at once.

- 3.** Select the collection by clicking it. Choose **New | Case Table** from the **Object** menu. A table appears that shows all of the data.



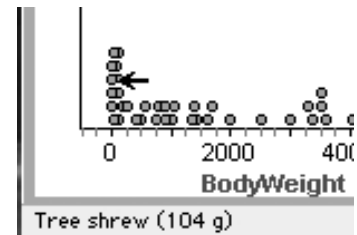
Attribute	Value	Formula
Species	Donkey	
BodyWeight	187.1 kg	
BrainWeight	419 g	
Hondreami...		
DreamingS...		
TotalSleep	3.1 h	
LifeSpan	40 y	
Gestation	365 d	
Predation	5	
Exposure	5	
Danger	5	

- Q6** Which mammal has the brain that weighs the most? The least? (*Hint: You can order the data by selecting an attribute's column and choosing **Sort Ascending** or **Sort Descending** from the **Table** menu.*)
- Q7** List the African elephant, mountain beaver, human, and rat in order from largest brain weight to smallest brain weight.
- Q8** List these four mammals in order from largest body weight to smallest body weight. Is this the same order as for their brain weights?



Graphs are another convenient way to look at the data.

- 4.** Drag a new graph from the object shelf into your document. An empty graph appears.
- 5.** Drag the attribute name *BodyWeight* from the case table to the graph. Drop the attribute below the horizontal axis to create a dot plot. Point the cursor at one dot to see that body weight in the lower-left corner of the Fathom window. Click the dot to highlight the case everywhere and show that case in the inspector.
- 6.** Make another dot plot of *BrainWeight*.



- Q9** Using a dot plot, find the mammal whose brain weighs the most.
- Q10** Are you able to use a dot plot to find the mammal whose brain weighs the least? Explain how you found it, or explain why you couldn't.
- Q11** Do the brain weights of all 62 mammals go in the same order as their body weights? Explain how you found your answer, and compare this answer to your answer for Q8. What do the results mean?

- 7.** Select the dot plot of *BrainWeight*. Use the pop-up menu in the upper-right corner to change to a histogram. A *histogram* shows the number (or *frequency*) of values that fall in certain intervals (or *bins*). Put your cursor over one of the bars to see the frequency of cases in that bin. Click a bar to highlight all of those cases everywhere.

- Q12** Which mammals have a brain weight between 500 g and 1000 g?

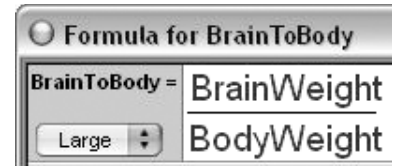
You've found the mammals that have the largest and smallest brains, based on brain weight. Does that mean they have the largest and smallest brains for their overall size?

- Q13** By hand or with a calculator, find the ratio of brain weight to body weight for the mountain beaver. What are the units of your ratio? What are some equivalent ways to write your ratio?

Next you'll create an attribute that finds each mammal's brain-to-body ratio.

- 8.** In the case table, scroll to the far right. Click **<new>** in the last column, type `BrainToBody`, and press **Enter**. An empty column appears.

- 9.** Select the *BrainToBody* column and choose **Edit Formula** from the **Edit** menu. The *formula editor* opens. Type `BrainWeight/BodyWeight` and click **OK**. The ratios appear.



- Q14** In the case table, find the brain-to-body ratio (with units) for the mountain beaver. Is this one of the answers you got for Q13?
- Q15** Which mammal has the largest brain for its overall size? The smallest? What are the ratios? Are these the mammals with the brains that weigh the most and the least?
- Q16** List the African elephant, mountain beaver, human, and rat in order from largest brain-to-body ratio to smallest brain-to-body ratio. Is this the same order that you predicted in Q3?
- Q17** The order in Q16 should not be the same as the order in Q7. What does it mean about the sizes of these mammals' brains compared to the sizes of their bodies?
- 10.** Make a graph of *BrainToBody* and change it to a box plot. A *box plot* shows how the data values divide into fourths (or *quartiles*). The upper and lower segments (or *whiskers*) each represent one-fourth of the values, and each half of the box represents one-fourth of the values. The vertical segment in the middle of the box is the *median*, and the distance between the ends of the box is the *interquartile range*.
- Q18** Do more mammals have brain-to-body ratios above 0.01 or below 0.01?
- Q19** Approximate the median and interquartile range for a mammal's brain-to-body ratio.

A *summary table* is a more precise way to find numerical statistics.



11. Drag a new summary table from the object shelf into your document. Drop the attribute *BrainToBody* in the row or column of the summary table. The mean appears automatically.
  12. Select the summary table and choose **Add Five-Number Summary** from the **Summary** menu. The five number summary is added to the summary table.
  13. Choose **Add Formula** from the **Summary** menu. Type `iqr()` and press **Enter**. The interquartile range is added to the summary table. You may have to resize the table to see all the formulas. If you click a formula, its value will be highlighted in the table.
- Q20** What are the median and interquartile range? Round your answers to four decimal places.
- Q21** What is a typical value for a mammal's brain-to-body ratio? Explain how you chose your answer.

## EXPLORE MORE

1. Create a new attribute that gives each mammal's brain weight as a *percentage* of its body weight. What formula did you use? How do the brain-to-body percentages compare to the brain-to-body ratios? How does a graph of the percentages compare to a graph of the ratios? Does this make sense mathematically?
2. From the data that you have, discuss whether brain weight would be a good way to judge intelligence. Would brain-to-body ratio be better?

# Reading the News

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You will need

- newspaper
- centimeter ruler
- clock with a second hand or stopwatch



Somebody once said that listening to a half-hour news broadcast on the radio was the same as reading the front section of the newspaper. You're going to find out if that's true.

## MAKE A CONJECTURE

You probably already have ideas about what will happen. Look through the front section of a newspaper and think about what you expect.

- Q1** How long would it take you to read the front section of the newspaper aloud?
- Q2** How many newspaper pages could you read in 30 minutes?

## EXPERIMENT

First you'll choose a partner and collect data.

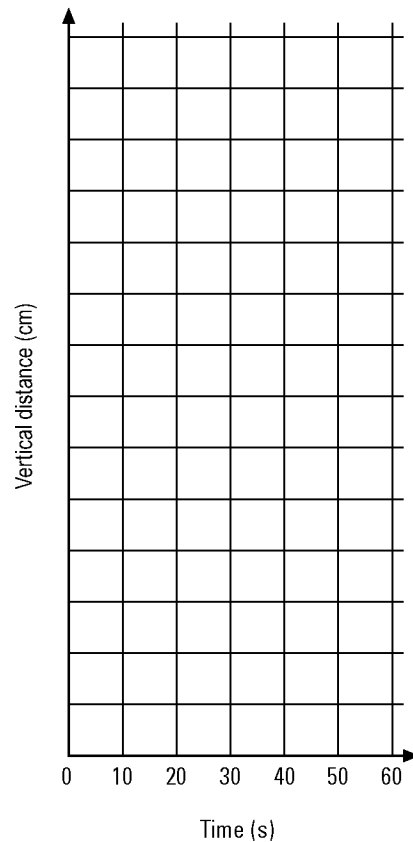
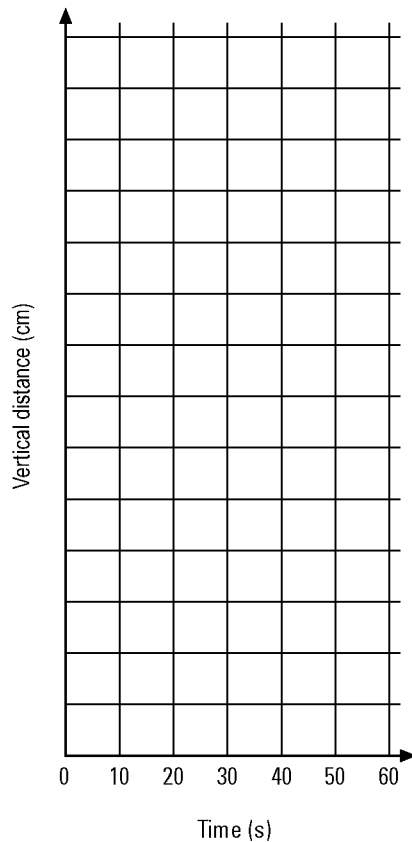
1. One person is the timer and the other is the reader. The reader picks a place to start reading. When the timer says "Go," the reader reads until the timer says "Stop." Read aloud as if you're a news announcer.
2. Measure and record the *vertical* distance of the column from your starting point to your stopping point. You'll read six different paragraphs, each for a different length of time. Use paragraphs in columns that are all the same width.

Name		
Time (s)	Vertical distance (cm)	Vertical distance(cm)
10		
20		
30		
40		
50		
60		

3. After one person reads six times, switch roles and repeat.

## INVESTIGATE (BY HAND)

- Q3** How many vertical centimeters of text are there on a typical page of your newspaper? Consider all columns, and exclude pictures and ads.
- Q4** Use your data to approximate how long it would take each of you to read one page.
- 4.** Make scatter plots of *vertical distance* versus *time*. Scale the vertical axes to match your data.



- 5.** For each graph, draw a single straight line that approximates the data.
- Q5** Do your lines go through the point  $(0, 0)$ ? Should they? Explain.
- Q6** Calculate the slope of both lines.
- Q7** Your slopes' units are centimeters per second. That sounds like a speed. What does it mean in connection with reading?
- Q8** Who reads faster? Explain how you can tell from the graphs. Explain how you can tell from the slopes.

- Q9** Use your slopes to approximate how many centimeters you would each read in 100 seconds.

## INVESTIGATE (WITH FATHOM)

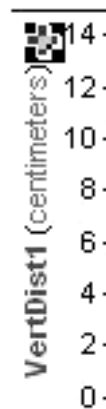
Now you'll further analyze the data with Fathom.

- 6.** Start Fathom. You'll have an empty document.
- 7.** Drag a new case table from the object shelf into your document. Click **<new>** in the case table. Type *Time* and press **Enter** to make a new attribute. An empty collection appears.
- 8.** Make two more attributes, *VertDist1* and *VertDist2*, for the vertical distances of you and your partner.
- 9.** Enter the data from your table in step 2. Type the first value and its unit under each attribute. The unit will be applied to every value for that attribute.

	<i>Time</i>	<i>VertDist1</i>	<i>VertDist2</i>
units	seconds	centimeters	
1	10 s	20 cm	
- 10.** Drag a new graph from the object shelf into your document. Drag the attribute *Time* from the case table and drop it below the horizontal axis. Drag *VertDist1* to the vertical axis. The graph changes to a scatter plot. Compare Fathom's scatter plot to the one you made.
- 11.** Select the graph by clicking it. Now choose **Add Movable Line** from the **Graph** menu. A line and its equation appear. Choose **Lock Intercept at Zero** from the **Graph** menu to make the line pass through the origin.
- 12.** Get comfortable with changing the line. Then move the line to best approximate the points. (*Hint:* When you try to move the line, you may accidentally grab a data point and change your data. If this happens, choose **Undo** from the **Edit** menu until everything is all right.)
- Q10** What is the equation of the line that approximates the points? Write the equation exactly as Fathom shows it, including units.
- Q11** The quantity multiplied by *Time* in the equation should be close to something you found before. What does this coefficient represent?
- 13.** Select the graph and choose **Remove Movable Line** from the **Graph** menu. Now choose **Plot Function** from the **Graph** menu. In the formula editor, type the right side of the equation from Q10, including units, and click **OK**. This makes a fixed, unmovable line.



14. Drag *VertDist2* from the case table to your graph. When you are over the vertical axis, you'll notice a plus sign at the top of the axis. Drop the attribute on the plus sign, making a scatter plot of both sets of points.
15. Repeat steps 11–13 to find a line that fits the new points.
- Q12 How do the equations of the two lines compare? From the equations, how can you tell who reads faster?
16. Move the cursor over either line until you see a red point. Click and drag the red point to trace the line. The coordinates of the trace appear beside the point and in the lower-left corner of the Fathom window.
- Q13 Use the lines and trace feature to answer these questions.
- How many centimeters could each of you read in 100 seconds?
  - How long would it take each of you to read one page?
  - How long would it take each of you to read the front section of your newspaper? Compare this to your prediction in Q1.
  - How many pages could each of you read in 30 minutes? Compare this to your prediction in Q2. Did you overestimate or underestimate?
- Q14 Is it true that listening to a half-hour news broadcast on the radio is the same as reading the front section of the newspaper? Explain.
- Q15 What are some factors that would make reading the front section of the newspaper take more or less time than listening to a news broadcast? How might it be possible to make the timing about the same?



## EXPLORE MORE

- Make a graph with *VertDist* (1 or 2) on the horizontal axis and *Time* on the vertical axis. (*Hint:* You can swap the axes in a scatter plot by dragging the attribute on one axis and dropping it on the other axis.) Find a line to fit the points. What does the slope of this line mean? How is it related to the slope in Q6?
- How would your results change if the newspaper columns were twice as wide? Half as wide?

# Slope-Intercept Form

In this activity, you'll study data that fit perfectly on a line. By changing the data, you'll explore how the equation of the line changes.

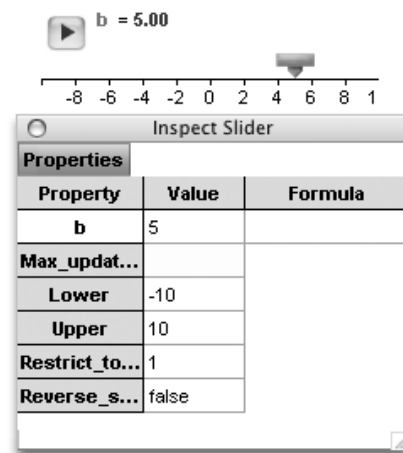
## INVESTIGATE

1. Open the document **SlopeIntercept.ftm**. You'll see a collection and case table of  $x$ - and  $y$ -coordinates. You'll also see a scatter plot of the coordinate pairs  $(x, y)$ . Notice that the points form a perfect line.
- Q1** Look for a pattern in the coordinates. What equation relates the  $x$ - and  $y$ -coordinates? Check your guess by selecting the graph and choosing **Median-Median Line** from the **Graph** menu. (*Note:* For this activity, you only need to know that a median-median line gives you a line that fits the points and shows you the equation of that line.)



You are now going to explore what happens when you add the same amount to every  $y$ -coordinate. You'll use a slider that allows you to easily explore the effect of adding different amounts.

2. Drag a new slider from the object shelf into your document. The slider will be called  $V1$ . Drag the slider and notice how the value of  $V1$  changes to different decimal values. Click the green "play" button to watch the slider change by itself; click the red "stop" button to stop it.
3. Double-click near the slider's axis to show the slider inspector. Enter the values shown here, which rename the slider  $b$  and limit its values to integers (multiples of 1) between  $-10$  and  $+10$ . Close the inspector and drag the slider to test its behavior.
4. In the case table, create a new attribute,  $yPLUSb$ . Define it with a formula that adds the value of slider  $b$  to each  $y$ -coordinate.

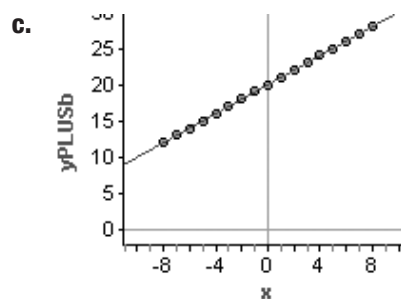
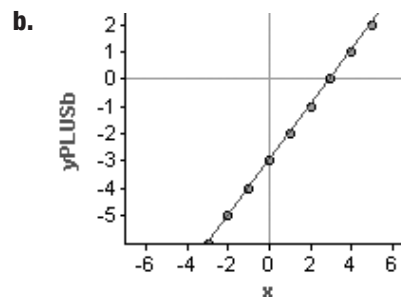
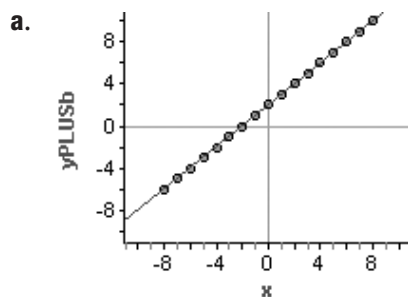


- Q2** Set the value of  $b$  to 4. How do the coordinates  $yPLUSb$  compare to  $y$ ? If you make a scatter plot of points  $(x, yPLUSb)$ , how do you think it will compare to the scatter plot of points  $(x, y)$ ? You'll check your answer in the next few steps.
5. Select the scatter plot of  $(x, y)$  and choose **Duplicate Graph** from the **Object** menu.

## Slope-Intercept Form

(continued)

6. Select the duplicate graph and choose **Show Axis Links** from the **Graph** menu. A broken chain link appears by each axis. Drag the broken chain link from the  $x$ -axis and drop it on the  $x$ -axis of the original graph. Do the same to link the  $y$ -axes. Now, if you change the axes in one graph, the axes change in the other graph, too.
7. Drag the attribute  $yPLUSb$  from the case table and drop it on the  $y$ -axis of the duplicate graph. You should have a scatter plot of  $(x, yPLUSb)$ .
- Q3 How does the scatter plot of  $(x, yPLUSb)$  compare to the scatter plot of  $(x, y)$ ? How did the points change when you added  $b$  to each  $y$ -coordinate? Compare the results to your prediction in Q2. (*Hint: If you select a point in one graph, its corresponding point will be selected in the other graph.*)
- Q4 How does the equation of the line for  $(x, yPLUSb)$  compare to the equation for  $(x, y)$ ? How did the equation change when you added  $b$  to each  $y$ -coordinate?
- Q5 An important aspect of any line is the place where it crosses the  $y$ -axis, or its  $y$ -intercept. What is the  $y$ -intercept for the line for  $(x, yPLUSb)$ ?
- Q6 Drag the slider to change the value of  $b$ . For several different values of  $b$ , notice how the points, the equation, and the  $y$ -intercept change. Write a few sentences that describe the general effects of  $b$ .
- Q7 Use what you've learned to predict the equation of each line.

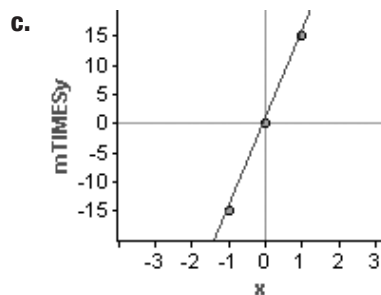
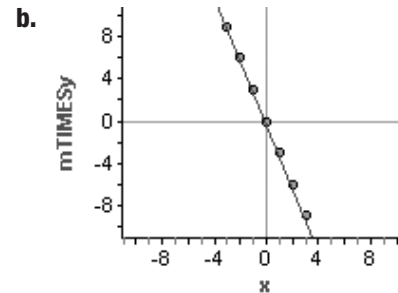
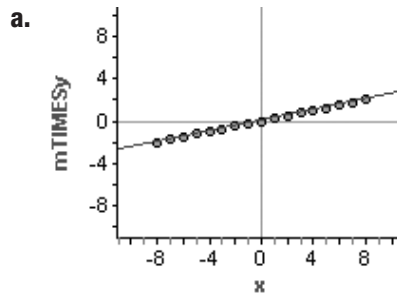


## Slope-Intercept Form

(continued)

Now that you've created a slider for  $b$  and explored the effects of adding to the  $y$ -coordinate, it's time for you to explore the effects of multiplication.

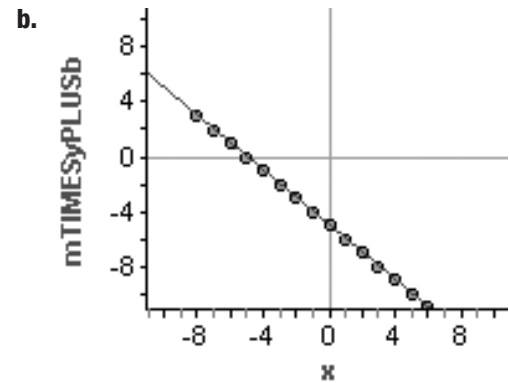
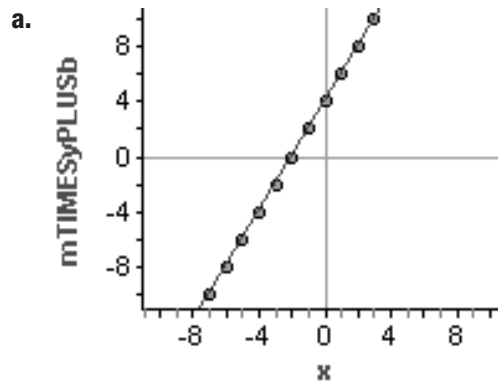
8. Create a slider called  $m$  that goes from  $-10$  to  $+10$  by multiples of  $0.25$ .
  9. Create a new attribute called  $mTIMESy$ . Give it a formula that multiplies the value of  $m$  by the original  $y$ -coordinates.
  10. Make a scatter plot of  $(x, mTIMESy)$ . Use a duplicate graph with linked axes so that you can compare the points and equation for  $(x, mTIMESy)$  to the points and equation for  $(x, y)$ .
  11. Drag the slider for  $m$  and watch how the coordinates in the case table change, how the points on the graph change, and how the equation changes.
- Q8** How does the scatter plot of  $(x, mTIMESy)$  compare to the scatter plot of  $(x, y)$ ? How do the points change as the value of  $m$  changes? How does the equation of the line change? Write a few sentences that describe the general effects of  $m$ .
- Q9** Another important aspect of any line is its *slope*. Write a few sentences explaining how  $m$  relates to the slope of the line.
- Q10** Use what you've learned to predict the equation of each line.



Now you'll explore the combined effects of multiplication and addition.

- 12.** Create a new attribute,  $mTIMESyPLUSb$ . Give it a formula that multiplies the original  $y$ -coordinates by  $m$  and then adds  $b$ . Make a new scatter plot linked to the original plot. Explore as much as necessary for you to understand the combined effects of  $m$  and  $b$ .

- Q11** Use what you've learned to predict the equation of each line shown or described here.

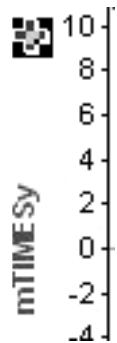


- c.** A line with slope 0.75 and  $y$ -intercept  $-9$ .  
**d.** A line with  $y$ -intercept 0 and slope 12.  
**e.** A line with slope 3.5 and  $y$ -intercept 2.

- Q12** A linear equation in the form  $y = mx + b$  is said to be in *slope-intercept form*. Why is this an appropriate name for this form?

## EXPLORE MORE

- Make a graph of  $(x, mTIMESy)$ . Then add  $mTIMESyPLUSb$  as a second attribute to the  $y$ -axis by dropping it on the plus sign. You should see two sets of points and two lines. Adjust the sliders and watch how the lines change relative to each other. What geometric word describes the two lines?
- Explore what happens if you change the  $x$ -coordinates instead of the  $y$ -coordinates. Look at scatter plots of  $(xPLUSb, y)$ ,  $(mTIMESx, y)$ , and  $(mTIMESxPLUSb, y)$ . Generalize the results and then explain how the results compare to the changes for the  $y$ -coordinates. When you change the  $x$ -coordinates, does  $b$  still relate to the  $y$ -intercept? Does  $m$  still relate to the slope? If yes, explain how. If not, explain what  $b$  and  $m$  do relate to.



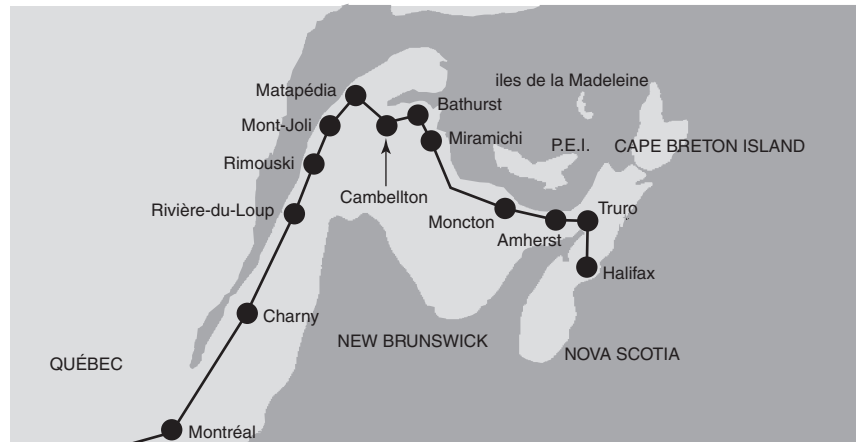
# The Ocean Train

You will need

- schedule for the Ocean train

In this activity, you'll study a passenger train called the Ocean, which runs from Halifax, Nova Scotia, through New Brunswick, to Montréal, Quebec. The trip takes place on parts of two days. If you leave Halifax Saturday afternoon, you get to Montréal Sunday morning.

How fast does the Ocean go? You'll use Fathom to find out.



## UNDERSTAND THE DATA

Train schedules can be confusing. You have part of the VIA Rail Canada timetables that shows information for two trains. Notice that the schedule uses a 24-hour clock, so 1920 means 7:20 P.M.

Assume that you'll travel from Halifax on a Thursday in next January. Work with a partner to understand the schedule.

- Q1** What day of the week could you *not* leave Halifax?
- Q2** When does the train leave Halifax in January?
- Q3** How many kilometers is it from Halifax to Moncton?
- Q4** What's the first city after midnight on the trip?
- Q5** What's the next city the train stops at after Matapédia?
- Q6** How many kilometers between Charlo and Montmagny?

## INVESTIGATE

1. Start Fathom. In a new document, create a collection and case table for the data in the train schedule. You are interested in speed, so distance and time are important. The names of the stations are useful, too. At a minimum, you need these attributes:

*Station* (the station name)

*Distance* (the distance in kilometers from Halifax)

*Hour* (the hour the train *arrives*, by a 24-hour clock)

*Minute* (the minute the train arrives)

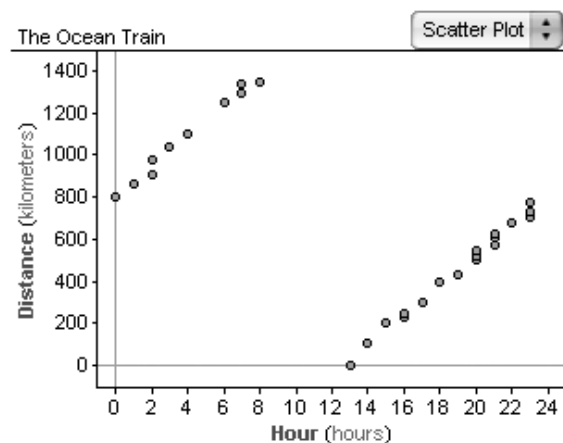
2. Once you have your case table, enter cases for the Ocean train's schedule in January. Use units to enter values for the first case and the units will be applied to every case.

	Station	Distance	Hour	Minute
<b>units</b>		kilometers	hours	minutes
<b>1</b>	Halifax	0 km	13 h	5 min
<b>2</b>	Truro	103 km	14 h	30 min
<b>3</b>	Springhill Junction	200 km	15 h	55 min
<b>4</b>	Amherst	227 km	16 h	20 min
<b>5</b>	Sackville	243 km	16 h	37 min
<b>6</b>	Moncton	304 km	17 h	25 min

Between Amherst and Sackville, the train goes 16 kilometers in 17 minutes, which is about 56.5 kilometers per hour. Is that a typical speed for this train? Next, you'll find a pattern for all of the cases.

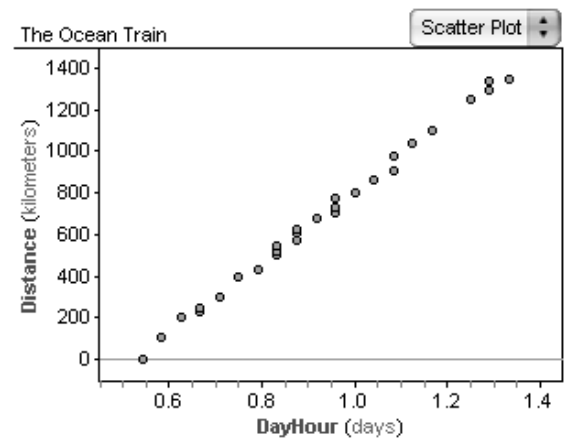
3. Drag an empty graph from the object shelf into your document. Make a scatter plot of *Distance* versus *Hour*. You should see something like this graph.

- Q7** Why are there two "lines" of points? What does each group of points represent?



**Q8** You need to “fix” the data to show only one line of points. Explain one way that you could manipulate the data to do that. (*Hint:* Think of ways to create and combine attributes so that you don’t have to change the original data.)

4. Now follow your plan and fix the data to show only one line of points. Make a scatter plot with your new attribute(s) to verify that you have one line. Your graph should look something like this. If you don’t get one line, try again. When you find a good fix, add it to your answer to Q8.



5. In some places, for example, between Bathurst and Jacquet River, the graph of points form a vertical line. What does that mean about the train’s speed? Look back at the data and find another way to manipulate the data to fix this problem.

6. Select the graph and choose **Add Movable Line** from the **Graph** menu. Adjust the movable line to fit the points as best you can.

**Q9** What is the equation of your line of fit?

**Q10** What feature of your line represents the train’s average speed? What is the average speed, including units? Does that seem like a reasonable speed for a passenger train?

**Q11** What is the vertical intercept of your line? What are the units of the intercept? Explain the meaning of your intercept in relation to the train schedule.

## EXPLORE MORE

1. If you look at the original schedule, you might notice an “error” between Campbellton and Matapédia. It appears that the train passes through Campbellton at 9:55 P.M., goes 19 kilometers, and then arrives at Matapédia at 9:53 P.M. But it’s impossible for the train to gain 2 minutes. What is the problem here? Find a way to manipulate the data to fix this problem. Does fixing the data in this way change the average speed of the train? If so, by how much?
2. Try zooming in on smaller groups of points and readjust your line of fit for these points. Does the slope of the line become steeper or shallower? If so, what does that mean about the average speed of the train for these small parts of the trip?



# The Ocean Train

(continued)

## The Via Rail Canada Schedules

### HALIFAX • GASPÉ • MONTRÉAL

TRAIN	KM	15	15	17	17
NAME NOM		Océan Océan	Océan Océan	Chaleur Chaleur	Chaleur Chaleur
DAYS/JOURS		x2	x2	1,4,6	1,4,6
DP <b>Halifax, NS</b> AT/HA	0	1305	1245		
<b>Truro</b>	103	1430	1415		
<b>Springhill Jct.</b> ☆	200	1555	1540		
<b>Amherst, NS</b>	227	1620	1605		
<b>Sackville, NB</b>	243	1637	1623		
AR DP <b>Moncton</b>	304	1725	1710		
		1745	1740		
<b>Rogersville</b> ☆	397	1842	1842		
<b>Miramichi</b>	433	1920	1920		
<b>Bathurst</b>	504	2016	2016		
<b>Petit Rocher</b> ☆	521	2031	2031		
<b>Jacquet River</b> ☆	549	2051	2051		
<b>Charlo</b> ☆	574	2111	2113		
<b>Campbellton, NB</b> AT/HA	605	2155	2200		
AR DP <b>Matapédia, QC</b> ET/HE	624	2153	2158		
<b>Gaspé, QC</b> ET/HE	0			1445	1450
<b>Barachois</b>	40			1527	1533
<b>Percé</b>	63			1559	1604
<b>Grande Rivière</b>	80			1622	1627
<b>Chandler</b>	97			1639	1644
<b>Port-Daniel</b>	130			1736	1741
<b>New Carlisle</b>	167			1831	1836
<b>Bonaventure</b>	182			1855	1850
<b>Caplan</b>	200			1911	1916
<b>New Richmond</b>	214			1928	1933
<b>Carleton</b>	254			2012	2017
<b>Nouvelle</b> ☆	269			2027	2032
AR DP <b>Matapédia</b>	325			2125	2130
<b>Matapédia</b>	624	2155	2200	2155	2200
<b>Causapsal</b> ☆	681	2241	2246	2241	2246
<b>Amqui</b>	703	2301	2306	2301	2306
<b>Sayabec</b> ☆	727	2320	2325	2320	2325
<b>Mont-Joli</b>	774	2359	0004	2359	0004
<b>Rimouski</b>	803	0023	0029	0023	0029
<b>Trois-Pistoles</b>	864	0106	0136	0106	0136
<b>Rivière-du-Loup</b>	907	0201	0212	0201	0212
<b>La Pocatière</b>	975	0241	0251	0241	0251
<b>Montmagny</b> ☆	1035	0315	0324	0315	0324
<b>Charny</b>	1099	0445	0447	0445	0447
<b>Drummondville</b>	1246	0615	0625	0615	0625
<b>Saint-Hyacinthe</b>	1292	0700	0700	0700	0700
<b>Saint-Lambert</b>	1339	0742	0742	0742	0742
AR DP <b>Montréal, QC</b> ET/HE	1346	0800	0800	0800	0800

### HALIFAX • GASPÉ • MONTRÉAL

TRAIN	KM	15	15	17	17
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AR DP <b>Montréal, QC</b> ET/HE	1346	0800	0800	0800	0800

Days of operation	Jours où le train est en service
Monday	1
Tuesday	2
Wednesday	3
Thursday	4
Friday	5
Saturday	6
Sunday	7
Except	x
Except Saturday and Sunday	x6,7
Daily	Blank / Aucun symbole

Days of operation	Jours où le train est en service
Monday	1
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Except	x
Except Saturday and Sunday	x6,7
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# Olympics

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The first Olympic Games of modern times were held in Athens, Greece, in 1896. They have been held every four years since, with three exceptions—they were not held in 1916, 1940, or 1944 because of World Wars I and II.

In this activity, you'll explore the track-and-field gold-medal results from the Summer Olympic Games, 1896 to 2004. The data you'll use have the winning times or distances for several of the events that both men and women compete in.

## MAKE A CONJECTURE

You probably already have some ideas about what the data look like. Think about what you expect to see.

- Q1** In how many seconds do you think a male athlete can run the 100-meter dash?
- Q2** From 1896 to 2004, do you think men's gold-medal times for the 100-meter dash have gotten longer, gotten shorter, or stayed the same? Explain your thinking.
- Q3** How do you think the Olympic results for the 100-meter dash compare to the results for the 200-meter dash? Explain your thinking.
- Q4** How do you think the men's results compare to the women's results for the 100-meter dash? If you think one gender's results are better, how much better do you think they are?
- Q5** If there is a difference between men's and women's times for the 100-meter dash, do you think the difference has changed over time? Have the times gotten closer together, gotten farther apart, or stayed the same?

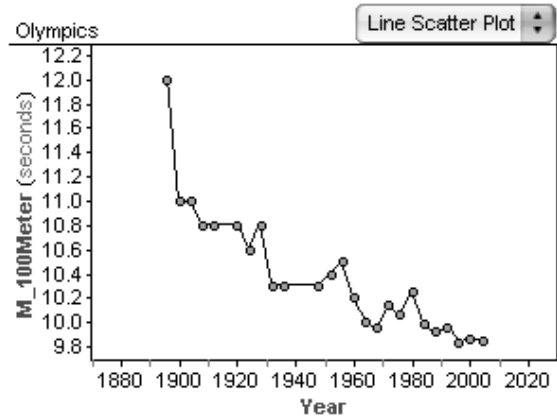
## INVESTIGATE

Now you'll use Fathom to look at the Olympic data. You'll make several graphs and look for patterns and relationships. Keep questions Q1–Q5 in mind because you're going to see whether your predictions were correct.

- 1.** Open the document **Olympics.ftm**. You'll see only a collection.
- 2.** Use the collection inspector or a case table to look at the data. Be sure that you understand what each case and each attribute represent. You'll notice that some events (especially women's events) do not have values for every year. That's because more and more events have been added over time—not every event was held in 1896.

Question Q2 asked about changes in the men's gold-medal times for the 100-meter dash. You'll look at that event first.

3. Make a scatter plot of  $M_{100\text{Meter}}$  versus  $Year$ . Change the graph to a line scatter plot, which connects the points in order by year.



- Q6** Based on your graph, have the times for the men's 100-meter dash gotten longer, gotten shorter, or stayed the same? Explain how you know.
- Q7** Between which two years was there the greatest improvement? From the graph, how can you distinguish improvement from setback?
- Q8** Are there any years for which the gold-medal result was unusual? If so, tell which years and explain why you picked those points.
4. Add a line of fit to your graph. You can use a movable line, median-median line, or least-squares line, whichever you think fits the best.
- Q9** What is the meaning (if any) of your line's slope? What is the meaning (if any) of its  $y$ -intercept?
- Q10** Use your line to predict the men's gold-medal time for the 100-meter dash in the next Olympics.

Question Q3 compared the results for the 100-meter dash and the 200-meter dash. Next you'll look at those two events.

5. Make a single scatter plot that compares the results for the 100-meter dash and the 200-meter dash over time. You can use either men or women, but use the same gender for both events.
- Q11** Does your scatter plot support your prediction from Q3? If so, explain how. If not, describe the comparison that the graph does show. (*Hint:* You might want to adjust the graph's axes.)

Questions Q4 and Q5 compared the results for the men's 100-meter dash and the women's 100-meter dash. Now you'll look at those two events together.

6. Make a single scatter plot that compares the results for the men's 100-meter dash and the women's 100-meter dash over time. Look for patterns that help you understand how the data compare and change.

7. Add lines of fit to approximate the trends of each data set. Use median-median lines or least-squares lines because they'll give you a line for men and a line for women. Notice and interpret the slope and  $y$ -intercept of each line.
- Q12** In general, how do the men's results compare to the women's results for the 100-meter dash? Are one gender's results better than the other's? If so, how much better?
- Q13** The graphs definitely show a difference between the genders. Is this difference changing over time? Explain.
- Q14** Based on your lines, will one gender ever "catch up" to the other gender? If so, when? How confident are you about this prediction?

## EXPLORE MORE

1. In question Q8, you identified unusual results in the men's 100-meter dash. You probably did this by finding points that were very far from the general pattern of the data. When you add a line of fit, the line represents the general pattern of the data. You can then use *residuals* to measure how far each point is from the line.

Go back to your graph of  $M_{100Meter}$  versus  $Year$  and make sure you have a line of fit. Select the graph and choose **Make Residual Plot** from the **Graph** menu. Spend some time understanding what the residual plot shows you. How can you recognize points that are unusual for the pattern? How do you recognize points that fit the pattern almost perfectly? Really unusual points are sometimes called *outliers*. Try deleting one or two outlier cases from your collection and see whether the line of fit changes. After you've seen the effect of deleting the outliers, choose **Undo** from the **Edit** menu to bring back the cases.

2. Are there events for which there is no noticeable difference between the genders? Are there events for which the difference between the genders doesn't seem to be changing? Compare the data for other events and describe your findings.

# Sequence of Squares

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In this activity you'll explore the square numbers:

1   4   9   16   25   ...

You'll use mental math to recognize a relationship between these numbers and then use Fathom to confirm or refute your conjecture.

## MAKE A CONJECTURE

Without using Fathom or a calculator, look for a relationship between each square number and the one that follows it. Think about ways to use words, numbers, or algebra to make the conjecture as general as possible.

**Q1** What is the relationship between any pair of square numbers? Be as specific as you can.

## INVESTIGATE

Now use Fathom to test your conjecture. Make a collection in which one attribute contains the square numbers and another computes the relationship you predicted. Use any attributes or formulas that you want. In case you are stuck, here are some functions that you can research in Fathom Help: *caseIndex*, *prev*, *next*. You can also choose **New Cases** from the **Collection** menu to add cases.

**Q2** List the formulas that you used and describe what happened.

Look at your results in Fathom and compare them to your original conjecture. Use the next questions to help summarize your findings.

**Q3** Did your calculations match your conjecture? If not, explain why and write a revised conjecture.

**Q4** Did your calculations reveal any other patterns in the sequence? If so, explain.

## EXPLORE MORE

One of the problems with exploring data is that you don't know if your conjecture is *always* true. Even if your Fathom document has 5000 cases that show your conjecture to be true, you don't know for sure about case 5001. Make a convincing explanation (verbal, algebraic, or geometric) telling why your conjecture is true for all square numbers.