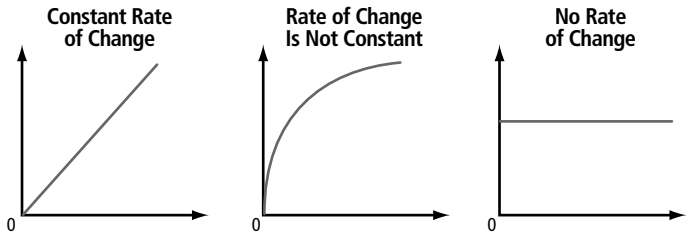
Chapter 6 Linear Relations and Functions

6.1 Graphs of Relations

KEY IDEAS

- When comparing two quantities, straight lines are used to indicate a constant change in the relationship. Curves are used when the rate of change is not constant. Horizontal lines are used if one quantity is not changing relative to a change in the other quantity.

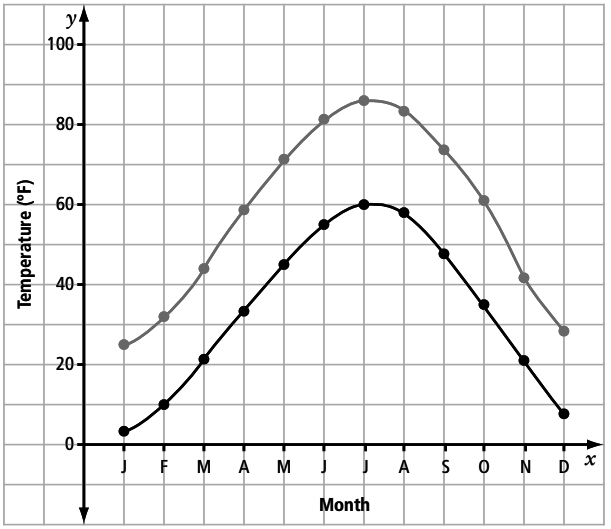


Example

Travel guides often provide climate information, such as the graph shown here. Travellers can use this information to plan their trips.

a) What might the curves represent? Can you think of more than one explanation? What would the points on the curves represent for each of your explanations?

b) What assumptions can you make about the climate and location based on the shapes of the curves?



Solution

a) There are several possible explanations for having two curves:

- Both lines could represent temperatures for the *same* location. The upper curve would represent the average high temperature and the lower curve would represent the average low temperature. The dots on the curve would represent the average high and low temperature for each month.
- The curves could represent the average monthly temperatures for two *different* locations. Again, the dots would represent the average temperature for the month in each location.
- The curves could represent the record high and low temperatures in a single location, or compare record temperatures in two locations. The points on the curve would represent the record temperatures each month. But this explanation is unlikely. It is doubtful that the record temperatures would follow such a consistent pattern, represented by a smooth curve.

b) We can make several assumptions about the location from the shapes of the curves:
- If the curves represent two locations, the shapes and curves are similar enough that the two locations are probably both in the same area or in a similar climate zone. The location represented by the lower curve would be in a cooler location, perhaps further north or at a higher elevation.
- Considering that the highest temperatures occur in July, the location(s) are in the northern hemisphere.
- The slopes of the curves show a significant difference between winter and summer temperatures. But the differences are not extreme, as they might be in many places on the Canadian prairies. The average temperature curves here would be steeper. Similarly, in locations on the west coast, such as Victoria, British Columbia, where there is a more moderate climate, the curves would be flatter.

A Practise

1. Describe in words how each of the following situations can be drawn on a graph where time is on the horizontal axis and distance is on the vertical axis.

a) walking at a slow, constant rate away from the school

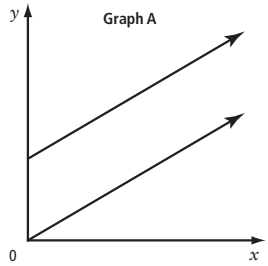
b) running at a constant rate toward the school

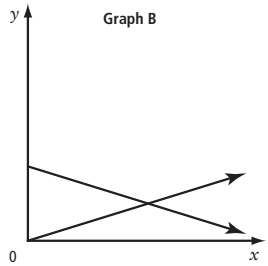
c) walking quickly away from the school, but constantly slowing the rate

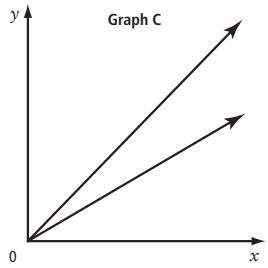
d) standing still a distance from the school

e) running away from the school at a constant rate, and then suddenly turning around and walking toward the school at a constant rate

f) walking away from the school to a point, and then walking in a perfect circle around the school, all the while keeping a constant pace





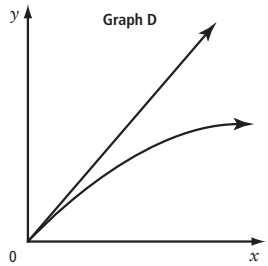


2. For the pairs of lines in each graph

a) state what is similar

b) state what is different

c) give a real-life scenario that could be represented by the graph



☆**3.** For each scenario, draw a graph that is appropriate to the context, representing the activity in relation to time. Label the axes and provide a scale, if possible.

a) eating a bowl of cereal for breakfast

b) reading a novel from start to finish

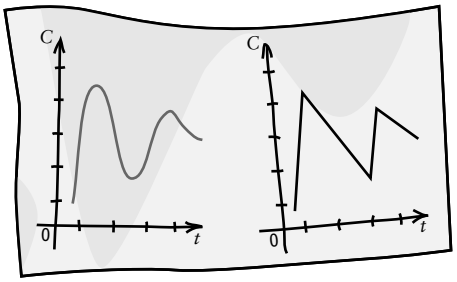
c) washing a load of laundry

d) flying from Calgary to Edmonton

4. **a)** Give two scenarios in which you would use only line segments to represent the relation.

b) Give two scenarios in which you would use only curves to represent the relation.

5. A student is drawing a graph, plotting time, t, in relation to cost, C, as shown. On his first attempt, the student produced a curve. After reconsidering the graph, he changed it to produce a line segment.



a) Explain the similarities that you see between the two relations.

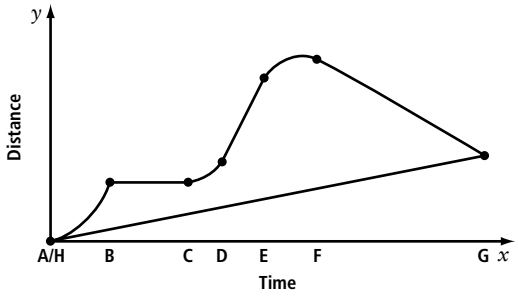
b) Why might the student have made this change?

B Apply

☆**6.** The directions for cooking a particular type of rice say to add 1 cup of rice to 2 cups of boiling water, and then simmer the rice until the water is absorbed. Graph the cooking process from the time the pot is put on the stove, to the time the rice is cooked.
Hint: Put time along the horizontal axis, and choose what will be represented on the vertical axis.

☆**7.** In long track speed skating, skaters race around an oval track. Skaters start the race at the beginning of a long straightaway. They then race around the track for a number of laps, finishing near the end of the straightaway on which they started the race. Create a graph showing time versus distance from the finish line for a skater who skates at a constant pace for 2 laps. Explain why the symmetry occurs in your graph.
Hint: Draw a diagram of this situation and trace the path of a skater.

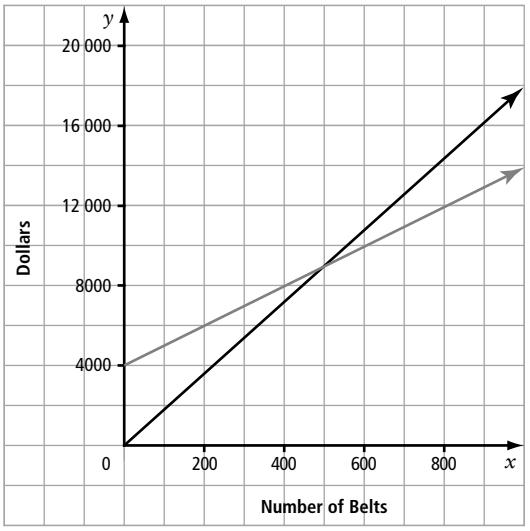
8. Kari drew the distance-time graph below to represent a scenario described by their teacher:
- time A to B: drive away from home accelerating to 50 km/h
- time B to C: continue away from home driving at 50 km/h
- time C to D: continue away from home accelerating to 100 km/h
- time D to E: continue away from home driving at 100 km/h
- time E to F: continue away from home decelerating to 0 km/h
- time F to G: spend 30 minutes in the mall
- time G to H: drive straight home at 40 km/h



a) For sections that you think are drawn incorrectly, state what you think is wrong. Then, draw the graph correctly.

b) Draw a speed-time graph for the scenario.

9. Les is the marketing manager at Noble Leather Goods in Winnipeg, Manitoba. His company is considering a new line of belts. Les's boss has asked him to present the business model for the new line. Les produced a simple model for cost (amount of money paid out) and revenue (amount of money received) relative to the number of belts made and sold. The graph shows his predictions for the first batch of belts to be produced.



a) Les forgot to label the lines on his graph. Which of the lines represents revenue and which represents cost? Explain.

b) What is the initial cost (the amount of money to start the production)?

c) How many belts does the company have to make and sell to break even (revenue exactly equals cost)?

d) What are the cost and revenue at the breakeven point?

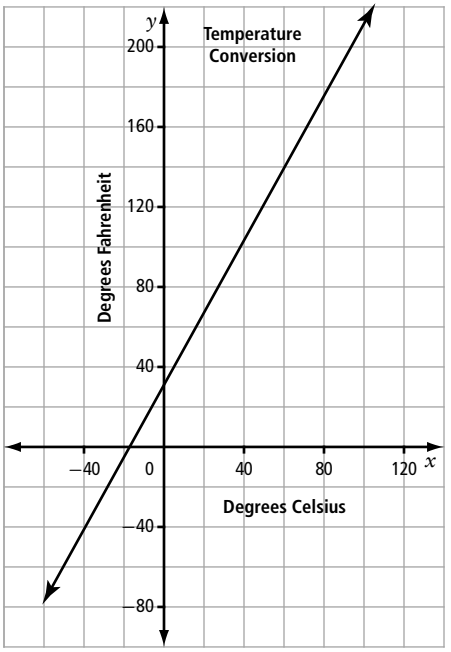
e) What is the predicted profit (the difference between revenue and cost) if the company makes and sells 1000 belts?

f) How much would the company lose if, after setup, management decide not to produce any of these belts?

g) What is the projected selling price of one belt?

C Extend

10. Use the graph below to discover or verify facts regarding the relationship between temperatures measured in Celsius and those measured in Fahrenheit.



D Create Connections

11. Supply and demand is a model that economists use to show how prices are determined for goods and services. This graph represents this model. The point where the two curves intersect represents where supply is equal to demand. Many factors affect the location and steepness of the curves, and where they intersect. Research supply and demand and try to determine three of these factors.