Designing Cell Phone Games

An 8th-grade unit on linear functions

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Working at TexStar Games

Welcome to the headquarters of TexStar Games, Inc.

We make games for cell phones—teens love them!

Other game design companies are cutting into our business so we need to make improvements. That's why you have been hired.

To make TexStar Games more competitive you will

- Use mathematics to analyze our game designs; for example, determine how to make characters move across the screen.
- Analyze our business.

This will require a lot of mathematics. Now's the time to learn it! With the materials in this book, you will learn about functions, both proportional and nonproportional. You will also learn the "real truth" about average rates. And you will understand the connections between tables, graphs, and algebraic expressions. Don't worry, it will all be clear by the time you are done!

All this math will help us in our business, but you will also use it in later math classes and in your life. Keep that in mind as we move ahead.

Cell Phone Games and Design

A few facts about cell phone game design will help you in this unit.

Electronic games—on cell phones, on consoles, on computers—all must be designed (created) by a team of people. The team works together, but there are different jobs to do.

Designers come up with ideas for games and rules for how the game will work. A designer must think about how realistic the game is and what rules will make the game fun and just difficult enough. Math is used in doing this.

Programmers take the ideas and turn them into games. They use mathematics and logic to write programs.

Artists make the images you see on the phone as you play. They must use math to think about how big to make the images on the screen and how much room their art will take up.

Business staff make sure the business is running smoothly. They are in charge of things like employee salaries and tracking how much money the company is saving and spending.

Cell phone designers, programmers, and artists get paid for their work in different ways. Sometimes all these people work for a company like TexStar Games, and they get a paycheck every month. Other times, the programmers, designers, and artists work on their own and get paid for each piece of work they do.

The cell phone business is growing, and it’s likely that more designers, programmers and artists will be needed in the future. Knowing math helps.

Yari, The Yellow School Bus

TexStar Games is working with a traditional windup toy company to design new games for younger kids. We need to analyze the motion of the real toy. Then we can make our cell phone version. Our partner's best selling toy is Yari, The Yellow School Bus.

1. Watch the movie of the actual windup toy —Yari, The Yellow School Bus—moving along a centimeter ruler. Open the file *Yari.swf*. Run it several times. Answer the following:

   A. How many centimeters (cm) did Yari travel?

   B. How many seconds did Yari travel?

   C. Using A & B, calculate Yari's speed (how fast Yari traveled) for this trip.

   D. Explain how your answers for A, B, and C are related.

Explain

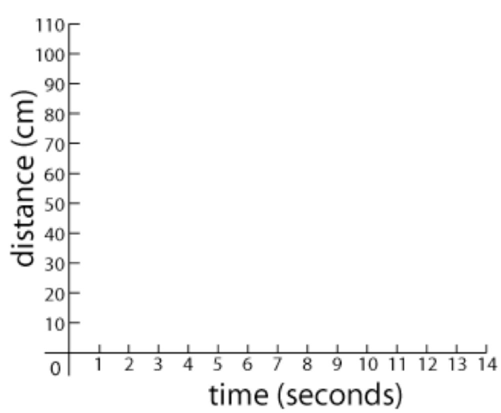
Each time you give a number answer, explain how you know.

2A. In the movie, when did Yari go *fastest*? (circle your answer.)
Beginning Middle End

2B. In the movie, when did Yari go *slowest*? (circle your answer.)
Beginning Middle End

3. Using the movie and stop action, fill in the table and make the graph.

seconds	cm
1	
2	
3	
4	
5	
7	
10	



Our First Cell Phone Game

Our programmer has made our first cell phone game. It has a picture of Rita, The Red School Bus, which is used in the game.

We want to compare the motion of the classic windup toy Yari to our character in the cell phone game named Rita, The Red School Bus.

1. Open the Java MathWorlds file named *FirstGame1.smw*. Use the play button to watch the trip of the character in the simulation and the graph. Run the simulation as many times as you need to answer the following.

   A. How many centimeters (cm) did Rita travel?

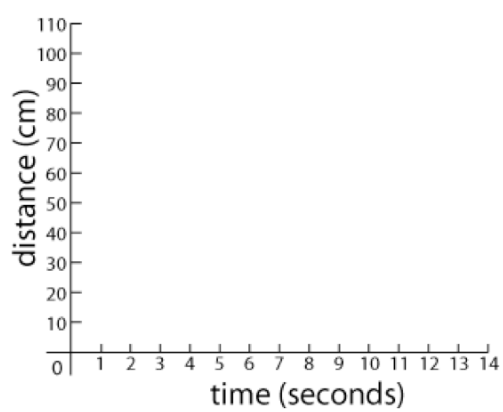
   B. How many seconds did Rita travel?

   C. What was the Rita's speed?

2. Using step and play, watch how the graph builds as the character moves. Explain how the graph and the simulation are related.

3. Complete the table below:

seconds	cm
1	
2	
3	
4	
5	
7	
10	



4. Describe how

   A. the trips of the cell phone character and the real windup toy are *the same*.

   B. the trips of the cell phone character and the real windup toy are *different*.

For Your Information

In mathematics, we often simplify things so that we can work with them. Two ways we simplify are using averages and creating models. Rita is a model of the classic windup toy, Yari. The cell phone game character is a *model* of the real windup toy. It simplifies the motion of the windup toy. Models always simplify the “real thing” in some ways.

Controlling Characters with Graphs: Texas Road Rally

We need to set up the mathematics controllers for the new game, *Texas Road Rally*. We can use graphs to control motion. Remember: we'll make the game cool later!

In road rally races, cars compete as they travel from town to town.

For Your Information

Graphs, tables and equations are mathematical representations. Each can show the same motion in a different way.

1. Open *Roadrally1.smw*. It shows the Yellow Rose team car in the Texas Road Rally. The car starts in El Paso and stops in Big Spring. Run the file, watching the simulation and graph.

   A. When the car stops, how far has it traveled and how much time has passed?

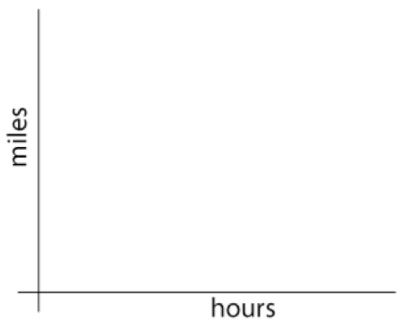
   B. When the car has traveled for one hour, how far has it gone?

   C. How fast is this car going? Explain how you know in two ways. Think about your answers to A and B or use other ideas.

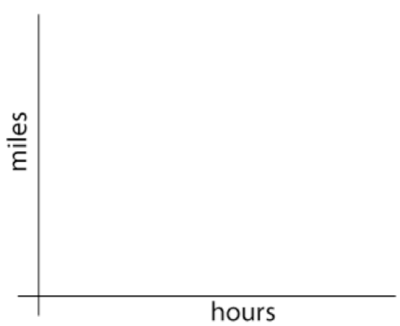
   D. Change the speed of the car using the graph window. It still must start in El Paso and stop in Big Spring. Use the same ideas to find the new speed. What is the new speed?

2. Open but DO NOT RUN *Roadrally2.smw*. It shows graphs of the Yellow Rose team car and the Longhorn team car ready to travel from San Antonio to Beaumont.

   A. Sketch the graph of the two cars' trips on the same axes and fill in the boxes.

	Speed of Each Car	Fastest Car

   B. Use the graph window to change the speed of each car so that the other car is faster this time. Now fill in the same information as in A.

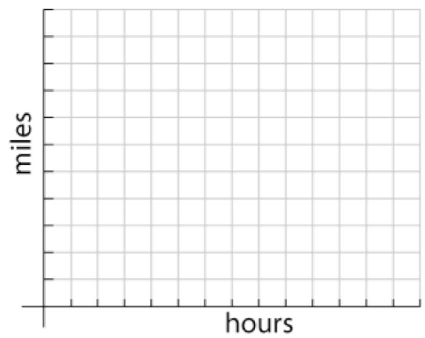
	Speed of Each Car	Fastest Car

   C. By looking at the position/time graphs of two cars in a rally, how can you predict which one will win?

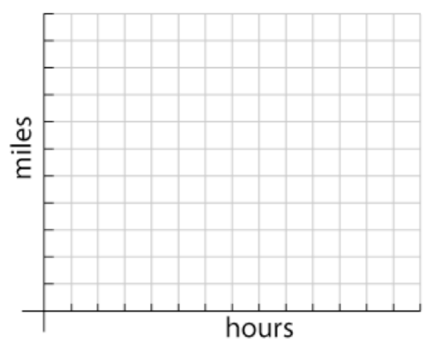
   D. Explain how the cars' speeds and their graph lines are related to one another.

3. Below are ideas to use in other games. Please help our programmers by drawing graphs on the axes provided. Test out your graph using *Roadrallytest3.smw*. Make up your own characters for the Green Iguana and Blue Sky team cars. *Note: There is more than one way to draw the graph for most of these*.

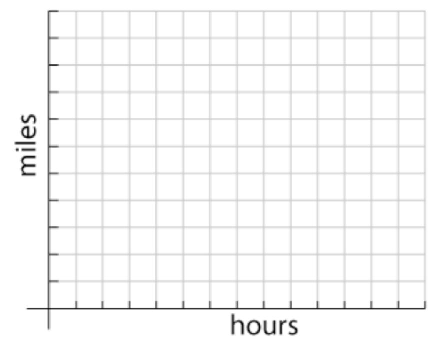
   A. Draw a graph of a race in which the Green Iguana and Blue Sky team cars start at the same position and travel the same distance but at different speeds.



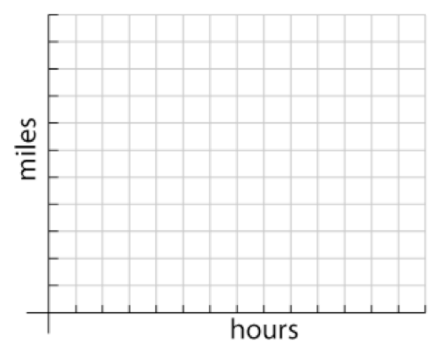
   B. Draw a graph of a race in which the two characters start at the same position and travel the same amount of time, but Green Iguana is faster than Blue Sky.



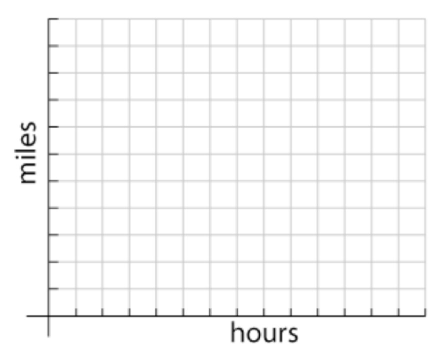
C. Draw a graph of a race in which the two characters start at the same position and travel the same distance, but Blue Sky finishes two hours before Green Iguana.



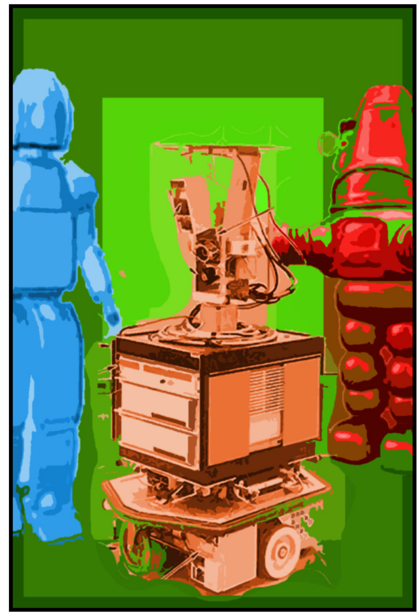
D. Draw a graph of a race in which Green Iguana starts at the starting line (0 miles), and Blue Sky starts 50 miles ahead (50 miles). The two characters finish at the same position and the same time.



E. Draw a graph of a race in which Green Iguana starts at the starting line and Blue Sky starts 50 miles ahead. The two characters travel at the same speed and travel the same distance.



Controlling Characters with Equations



So far, our graphs of moving characters have shown the relationship between time and position—where the character is at what time.

Equations show that same relationship with numbers and symbols. This means: give us any time, and we can find the position of the character at that time.

We need to be able to control our characters with graphs as well as equations (also called algebraic expressions). The equations are so efficient!

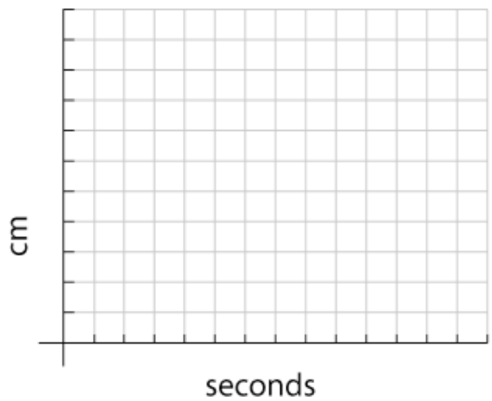
Let's work on a game with robots. We need to set up the mathematics to make our robot move at different speeds.

1. Open *Shakey.smw*, which shows Shakey the Robot.

   A. Run the simulation. How fast is Shakey going? How do you know?

B. Look at the table, the graph, and the algebraic expression window. Record the graph, table, and equation below.

Graph



Table

x (seconds)	y (cm)
0	
1	
2	
3	
4	
5	
10	

Equation

C. To answer these questions, run the *Shakey.smw* file using step as much as you need to.

- How is time represented in the table? In the equation?

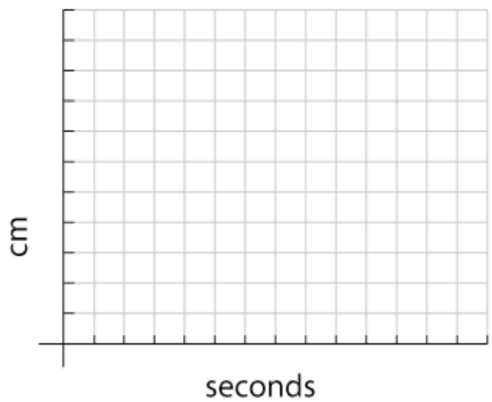
- How is position represented in the table? In the equation?

- How is speed represented in the table? In the equation?

D. Change the graph so that Shakey moves slowly. Write down the table and equation for each graph. Then make Shakey move fast and write down the new information.

Slow Shakey

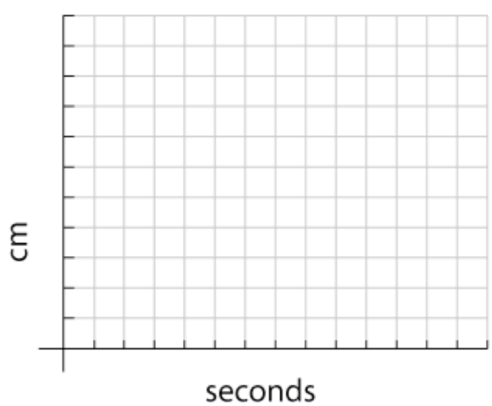
Graph **Table** **Equation**



x (seconds)	y (cm)
0	
1	
2	
3	
4	
5	
10	

Fast Shakey

Graph **Table** **Equation**



x (seconds)	y (cm)
0	
1	
2	
3	
4	
5	
10	

E. Describe how to write an equation if you have the table and graph that go with it. Use the tables, graphs, and equations above to help you.
If you are not sure yet, just make your best guess.

2. Let's try another way to learn how to write equations from tables. No more algebra and table windows to help! Open *Roberta.smw*.

Variables and Letters

Here we use t and p as the variables in our equations instead of x and y.

A. First, fill in the p column in the table below.
Fill in the mathematical rule to get p, when you know t.

Roberta

t (time in seconds)	Rule to get p	p (position in cm)
0		0
1		
2		
3		
4		
5		
10		
t		p

1st: Describe the pattern in the time column.

2nd: Describe the pattern in the position column.

3rd: Use those patterns to find the relationship that connects the time and the position in each row.

B. For every second that Roberta travels, how many centimeters does the robot move?

At what rate does Roberta move?

How does this rate relate to your rule?

Describe the pattern in the position column.

Use those patterns to find the relationship that connects the time and the position in each row.

C. Write the equation that will work for any row that could be in the table.

3. Open *Gliderhal.smw*. Go through the same steps as in Question 2 to find the equation for these two robots' motion.

Glider

t (time in seconds)	**Rule to get p**	**p (position in cm)**
0		0
1		
2		
3		
4		
5		
10		
t		p

1st: Describe the pattern in the time column.

2nd: Describe the pattern in the position column.

3rd: Use those patterns to find the relationship that connects the time and the position in each row.

Equation:

Hal

t (time in seconds)	**Rule to get p**	**p (position in cm)**
0		0
1		
2		
3		
4		
5		
10		
t		p

1st: Describe the pattern in the time column.

2nd: Describe the pattern in the position column.

3rd: Use those patterns to find the relationship that connects the time and the position in each row.

Equation:

4. Explain, in your own words, how to use a table to find an equation that represents a character's motion.

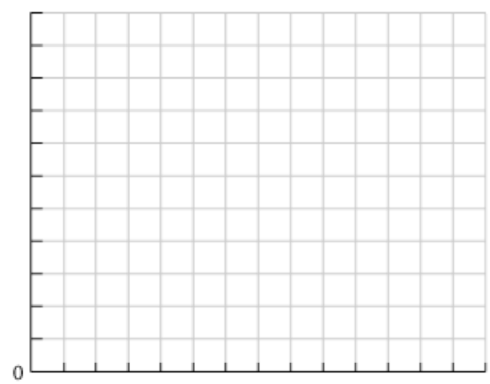
5. Use what you have learned to help Monica figure out the relationship between her salary and the time (number of months) she works.

   Monica is one of TexStar's best programmers. Every month, she earns a salary of $8,200. The programming team took the weekend off—they only left us a blank table to use. So, you have to do most of the work this time.

   Make a representation (graph, table, or equation) so that she can choose any month (where January is month 1) and find out how much she has earned so far that year.

   Equation:

Months		**$ earned**



One to Another

You have seen how graphs, equations and tables can each represent a character moving at a certain speed. Now complete all the representations for each speed or rate. The axes of each graph are labeled for you.

You can use any variable when writing equations. In “Controlling Characters with Equations,” we used t for time and p for position. In most, we used x and y. Name your own variable for each situation below. Just make sure that you use the same variables in your table and equation.

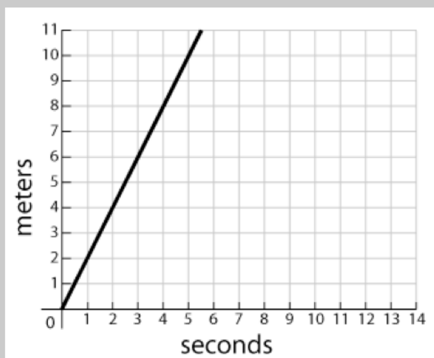
Example:

Gonzalo runs at a constant speed of 2 meters every second.

Table

_x_ (seconds)	_y__ (meters)
0	0
1	2
2	4
3	6
5	10

Graph



Equation

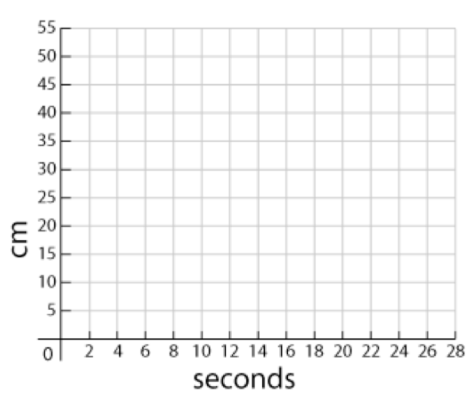
$y = 2x$

1. A toy robot moves on average 4 centimeters every 2 seconds.

Table

___ (seconds)	___ (cm)
0	0
24	

Graph



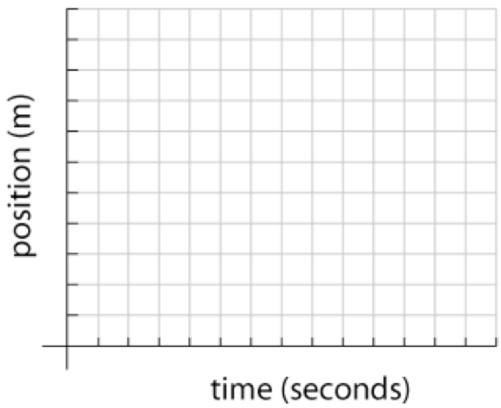
Equation

2. A sloth moves on average ___ meters every ___ second.

Table

___ (seconds)	___ (m)
0	0
60	

Graph



Equation

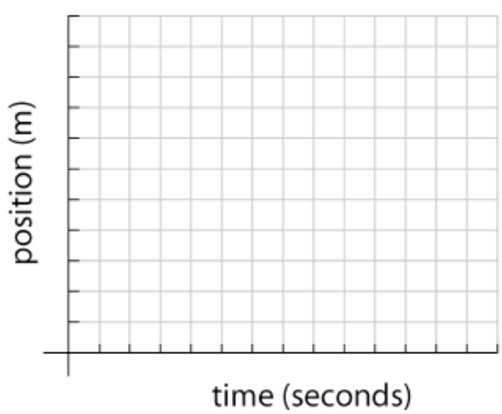
$p = .5\,t$

3. An Australian Tiger Beetle runs on average 2.5 meters every ____ seconds.

Table

___ (seconds)	___ (m)
0	0
30	15

Graph



Equation

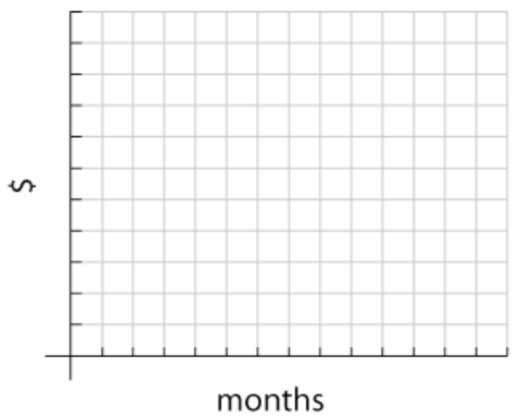
4. Instead of speed—or rate of motion—we can make the same representations for other rates, such as money earned per month.

   A. Sergei, a beginning game designer at our company, earns an average of $5,000 per month.

Table

___ (months)	___ ($)
0	0
12	

Graph



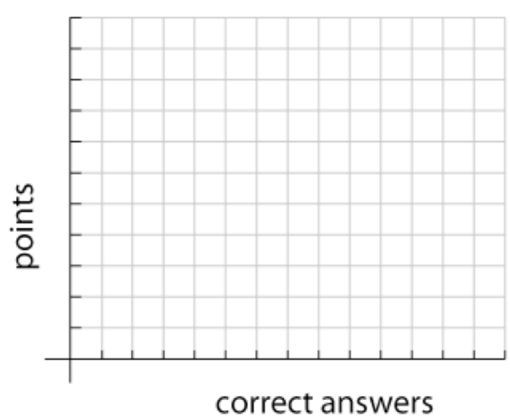
Equation

   B. In a quiz game, players get ____ points for every correct answer.

Table

___ (correct answers)	___ (points)
0	0
	27

Graph



Equation

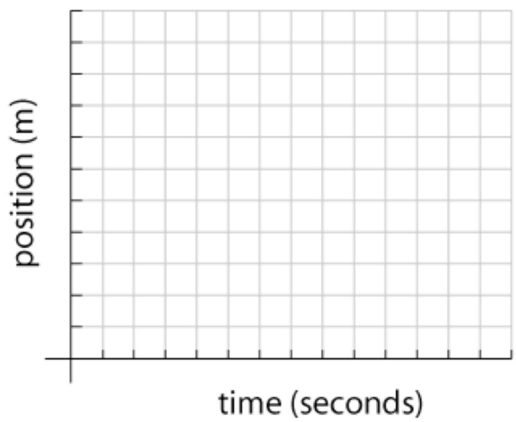
$$p = 3a$$

5. A toy car moves ____ meters every ____ second.

Table

____ (seconds)	____ (m)
0	0
16	4

Graph



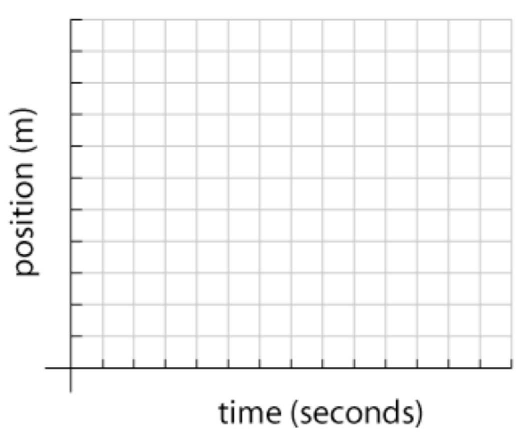
Equation

6. A helicopter flies up into the sky at 5 meters per second.

Table

___ (seconds)	____ (m)
0	0
	75

Graph



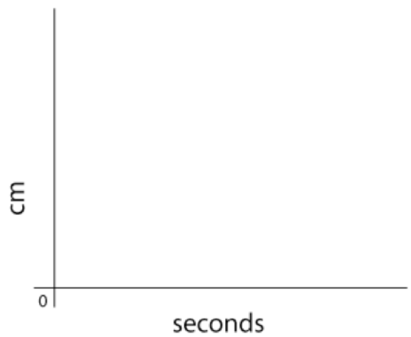
Equation

Better Games

We need to make mathematical controls for Reynaldo, Bommakanti, and Geneva, who will be used in a retro arcade game for cell phones. The equations are more complicated because these characters all start at different places.

Open *Better1.smw*.

1. Run the simulation. Predict what the graph will look like for each character's motion, by sketching three lines on the axes below. Don't forget to label your lines.



2. Now open the graph window. Run the file several times. Pay attention to the graph and the simulation and how they work together.

   A. Was your prediction right? Explain why or why not.

   B. Where did each character begin its motion? How does the graph represent this?

   C. What is the speed of each character?

   Which character was fastest?

   Which character was second fastest?

   Which character was slowest?

   D. How did you know which character was fastest?

3. You can find the equations for these characters' movements, using the method we learned in "Controlling Characters with Equations."

   A. Let's start with Reynaldo. We want to find the mathematical rule to get p, when you know t.

1st: Describe the pattern in the time column.

2nd: Describe the pattern in the position column.

3rd: Use those patterns to find the relationship that connects the time and the position in each row.

t (time in seconds)	**Rule to get p**	**p (position in cm)**
0		5
1		
2		
5		
10		
t		p

Equation:

   B. For every second that Reynaldo travels, how many centimeters does he move? How does this relate to your rule?

   C. Write the equation that will work for any row that could be in the table.

The equation for finding p when you know t is:

$$p = \_\_\_\_ \, t + 5$$

D. Write the three steps from question 3C in your own words. Use the same steps for Geneva and Bommakanti to find equations for their motions.

Geneva

t (time in seconds)	Rule to get p	p (position in cm)
0		10
1		
2		
3		
4		
5		
10		
t		p

1st:

2nd:

3rd:

Equation:

Bommakanti

t (time in seconds)	Rule to get p	p (position in cm)
0		0
1		
2		
3		
4		
5		
10		
t		p

1st:

2nd:

3rd:

Equation:

4. For A—D below, use math to describe the motion for one character only. Do the following:

   - Decide on a start position and speed for your character.
   - Fill in the equation that will go with it.
   - Sketch the graph that will go with it and label your axes.
   - Use the file, *Better4.smw*, to see if you were right. If you were not right, correct your equation.

A.
Start position:

Speed:

Equation:

B.
Start position:

Speed:

Equation:

C.
Start position:

Speed:

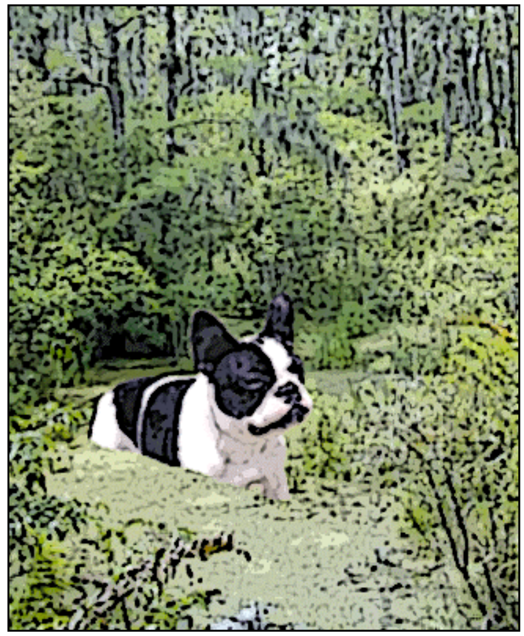
Equation:

D.
Start position:

Speed:

Equation:

Wendella's Journey: Moving At Different Speeds



In our game, *Lost in the Pines*, Wendella the dog makes many journeys through the magical Lost Pines Woods.

On her journeys,

- Wendella moves
  - *Forward slowly* when she is in the swamp.
  - *Forward faster* when she is on the road.
- Wendella *stops* and barks for help when she is in quicksand.

We need many journeys and stories to use in our game. Help us set up the math and tell the story for each journey. Your work is very important. Remember—you are doing the math that will make the game work.

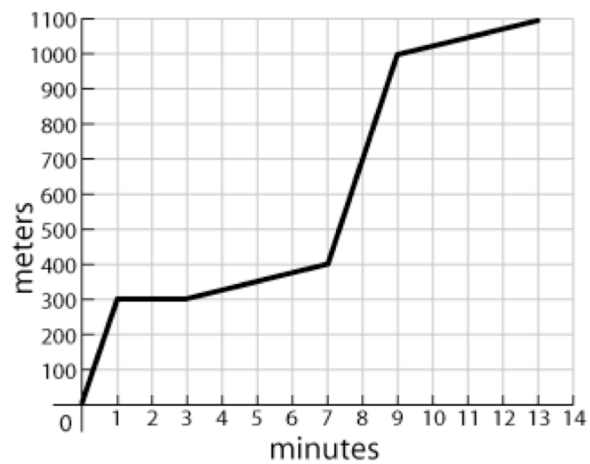
1. Open BUT DO NOT RUN the file for Wendella's first journey, *Wendella1.smw*.

   Using the graph for this journey, predict how Wendella will travel. Finish the story below.

Wendella started out fast on the road. She was happy to be on her journey. Then…

2. Here is a different journey that Wendella took.

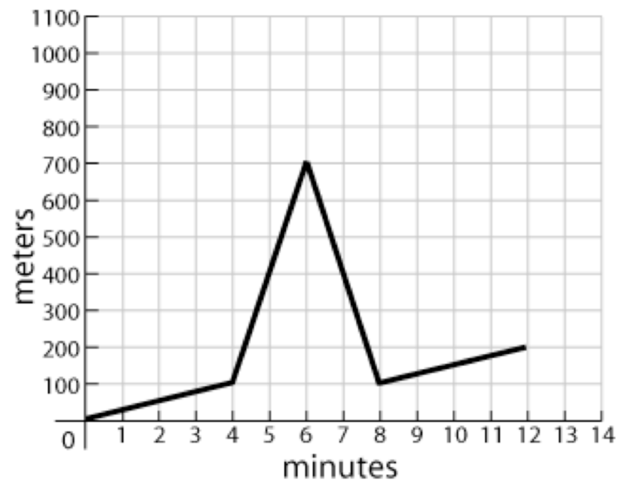
   A. Mark on the graph below, show when Wendella was in the swamp, in the quicksand, and on the road. Mark the times on the minutes axis.



   B. For each line segment in the graph above, find the number of minutes Wendella traveled, the number of meters she traveled, and her speed. You can make a table to keep it all organized.

   C. Choose one line segment in the graph—not the first one—and explain how you found Wendella’s speed for that segment.

3. Open the file *Wendella3.smw* for the third journey. The graph is also shown below.



A. Run the file. Wendella does something new here!
   Write a story to go with Wendella's journey.

B. What did Wendella do 6 minutes after starting this journey?

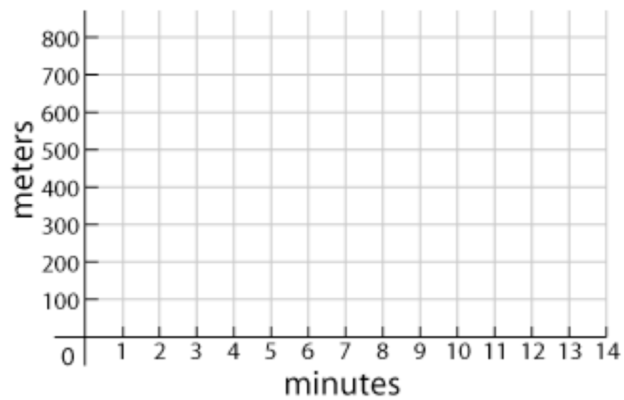
C. How does the graph show this motion?

D. What is her speed between 6 and 8 minutes?

4. Open the file *Wendella4.smw*, and do the following.

   A. Change the graph so that Wendella goes forward and backward at least twice in her journey. Run the graph to make sure it works.

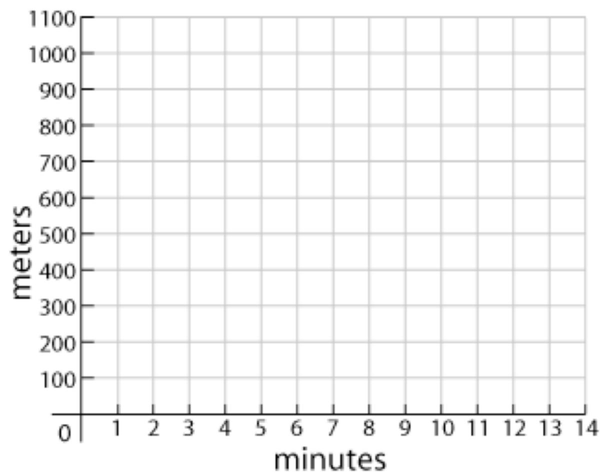
   B. Record your graph on the axes provided.



   C. Write a story to go with this Wendella journey.

   D. One of the programmers doesn't understand what is happening in the graph. Explain how to use the graph to get Wendella to go backward in her journey.

5. We need more journeys and stories. Using *Wendella5.smw*, make your own graph showing Wendella's next journey. Sketch the graph on the axes. Write a story to match your graph.



Story:

Money Matters

We're glad you helped us with some great designs for our cell phone games. But TexStar Games has to make money too! Please help us with some business problems.

1. We keep a record of how much money we have in the bank. When we make money, we add it to our bank account. When we spend money, we take it out of our bank account.

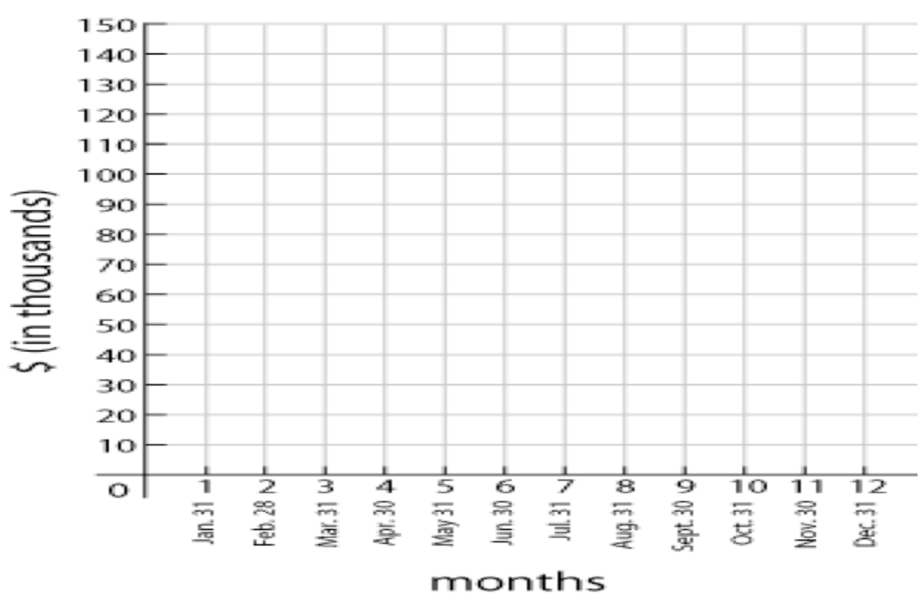
   - The amount of money (in $) that we have in the bank on any day is called our bank account balance.

   - On the last day of each month, we check our bank account balance and we graph it, comparing month to balance.

   Help us understand what happened to our bank account this year.

   A. Open the file *Bankaccount.smw*, which shows our bank account balance over the past year. Run the simulation to see how the bank account balance changed from month to month. Using the graph, simulation, and tables, answer the questions below.

      - Fill in the graph below.



- Find the following and explain how you know (from the graph, table, or simulation).

Beginning balance.	Ending balance.
Months in which our balance increased.	Months in which our balance decreased.
Month with highest increase in balance.	Months during which the balance did not change at all.
Month in which the balance was the highest.	

B. Write a sentence or two that describes what happened to our bank account balance over the year. Make up your own explanations for what might have happened. For example: The balance decreased between January and February. This is because we had to pay for a lot of artwork for a new game.

C. Our goal was to have $60,000 in our bank account by the end of the year. By how much did we miss our goal?

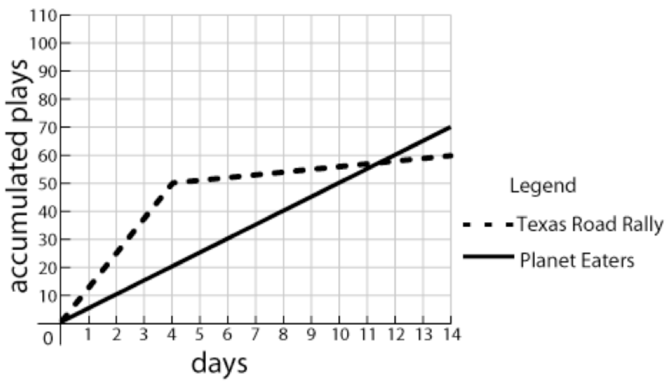
D. Our goal for next year is to end the year with $110,000 in our bank account. We would like to put the same amount of money in the bank each month. Complete the graph below to show this.

E. Use the graph you made to answer the following questions.

- How much money do we need to put in the bank each month to reach our goal?

- How can we predict what our balance will be each month?

2. We have two new games, *Texas Road Rally* and *Planet Eaters*. Next month, we want to start selling just one of them. To help us decide which one to sell, we let kids in the Electronic Gaming Afterschool Club use our games for 14 days. At the end of each day, we graphed the total number of times each game had been played altogether.



A. About how many times had each game been played after

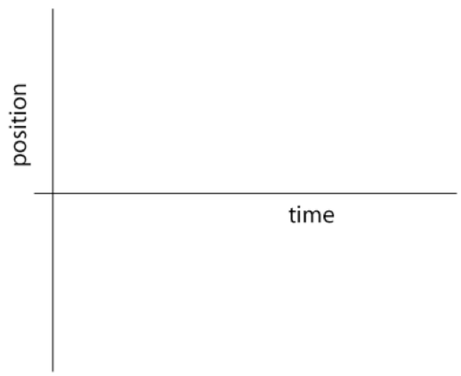
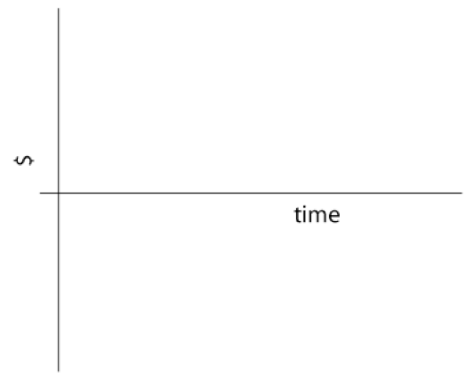
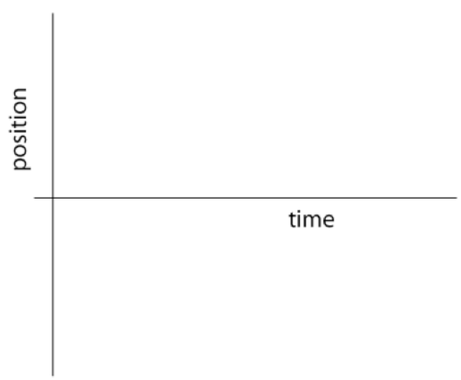
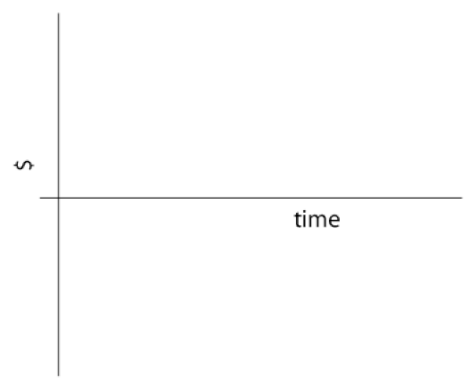
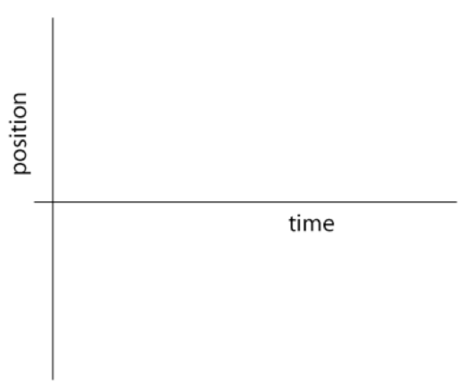
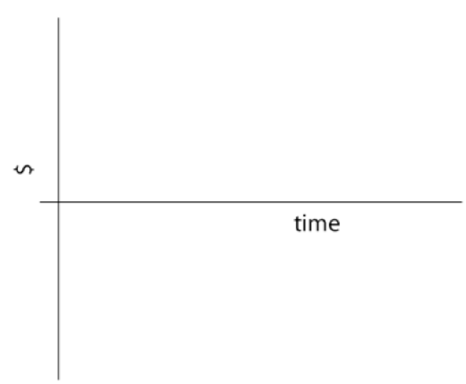
- 1 day?
- 4 days?
- 10 days?
- 14 days?

B. Compare the kids' use of the two games over the 14 days.

C. We care about selling games kids really like to play. Using the information in the graph, advise us: Which game should we start selling next month? Make your own decision, and defend it with mathematics. (There is no one right answer.)

Mathematically Speaking: Graphs to know

In order to understand graphs, it helps to know some “by sight.” Sketch a graph for each of the following movements. Use what you learned in the Wendella game and the Bank Account activity to think about these more general situations.

An object moving, then speeding up. 	A bank account with its amount increasing and then increasing at a higher rate. 
An object moving forward, then moving the backward. 	A bank account’s money increasing and then decreasing. 
An object standing still (not moving). 	A bank account whose amount is not changing. 

Crab Velocity

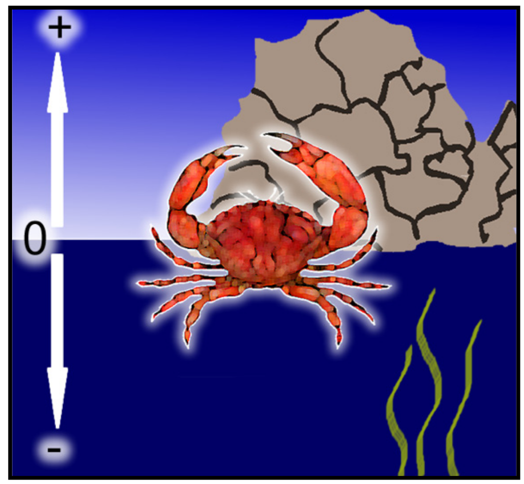
In our other games, characters can move forward and backward, or up and down. We already know how to calculate their speed. But there's a bit more to it than that. Help us learn how to use velocity in our games.

Velocity?

It's just speed—but with direction!

+ (positive) for up or forward

- (negative) for down or backward



Our crab characters, Karla and Lenny, move up and down—above the water (on the rocks) and below it. The water level is at 0 meters.

- Positive positions are above the water line.
- Negative positions are below the water line.

1. Open the file *Crab1.smw*, run the simulation, and find

- Karla's speed:
- Lenny's speed:
- Karla's velocity:
- Lenny's velocity:

2. Open file *Crab2.smw*. The graph shows the motion of Lenny, Karla and their children Dolores, Antonia, and Orlando.

   A. Find the velocity of each crab in the family.

      - Karla:
      - Lenny:
      - Dolores:
      - Antonia:
      - Orlando:

   B. Using what you already learned, write the equation for Antonia's motion.

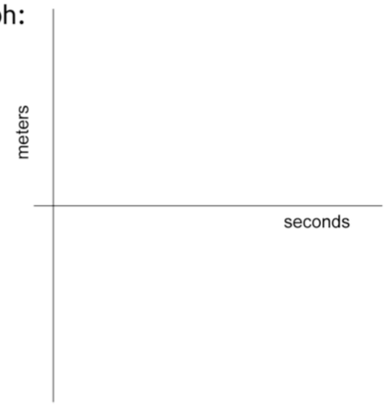
   C. Predict the equation for Dolores' motion. Use the algebraic expression window to see if you are right.

   D. Compare the equations for Antonia's and Dolores' motions.

3. Using *Crab3.smw*, make a graph for each situation below. Then, sketch the graph and write an equation for your graph. Remember, the water level is at position 0.

Crab going up, starting from water level.

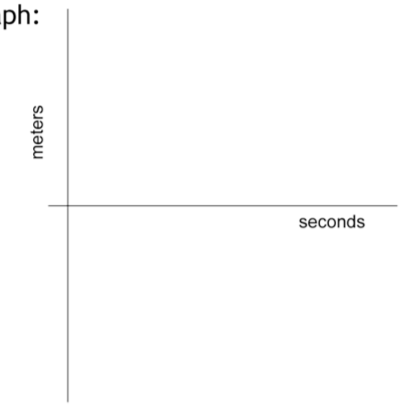
Graph:



Equation:

Crab starting from above water level and going up.

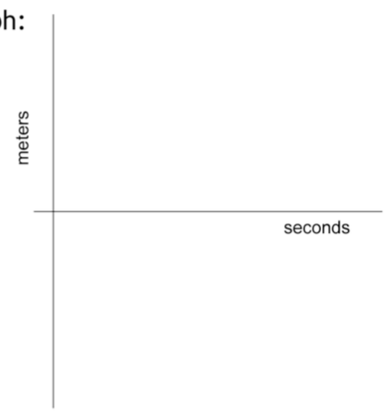
Graph:



Equation:

Crab going down, starting from water level.

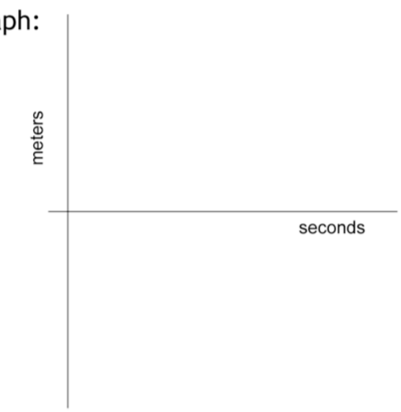
Graph:



Equation:

Crab starting from below water level and going further down.

Graph:



Equation:

4. Open *TemperatureGauge4.smw*. The graph shows the temperature inside TexStar Games' supercomputer used for running simulations. Zane, our supercomputer technician, can't run a simulation unless the computer's temperature is at least 30 degrees below freezing (-30 degrees Celsius).

   A. Find the speed of the temperature change in the supercomputer.

   B. Find the velocity of the temperature change in the supercomputer.

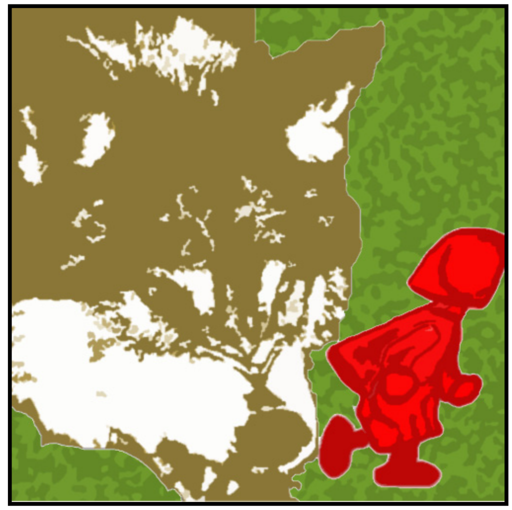
   C. If the temperature inside the computer starts at 0 degrees Celsius and the rate of temperature change stays the same, how long must Zane cool the computer before he can run a simulation? You can change the graph to help you, but you must keep the rate of temperature change the same.

      Explain how you got your answer:

   D. Change the graph so that the starting temperature is 20 degrees Celsius. If the rate of temperature change stays the same, how long must Zane cool the computer before he can run a simulation?

      Explain how you got your answer:

Wolf and Red Riding Hood



We need you to test a new game based on the fairy tale, Red Riding Hood.

In this game, Red Riding Hood (RRH) and the Wolf start from Home and move toward Grandma's House. RRH moves at two velocities during the journey. The Wolf moves at the same velocity the whole time.

The Wolf *must arrive at Grandma's House at exactly the same time as RRH.* Then he can devour her.

Help us find the "trick" so that the Wolf always arrives at exactly the same time as RRH.

1. Open *Wolf1.smw*. Use the graph to:

   A. Describe RRH's trip to Grandma's. Include how long it took her to get there and estimates of her two velocities.

   B. Predict the Wolf's velocity so that he and RRH meet at Grandma's, at exactly the same time.

   C. Test your prediction by changing the Wolf's graph and running the simulation. Were you right? Why or why not? Revise until you get it right.

2. The next round of the game is *Wolf2.smw*. Again, there are two velocities for RRH, we need to find the one for the Wolf to catch her at Grandma's House.

   A. Use the graph to find the Wolf's velocity.
      What is the Wolf's velocity?

   B. Explain how to use graphs to find the Wolf's velocity, when you have a graph of RRH's journey.

3. Use *Wolf3.smw* to predict the Wolf's velocity with an equation.

   A. Using the algebraic expression window, predict the Wolf's velocity, check and revise until you get it right.
      What is the Wolf's velocity?

   B. Explain how to use equations to find the Wolf's velocity, when you have an animation of RRH's journey.

4. We can use graphs or equations to find the Wolf's velocity. Explain the advantages and disadvantages of each.

Secrets of Average Rate Revealed

We need to use averages a lot in our work. You've already learned about averages in math class. And, you know something about them in real life. Use what you already know to find out more about average rate.

1. When playing a game *Robots Gone Awry*, Deborah gets scores of 70, 87, and 99. Use what you learned in math class to find her average, or mean score. Explain how you did it.

2. Some game designers get paid for each game they make, charging different amounts for different games. In January, the designer, Sandro, sold 3 different games.

Name of the Game	Charge for the Game
Lost in the Pines	$10,000
Robots Gone Awry	$20,000
Texas Road Rally	$6,000

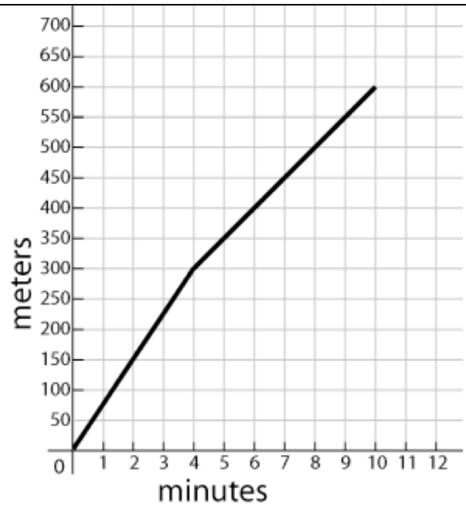
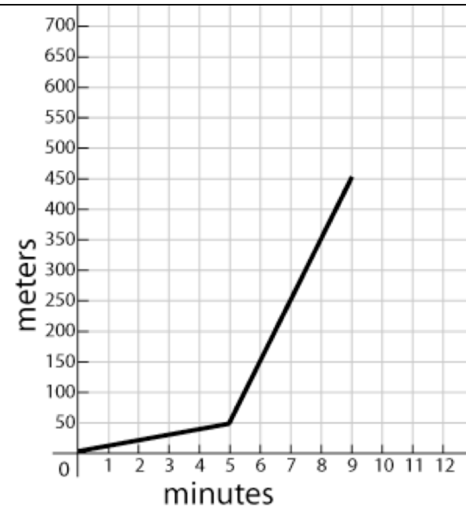
A. What was total amount of money Sandro was paid in January from selling these games?

B. Sandro would like to charge the same amount for each game. What would he have to charge for each game, in order to make the same total amount of money for January?

C. What's the average rate (in dollars per game) that Sandro was paid, in January? Explain how you know, in two different ways.

3. Speed and velocity are rates, too. *Red Riding Hood and the Wolf* can help us think about average rate, using graphs. RRH's average rate is the single rate at which she could make the same journey in the same amount of time.

   A. You've seen these graphs before. Each graph shows RRH moving at two different rates.

	
First, RRH moves at ____ meters per minute for _____ minutes. Then, she moves at _____ meters per minute for _____ minutes. Predict: What is her average rate, in meters per minute? (Hint: What was the Wolf's rate, in meters per minute?)	First, RRH moves at ____ meters per minute for _____ minutes. Then, she moves at _____ meters per minute for _____ minutes. Predict: What is her average rate, in meters per minute? (Hint: What was the Wolf's rate, in meters per minute?)

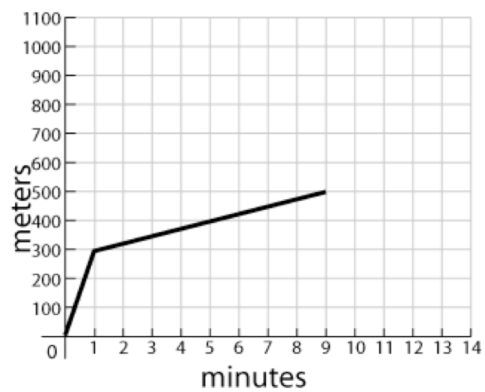
   B. Look at the work you just did in Part A. In a sentence or two, explain the relationship between RRH's average rate and the Wolf's rate.

Problem Solving

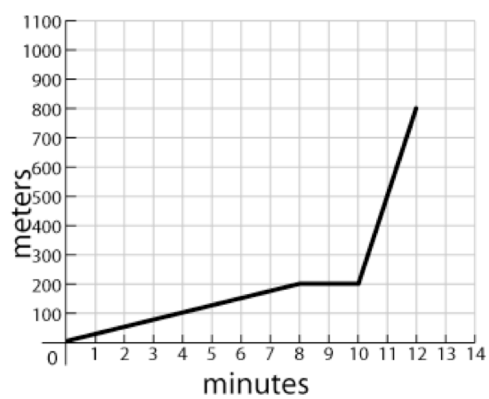
We still have other problems to solve at TexStar Games! Use all you have learned to help us with the following problems.

1. Think back to *Lost in the Pines.* Help us analyze Wendella's journeys and average rate.

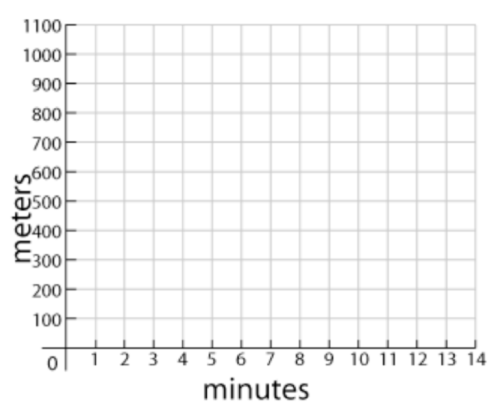
   A. What is Wendella's average rate of motion (her average speed) on this journey?



   B. What is Wendella's average rate of motion (her average speed) on this journey?



   C. Wendella went 100 meters through the swamp in 4 minutes, then 350 meters on the road in 2 minutes. Using the graph to help you, what was her average rate, in meters per minute?

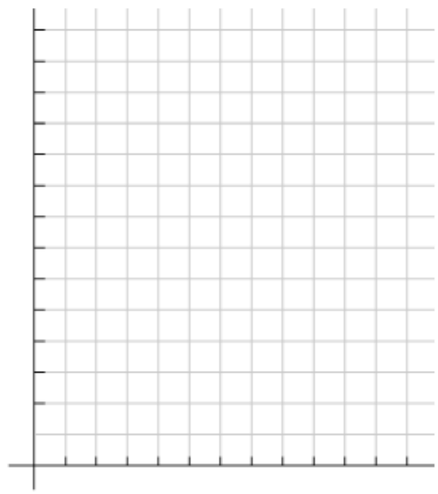


2. Marissa has worked for TexStar Games for 5 years. For the first 2 years, her salary was $50,000 per year. Then she got a big raise. For the last 3 years, her salary has been $70,000 per year.

   Marissa says, "So my average yearly salary for these 5 years has been $60,000."

   Her supervisor, Tanya, disagrees, "Actually, Marissa's average salary has been $62,000."

   The $2,000 difference matters to them! Explain who is right and why (use the graph if it helps you).



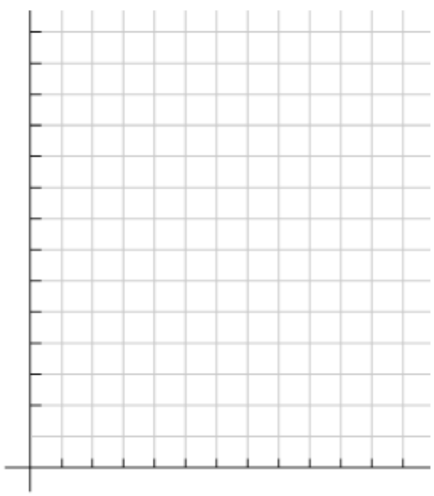
Problems from the TexStar Lunchroom

1. Our TexStar employees drink a lot of strong coffee while creating our great cell phone games. We know that with each 1.5-lb. (pound) bag of coffee, we can make 36 cups.

   A. How many pounds do we need to make 72 cups? How about 120 cups?

   B. If we have 3.5 bags of coffee left, how many cups can we make with it?

   C. Make a graph that lets us figure out how many pounds of coffee we need no matter how many cups we plan to make that day.



2. Shanae, the programmer, often writes in math symbols instead of words. She put up this ad on the company bulletin board:

   Dog sitter wanted!
   Will pay y dollars, where $y = 9x + 20$, and x is the number of hours you work.

   Explain what Shanae means in words:

3. Darrell, from the business office, is helping his son sell raffle tickets to raise money for his school. He's making a chart so that his son can quickly check that he has the right amount of money for the number of tickets he has sold. Fill in the missing numbers for him. There is no discount for buying a lot of tickets.

Tickets sold	Money Collected ($)
5	
10	25
25	
40	

4. TexStar's company plane, the SuperNova, can fly at an average speed of 225 mph. It has only enough fuel for 3½ hours of flight.

   A. Complete the table below.

City	Distance from Dallas	Travel Time	Non-stop Flight? (yes or no)
Cincinnati, OH	800		
Albuquerque, NM	580		
Chattanooga, TN	675		
Chicago, IL	795		
Athens, GA	780		

   B. Which cities can the SuperNova fly to non-stop (with only a single tank of fuel) if it starts in Dallas?

Mathematically Speaking
Linear Relationships:
Proportional and Nonproportional

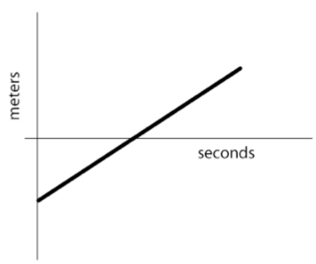
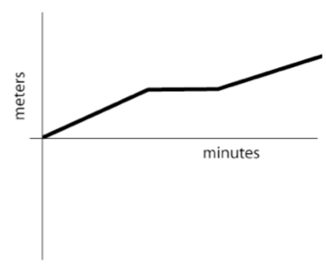
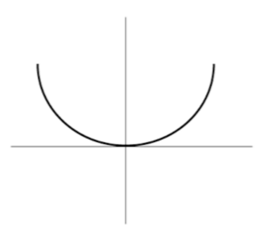
So far at TexStar Games, we have worked with relationships—for example, time and money in the bank, time and position of a character. It will help us to know mathematical terms for some of these different relationships.

Your task: Help us categorize relationships to make our work more efficient.

Linear Relationships vs. Nonlinear Relationships

1. In this unit, and in the math you will study in high school, we say:
   A linear relationship has a graph that is a single straight line.

Put a check by the representations of linear relationships and explain.

	
☐ Linear ☐ Not Linear Why?	☐ Linear ☐ Not Linear Why?
$y = 3x$	$y = x^3$
☐ Linear ☐ Not Linear Why?	☐ Linear ☐ Not Linear Why?
$y = 4x-3$	
☐ Linear ☐ Not Linear Why?	☐ Linear ☐ Not Linear Why?

Linear Relationships: Proportional vs. Nonproportional

2. Use this memo from Dora to help you think about linear relationships that are proportional and linear relationships that are NOT proportional. Reply to Dora in the spaces provided.

Hey - check this out. I have been looking at the numbers when a Planet Eater starts from the Sun (at zero) or some other place.

Table A shows the relationship between time and position when a character starts at 0.

Table A

Time	Position
1	3
2	6
4	12
5	15
10	30

x 2 x 2

I worked out the equation as y = 3x and I noticed a pattern between the rows here.

When time is 2, position is 6. Double 2 to get 4, and double 6 to get 12. Sure enough, when time is 4, position is 12.

So I can use doubling or multiplying to get one row from another. I think that works for any two rows in this table.

A. Try it yourself. Choose two rows and explain how to get one from the other using multiplication.

B. Would this work with ANY two rows, even if I kept making new rows for this character's motion?

Why or why not?

Table B shows the relationship between time and position when a character starts at 2.

Table B

Time	Position
1	5
2	8
4	14
5	17
10	33

C. How about in this table: Can I double the numbers in a row, and get numbers from another row?

3. Dora uncovered two kinds of linear relationships. Fill in the properties of each below, using the relationship between time and distance in motions to help you think it through.

Motions starting at 0.	**Motions starting at some place other than 0.**
Example equations:	Example equations:
Example graphs:	Example graphs:
We call relationships with these properties **proportional linear relationships.** They have equations where: They have graphs that:	We call relationships with these properties **nonproportional linear relationships.** They have equations where: They have graphs that:

4. Go back through your workbook and find two **proportional linear relationships**. Write a sentence describing the relationship. Fill in the equation, table and graph for each.

x	y

Sentence:

Graph:

Equation:

x	y

Sentence:

Graph:

Equation:

5. Go back through your workbook and find **nonproportional linear relationships.** Write a sentence describing two of them below. Also, fill in the graph, equation and table for each.

x	y

Sentence:

Graph:

Equation:

x	y

Sentence:

Graph:

Equation:

6. Label each relationship as proportional or nonproportional. You can use a graph, table, or equation to help you decide.

   A. A toy begins at 0 cm, the “start” line of a race, and moves at a constant rate of 3 cm per second.
   Relationship between time and the toy’s position?

   B. A character starts out 5 cm in front of the “start” line and moves at a constant rate of 3 cm per second.
   Relationship between time and the toy’s position?

   C. A game designer earns $5,000 per month.
   Relationship between number of months on the job and total dollars earned?

   D. A game design company has $50,000 in a bank account. They take $4,500 out of the bank to pay for each animation they need.
   Relationship between money in the bank account and the number of animations paid for?

   E. You pay $10 to join the PlayCell game club. Then you pay only $1 for each game you buy.
   Relationship between total dollars ($) paid and the number of games bought?

7. How did you decide whether a relationship was proportional or nonproportional?

TexStar Games: Going Full-Time

Your co-workers at TexStar Games were very pleased with what you have done. You've helped them improve their work, you are such a hard-worker, and you have also learned the math that is important to future success.

There are several openings at TexStar Games, and many people think you would be an asset to the company. Fill in the letter of application below so that Ms. Bahey, our Hiring Manager, will know your strengths and interests.

Desired Position:

☐ Designer ☐ Programmer ☐ Artist ☐ Business Staff

Dear Ms. Bahey,

Thank you for the opportunity to work for your company. I have learned a lot about the challenges that come with a growing business like TexStar Games, Inc. I also realized how useful math can be in various aspects of your company. For example, *(list specific examples of what you learned)*

A number of TexStar employees have said that my math skills were valuable in addressing their problems. In particular, *(give 2-3 examples)*

In addition, I have other experiences and interests that can help improve your business. *(List examples like I am an avid cell-phone gamer myself; or I create computer graphics in my spare time.)*

I hope you will give my application your kind consideration. I am looking forward to helping TexStar Games create the most popular, fun and educational cell phone games in the country!

Respectfully yours,

____