Lab Template

Text: Financial Algebra
Volume: 1   **Chapter: Prepare a Budget**
Unit number: 10   **Title of unit: Electronic Utilities**
Developed by: Lisa Williksen
Date: June 27, 2012

Attach the Following Documents:
1. **Lab Instructions**
2. **Student Handout(s)**
3. **Rubric and/or Assessment Tool**

Short Description (Be sure to include where in your unit this lab takes place):

> This lab will have student find several different cell phone, cable TV and internet provider plan offers and then determine which plan is best for particular customers.

Electronic Utility Choices

LAB PLAN

TEACHER: *Lisa Williksen*

- ⚔ **Lab Objective**
  - ⚔ *For students to recognize that different electronic plans are better for certain customers than others and how important it is to realistically recognize their plan needs and then using mathematical calculations determine which plan is best suited for particular customers and ultimately for the student themselves.*
  - ⚔ *Understand piecewise functions*
  - ⚔ *Understand how to write piecewise functions to represent your electronic bill plan*
  - ⚔ *Understand how to determine your electronic device bill through your personal usage*
  - ⚔ *Understand how to compare different electronic utility plans to determine which one is best to meet personal needs*

- ⚔ **Statement of prerequisite skills needed**
  - ⚔ *Completion of Chapter 10, Section 2 before beginning this lab*
  - ⚔ *Understanding of piecewise functions*
  - ⚔ *Understanding of solving algebraic equations*
  - ⚔ *Knowledge of domains and ranges*

- ⚹ **Vocabulary**
  - ⚹ **Piecewise Function –** A set of function rules for each domain of a functions where f(x) is computed differently for depending upon the value of x
  - ⚹ **Domain –** the set of all values of the independent variable (x) in an ordered pair
  - ⚹ **Range –** the set of all values of the dependent variable (y) in an ordered pair that correspond to a given set of x-values.
  - ⚹

- ⚹ **State Standards addressed:**
- ⚹ **Math:** (Common Core State Standards)
  - ⚹ **A-SSE Interpret the structure of expressions**
  - ⚹ 1a – Interpret parts of an expression, such as terms, factors and coefficients.
  - ⚹ **F-IF Analyze functions using different representations**
  - ⚹ 7a – Graph linear and quadratic functions and show intercepts, maxima, and minima
  - ⚹ **F-IF Analyze functions using different representations**
  - ⚹ 7b – Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions

- ⚹ **Reading:** (Common Core State Standards)
  - ⚹ Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

- ⚹ **Leadership:**
  - ⚹ **1.1 -** Student will analyze, refine & apply decision-making skills through classroom, family, community, and business and industry experiences.
  - ⚹ **1.4 -** Student will be involved in activities that require applying theory, problem-solving, and using critical & creative thinking skills while understanding outcomes of related decisions.
  - ⚹ **2.1 –** Student will communicate, participate, and advocate effectively in pairs, small groups, teams and large groups in order to reach common goals.
- ⚹ **Writing:**
  - ⚹ **2 –** The student write in a variety of forms for different audiences and purposes.
  - ⚹ **3 –** The student writes clearly and effectively
  - ⚹ **SCAN Skills/Workplace Skills:**
    Basic Skills
    C. Identifies relevant details, facts and specifications
    Writing
    A. Communicates thoughts, ideas, information, and messages in writing
    B. Records information completely and accurately
    Mathematics
    A. Approaches practical problems by choosing appropriately from a variety of
    mathematical techniques.
    B. Uses quantitative data to construct logical explanations for real world situations

Speaking
    A. Organizes ideas and communicates oral messages appropriate to listeners and situations
    B. Participates in conversation, discussion, and group presentations

Thinking Skills

Decision Making- Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternatives.

Reasoning
    A. Discovers a rule or principle underlying the relationship between two or more objects that applies it in solving a problem
    B. For example, uses logic to draw conclusions from available information, extracts rules or principles from a set objects or written text

- **Teacher Preparation:** *(What materials and set-up are required for this lesson?)*
  - Materials: Computer access for each pair of students to find Internet providers & plans, cable/satellite TV providers & plans, cell phone providers & plans
  - Set-Up Required: Printing the lab worksheets for each pair.
  - Sample website: http://www.duglin.net/2011/02/cell-phone-plan-comparison-chart.html
  -

- **Lab Organizational Strategies:**
  - Cooperative Learning: Students will be working in pairs
  - Expectations: Completion of the lab worksheet and 3 different plan comparison tables created by each pair
  - Time-line: 2 days

- **Post Lab Follow-Up/Conclusions** *(to be covered after student completes lab)*
  - Discuss real world application of learning from lab: That students take away an understanding of how to create a comparison of different plans, the value of being a careful consumer and the validity of performing calculations to determine the appropriate cell phone, cable TV and internet service plans
  - Career Applications: Understanding on how to create comparison tables for marketing purposes or evaluations on product purposes for business.
  - Optional or Extension Activities: Students could review this lab with their parents to determine if their family cell phone, cable TV and internet service providers are appropriate for their family needs.

Electronic Utility Comparison Lab

Your mission, should you accept, is to compare cell phone, cable TV, and internet service providers in your area to determine which provider's plan offer is the most cost efficient for your family budget.

I.   Cell Phone Comparison – Your first mission is to create a comparison chart for cell phone plans in your area. Before you begin, it is important to ask yourself exactly what your cell phone usage needs are and then to plan and create your comparison chart from this perspective.

      A.   Instructions

          1.   Determine 4 cell phone carriers in your area that you would consider using.

          2.   Ask yourself what features are important to you and require comparison between providers:

               a)   Do you text a lot or not at all?

               b)   How long do you talk on the phone?

               c)   Do you use your phone for emergencies only?

               d)   Do you access the internet on your phone?

               e)   Do you need a family or individual plan?

               f)   How important are mobile-to-mobile minutes?

               g)   Do you mainly use your phone at night or during the day?

               h)   Any other features that are important to you?

          3.   Create your comparison chart to document each provider and their plans. You must include data from at least 4 different providers with a minimum of 10 different plan offers. Your chart should be well organized and easy to read.

          4.   Figure out the average monthly total for each of the plans on your comparison plan using your typical monthly usage of voice minutes, data, text messages, etc. Be sure to include your monthly usage averages that you used for your calculations.

          5.   What other considerations should you discuss before switching plans immediately today if you found a cell phone plan that is less expensive than the plan you're using? Fully explain in complete sentences.

II.   Cable/Satellite TV Providers – Your second mission is to create a comparison chart for TV cable/satellite providers and plans in your area. Before you begin, it is important to ask yourself exactly what features you use or wish you had on your TV. Next you need to create your comparison chart from this perspective.

      A.   Instructions

          1.   Determine 4 TV cable/satellite carriers in your area that you would consider using.

          2.   Ask yourself what features are important to you and require comparison between providers. You need to list the questions that you considered about your usage.

               a)

               b)

c)

d)

e)

f)

g)

3.   Create your comparison chart to document each provider and their plans. You must include data from at least 4 different providers with a minimum of 10 different plan offers. Your chart should be well organized and easy to read.

4.   Figure out the average monthly total for each of the plans on your comparison plan using your typical monthly usage. Be sure to include your monthly usage averages that you used for your calculations.

5.   What other considerations should you discuss before switching plans immediately today if you found a cable/satellite TV plan that is less expensive than the plan you're using? Fully explain in complete sentences.

III.   Internet Service Providers – Your third mission is to create a comparison chart for Internet Service providers and plans in your area. Before you begin, it is important to ask yourself exactly what features you use or wish you had on your internet service. Next you need to create your comparison chart from this perspective.

A.   Instructions

1.   Determine 4 internet service providers in your area that you would consider using.

2.   Ask yourself what features are important to you and require comparison between providers. You need to list the questions that you considered about your usage.

a)

b)

c)

d)

e)

f)

g)

3.   Create your comparison chart to document each provider and their plans. You must include data from at least 4 different providers with a

minimum of 10 different plan offers. Your chart should be well organized and easy to read.

4.   Figure out the average monthly total for each of the plans on your comparison plan using your typical monthly usage. Be sure to include your monthly usage averages that you used for your calculations.

5.   What other considerations should you discuss before switching plans immediately today if you found a cable/satellite TV plan that is less expensive than the plan you're using? Fully explain in complete sentences.

Washington Applied Math Council

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Financial Algebra Chapter 10 Section 2

Electronic Utility Comparison Lab Rubric

Category	4	3	2	1
Neatness and Organization of Comparison Charts	The work is presented in a neat, clear, organized fashion that is easy to read.	The work is presented in a neat and organized fashion that is usually easy to read.	The work is presented in an organized fashion but may be hard to read at times.	The work appears sloppy and unorganized. It is hard to know what information goes together.
Strategy and Procedures to create Comparison Charts	Typically, uses an efficient and effective strategy to solve the problem(s).	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.
Mathematical Reasoning	Uses complex and refined mathematical reasoning to calculate plan offers.	Uses effective mathematical reasoning to calculate plan offers.	Some evidence of mathematical reasoning to calculate plan offers.	Little evidence of mathematical reasoning to calculate plan offers.
Working with Others	Student was an engaged partner, listening to suggestions of others and working cooperatively throughout lesson.	Student was an engaged partner but had trouble listening to others and/or working cooperatively.	Student cooperated with others, but needed prompting to stay on-task.	Student did not work effectively with others.
Accuracy of Data Entry of selected plans	Data is accurately entered and displayed; including all calculated data.	Majority of data is accurately entered and displayed; including all calculated data, with only a minor error.	Majority of data is accurately entered and displayed; including all calculated data, with only a couple of minor errors.	Majority of data is not accurately entered and displayed; including all calculated data.
Explanation of selected plans	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components	Explanation is difficult to understand and is missing several components OR was not included.

Lesson Plan

Text: Financial Algebra
Volume: 1   **Chapter: Prepare a Budget**
Section number: 10-2   **Title of unit: Electronic Utilities**
Developed by: Lisa Williksen   williksenl@evsd.org
Date: June 27, 2012

Short Description (Be sure to include where in your unit this lesson takes place):

> This lesson covers Chapter 10 Section 2 which helps students understand expensive electronic devices are to personal utility budgets and how to best manage/monitor these expenses.

LESSON PLAN

TEACHER: Lisa Williksen

- **Lesson Objectives:**
    - Understand piecewise functions
    - Understand how to write piecewise functions to represent your electronic bill plan
    - Understand how to determine your electronic device bill through your personal usage
    - Understand how to compare different electronic utility plans to determine which one is best to meet personal needs

- **List of prerequisite skills needed:**
    1. Understanding of solving algebraic equations
    2. Knowledge of domains and ranges

- **Vocabulary:**
    1) **Piecewise Function –** A set of function rules for each domain of a functions where $f(x)$ is computed differently for depending upon the value of x
    2) **Domain –** the set of all values of the independent variable (x) in an ordered pair
    3) **Range –** the set of all values of the dependent variable (y) in an ordered pair that correspond to a given set of x-values.

- **State Standards addressed:** *(You may use your District's Power Standards if applicable, Highlight "Green" Standards)*
    Math: (Common Core State Standards)
    > **A-SSE Interpret the structure of expressions**
    > > 1a – Interpret parts of an expression, such as terms, factors and coefficients.

F-IF Analyze functions using different representations
>7a – Graph linear and quadratic functions and show intercepts, maxima, and minima

F-IF Analyze functions using different representations
>7b – Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions

Reading: (Common Core State Standards)
>Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

Leadership:
>**1.1 -** Student will analyze, refine & apply decision-making skills through classroom, family, community, and business and industry experiences.
>**1.4 -** Student will be involved in activities that require applying theory, problem-solving, and using critical & creative thinking skills while understanding outcomes of related decisions.

- **Teacher Preparation:** *(What materials and set-up are required for this lesson?)*
    1. Variety of cell phone plans from several companies
    2. Variety of internet and cable TV plans from several companies
    3. Graph paper
    4. Knowledge of piecewise functions
    5. Piecewise Function Worksheets that are appropriate for your class
    6.
- **Content Delivery:** *(How will the lesson be delivered? List any grouping and instructional strategies as well.)*
    1. Discussion on why it's important to review different cell phone, TV and Internet plans.
    2. Discussion on what information you should gather before reviewing different plans to determine the best plan for your personal usage.
    3. Discussion on how the majority of plans are actually piecewise functions and what is a piecewise function. Discuss what other areas of our lives have piecewise functions (such income tax structure)
    4. Direct Instruction on the Piecewise Function Worksheets that you select for your class. You will need to provide time to complete the worksheets in class or as homework and then review the answers. This will take from 1 to 5 days depending upon your students' prerequisite knowledge.
    5. Several websites that provide good instructional videos on piecewise functions.
        - http://www.brightstorm.com/math/algebra-2/additional-topics/piecewise-functions/
        - http://www.brightstorm.com/math/precalculus/introduction-to-functions/domain-restrictions-and-functions-defined-piecewise/
    6. Direct Instruction of Examples 1 through 6 on page 491 to 493 with multiple examples on each. Be sure to complete and discuss all of the Check Your Understanding problems.

7. Have students complete the Application problems #1-12 all.

- **Instructional Documents** *(Please attach any Worksheet, Quiz, Reading Guide, etc)*
  - FA 10-2 piecewise worksheet#1
  - FA 10-2 Piecewise worksheet#2
  - FA 10-2 Piecewise worksheet#3
  - FA 10-2 Piecewise worksheet#4
  - FA 10-2 Piecewise worksheet#5
  - Financial Algebra 10-2 Application problems on p.494-495
  - YouTube videos
    - http://www.youtube.com/watch?v=p0ZsBwGbtrM
    - http://www.youtube.com/watch?v=-pXi0mw1zkA
    - http://www.youtube.com/watch?v=Dd9GLb0ZFEE
    - http://www.youtube.com/watch?v=yocyq_t_Iv0
    - http://www.youtube.com/watch?v=havxXzYnt-M&feature=results_main&playnext=1&list=PL8F273C0B9E52D880

- **Assessment Tool used in this Lesson** *(scoring method, guide, or rubric)*
  - FA 10-2 Quiz

- **Reinforcement/Intervention/Extension Activities**
  - FA 10-2 Lab

- **Career Applications** *(When will this be used in "real life"?)*
  - The majority of students already have a cell phone and regularly use the internet, but these services are provided by their parents. This lesson will hopefully help prepare them for being wise consumers of evaluating electronic plans that truly meet their individualized needs when they become independent upon graduation.

Piecing Together Piecewise Functions

Piecewise functions, typically introduced in Algebra 2, help set the foundation for deeper explorations of the graphs of various functions in pre-calculus and for computing limits in calculus. Therefore, it is important that students gain a solid understanding of piecewise functions before entering either of these branches of mathematics. I began to ask myself how I could present piecewise functions in such a way that my students would gain more than a superficial understanding, allowing them to discover their relevance. My answer came through a guided discovery activity involving connections across the curriculum and a peer project which required problem solving and reasoning skills.

Guided Discovery Activity:

Since algebra 2 students have had significant practice with linear functions, starting with these activities would be best. Pass out the Piecing Together Piecewise Functions - Guided Discovery Activity worksheet (see below) along with rulers and transparency paper. You may guide students through numbers one and two; however, it may be more beneficial to allow them to work through the first two questions with a peer and then come together as a class to discuss questions three and four.

Discussion

Allowing students to share their findings in question three and their definition in question four will help you determine if it would be best to practice graphing more piecewise functions involving linear equations before doing the peer project.

Provide students the opportunity to build on one another's observations and answer each other's questions. This will allow them to use their mathematical language and enhance their communication skills - an NCTM standard (NCTM, 2000). Many students will notice that when both equations are put on one graph, the second equation begins where the first one ended. This makes a continuous function. (The different-colored pencils help students recognize this aspect of the graph.) At this point ask your students, "Will this always be the case? Justify your answer." Once students are confident with their answer and justification, look at an example in which this is not the case. After discussing question three, reiterate how this problem would look when written as a piecewise function in functional notation. Then allow students to share their definitions written for question four. It may be helpful to list key ideas on the board and use those to create a class definition. It is important to stress that different parts of the domain have different roles.
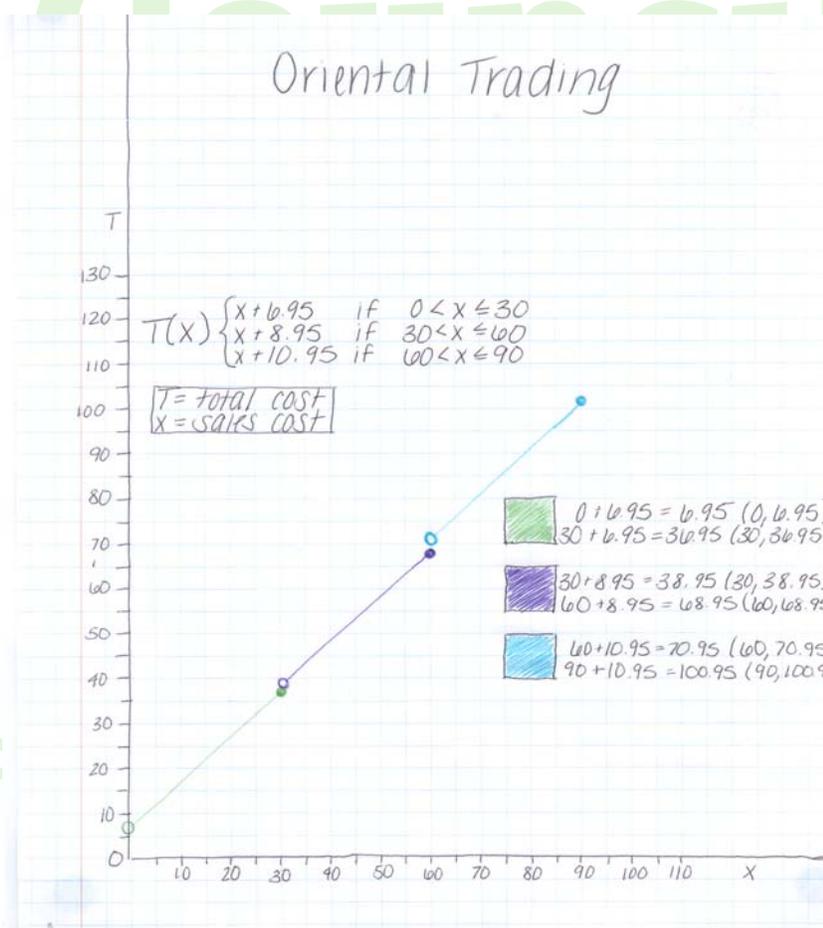
Peer Project:

Provide each team of students (I would recommend keeping the teams to two or three students) with a magazine containing shipping costs for a particular company. This project will be more fun for students if the magazines have items that pertain to their interests (sports equipment,

prom party supplies, etc.). Allow students to flip through the magazine for a few moments, and then ask them to find the page that contains the shipping costs. Their task is to write and graph the piecewise function for total cost (cost of order + cost of shipping) for standard shipping on all orders up to and including $90.00. You may need to change this number depending on the shipping cost intervals of the magazine your students are using and how many equations you would like them to include in their function. You may also choose to have them compare shipping costs for different areas of the United States. Before students begin, make sure they understand that they are creating a function for any possible order. Since the order cost will vary from person to person they must use a variable.

Below is a portion of the shipping cost standards for Oriental Trading Company that was used by a team in my classroom for this particular project.

Order Total	Standard (7-10 business days)	Express (3-5 business days)
Up to $30.00	$6.95	$14.95
$30.01 to $60.00	$8.95	$16.95
$60.01 to$90.00	$10.95	$18.95

Once students have written their piecewise function, you may want to check to make sure it is correct before they take the time to graph it. [Mike, I would enlarge the graphic below when you lay it out. – DK]

Oriental Trading

$$T(x) \begin{cases} x + 6.95 & \text{if } 0 < x \le 30 \\ x + 8.95 & \text{if } 30 < x \le 60 \\ x + 10.95 & \text{if } 60 < x \le 90 \end{cases}$$

T = total cost
X = sales cost

$0 + 6.95 = 6.95 \ (0, 6.95)$
$30 + 6.95 = 36.95 \ (30, 36.95)$

$30 + 8.95 = 38.95 \ (30, 38.95)$
$60 + 8.95 = 68.95 \ (60, 68.95)$

$60 + 10.95 = 70.95 \ (60, 70.95)$
$90 + 10.95 = 100.95 \ (90, 100.9)$

Upon conclusion of graphing the function, allow students to share their graphs and findings with their classmates. Here are some questions you may want to pose to help generate a discussion:

- Why do we not include zero when calculating total cost for orders up to $30.00?
- Why do you suppose that express shipping is often less than twice the amount of standard shipping?
- How would your function change if shipping costs for orders greater than $60.00 were 15% of the total cost?
- When would a 15% shipping cost be to the buyer's advantage?

Conclusion:

Graphing piecewise functions and understanding their derivation is only the beginning of obtaining a firm foundation. It is also important that students are able to recognize and write piecewise functions for given scenarios. Here is one example:

> Suppose you plan to buy many blank compact disks. You check price lists and find out that if you buy 100 CDs or fewer you pay $0.74 each. However if you buy between 100 and 300 CDs the price drops to $0.69 each for the second hundred. Write a function that describes the cost c of n number of CDs purchased.

In my experience, students find writing the function more challenging than graphing the function, thus this aspect of the lesson takes longer. Choosing scenarios which are realistic to them, however, will make the lesson relevant and fun!

References:

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

Orientaltrading.com

https://wa-appliedmath.org/

Piecing Together Piecewise Functions - Guided Discovery Activity

1) Given the following linear equations, represent solutions graphically on two separate coordinate planes. $y = 3x$ and $y = -2x+20$
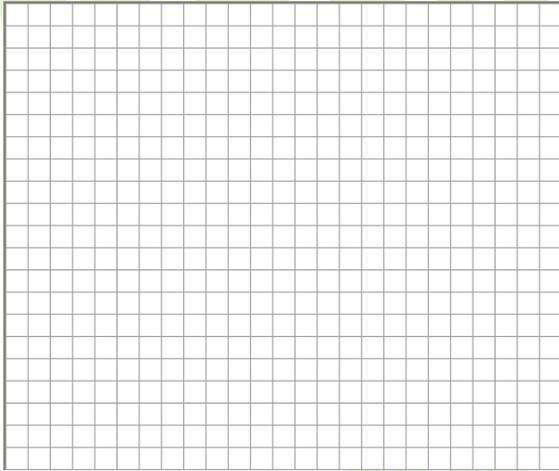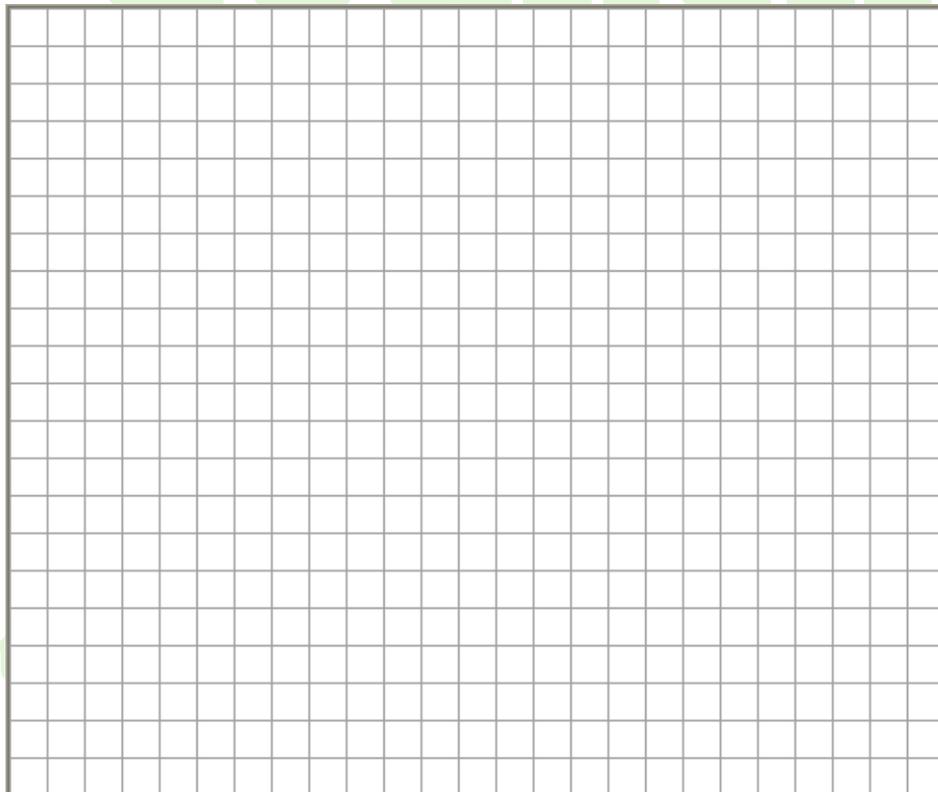
2) Using the coordinate plane below, place a piece of transparent paper on top and graph the solution of the first equation according to the given domain.

   $y = 3x$ where $-1 \le x < 4$

   Now place a second piece of transparent paper on top and using a different colored pencil, graph the solution of the second equation according to the given domain.

   $y = -2x+20$ where $4 \le x \le 6$

3) What are some similarities between your first two graphs and the third one? What are some differences?

Written in functional notation, number two would look like the following:

$$f(x) = \begin{cases} 3x & -1 \le x < 4 \\ -2x + 20 & 4 \le x \le 6 \end{cases}$$

4) This is known as a piecewise function. Using the third graph and the discussion we just had, write your own definition for a piecewise function.

Piecewise Functions and Word Problems

Examples:

p.260 # 48

In May 2003, Nicor Gas had the following rate schedule for natural gas usage in single-family residences.

Monthly Customer Charge	$6.45
Distribution Charge	
1st 20 therms	$0.2012/therm
Next 30 therms	$0.1117/therm
Over 50 therms	$0.0374/therm
Gas supply charge	$0.7268/therm

(a) What is the charge for using 40 therms?

$C = 6.45 + 20(.2012) + 20(.1117) + 40(.7268)$

$C = \$41.78$

(b) What is the charge for using 202 therms?

$C = 6.45 + 20(.2012) + 30(.1117) + (152)(.0374) + 202(.7268)$

$C = \$166.32$

(c) Construct a function that gives the monthly charge C for x therms of gas. $\quad$ X = NUMBER OF THERMS USED

$$c(x) = \begin{cases} 6.45 + .2012x + .7268x, & 0 \le x \le 20 \\ 6.45 + .2012(20) + .1117(x-20) + .7268x, & 20 < x \le 50 \\ 6.45 + .2012(20) + .1117(30) + .0374(x-50) + .7268x, & x > 50 \end{cases}$$
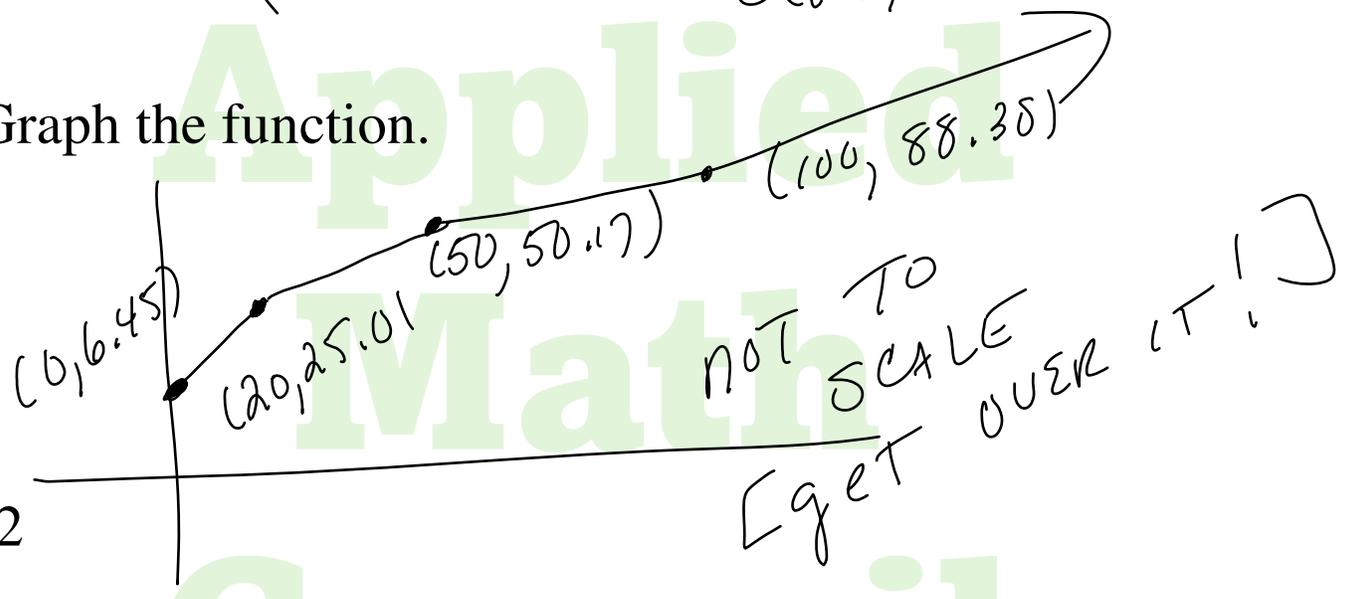
make
pretty!

$$C(x) = \begin{cases} 6.45 + .928x, & 0 \leq x \leq 20 \\ 8.24 + .8385x, & 20 < x \leq 50 \\ 11.955 + .7642x, & x > 50 \end{cases}$$
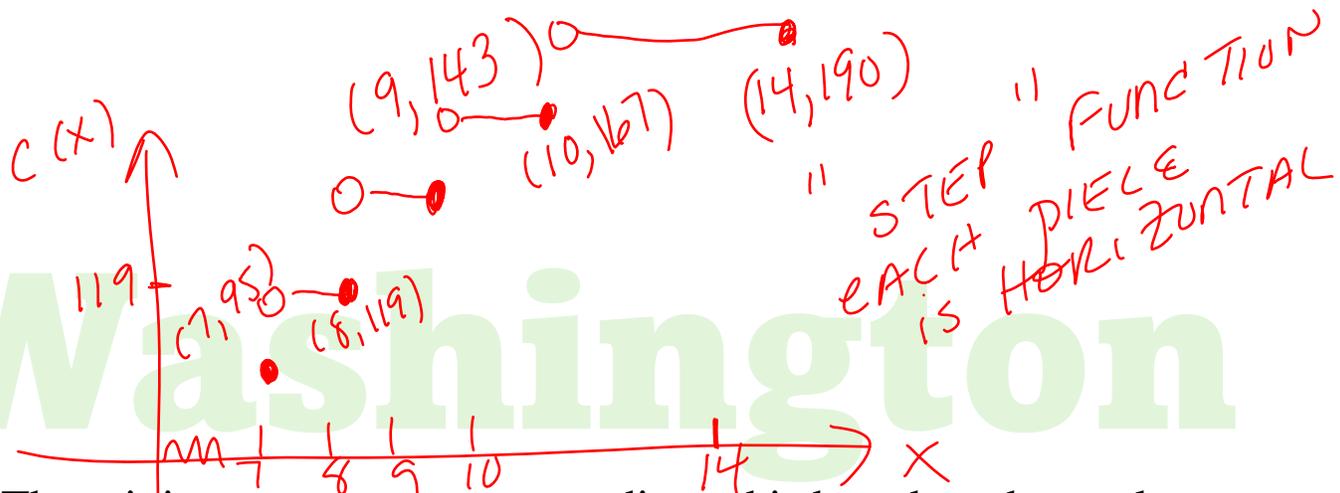
$C(100) = 88.38$

(d) Graph the function.

$(0, 6.45)$ $(20, 25.01)$ $(50, 50.17)$ $(100, 88.38)$

not to scale
[get over it!]

52

An economy car costs $95 per week. Extra days cost $24 per day until the rate exceeds the weekly rate, in which case the weekly rate applies. Find the cost C of renting an economy car as a piecewise-defined function of the number x of days used, where $7 \leq x \leq 14$. Graph the function.

$$C(x) = \begin{cases} 95, & x = 7 \\ 119, & 7 < x \leq 8 \\ 143, & 8 < x \leq 9 \\ 167, & 9 < x \leq 10 \\ 190, & 10 < x \leq 14 \end{cases}$$

2 weeks with weekly rate
$2(95) = 190$

Handwritten annotations around graph:

$C(x)$

$(9, 143)$
$(10, 167)$
$(14, 190)$

"STEP" FUNCTION
eACH PIECE
IS HORIZONTAL

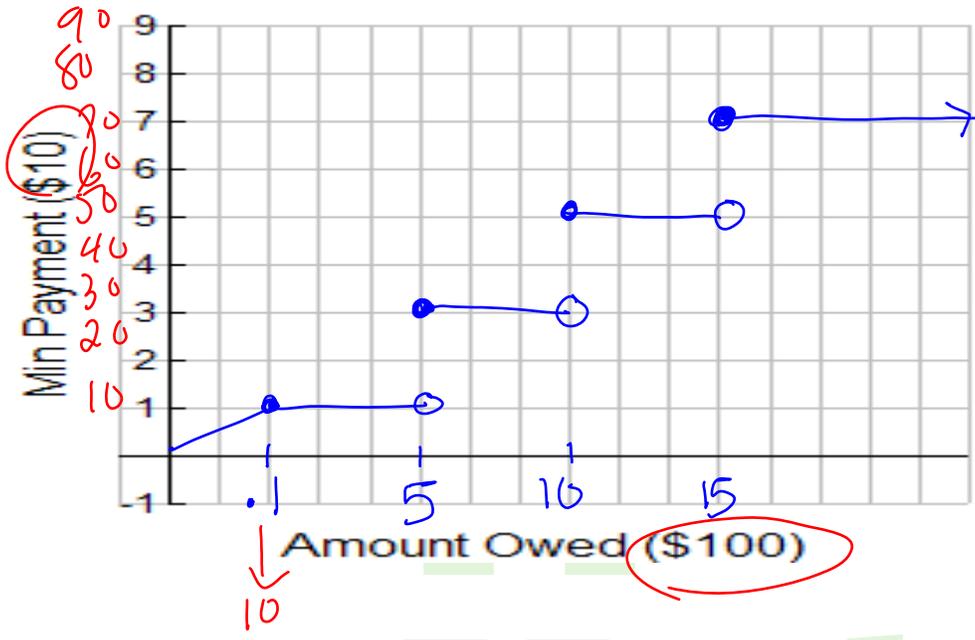$119 -$
$(7, 95)$
$(8, 119)$

x-axis marks: 7 8 9 10 14 → X

#53 The minimum payment on a credit card is based on the total amount owed. A credit card company uses the following rules: For a bill less than $10 the entire amount is due. For a bill of at least $10 but less than $500, the minimum due is $10. There is a minimum of $30 due on a bill of at least $500 but less than $1000, a minimum of $50 due on a bill of at least $1000, but less than $1500, and a minimum of $70 is due on bills $1500 or more. Find the function f that describes the minimum payment due on a bill of x dollars. Graph the function.

$x =$ AMOUNT OWED

$f(x) =$

$f(x) =$ MINIMUM PAYMENT DUE

$$f(x) = \begin{cases} x & x < 10 \\ 10 & 10 \le x < 500 \\ 30 & 500 \le x < 1000 \\ 50 & 1000 \le x < 1500 \\ 70 & 1500 \le x \end{cases}$$

90
80
70
60
50
40
30
20
10

Min Payment ($10)

10

Amount Owed ($100)

Once Again Another Step Function!

HW p259 # 29,33,35,41,42,45,47,51,54

Activity 3.4 Piecewise Functions

Overview:

Given a description of the cost per square yard of carpet, students are asked to find the cost of specific amounts of carpet, to graph the data points found, and to find a function that gives the cost of carpet as a function of yardage.

Estimated Time Required: The activity should take approximated 30 minutes.

Technology: none

Prerequisite Concepts:

- Piecewise function
-

Discussion:

Point out that a function may or may not have a formula giving its rule. In the same manner, there is no reason that one function cannot have a rule that requires more than one formula. Students may have trouble deriving the equations for the different amounts of carpet.

Encourage them to calculate the prices for different purchases of carpet and then use those points to calculate each of the equations of the linear functions involved. If you have students do this, be aware that there are many ways that students can go wrong here. For example, if they calculated the line between a point where $x < 100$ and a point where $x > 100$. If you can afford the class time, these failures are highly illustrative of the basic principle of formulas for piecewise function that the given formulas only apply over a limited range of input values, not over the entire domain of the function.

After students complete part *a* and *b* of the activity, you can introduce the standard notation for representing piecewise function and their domains. Be sure to emphasize that this is one function that just happens to use two different formulas in its rule.

Activity 3.4 Piecewise-defined Functions

Suppose a carpet store sells carpet for $10 per square yard for the first 100 square yards purchased, and then lowers the price to $7 per square yard after the first 100 yards have been purchased.

a.) Find the cost of buying the yardages indicated in the table:

Square Yards (x)	Cost (C)
0	
25	
50	
75	
100	
125	
150	
175	
200	

b.) Graph the points you found above. Label your scale clearly.
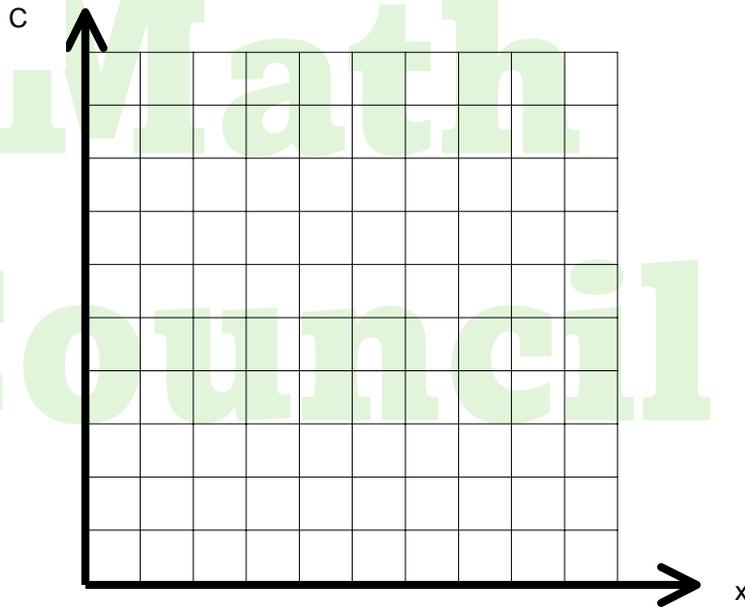
c.) Find a function $C = f(x)$ that gives the cost of purchasing any number of square yards of carpet between 0 and 200.

Financial Algebra

Chapter 10 Prepare a Budget

Section 2 Electronic Utilities

Voice Plans to Select From

| Plan Name	Voice Minutes	Cost per month	Price for Overage minutes	Cost per additional line
Nationwide Single Line	450	$39.99	$0.45/min	N/A
Nationwide Single Line	900	$59.99	$0.40/min	N/A
Nationwide Single Line	Unlimited	$69.99	N/A	N/A
Nationwide Family Plan	700	$69.98	$0.45/min	$9.99/month up to 3 lines
Nationwide Family Plan	1400	$89.98	$0.40/min	$9.99/month up to 3 lines
Nationwide Family Plan	2000	$99.98	$0.35/min	$9.99/month up to 3 lines
Nationwide Family Plan	Unlimited	$119.98	N/A	$49.99/month up to 3 lines

Text Plans to Select From

Plan Name	# of Text Msgs	Cost per month	Price for Overage texts
Pay as you go	0	N/A	$0.20/msg
1000	1000	$10	$0.10/msg
Unlimited	N/A	$20	N/A

Using the two tables above, answer the following questions.

1. Write a piecewise function to determine the monthly bill for a customer who selects the Nationwide Single Line plan with 450 minutes and pay as you go text messaging.

2. Graph the piecewise function written above.
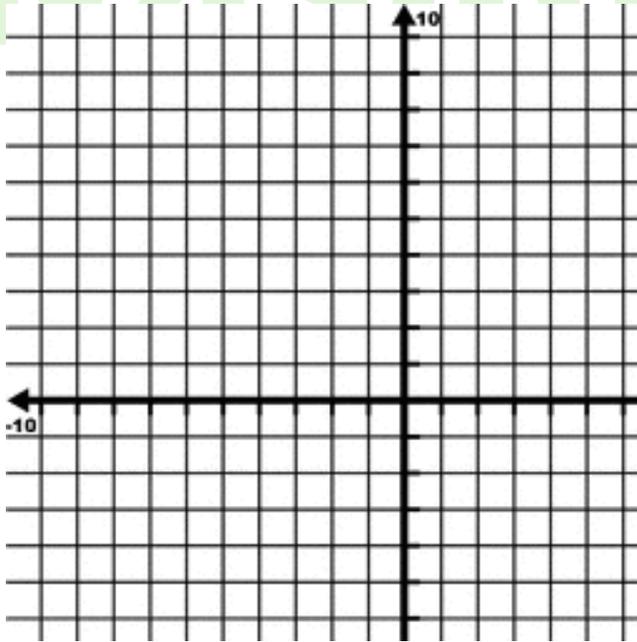
3. Calculate the monthly bill for the customer in problem #1 who used 568 minutes, sent 25 messages and received 30 messages.

4. Write a piecewise function to determine the monthly bill for a customer who selects the Nationwide Family Plan with 1400 minutes and 1000 text messages. Where $f(x)$ is the total monthly bill, m is the number of voice minutes used, l number of extra lines and t is the number of text messages sent.

5. Graph the piecewise function written for problem #4 above.
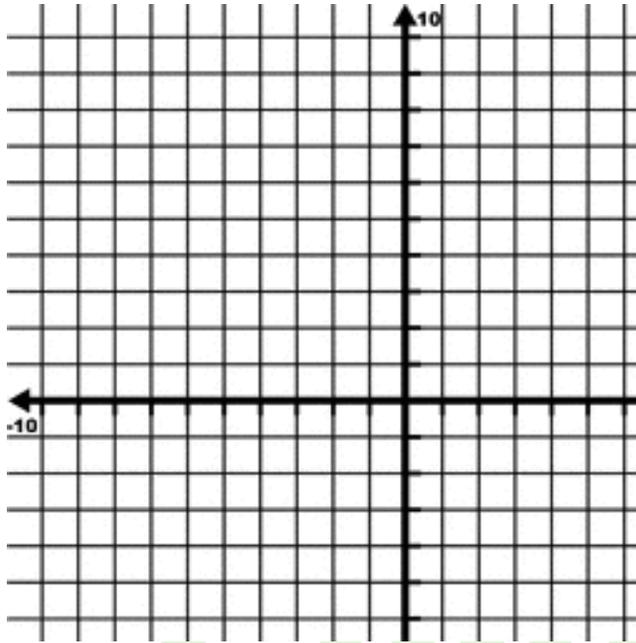
6. Calculate the monthly bill for the customer in problem #4 who used 1350 minutes, has 2 extra lines and used 1234 messages.

7. Using the tables at the beginning, select the plan would best work for you and prove mathematically why this is the best plan for you.

Answer Key

1)

F(x) = {	$39.99 + $0.20*t* for *m* ≤ 450
	$39.99 + $0.45(m-450) + $0.20*t* for m > 450 and an integer
	$39.99 + $0.45([m-450] +1) + $0.20*t* for m > 450 and not an integer

2) Answers may be graphically drawn via manual table entry, graphing equations or via a graphing calculator.

3) $39.99 + $0.45 * 118 + $0.20 * 55 = $104.09

4)

F(x) = {	$89.98 + $10+ $9.*99l for m* ≤ 1400 and *t ≤ 1000*
	$89.98 +$10 + $0.10(*t*-1000) + $9.*99l for m* ≤ 1400 and *t > 1000*
	$89.98 +$10 + $0.40(*m*-1400) + $9.99*l* for m > 1400 and an integer plus *t ≤ 1000*
	$89.98 + $10+ $0.40(*m*-1400) + $0.10(t-1000) + $9.99*l* for m > 1400 and an integer plus *t> 1000*
	$89.98 + $10 + $0.40(*m*-1400) + $9.99*l* for m > 1400 and an integer plus *t ≤ 1000*
	$89.98 + $10 + $0.40([*m*-1400]+1) + $9.99*l* for m > 1400 and not an integer plus *t ≤ 1000*
	$89.98 + $10 + $0.40([*m*-1400]+1) + $0.10(t-1000) + $9.99*l* for m > 1400 and

		not an integer plus *t > 1000*

5) Answers may be graphically drawn via manual table entry, graphing equations or via a graphing calculator.

6) $89.98 + $10 + $0.10*234+ 2*$9.99 = $143.36

7) Answer will vary… looking for students to have calculated their "average usage" on a variety of plans to determine which one is most cost effective for them.