Weekly Focus: one-variable equations
Weekly Skill: solve, apply

LESSON 23: Linear Equations with One Variable

Lesson Summary: For the warm-up, students will solve a problem about pay options. In Activity 1, they will learn the steps to solve one-variable equations and practice one-step equations and two-step equations. In Activity 2, students can practice more two-step equations. Activity 3 consists of word problems. Activity 4 is an application problem about cheeseburgers. Estimated time for the lesson is 2 hours.

Materials Needed for Lesson 23:

- Video (length 9:16) on one-variable equations. The video is required for teachers and optional for students.
- 2 Worksheets (23.1, 23.2) with answers (embedded links)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Student Book (pages 60 – 61)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Workbook (pages 78 – 81)
- Application Activity instructions, picture, and solution (attached)
- For more details on the application activity: http://robertkaplinsky.com/work/in-n-out-100-x-100/

Objectives: Students will be able to:

- Solve the 'pay' word problem
- Solve one-variable equations with one or two steps
- Solve the application problem about cost

ACES Skills Addressed: N, CT, LS, EC
CCRS Mathematical Practices Addressed: Building Solution Pathways, Model with Math
Levels of Knowing Math Addressed: Intuitive, Pictorial, Abstract, and Application

Notes:
You can add more examples if you feel students need them before they work. Any ideas that concretely relate to their lives make good examples.

For more practice as a class, feel free to choose some of the easier problems from the worksheets to do together. The "easier" problems are not necessarily at the beginning of each worksheet. Also, you may decide to have students complete only part of the worksheets in class and assign the rest as homework or extra practice.

The GED Math test is 115 minutes long and includes approximately 46 questions. The questions have a focus on quantitative problem solving (45%) and algebraic problem solving (55%).

Students must be able to understand math concepts and apply them to new situations, use logical reasoning to explain their answers, evaluate and further the reasoning of others, represent real world problems algebraically and visually, and manipulate and solve algebraic expressions.

This computer-based test includes questions that may be multiple-choice, fill-in-the-blank, choose from a drop-down menu, or drag-and-drop the response from one place to another.

The purpose of the GED test is to provide students with the skills necessary to either further their education or be ready for the demands of today's careers.

Lesson 23 Warm-up: Solve the pay problem	**Time: 5-10 Minutes**

Write on the board: Elise was hired to work as a salesperson. Her boss offered her a choice of pay packages: Would she prefer (a) to get paid a straight salary of $3,200 a month, or (b) a base salary of $1,000 + 5% commission on sales she made?

Basic Questions:

- What other information do we need before we can answer the question?
  - Projected monthly sales
- If Elise is projected to have $60,000 in sales monthly, which is a better deal?
  - Choice B is better: $1,000 + 0.05 (60,000) = 1,000 + 3,000 = $4,000
  - Note: Did anyone mentally take 10% of $60,000 and cut it in half to get 5%?

Extension Question:

- Write an equation for choice B with s for sales and p for pay.
  - P = $1,000 + 0.05s

Lesson 23 Activity 1: How to Solve One-Variable Equations	**Time: 30 Minutes**

1. Steps to Solving a One-Variable Equation:
   a. Group all the variable terms on one side of the equation.
   b. Undo addition and subtraction by doing inverse operation.
   c. Undo multiplication and division by doing inverse operation.
   d. Check your answer by substituting answer back into original equation.

2. Example: The perimeter (P) of a basketball court is 90 meters and the width is 13 meters. What is the length (L)? Write an equation and solve it.
   a. We know that P= 2W + 2L. Substitute the numbers we are given to get 90 = 2(13) + 2L. 90=26 + 2L
   b. Solve for the variable L using the above steps.
      i. 90-26 = 26-26 + 2L
      ii. 64 = 2L
      iii. 23 = L
      iv. Check: 26 + 2(23) = 26 + 64 = 90. It is correct.
      v.

3. Do **Worksheet 23.1** One-Step Equations (10 minutes). Students had some practice with this in Lesson 19, so it is optional if students can already do one-step equations easily.

4. Do the problems in the **student book pages 60-61** together. Follow the steps outlined above.

   Teacher Note: You can also show the subtraction of 26 from both sides by writing -26 underneath the 90 and underneath 26 in a different color marker. Many students prefer this method visually.

Lesson 23 Activity 2: Two-Step Equations Practice	**Time: 15 Minutes**

Let students work independently on **Worksheet 23.2** Two-Step Equations**.** Follow steps outlined above. Do a few together first.

Lesson 23 Activity 3: Word Problems	**Time: 35-45 Minutes**

1. Have students work independently in the **workbook pages 78-81.**
2. These problems include one more step: multiplying the quantity in parentheses by the quantity outside the parentheses. Explain the example on page 78 and do #1 and #2 on the board together.
3. Circulate to help. Review any questions that students found challenging. Choose a few problems to have volunteer students do on the board.

Lesson 23 Activity 4 Application: Large Cheeseburger	**Time: 30-40 Minutes**

Notes for the teacher:

1. This activity practices input/output tables, equations, and graphing.
2. If you have time, look at the website for more information and pictures: http://robertkaplinsky.com/work/in-n-out-100-x-100/
3. Read the instructions below for the activity. Just do the cost, not the calories, unless you have time at the end.
4. If you don't have time to do the whole activity:
   a. start the input/output table for a cheeseburger, a double, a triple, etc.
   b. write the equation together
   c. solve the equation for 100 cheeseburgers
   d. show the students the picture of 100 patties

Lesson 23 Application: Large Cheeseburger

The Situation

In-N-Out ordinarily sells hamburgers, cheeseburgers, and Double-Doubles (two beef patties and two slices of cheese). While they don't advertise it, they have a secret menu which includes a burger where you can order as many extra beef patties and cheese slices as you like. The prices and nutrition information are not listed though. The most common orders are 3×3's (read as "three by three") and 4 by 4's (read as "four by four") that contain three and four layers of beef and cheese, respectively. However some people have ordered 20×20's (pictured below) and even a 100×100!

The Challenge(s)

- How much money does a 3×3 cost?
- How many calories is a 3×3?
- How much money does a 20×20 cost?
- How many calories is a 20×20?
- How much money does a 100×100 cost?
- How many calories is a 100×100?
- How much money does an NxN cost?
- How many calories is an NxN?

Question(s) To Ask

These questions may be useful in helping students down the problem solving path:

- How would you describe what ingredients are in a 3×3? (To help students realize it is a cheese burger with all the cheese burger toppings plus 2 additional layers of beef patties and cheese)
- How can we figure out how much an additional beef patty and cheese slice cost?
- What are the differences between a cheeseburger and a Double-Double?
- Where do you see the cost of the extra layer mentioned in the words in the table, graph, and symbols?
- Where do you see the cost of the cheeseburger in the words in the table, graph, and symbols?
- How would your answer change if you had started with a Double-Double and added 98 layers versus a Cheeseburger and added 99 layers?

Consider This

This awesomely gross lesson provides students with a real world context for building linear functions. I recommend beginning with exploring cost before calories because I have included a receipt that shows the actual price of a 100×100 burger. You may choose to begin by asking students about the cost of a 100×100 or start with something smaller like a 3×3. I have found that students with emerging skill sets need to begin with a 3×3 to establish that it is not the same thing as ordering 3 cheeseburgers or a Double-Double and a cheeseburger. Eventually you want them to be able to generalize the cost of an NxN burger.

As much as possible, you want students to do all of the discovery. Make sure to have a conversation about what is on a 100×100. Essentially it is a cheeseburger with 99 additional beef patty and cheese layers or a Double-Double with 98 additional beef patty and cheese layers. There are no additional buns or toppings such as lettuce, tomato, onions, or spread.

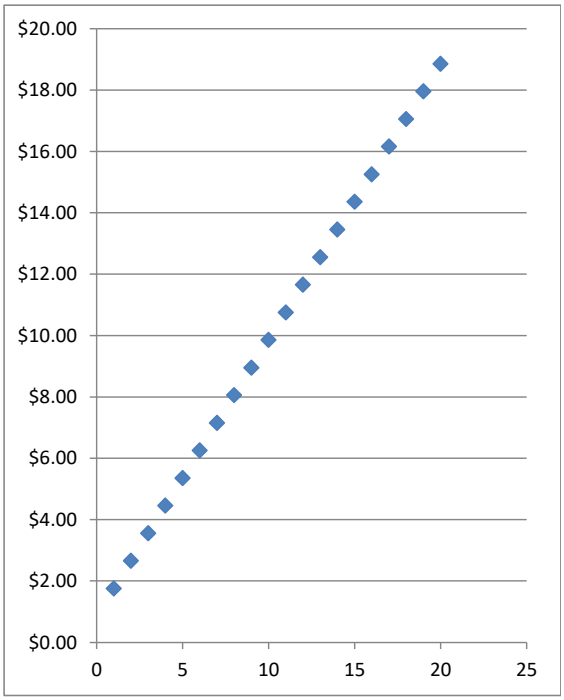
We then want to ask students, "How can we figure out how much an additional beef patty and cheese slice cost?" Hopefully they struggle with this question. You may have to ask them, "What are the differences between a cheeseburger and a Double-Double?" We want them to realize that they are the same except for an extra beef patty and cheese slice and a cost difference of $0.90. They can get $0.90 by subtracting the price of a cheeseburger ($1.75) from the price of a Double-Double ($2.65) using the menu below. We want them to make the assumption that perhaps $0.90 is the cost of one layer of beef patty and cheese slice. Note that these prices were from 2004 and were used so they matched the receipt that has the price of the 100×100 on it.

Something for students to aspire to would be to explain their solution using numbers (an input-output table), symbols (Algebra), pictures (graph), and words (a written explanation of how they approached the problem) which is CCSS F-LE.2. I have included an example of how that may look below. The most important part of the multiple representations is challenging students to explain connections between the representations. For example, where do you see the cost of the extra layer mentioned in the words, in the table, in the graph, and/or in the symbols? What about the cost of the cheeseburger? Note that this is a discrete and not continuous function as you can only get whole number layers.

Numbers

Layers	Cost
1	$1.75
2	$2.65
3	$3.55
4	$4.45
.	.
.	.
20	$18.85
.	.
.	.
100	$90.85
.	.
.	.
N	$1.75 + (N-1)*$0.90

Pictures



Symbols

Cost = Cheeseburger + Extra Layers
Cost = $1.75 + (L-1)*$0.90

or

Cost = Double-Double + Extra Layers
Cost = $2.65 + (L-2)*$0.90

Words

To find the cost of an extra layer of cheese and meat, I subtracted the cost of the cheeseburger from the cost of the Double-Double and got 90 cents. I then multiplied the number of extra layers of meat and cheese (which was one less than the total number of layers because a cheeseburger already comes with a layer) by 90 cents to get the extra charge. I then added the extra charge of the meat and cheese to the price of the cheeseburger to get my total cost.