Weekly Focus: functions
Weekly Skill: solving and understanding

LESSON 22: Patterns and Functions

Lesson Summary: For the Warm Up, students will solve a problem about time using scientific notation. In Activity 1, they will learn vocabulary about functions. In Activity 2, they will study algebraic patterns. In Activity 3, they will practice solving functions. In Activity 4, they will do word problems. The Activity 5 application is about beehives. There is an extra problem at the end that could also be used as an exit ticket. Estimated time for the lesson is 2 hours.

Materials Needed for Lesson 22:

- 2 Worksheets (22.1, 22.2) with answers (attached)
- Application Activity photo, picture, questions, and answers
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Student Book (pages 58 – 59)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Workbook (pages 74 – 77)
- For more information on the application activity: http://hungryteacher.com/downloads/mind-your-own-beeswax/

Objectives: Students will be able to:

- Solve the review word problem and use scientific notation
- Understand what functions are
- Solve functions and related word problems

ACES Skills Addressed: N, CT, L, ALS
CCRS Mathematical Practices Addressed: Building Solution Pathways, Make Sense of Problems and Persevere in Solving Them
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 relates 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 22 Warm-up: Solve the time problem	**Time: 5 Minutes**

Write on the board: Scientists estimate that modern humans have lived on earth for about 200,000 years and that the Earth is 4.5 billion years old.

Basic Question:

- Write a fraction to show how long modern humans have lived on earth. Reduce it.
  - *200,000/4,500,000,000 = 2/45,000*
- Change to a decimal. *0.000044*

Extension Questions:

- Write 200,000 in scientific notation. *2.0×10^5*
- Write 4.5 billion in scientific notation *4.5×10^9*
- Write the above decimal in scientific notation *4.4×10^{-5}*

Lesson 22 Activity 1: Vocabulary	**Time: 5 Minutes**

This activity can be projected on the board and done as a whole class. Have students volunteer to write answers.

Answers: 1. Pattern, 2. Rule 3. Function 4. Domain 5. Range

1. A _____is a sequence of numbers arranged in a specific order. 2. The _____ determines which number goes next in that sequence. 3. An algebraic rule is called a_____. It means for every input x, there is only one output y. 4. All the x values in a function are called the _____. 5. All the y values are called the _____.	A. range B. pattern C. function D. domain E. rule

Lesson 22 Activity 2: Patterns	Time: 20-25 Minutes

(Either give **Worksheet 22.1** to students or project the following examples.)
Example 1: A man wants to know how many calories he burns jogging:

Minutes Jogging X	Calories Burned Y
1	
15	150
30	
45	450
60	

A. Ask students what pattern they see. *(10 calories are burned for every minute jogging)*
B. What is the rule? What happens to x to get y? *(x is multiplied by 10 to get y)*
C. What is the equation? *(10x = y)*
D. Fill in the missing numbers. *(10, 300, 600)*
E. What is the domain? *(1, 15, 30, 45, 60)*
F. What is the range? *(10, 150, 300, 450, 600)*

Example 2: A woman drives at the following speed.

Driving Time in hours t	Distance in miles d
0.5	
1	50
1.5	
2	100
2.5	

A. Ask students what pattern they see. *(She drives 50 miles per hour)*
B. What is the rule? What happens to t to get d? *(t is multiplied by 50 to get d)*
C. What is the equation? *(50t = d)*
D. Fill in the missing numbers *(25 miles, 75 miles, 125 miles)*
E. What is the domain? *(0.5, 1, 1.5, 2, 2.5)*
F. What is the range? *(25, 50, 75, 100, 125)*

Worksheet 21.1 (2 pages)

Example 1: A man wants to know how many calories he burns jogging:

Minutes Jogging **X**	**Calories Burned** **Y**
1	
15	150
30	
45	450
60	

A. What pattern do you see?

B. What is the rule? What happens to x to get y?

C. What is the equation?

D. Fill in the missing numbers.

E. What is the domain?

F. What is the range?

Example 2: A woman drives at the following speed.

Driving Time in hours **t**	**Distance in miles** **d**
0.5	
1	50
1.5	
2	100
2.5	

A. What pattern do you see?

B. What is the rule? What happens to x to get y?

C. What is the equation?

D. Fill in the missing numbers.

E. What is the domain?

F. What is the range?

Lesson 22 Activity 3: Functions	Time: 30 Minutes

1) The above patterns are examples of **functions**. Functions are defined as:
   a. Equations with 2 variables
   b. They are like a machine with instructions (the **rule**) so that for each input (x) there is only one output (y).
   c. A function equation may be written with f(x) instead of y. This is read as "f of x".
   d. Substitute each x value (input) into the equation to get the f(x) or the y value (output).
   e. An equation for which there are 2 outputs is not a function. An example is the square root of a number. Ex. $\sqrt{x}$ = y is an equation but not a function. $\sqrt{25}$ = -5 or +5, two outputs, so it cannot be a function.
   f. We will study linear functions (lines) and quadratic functions (with an x^2).
   g. When you graph equations in later lessons, you will be able to see what a function is and what it is not.

2) Practice finding the output (y) with **Worksheet 22.2.** The equation is the rule of what happens to x to get the output x (10 minutes)

3) Do patterns and functions word problems together in the **student book pages 58 – 59**. (15 minutes)

Lesson 22 Activity 4: Word Problems	Time: 35-45 Minutes

Have students work independently in the **workbook pages 74 – 77.** Circulate to help. Review any questions that students found challenging. Choose a few problems to have volunteer students do on the board and explain if they want.

Note: Students have not learned how to factor equations yet and have not had much practice with solving equations either, so they may be using substitution in problems like #9, #13 and others. That is ok. If students already know how to factor, they can solve that way, but don't spend time explaining factoring yet; wait until a future lesson.

Lesson 22 Application: Mind Your Own Beeswax	Time: 20-25 Minutes

Notes to teacher:

1. This application lesson practices patterns and reviews area. It requires critical thinking and discussion.
2. For more details and information on the lesson, go to: http://hungryteacher.com/downloads/mind-your-own-beeswax/
3. Before you start, show the actual pictures of beehives to students as some may not know what they look like. Then show the diagram of the beehive before you start the questions and

ask what patterns they see. If you can't project the pictures, draw on the board.

Lesson 22 Group Exit Ticket	**Time: 10 Minutes**

Have students work in pairs to complete problem #1. Problem #2 is a challenge problem.

1) Make an input/output table to illustrate this problem: An online ticket seller charges a $4 handling fee for one ticket and a $2 handling fee for each additional ticket.

Tickets Ordered x	1	2	3	4
Handling Fee F(x)	$4	$6	$8	$10

2) Write a function (challenging!): *f(x) = $4 + $2 (t – 1)*

Worksheet 22.2 Functions Practice

Complete the function table for each equation.

1. $y = x - 7$

x	y
2	
5	
-1	
7	
3	

2. $y = x - 3$

x	y
8	
2	
-2	
9	
1	

3. $y = x - 4$

x	y
3	
6	
-7	
4	
2	

4. $y = 7x - 3$

x	y
6	
5	
-9	
1	
2	

5. $y = 4x - 2$

x	y
9	
2	
-6	
3	
4	

6. $y = 8x - 5$

x	y
3	
5	
-2	
1	
4	

Worksheet 22.2 Answers

1.

x	y
2	-5
5	-2
-1	-8
7	0
3	-4

2.

x	y
8	5
2	-1
-2	-5
9	6
1	-2

3.

x	y
3	-1
6	2
-7	-11
4	0
2	-2

4.

x	y
6	39
5	32
-9	-66
1	4
2	11

5.

x	y
9	34
2	6
-6	-26
3	10
4	14

6.

x	y
3	19
5	35
-2	-21
1	3
4	27

Application: Mind Your Own Beeswax

Mind Your Own Beeswax

BEGINNER

Why are honey bees' honeycombs hexagons?

INTERMEDIATE

The length of one side of the honey bees' honeycomb is approximately 3 mm, and the depth of the honeycomb is approximately 20 mm.

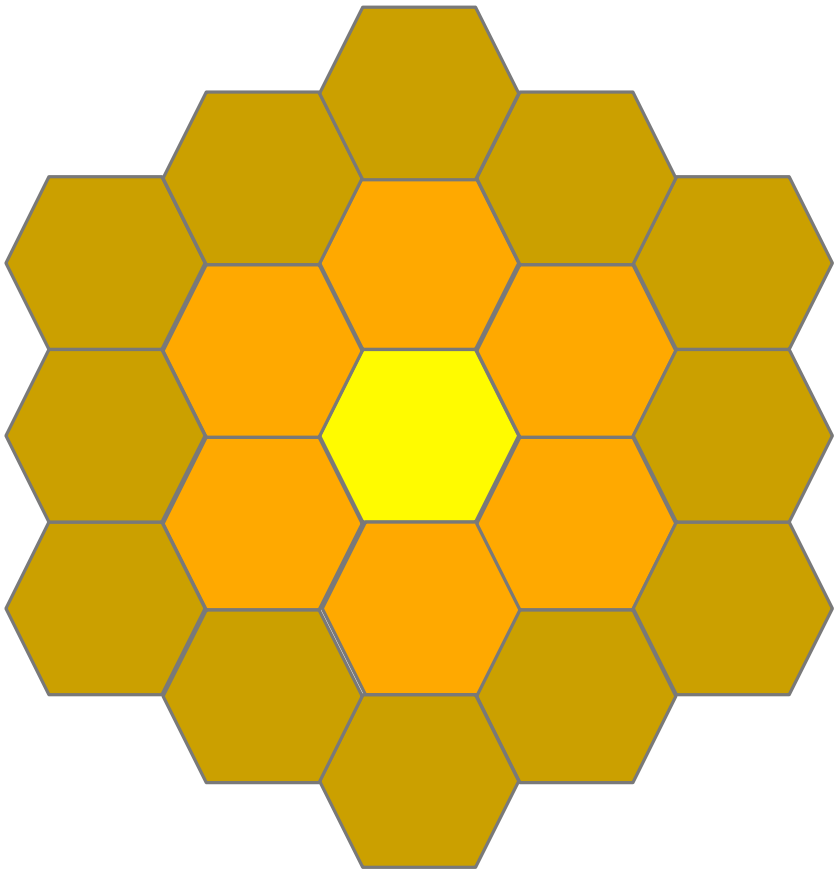
How much wax would it take for a bee to create one honeycomb?

How much wax would it take a bee to create one honeycomb with a ring of 6 more honeycombs around it?

How much wax would it take a bee to create another ring of honeycombs?

Describe what patterns you see.

Actual Beehives



Wind Your Own Beeswax

Teacher Edition

BEGINNER

Why are honey bees' honeycombs hexagons?

What factors would go into deciding what shape would be best for a honeycomb?

- They want a *safe* place to live and store their food. A collection of small cells (honeycomb) would provide protection from larger predators, but what shape for the cells?
- They want a shape that gives them the most storage space for a given amount of resources (wax) to make the shape.
  - Maximize area for a given perimeter.
- *What shapes qualify?*
  - Circles maximize area.
    - *Why not circles?*
      - leave gaps
  - Cells need to tesselate
- *What regular shapes tessellate?*
  - triangle, square, hexagon
- *Why not use the triangle or square?*
  - Hexagons maximize area (can prove it.)
- *Why are we only considering regular shapes?*
  - The shapes need to be regular so many bees can build identical cells simultaneously, and the cells will still tessellate.

INTERMEDIATE

The length of one side of the honey bees' honeycomb is approximately 3 mm, and the depth of the honeycomb is approximately 20 mm.

How much wax would it take for a bee to create one honeycomb?

- 360 mm^2 of wax

How much wax would it take a bee to create one honeycomb with a ring of 6 more honeycombs around it?

- Animation on slide 7
- 9,000 mm^2 of wax
- There are 6 more hexagons, but only 24 (not 36) more sides.

How much wax would it take a bee to create another ring of honeycombs?

- Another ring is 12 more honeycombs, but 48 more sides. Which means 17,280 mm^2 of wax, or 26,280 mm^2 wax total for the two rings and the initial honeycomb.

Describe what patterns you see.

A few patterns are the:

- number of honeycombs added per ring: 6 honeycombs
- number of sides added per ring: 24 sides
- amount of wax added per ring: 8640 mm^2