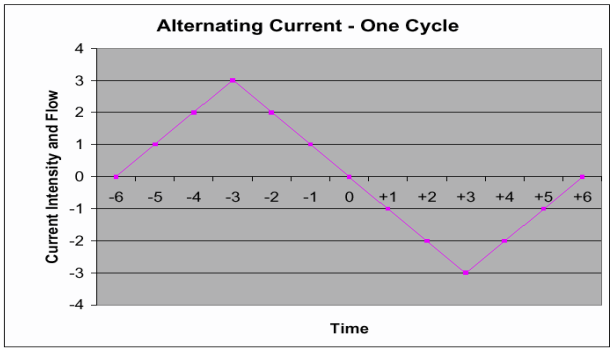
HVAC (47.0201) T-Chart

Interpret graphs = Graph and analyze functions, and use their properties to make connections between the different representations

Program Task: Measure amps, volts, resistance in an electrical circuit.

Program Associated Vocabulary:
TABLE, GRAPH, COORDINATE, X-AXIS, Y-AXIS, MEASURABLE CHARACTERISTICS, FUNCTION

Program Formulas and Procedures:
Graphs are perhaps the most efficient medium for describing the HVAC professional's world of energy, technology, and money. Thousands of graphs can be found to describe and illustrate every aspect of the HVAC industry.



For example, the graph above is a picture of the relationship between amperage and time in an active alternating current (AC) circuit. The **X** coordinates (horizontal) represent points in time (neg = past, 0 = present, pos = future). The actual length of time is irrelevant in this example. The **Y** coordinates (vertical) represent two distinct characteristics of current: the amount or intensity (i) of electron flow (distance from 0 amps), and the direction in which the electrons are flowing (above or below the X axis).

Example:
The maximum amperage, in either direction, is 3 amps (in this case it doesn't matter if it's negative or positive, it's still 3 amps). If you wanted to build a table of x and y coordinates, you could easily pick out the following coordinate pairs (-6, 0) (-5, 1) (-4, 2) (-3, 3) (-2, 2) (-1, 1) (0, 0) (1, -1) (2, -2) (3, -3) (4, -2) (5, -1) (6, 0).

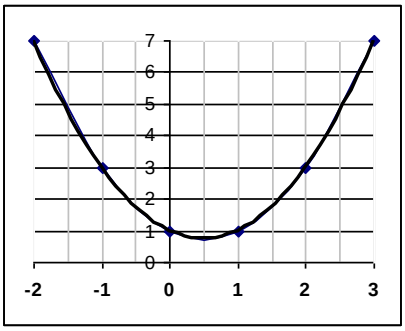
With very few words, the graph shows how electrons are flowing in this particular conductor (let's say it's simply a piece of wire). The section of purple line above the graduated X axis represents current that is flowing in one direction (we'll say from point A to point B). As the cycle approaches midpoint (zero time on the X axis) the electrons come to a complete stop (no current is flowing). They then turn around and begin to flow in the other direction (point B to point A).

PA Core Standard: CC.2.2.HS.C.2

Description: Graph and analyze functions, and use their properties to make connections between the different representations.

Math Associated Vocabulary:
FUNCTION, TABLE, COORDINATE, X-INTERCEPT, Y-INTERCEPT, X-AXIS, Y-AXIS, CARTESIAN COORDINATE SYSTEM, QUADRANT, ORIGIN

Formulas and Procedures:
Matching the graph of a given function to its table or equation assesses a student's ability to recognize that a graph is created from coordinates that can be written in a table or used to make an equation true.



Example: Identify the table that corresponds with the graph above.
Step 1: Identify coordinates through which the graph passes.
If you look at the graph, you can see that the graph passes through the following coordinates: (-2,7),(-1,3),(0,1), (1,1), (2,3), (3,7)

Step 2: Identify the table containing the points from step 1.
In many cases, some tables contain one of the values, but also include values that are not part of the graph.

A.

x	y
-2	7
1	0
2	3

B.

x	y
0	1
1	1
-2	7

Look at options A and B above. The only correct answer can be option B, since the graph passes through all of these points or coordinates. Option A is incorrect because the graph does NOT pass through x = 1 and y = 0 which can be represented as (1, 0).

Example: Identify the equation that represents the graph above.
The equation that matches the graph above is one in which all data points on the graph work to make the equation true. Substitute values from the graph into the equation choices to see which ones work.

One of the following equations represents the given graph: Let's check (0, 1) and (1, 1) to see which one works!

A. $y = x^2 - 2x + 1$
$1 = (0)^2 - 2(0) + 1$
$1 = 1$

B. $y = x^2 - x + 1$
$1 = (0)^2 - (0) + 1$
$1 = 1$

So (0, 1) works for both equations. Let's try (1, 1).

A. $y = x^2 - 2x + 1$
$1 = (1)^2 - 2(1) + 1$
$1 \neq 0$

B. $y = x^2 - x + 1$
$1 = (1)^2 - (1) + 1$
$1 = 1$

Therefore (1, 1) only works for B. B is the correct answer.

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Instructor's Script - Comparing and Contrasting
HVAC technicians work with formulas, equations, tables, and graphs. An important aspect to reading graphs is the ability to identify the table of values that represent the graph. It is also important to HVAC technicians to see the relationship between tables, graphs, and equations that represent the same situation.

Common Mistakes Made By Students
Matching Coordinates to Table Values: Some students have a difficulty reading the scale on a graph. Some axes increase by increments of 10, 5, 2, 1, or less than one. Students should check the scale before identifying the coordinates.

Substituting values from the graph into the equations: When given 4 possible equations, students should substitute the (x, y) values into each equation to see with which equation all the coordinates work. Students sometimes erringly substitute the x value into the y variable.

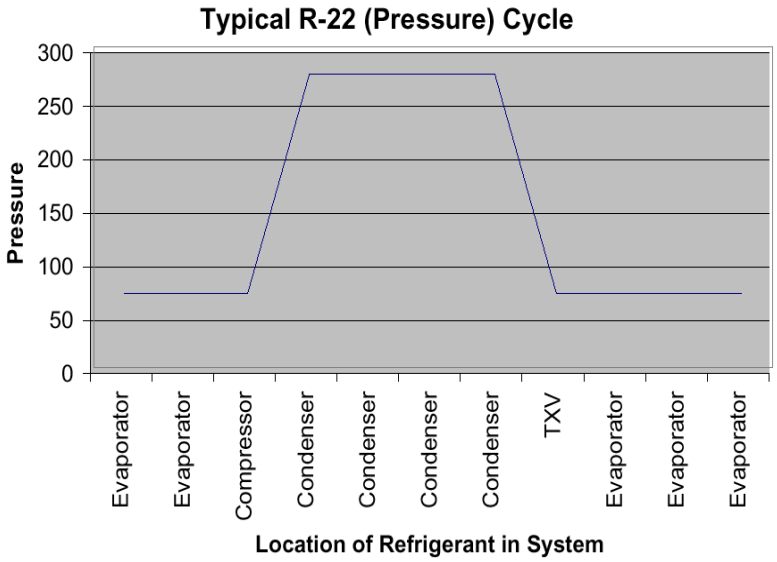
CTE Instructor's Extended Discussion
The word "function" is interesting because it is used by the math teacher as well as by the HVAC teacher.

The math definition of "function" is a variable that is related to another such that for each value assumed by one there is a value determined for the other.

For example, the math teacher may say that y = 2x. So if we know that x = 4, then y must = 8 because 2 x 4 = 8. We also could say that y is a function of x, because the value of y depends on the value of x.

In this HVAC example, one might look at the graph and determine that one function of the Thermostatic Expansion Valve (TXV) is to cause pressure to drop in the system. In this case, the evidence provided is the drop in pressure from 275 psi to 70 psi at the TXV intercept!

We can also see that a function of the compressor is to raise the refrigerant pressure.



If a change in one variable causes a predictable change in another, the variable that changes in response is said to be a function of the first change. In this case, a change in X (adding a Thermostatic Expansion Valve, or TXV) causes a change in Y (the refrigerant pressure is reduced). Therefore, Y is a function of X.

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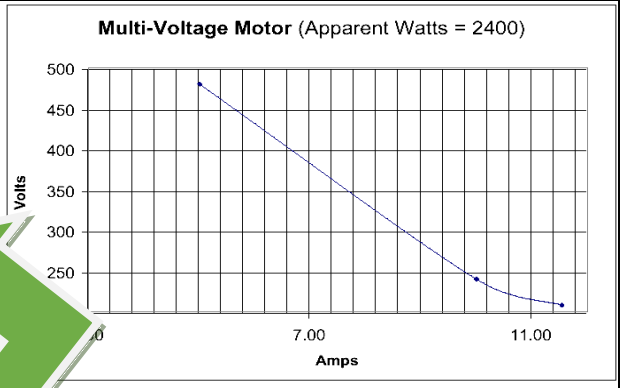
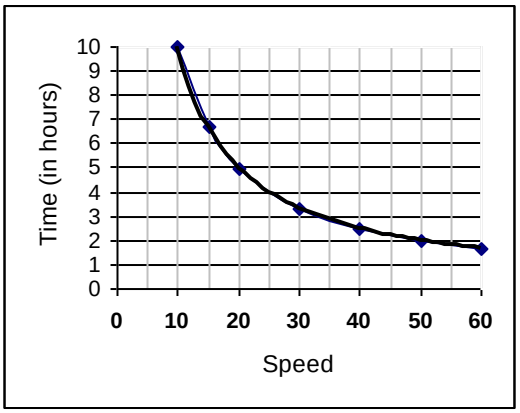
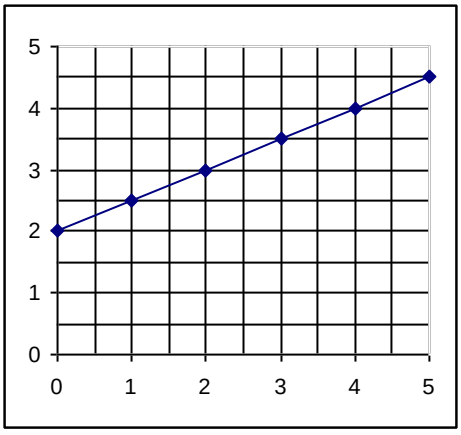
Problems	Occupational (Contextual) Math Concepts	Solutions
1. Create a list of 3 estimated coordinate pairs from the function graphed to the right. 2. Which of the following equations best represents the function graphed to the right? a) y = 20x b) y = 1000/x c) y = 2400/x d) y = x 3. Using the equation from #2, create a table of values for X and Y based on the graph to the right.		

Problems	Related, Generic Math Concepts	Solutions
4. Identify 3 ordered pairs from the graph to the right. 5. Create a table which represents the graph to the right. 6. Which of the following equations could be used to represent the function graphed to the right? a) y = 10x b) y = 100/x c) y = x/100 d) y = x		

Problems	PA Core Math Look	Solutions
7. Create a list of 6 coordinates from the function graphed to the right. 8. Create a table of values for the graph at the right. 9. Which of the following equations best represents the function graphed to the right? a) y = 2x + 2 b) y = ½ x + 2 c) y = x + ½ d) y = 2x + ½		

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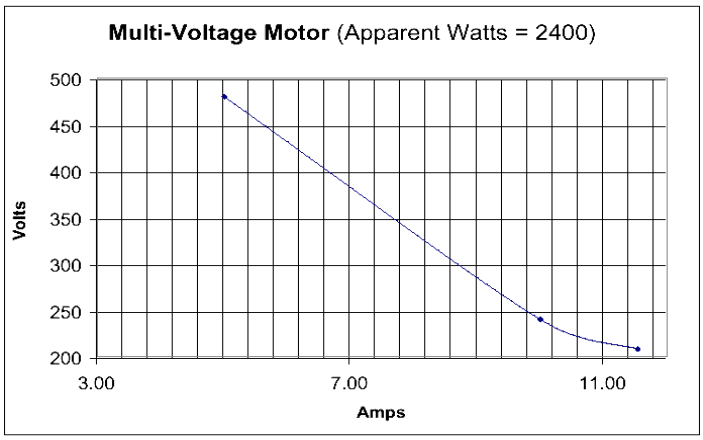
Problems **Occupational (Contextual) Math Concepts** **Solutions**

1. Create a list of 3 estimated coordinate pairs from the function graphed to the right.

   (5, 480), (10, 240), (11, 210)



2. Which of the following equations best represents the function graphed to the right?
   a) y = 20x b) y = 1000/x c) y = 2400/x d) y = x
   Test each equation by substituting values for x.
   The correct answer would be c) y = 2400/x.

3. Using the equation from #2, create a table of values for X and Y based on the graph to the right.
   Answers may vary

Amperage	Voltage
x	y
11.54	208.00
10.00	240.00
5.00	480.00

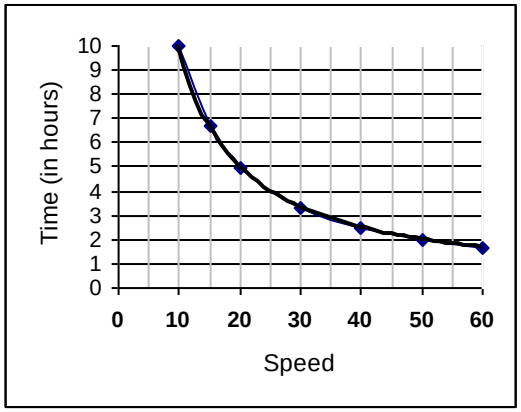
Problems **Related, Generic Math Concepts** **Solutions**

4. Identify 3 ordered pairs from the graph to the right.

   (10,10), (15, 6.7), (20,5), (30, 3.33), (40,2.5), (50,2), (60,1.7)

5. Create a table which represents the graph to the right.

Mph	10	15	20	30	40	50	60
Time	10	6.7	5	3.33	2.5	2	1.7



6. Which of the following equations could be used to represent the function graphed to the right? No answer provided

   a) y = 10x b) y = 100/x c) y = x/100 d) y = x

   The correct answer is b, y = 100/x.

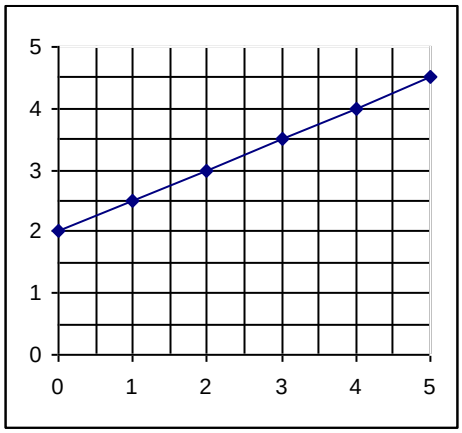
Problems **PA Core Math Look** **Solutions**

7. Create a list of 6 coordinates from the function graphed to the right.

   (0,2), (1,2.5), (2,3), (3, 3.5), (4,4), (5,4.5)

8. Create a table of values for the graph at the right.

x	y
0	2
1	2.5
2	3
3	3.5
4	4
5	4.5



9. Which of the following equations best represents the function graphed to the right? No answer provided.

   a) y = 2x + 2 b) y = ½ x + 2
   c) y = x + ½ d) y = 2x + ½

   The correct answer is b, y = ½ x + 2