Automotive Technology (47.0604) T-Chart

Find boiling point of coolant	=	**Write functions or sequences that model relationships between two quantities**

Program Task: Diagnose lubrication and cooling systems.

Program Associated Vocabulary:
RATIO, PROPORTIONS, PERCENT, PRESSURE, BOILING POINT CHANGE DUE TO THE CHANGE IN THE PROPORTION (PERCENT) OF ANTI-FREEZE TO WATER

Program Formulas and Procedures:
A 50/50 mix of coolant (50% coolant, 50% water) under 16 lbs. of pressure boils at approximately 260° F. 100% coolant under 16 lbs. pressure boils at approximately 280° F. If the amount of coolant deceases to a 30/70 mix (30% coolant, 70% water) at what temperature will the coolant mixture boil? First, find the domain (x) and the range (y) and two data points. Then, using the graph, estimate the rate of change to determine the new boiling point.

Data points = $(\overset{x_1}{0}, \overset{y_1}{280}), (\overset{x_2}{50}, \overset{y_2}{260})$ x is % coolant, y is boiling temp.

To find the slope (m):

$$m = \frac{y_2 - y_1}{x_2 - x_1}\left(= \frac{\text{change in } y}{\text{change in } x} = \frac{\Delta y}{\Delta x}\right)$$

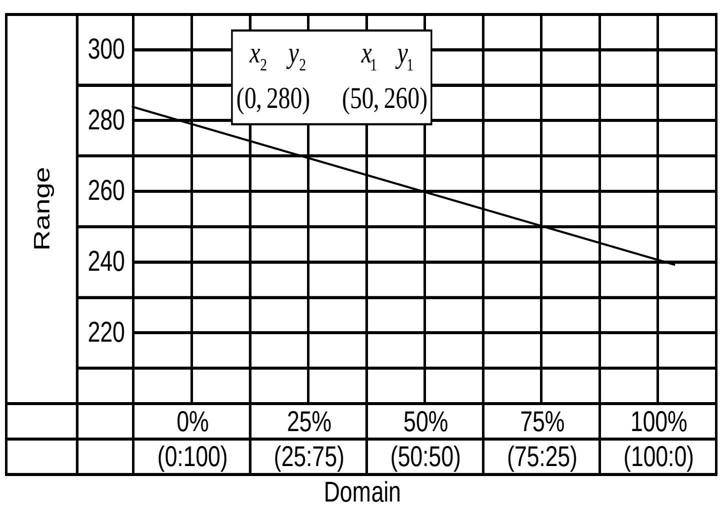
$$m = \frac{260 - 280}{50 - 0} = \frac{-20}{50} = -0.4\ \text{°F per 1\% coolant rise}$$

50% coolant to 30% coolant is -20% coolant change,

$\Delta y = m(\Delta x) = -0.4(-20) = +8$ °F increase

30% coolant mixture boils at (260°F + 8°F) = 268°F

The boiling point of the coolant under pressure is 268^{o} if the coolant ratio is 30% coolant and 70% H_2O.



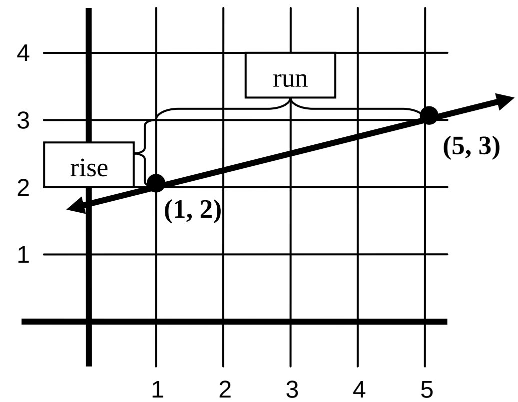
PA Core Standard: CC.2.2.HS.C.3

Description: Write functions or sequences that model relationships between two quantities.

Math Associated Vocabulary:
SLOPE, RISE, RUN, RATE OF CHANGE, LINE, ΔX, ΔY

Formulas and Procedures:

$$\text{slope} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta Y}{\Delta X}$$



Example: To find the slope of the line above:

Step1: Label your coordinates (x_1, y_1) and (x_2, y_2).

Note: It does not matter which coordinate you select to represent (x_1, y_1) and (x_2, y_2). For our example, we'll make $(x_1, y_1) = (1,2)$ and $(x_2, y_2) = (5,3)$

Step 2: Substitute values into the formula and solve.

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3-2}{5-1} = \frac{1}{4}$$

Note: Slope is written as a fraction in simplest form.

Instructor's Script – Comparing and Contrasting

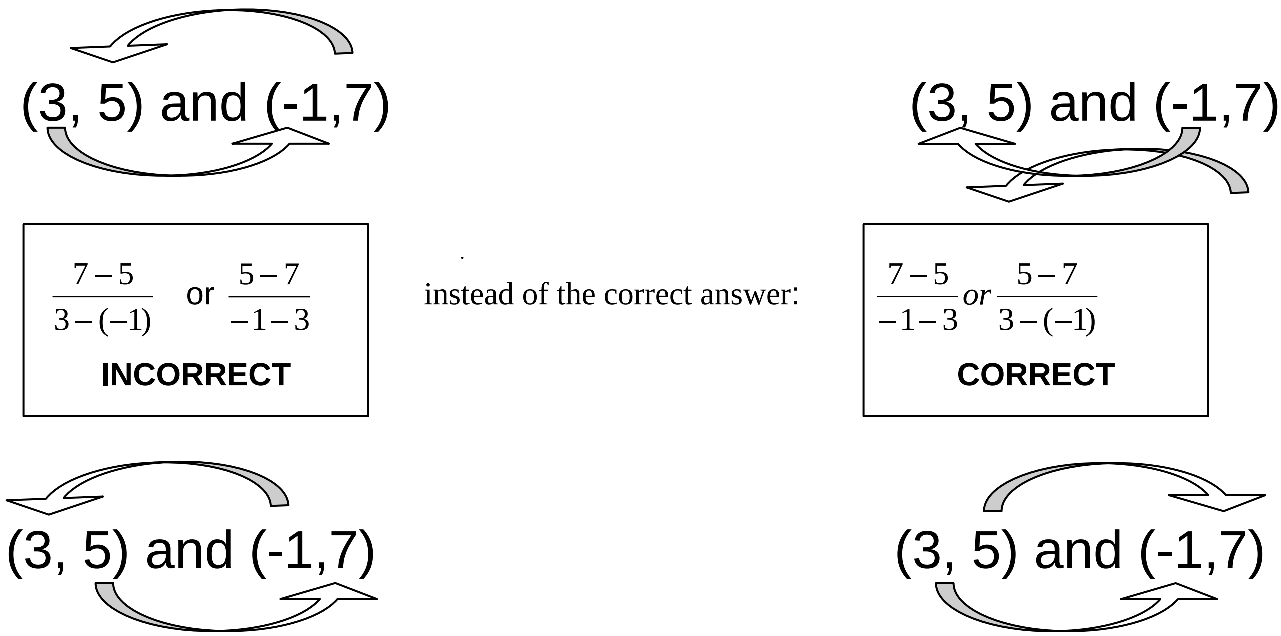
Slope is a concept with which many students are familiar, but don't realize it. Slope is simply a rate of change, or the change in one value based on a change of +1 in another value. Matter of fact, it is good practice to use units when specifying slope for a particular applied problem so students can "hear" the meaning:

A certain engine's power curve shows an increase in horsepower by 100 hp for every 1000 rpm. This curve would have a slope (m) of $\frac{100}{1000} = +\frac{1}{10}$ hp per 1 rpm.

Like the example above, most graphs and charts are hard to read values with any kind of precision. Reading the graph above at 30% coolant, students would most likely provide answers ranging from 260°F to 270°F. Calculating slope from 2 known points will often provide a much closer estimate to the actual value.

Common Mistakes Made By Students

Students will often not subtract consistently among x and y values. For instance, for the slope of a line passing through the points (3, 5) and (-1,7):



$\frac{7-5}{3-(-1)}$ or $\frac{5-7}{-1-3}$

INCORRECT

instead of the correct answer:

$\frac{7-5}{-1-3}$ *or* $\frac{5-7}{3-(-1)}$

CORRECT

Slope is a rate of change, not an actual value that appears on the graph or chart. It has a relationship to the "steepness" of the line and the direction (up or down), but it won't show up on the graph (except coincidentally).

CTE Instructor's Extended Discussion

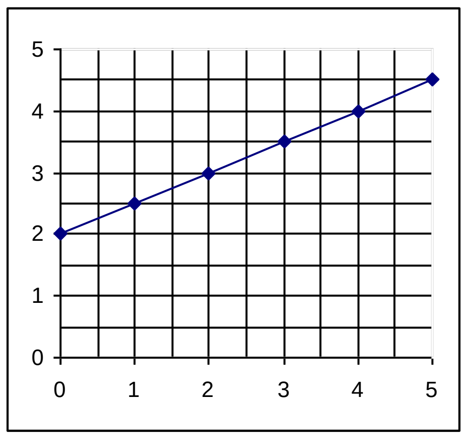
Technical tasks are usually not presented using this model. Therefore, it is important that technical instructors demonstrate to students how these math concepts link to and are relevant in their technical training and that the CTE instructor presents the math in a way which shows a relationship to the math which CTE students use in their academic school settings.

There are many other examples in the field of Automotive Technology that might have been used to demonstrate this math concept. Automotive technology professionals are concerned with rate of change and the control of mediums that affect the desired change (outcome). Numerous automotive technology texts & diagnostic flow charts include graphs displaying the relationship between some X and some Y coordinates. For example: Temperature/pressure, Time/distance and Voltage/resistance.

Make the effort and help your students become competent professionals by spending the time necessary to become comfortable with reading graphs, interpreting data points, and identifying important trends that lie hidden in slopes.

Automotive Technology (47.0604) T-Chart

Problems	Career and Technical Math Concepts	Solutions
All new vehicles are required to undergo static emission testing. In these tests, the vehicle is placed in an environmental chamber with the engine off for up to 15 days to determine the amount of emissions released by the tires, gasoline, paint, vinyl, plastics, coolant and even the windshield washer solvent. One particular system produces the following emission readings: (Day 2, 5.4ppm); (Day 5, 6ppm); (Day 10, 7ppm). First, graph the data points. Then using the graph: 1. Find the ppm at “0” days (“b”, the initial amount of emissions being produced before the vehicle was placed in the test chamber) 2. What was the ppm reading on day 7? 3. What day was the concentration 5.8 ppm?		

Problems	Related, Generic Math Concepts	Solutions
4. A ramp increases from ground level to a height of 5 feet over a span of 20 feet. What is the slope (rate of change) of the ramp?		
5. Determine the slope of the line graphed at the right:		
6. A sidewalk increases from ground level to a height of 3 feet over a span of 40 feet. What is the slope (rate of change) of the sidewalk?		

Problems	PA Core Math Look	Solutions
7. Find the slope of a line passing through the points (3, 5) and (2, 1).		
8. Find the slope of a line passing through the points (-2, 1) and (4, -5).		
9. Find the slope of a line passing through the points (4, 2) and (-5, 6).		

Automotive Technology (47.0604) T-Chart

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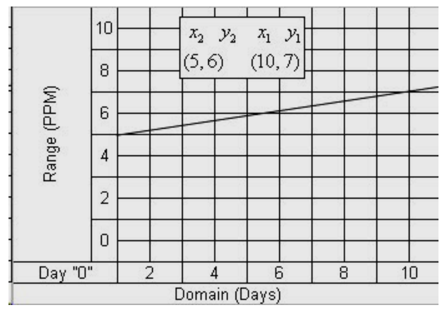
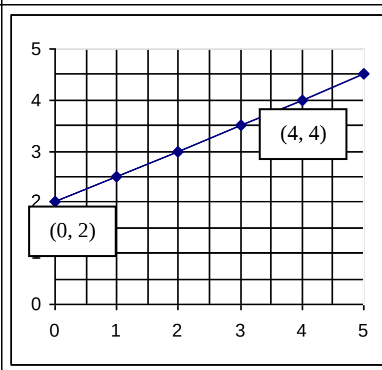
All new vehicles are required to undergo static emission testing. In these tests, the vehicle is placed in an environmental chamber with the engine off for up to 15 days to determine the amount of emissions released by the tires, gasoline, paint, vinyl, plastics, coolant and even the windshield washer solvent. One particular system produces the following emission readings: (Day 2, 5.4ppm); (Day 5, 6ppm); (Day 10, 7ppm). First, graph the data points. Then using the graph: 1. Find the ppm at "0" days ("b", the initial amount of emissions being produced before the vehicle was placed in the test chamber) 2. What was the ppm reading on day 7? 3. Using the graph, what day was the concentration 5.8 ppm?	Data points: (5, 6) (10, 7) 1. $m = \frac{7-6}{10-5} = \frac{1}{5}$ ppm per 1 day 2 days to 0 days is -2 day change: Δy = m (Δx) = 0.2 (-2) = -0.4 ppm change Day 0 had emissions of (5.4 ppm – 0.4 ppm) = **5 ppm** 2. 5 days to 7 days is +2 day change: Δy = m (Δx) = 0.2 (+2) = +0.4 ppm Day 7 had emissions of (6 ppm + 0.4 ppm) = **6.4 ppm** 3. 4 = x, (Day 4) 

Problems	Related, Generic Math Concepts / Solutions
4. A ramp increases from ground level to a height of 5 feet over a span of 20 feet. What is the slope (rate of change) of the ramp?	$\frac{5}{20} = \frac{1}{4}$
5. Determine the slope of the line graphed at the right:	 $m = \frac{4-2}{4-0}$ $m = \frac{2}{4} = \frac{1}{2}$
6. A sidewalk increases from ground level to a height of 3 feet over a span of 40 feet. What is the slope (rate of change) of the sidewalk?	$\frac{3}{40}$

Problems	PA Core Math Look / Solutions
7. Find the slope of a line passing through the points (3, 5) and (2, 1).	$\frac{5-1}{3-2} = \frac{4}{1} = 4$ or $\frac{1-5}{2-3} = \frac{-4}{-1} = 4$
8. Find the slope of a line passing through the points (-2, 1) and (4, -5).	$\frac{-5-1}{4-(-2)} = \frac{-6}{6} = -1$ or $\frac{1-(-5)}{-2-4} = \frac{6}{-6} = -1$
9. Find the slope of a line passing through the points (4, 2) and (-5, 6).	$\frac{6-2}{-5-4} = \frac{4}{-9} = -\frac{4}{9}$ or $\frac{2-6}{4-(-5)} = \frac{-4}{9} = -\frac{4}{9}$