Machine Tool Technology (48.0501) T-Chart

Calculate taper dimensions =	Write functions or sequences that model relationships between two quantities

Program Task: Perform taper turning operations.

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

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

Program Associated Vocabulary:
TAPER, TPI (TAPER PER INCH), TPF (TAPER PER FOOT)
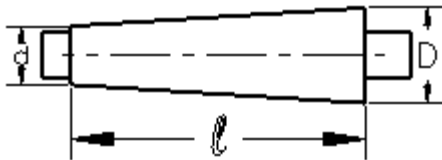
Math Associated Vocabulary:
SLOPE, RISE, RUN, RATE OF CHANGE, LINE, ΔX, ΔY

Program Formulas and Procedures:
Calculating taper dimensions is very common in the machining field. This sketch shows some important dimensions that are frequently given on blueprints.

D = Diameter of large end of taper

d = diameter of small end of taper

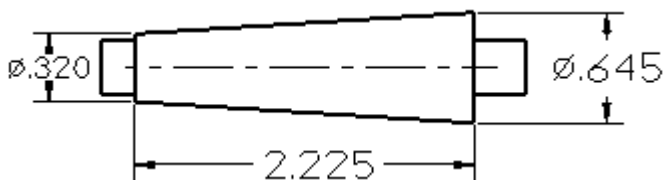L = length of the *taper* in inches (not length of the entire part)

To machine this taper on a conventional lathe TPI or TPF must be calculated.

$$TPI = \frac{D-d}{L} \text{ and}$$

$$\frac{Taper}{Foot} = \frac{Taper}{Inch} \times \frac{12 \text{ inches}}{1 \text{ Foot}}$$

This is similar to finding the slope of a line in math class. TPI is like the slope. $D - d$ is like the change in *y*. L is the like change in *x* (There is only one value because the starting point is at x = 0, and L − 0 = L).
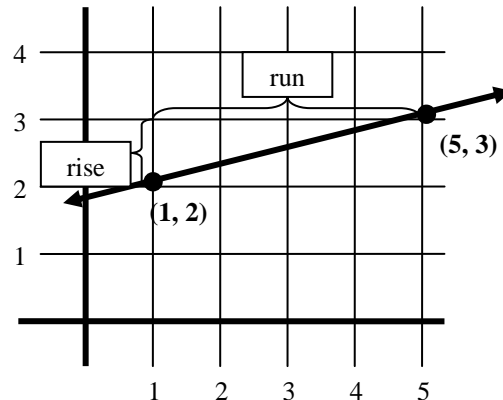
Example: What is the TPI of the part below?

$$TPI = \frac{D-d}{L}$$

$$TPI = \frac{.645 - .320}{2.225}$$

$$TPI = \frac{.325}{2.225} = .1461$$

Formulas and Procedures:

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

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.

$$slope = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{3 - 2}{5 - 1} = \frac{1}{4}$$

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

**Instructor's Script – Comparing and Contrasting**
This shows an example of computing slope that is a little different than the traditional way used in a mathematics classroom. It is using the same concept and it is a great way to show that the real life applications of slope my not follow the exact same formula that we use in the math classroom.

You can still see the rise and the run, but it is not in the coordinate plane. If you understand the concept of slope you can apply it in many areas.

Common Mistakes Made By Students
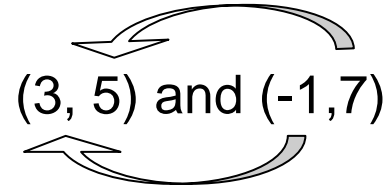Often students forget that the y-coordinates go in the numerator and the x-coordinates go in the denominator.

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

(3, 5) and (-1,7)
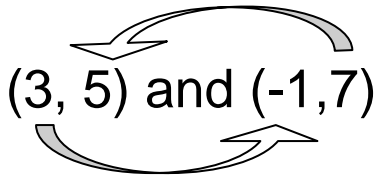
$$\frac{7-5}{3-(-1)} \quad \text{or} \quad \frac{5-7}{-1-3}$$

INCORRECT

instead of the correct answer:

(3, 5) and (-1,7)

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

**CORRECT**

(3, 5) and (-1,7)

(3, 5) and (-1,7)
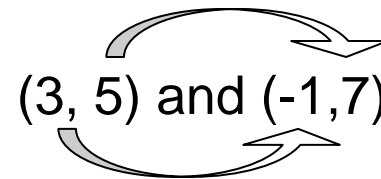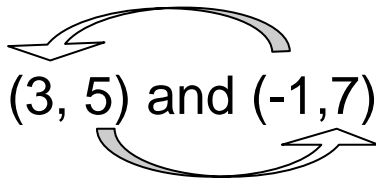
CTE Instructor's Extended Discussion
There is one difference between calculating taper per inch and slope of a line that is worth mentioning. When calculating TPI it is like there are two lines that are symmetrical about an axis instead of just one line with changing *x* and *y* values.

The TPI formula can also be rearranged to solve for either the large end diameter (D) or the small end diameter (d) when TPI is given.

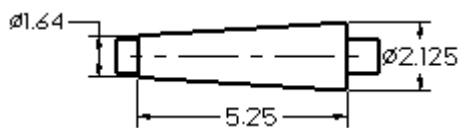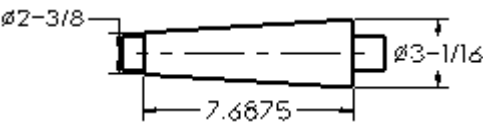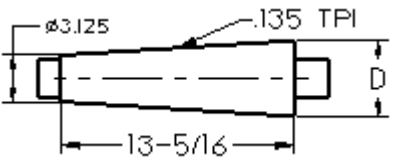Additionally, if TPF is required, conversion factors must be used to change TPI to TPF.
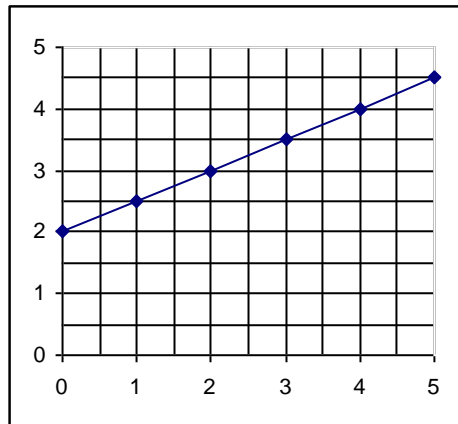
Example: Calculate the small end diameter of the part shown in the sketch.

.075 TPi
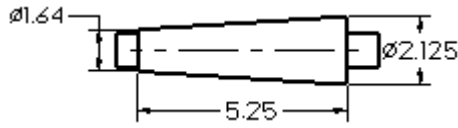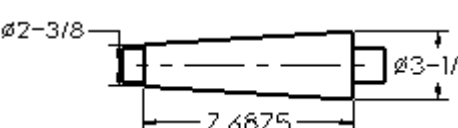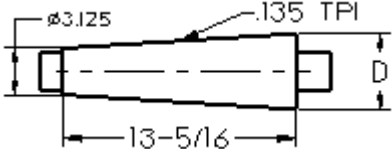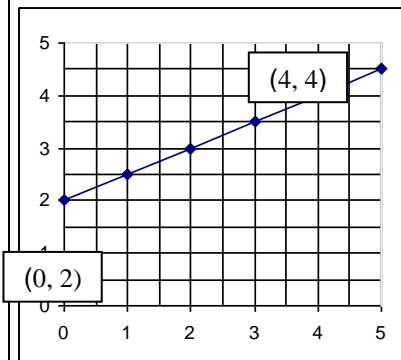
Ø 8.35

32
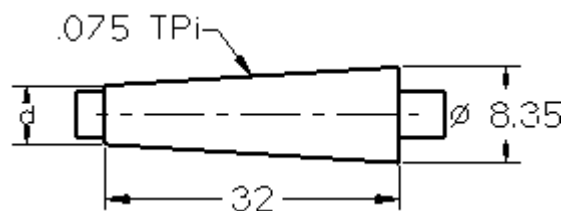
$$TPI = \frac{D - d}{L}$$

$$.075 = \frac{8.35 - d}{32}$$

$$2.4 = 8.35 - d$$

$$d = 5.95$$

What is the TPF for this part?

$$\frac{Taper}{Foot} = \frac{Taper}{Inch} \times \frac{12 \, inches}{1 \, Foot}$$

$$\frac{.075}{1 \, inch} \times \frac{12 \, inches}{1 \, Foot} = .9 \, TPF$$

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Problems	Career and Technical Math Concepts	Solutions
1. What is the TPI of the part?		
2. What is the TPF of the part in decimal form?		
3. What is the diameter of the large end of the part?		

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).		

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Problems	Career and Technical Math Concepts	Solutions
1. What is the TPI of the part?	$\text{TPI} = \dfrac{D-d}{L}$ $\text{TPI} = \dfrac{2.125 - 1.64}{5.25}$ $\text{TPI} = \dfrac{.485}{5.25}$ $\text{TPI} = .0924$	
2. What is the TPF of the part in decimal form?	$\text{TPI} = \dfrac{D-d}{L} \rightarrow \text{TPI} = \dfrac{3\frac{1}{16} - 2\frac{3}{8}}{7.6875} \rightarrow \text{TPI} = \dfrac{.6875}{7.6875}$ $\text{TPI} = .0894$ $\dfrac{.0894\,\text{taper}}{1\,\text{inch}} \times \dfrac{12\,\text{inches}}{1\,\text{foot}} = 1.0728\,\text{TPF}$	
3. What is the diameter of the large end of the part?	$\text{TPI} = \dfrac{D-d}{L} \rightarrow .135 = \dfrac{D - 3.125}{13\frac{5}{16}}$ $.135 \times 13.3125 = D - 3.125 \rightarrow 1.797188 = D - 3.125$ $D = 4.9222$	

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?	$\dfrac{5}{20} = \dfrac{1}{4}$	
5. Determine the slope of the line graphed at the right:		$m = \dfrac{4-2}{4-0}$ $m = \dfrac{2}{4} = \dfrac{1}{2}$
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?	$\dfrac{3}{40}$	

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