Drafting & Design Technology/Technician (15.1301) T-Chart

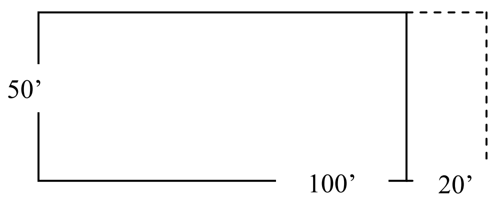
Describe linear dimension effects	=	Apply geometric concepts to model and solve real-world problems

Program Task: Determine how much fencing is needed if the length of the field is changed.

Program Associated Vocabulary:
LINEAR DIMENSION, PERIMETER, AREA, CIRCUMFERENCE

Program Formulas and Procedures:
Sometimes during the design phase, the architect may request dimension changes to allow for more area. The drafter must make the revisions and determine how the change in dimension affects the area or perimeter of the space.

Example:



The original fenced in area was designed at 50' x 100'. During the design stage, it was decided to add an additional 20' to the 100 foot length. How much more fencing is required with the modified design?

Solution:

Original Perimeter:
P = 2l + 2w
P = 2(100) x 2(50)
P = 200 + 100 = 300 lineal feet of fencing

New Perimeter:
P = 2l + 2w
P = 2(120) + 2(50)
P = 240 + 100 = 340 lineal feet of fencing

New fencing required: 340 lineal feet
Original fencing required: -300 lineal feet
Additional fencing required: 40 lineal feet

Since the width of the fenced in area was not changed, a simpler method would be to simply multiply the additional length required by 2 since both sides are affected: 2 x 20' = 40'.
Of course, this is only helpful if you have already calculated the perimeter of the original area.

PA Core Standard: CC.2.3.HS.A.14

Description: Apply geometric concepts to model and solve real-world problems.

Math Associated Vocabulary:
LINEAR DIMENSION, PERIMETER, CIRCUMFERENCE, AREA, VOLUME, DOUBLE, TRIPLE, CUBIC, SQUARE

Formulas and Procedures:
Students are often asked to evaluate the impact on perimeter, circumference, area, or volume when one of the linear dimensions, such as length, height or radius is increased. Often, the questions involve doubling or multiplying the dimension by a certain value.

In order to solve these problems, students should solve the problem using the original and larger linear dimension and then compare the results.

Example 1*:* If the radius of a circle is doubled, by how much is the area increased?

Step 1: Since a value has not been assigned to the original figure, assign any value to the original circle and solve for the area. For this example, use a value of 10 inches for the radius.

$A = \pi r^2$

$A = 3.14(10)(10) = 314 \text{ in}^2$

Step 2: Double the radius and solve for the area.

$A = \pi r^2$

$A = 3.14(20)(20) = 1256 \text{ in}^2$

Step 3: Compare the two areas. Did they double also or increase by some other multiplier? Hint: Divide the larger area by the smaller area.

1256 is 4 times larger than 314 because 1256/314 = 4

Example 2: If the side of a cube is increased from 3 in. to 6 in., by how much is the volume increased?

Step 1: Since a value has been assigned to the original figure, use this value (3 in.) and solve for the volume.

V = l x w x h (the length, width, and height all equal 3 in.)

$V = 3 \bullet 3 \bullet 3 = 27 \text{ in}^3$

Step 2**:** Find the volume of the larger figure.

$V = 6 \times 6 \times 6 = 216 \text{ in}^3$

Step 3: Compare the two volumes. Did they double also or increase by some other multiplier? Hint: Divide the larger area by the smaller area.

216 is 8 times larger than 27 because 216/27 = 8

Instructor's Script – Comparing and Contrasting

The example displayed on the drafting side of the T-chart on page one depicts the need for drafters to be able to analyze how changing a dimension of a rectangle affects perimeter. In addition to perimeters of rectangles, students must be able to analyze how changing a dimension also affects area, perimeter, circumference, and volume. This eligible content provides an avenue for teachers to approach the concepts of area, perimeter, circumference, and volume from more than one angle. Teachers should integrate these types of questions when they provide instruction on area, perimeter, circumference, and volume.

Common Mistakes Made By Students

Students often do not recognize that values may be substituted into the formulas to evaluate the effects of changing the linear dimensions. For instance, if the problem asks how the volume of a cube is affected if the lengths of the sides are doubled. For this example, the student could use two fictitious values to test, like 2 and 4 or 3 and 6.

CTE Instructor's Extended Discussion

From your own work experience you no doubt have had to perform many of these calculations. The drafting field is quite large and covers many disciplines including architectural, mechanical, electrical, machine design, etc. It is important that students recognize just how wide the field is and are prepared to enter their chosen field confident in their math skills.

Drafting & Design Technology/Technician (15.1301) T-Chart

Problems	Career and Technical Math Concepts Solutions
1. Reference the example problem on page one. You need to fence in a rectangular area of 5,000 sq. ft. One side is 100 feet long. What is the length of the other side? Later the design changes to require 6,000 sq. ft. while maintaining the same width you calculated in part one. What is the change in length of the fenced area?	
2. You have designed a house with a 6/12 roof slope. The width of the house is 24'. You change the width of the house to 30'. What is the change in the length of the rafter? (Note: the rafters meet in the center of the house, so the length of the base is half the width.)	
3. A pole is 40' high with guy wires forming a 20' diameter at the base. If you add 10' of height to the pole, and reuse the existing shackles at the bottom of the guy wires, what are the perimeters of the new and old triangles formed by the ground (base), pole (height) and guy wire (hypotenuse)?	
Problems	**Related, Generic Math Concepts Solutions**
4. A soup company would like to change the design of their cans so they hold more soup. If they triple the radius of the can, by how much will they increase the amount of soup each can will be able to hold?	
5. Jake and Jenny each have a beach ball, but Jenny's ball has twice the diameter of Jake's ball. How many times more volume of air can Jenny's ball hold?	
6. A family decides to extend their garden to make it bigger. It originally had a width of 10 feet and a length of 13 feet. If they increase the width of the garden to 12 feet, how much more fencing will they need to enclose the garden?	
Problems	**PA Core Math Look Solutions**
7. By how much does the area of a rectangle increase if the width remains the same but the length is doubled?	
8. The perimeter of a rectangle is 30 feet when the width is 5 feet and the length is 10 feet. Find the perimeter if the length is 15 feet.	
9. By how much does the volume of a cylinder increase if the radius remains the same, but the height doubles?	

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Problems	Career and Technical Math Concepts / Solutions
1. Reference the example problem on page one. You need to fence in a rectangular area of 5,000 sq. ft. One side is 100 feet long. What is the length of the other side? Later the design changes to require 6,000 sq. ft. while maintaining the same width you calculated in part one. What is the change in length of the fenced area?	$A = l \times w$ $5{,}000 = 100y \quad y = 50'$ Check: 50 x 100 = 5,000 square feet. $6{,}000 = 50y$ $y = 120$ 120 – 100 = 20 ft. change in length.
2. You have designed a house with a 6/12 roof slope. The width of the house is 24’. You change the width of the house to 30’. What is the change in the length of the rafter? (Note: the rafters meet in the center of the house, so the length of the base is half the width.)	Original length: A rise of 6” in 12’ = .5’ x 12’ = 6’ $C^2 = 12^2 + 6^2 \rightarrow C^2 = 144 + 36 \rightarrow C^2 = 180 \rightarrow C = 13.42$” New length: A rise of 6” in 12’ = .5’ x 15’ = 7.5’ $C^2 = 15^2 + 7.5^2 \rightarrow C^2 = 225 + 56.25 \rightarrow C^2 = 281.25 \rightarrow C = 16.77$” Change in length = 16.77 – 13.42 = 3.35’
3. A pole is 40’ high with guy wires forming a 20’ diameter at the base. If you add 10’ of height to the pole, and reuse the existing shackles at the bottom of the guy wires, what are the perimeters of the new and old triangles formed by the ground (base), pole (height) and guy wire (hypotenuse)?	Old triangle (40’ pole), Base = 20’ Pythagorean Theorem: $\sqrt{40^2 + 20^2}$ = 44.72’ Hypotenuse Old Perimeter = 40’ + 20’ + 44.72’ = 104.72’ New triangle (50’ pole) Base = 20’ Pythagorean Theorem $\sqrt{50^2 + 20^2}$ = 53.85’ Hypotenuse New Perimeter = 50’ + 20’ + 53.85’ = 123.85’
Problems	**Related, Generic Math Concepts / Solutions**
4. A soup company would like to change the design of their cans so they hold more soup. If they triple the radius of the can, by how much will they increase the amount of soup each can will be able to hold?	$V = \pi r^2 h$ Method 1: replace r with 3r (tripled) $V = \pi(3r)^2 h = \pi(9r^2)h$ The volume is nine times larger. Method 2: Compare the volumes using r = 1 and r = 3, h = 1. $V = \pi r^2 h \quad V = (3.14)(1)(1)(1) = 3.14$ $V = \pi r^2 h \quad V = (3.14)(3)(3)(1) = 28.26$ Divide the two values to find the factor by which the volume increases. $28.26 \div 3.14 = 9$
5. Jake and Jenny each have a beach ball, but Jenny’s ball has twice the diameter of Jake’s ball. How many times more volume of air can Jenny’s ball hold?	$V_1 = \frac{4}{3}\pi r^3, V_2 = \frac{4}{3}\pi(2r)^3 \quad V_2 = \frac{4}{3}\pi(8r^3)$ Jenny’s ball holds 8 times more air.
6. A family decides to extend their garden to make it bigger. It originally had a width of 10 feet and a length of 13 feet. If they increase the width of the garden to 12 feet, how much more fencing will they need to enclose the garden?	Original perimeter = 2(10)+2(13)=46 ft. New perimeter = 2(12)+2(13) = 50 ft. They will need 4 more feet of fencing.
Problems	**PA Core Math Look / Solutions**
7. By how much does the area of a rectangle increase if the width remains the same but the length is doubled?	$A_1 = lw, A_2 = 2lw$ The area doubles.
8. The perimeter of a rectangle is 30 feet when the width is 5 feet and the length is 10 feet. Find the perimeter if the length is 15 feet.	Perimeter = 2(5) + 2(15) = 40 feet.
9. By how much does the volume of a cylinder increase if the radius remains the same, but the height doubles?	If the height doubles, the volume doubles.