## Section 3.3 – Surface Area and Dimension Changes

- In the previous section we look at how to calculate the surface area of a $3 - D$ shape
- But what happens if the dimensions change?
- The length doubles or the height gets cut in half?
- What effect does it have on the overall Surface Area?

Example 1:

Scotty K. is a carpenter tasked with building a forest of trees of varying sizes. The trees are in the form of a square based pyramid shape.

- All the trees are made out of plywood sheets and have the same square base with sides $4.9m$ long.
- The small trees have slant heights of $5.5m$
- The medium trees have slant heights of $9.8m$
- The largest trees have slant heights of $18.2m$.

Slant Height
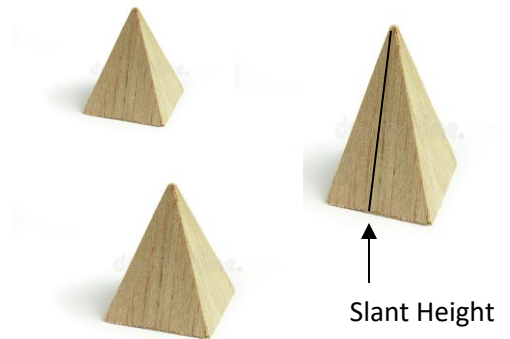
How much plywood is needed for each tree and by how much do they differ?

From the equation sheet: **Surface Area of a Square Based Pyramid** is: $\boldsymbol{SA = 2bs + s^2}$

Solution 1:

a) The smallest pyramid has a Surface Area of: $2(4.9) + 5.5^2 = \boldsymbol{40.05m^2}$
b) The medium pyramid has a Surface Area of: $2(4.9) + 9.8^2 = \boldsymbol{105.84m^2}$
c) The large pyramid has a Surface Area of: $2(4.9) + 18.2^2 = \boldsymbol{341.04m^2}$

So we can see they differ in Surface Area. Since Scotty has to buy his supplies, it is helpful if he knows how much material he needs for each sized tree.

The difference in supplies is:

The medium tree is: $235.20m^2$ less than the large tree and $65.79m^2$ more than the small tree.

The small tree is: $65.79m^2$ less than the medium tree and $300.99m^2$ less than the large tree.

This stuff is really a paint by numbers type of activity. Fill in the appropriate information into the equations and calculate the difference!

Example 2:   Ria is the owner of a restaurant in Victoria, she is looking at buying new light fixtures for the dining room. The fixtures are blown glass spheres with a radius of $4in$ that cost $30. She asked if the glass company could make glass spheres half the size and three times as big. What would be a fair price for the other sized fixtures.

Solution 2:

From our equation sheet the equation for the Surface Area of a sphere is: $\mathbf{4\pi r^2}$

- Let's look first at the Surface Area of the original light fixture

$$SA = 4\pi r^2 \qquad \rightarrow \qquad 4\pi(4)^2 = 201.06in^2$$

- How much Surface Area is required for the light fixture half the size? What factor changes?

$$SA = 4\pi r^2 \qquad \rightarrow \qquad 4\pi(2)^2 = 50.27in^2$$

Radius changes by a factor of one half.

Since the radius is squared, the SA changes by a factor of one quarter.

$$\left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

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How much Surface Area is required for the light fixture three times the size? What factor changes?

$$SA = 4\pi r^2 \qquad \rightarrow \qquad 4\pi(12)^2 = 1809.56in^2$$

Radius changes by a factor of three.

Since the radius is squared, the SA changes by a factor of nine.

$$(3)^2 = 9$$

A price per square inch breaks down like this: $\dfrac{\$30}{201.06in^2} = \$0.15/in^2$

So a fair price for the smaller fixture would be: $\dfrac{\$0.15}{in^2} \cdot 50.27in^2 = \$7.54$

A fair price for the largest fixture would be : $\dfrac{\$0.15}{in^2} \cdot 1809.56in^2 = \$271.43$

Section 3.3 – Practice Problems

1. You are starting a business and need various sizes of rectangular boxes (including lids). If the original box size is: $length = 5in, width = 4in, \ height = 3in$

   a) What is the surface area of the original box?

   3.0m

   4.0m

   5.0m
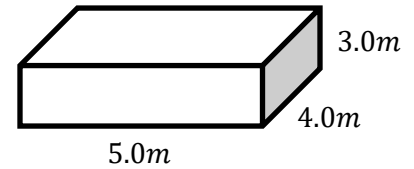
   b) What happens to the surface area if we double the length and the width?

   c) How does the surface area change if the height and length are tripled?

   d) If each side was multiplied by a factor of 4, what is the new surface area?

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2. Using the dimensions from the previous question, what happens to the surface area of the box if all sides are halved (divided by 2)?

3. Jim is going to build a tree house in the shape of a triangular prism. It costs $35/m^2$ of surface area. He is considering changing the depth from $5.0m$ to $7.0m$.

    a) What is the surface area of the original?
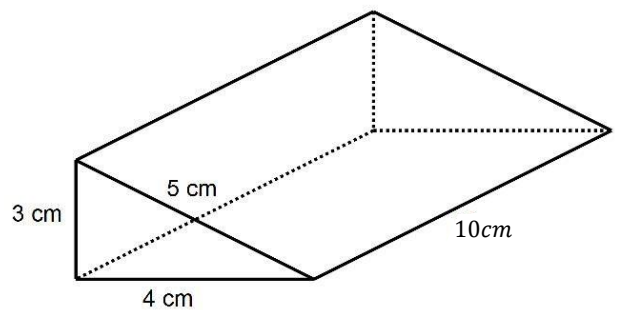

3.0m

2.6m

3.0m

5.0m
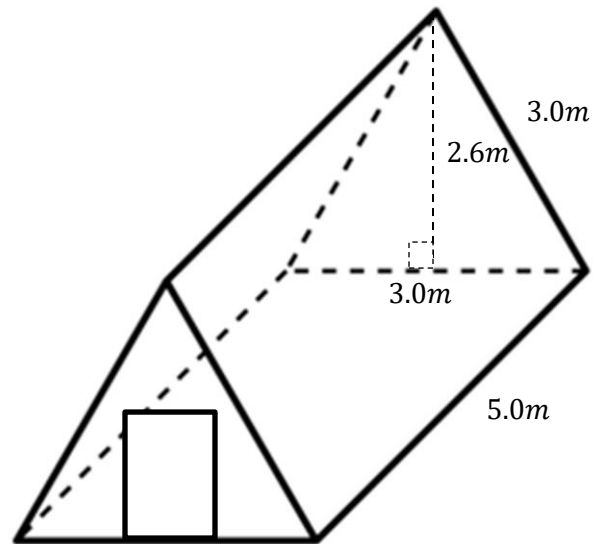
    b) What is the surface area of the larger plan?

    c)   What is the difference in the Surface Areas?

    d)   How much would it cost to increase the depth?

4. If you were to double or halve the length $(10cm)$ of the following image, how would by how much would the Surface Area change with respect to the original?

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Section 3.3 – Answer Key

1.
a) *Increase of* $94m^2$
b) *Increase of* $174m^2$
c) *Increase of* $368m^2$
d) *Increase of* $1410m^2$; *changes by a factor of* 16
2. *Decrease of* $70.5m^2$; *changes by a factor of* ¼
3.
a) $52.8m^2$; *Costs* $\$1848$
b) $70.8m^2$; *Costs* $\$2478$
c) *Changes by* $18m^2$
d) *Changes by* $\$630$
4. *Original*: $132cm^2$
Double: $252cm^2$; *Increase of* $120cm^2$
Half: $72cm^2$; *Decrease of* $60cm^2$