### Derived Formulas

<table>
<thead>
<tr>
<th>3-D Shape</th>
<th>Volume Formula</th>
<th>Area Formula</th>
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<tbody>
<tr>
<td>Rectangular Prism</td>
<td>( V = l \times w \times h )</td>
<td>( SA = 2(lw + lh + wh) )</td>
</tr>
<tr>
<td>Cylinder</td>
<td>( V = \pi r^2 h )</td>
<td>( SA = 2\pi r^2 + 2\pi rh )</td>
</tr>
<tr>
<td>Sphere</td>
<td>( V = \frac{4}{3} \pi r^3 )</td>
<td>( SA = 4\pi r^2 )</td>
</tr>
<tr>
<td>Cone</td>
<td>( V = \frac{1}{3} \pi r^2 h )</td>
<td>( SA = \pi r^2 + \pi rs )</td>
</tr>
<tr>
<td>Pyramid</td>
<td>( V = \frac{1}{3} l \times w \times h )</td>
<td></td>
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There are times when we need to change a formula to find one of the variables that we normally have. A good example of this is the Pythagorean Theorem where we normally use \( c^2 = a^2 + b^2 \), but occasionally change it to \( b^2 = c^2 - a^2 \).

Do you remember how to solve an equation for a variable – the \( 3x - 5 = 25 \) sort of problems where you had to manipulate terms on both sides of an equation in order to solve for \( x \)? You may recall having to, in the example above, add 5 to both sides then divide both by 3 to isolate \( x \) so that we would have a solution for it. We do the exact same thing with the equations for volume and surface area in order to determine the formula for one of its variables. Consider the example below.

Rewrite the formula for the volume of a cone to determine what the radius is.

\[
3V = \pi r^2 h \\
\frac{3V}{\pi h} = r^2 \\
\sqrt{\frac{3V}{\pi h}} = r
\]

**Activity 1:** Rewrite the formula for the volume of a cone to determine what the height is. Show all work or no mark. Use multiple steps.

Once you have a new formula, you can use it to answer the question at hand. For example, use the derived formula for radius of a cone to determine the radius of a cone with a Volume of 200 cm\(^3\) and a height of 7 cm.

\[
r = \sqrt{\frac{3V}{\pi h}} = \sqrt{\frac{3 \times 200}{3.14 \times 7}} = \sqrt{\frac{600}{21.98}} = \sqrt{27.30} = 5.2 \text{ cm}
\]

**Activity 2:** Use the formula for height of a cone if its radius is 8 cm and its volume is 500 ml.
Homework:
1. Rearrange the formula to determine the stated variable. They get harder as they go down.
   a) Determine height: \( V = l \times w \times h \)
   b) Determine width: \( V = \frac{1}{3} l \times w \times h \)
   c) Determine height: \( V = \pi r^2 h \)
   d) Determine radius: \( SA = 4\pi r^2 \)
   e) Determine radius: \( V = \pi r^2 h \)
   f) Determine radius: \( V = \frac{1}{3} \pi r^2 h \)
   g) Determine radius: \( V = \frac{4}{3} \pi r^3 \)
   h) Determine height: \( SA = 2(lw + lh + wh) \)
   i) Determine height: \( SA = 2\pi r^2 + 2\pi rh \)
   j) Determine side: \( SA = \pi r^2 + \pi rs \)

2. Use the derived formulas from above to solve the problems below. Refer to the front of this sheet to determine the correct formula and the method to solve the problem.
   a) A rectangular prism has a volume of 72 ml (cm³). The length and width are 3 and 4 cm respectively. Find height.
   b) A cylinder has a radius of 5 inches and a volume of 549.5 cubic inches. Determine the height of the cylinder.
   c) A sphere has a surface area of 113.04 in². Determine its radius.
   d) A cone has a volume of 40 ml. It has a height of 4 cm and a length of 5 cm. Determine width.
   e) A rectangular prism has a surface area of 168 square meters. Its length and width are both 6 meters. What is the height?
   f) A cylinder has a surface area of 150.72 cm². If the radius is 3 cm, what is the height?