What happens to volume and surface area of a three dimensional object when one of its parameters are changed? The answer, it turns out, depends on what the shape is, which parameter is changed, and how much it is change by.

In order to explore this, we will need formulas related to the shapes we will use. The shapes and formulas include:

**3-D shape** | **Volume formula** | **Area formula**
--- | --- | ---
rectangular prism | \( V = l \times w \times h \) | \( SA = 2(lw + lh + wh) \)
cylinder | \( V = \pi r^2h \) | \( SA = 2\pi r^2 + 2\pi rh \)
sphere | \( V = \frac{4}{3}\pi r^3 \) | \( SA = 4\pi r^2 \)
cone | \( V = \frac{1}{3}\pi r^2h \) | \( SA = \pi r^2 + \pi rs \)

There are two parameters in cylinders; we will examine both for change regarding radius. The first one is done as an example.

**Step 1:** Determine which formula you will use (volume of a cylinder).

**Step 2:** Determine which variable you will check (radius).

**Step 3:** Write the formula down twice, above and below each other.

**Step 4:** Draw a line between the two formulas showing division.

**Step 5:** Substitute variables. Use either an \( x \) or the number 1 for all variables EXCEPT for the variable you are exploring. See side note.

**Step 6:** Write the number 2 in place of the variable you are exploring for the top number. Use the number 1 for the same variable below.

**Step 7:** Solve the problem – divide the top by the bottom as the last part of the solution. The answer tells you the effect of change.

**Solution:**

\[
\frac{V = \pi r^2h}{3.14 \times 2^2 \times 1} = \frac{12.56}{3.14} = 4
\]

The number 4 means that when radius is doubled, volume increases by a factor of 4 times.

**Activity 1:** Determine the effect of doubling the radius for surface area. Follow the 7 steps.

**Step 1:** The formula we will use is ______________. **Step 2:** The variable to explore is ___________.

**Steps 3 & 4**

**Steps 5 & 6**

**Step 7**

**Conclusion:** When radius is doubled, surface area increases by a factor of _____ times.
Homework:
1. Determine the effect of doubling the **height** of a **cylinder** regarding **volume**.

2. Determine the effect of doubling the **height** of a **cylinder** regarding **surface area**.

3. Determine the effect of doubling the **length** of a **rectangular prism** regarding **volume**.

4. Determine the effect of doubling the **length** of a **rectangular prism** regarding **area**.

5. Determine the effect of doubling the **radius** of a **sphere** regarding **volume**.

6. Determine the effect of doubling the **radius** of a **sphere** regarding **surface area**.

7. Determine the effect of doubling the **radius** of a **cone** regarding **volume**.

8. Determine the effect of doubling the **radius** of a **cone** regarding **surface area**.

9. Determine the effect of doubling the **height** of a **cone** regarding **volume**.

10. Determine the effect of doubling the **side(s)** of a **cone** regarding **surface area**.