Part 1. Find the volume of each figure:

Hypothesis: How will the volume change with a dilation of 2 or 3?

Spheres: \( \text{Volume} = \frac{4}{3} \pi r^3 \)

radius = 3
radius = 6
radius = 9

Cylinders: \( \text{Volume} = \pi r^2 h \)

radius = 2
height = 3
radius = 4
height = 6
radius = 6
height = 9

Cones: \( \text{Volume} = \frac{\pi r^2 h}{3} \)

radius = 3
height = 4
radius = 6
height = 8
radius = 9
height = 12
Part 2. Find the surface area of each figure:

Hypothesis: How will the surface area change with a dilation of 2 or 3?

Spheres: \[ \text{Surface Area} = 4\pi r^2 \]

radius = 3 \hspace{1cm} radius = 6 \hspace{1cm} radius = 9

Cylinders: \[ \text{Surface Area} = 2\pi rh + 2\pi r^2 \]

radius = 2 \hspace{1cm} radius = 4 \hspace{1cm} radius = 6
height = 3 \hspace{1cm} height = 6 \hspace{1cm} height = 9

Cones: \[ \text{Surface Area} = \pi r \left( r + \sqrt{h^2 + r^2} \right) \]

radius = 3 \hspace{1cm} radius = 6 \hspace{1cm} radius = 9
height = 4 \hspace{1cm} height = 8 \hspace{1cm} height = 12
Part 3. Find the surface area:volume ratio of each figure:

Hypothesis: How will the surface area:volume ratio change with a dilation of 2 or 3?

Spheres:

\[
\text{radius} = 3 \\
\text{radius} = 6 \\
\text{radius} = 9
\]

Cylinders:

\[
\text{radius} = 2 \\
\text{height} = 3 \\
\text{radius} = 4 \\
\text{height} = 6 \\
\text{radius} = 6 \\
\text{height} = 9
\]

Cones:

\[
\text{radius} = 3 \\
\text{height} = 4 \\
\text{radius} = 6 \\
\text{height} = 8 \\
\text{radius} = 9 \\
\text{height} = 12
\]

Images from Wikipedia, authors: Dirk Hünniger, Ævar Arnfjörð Bjarmason, and Kf
**ANSWER KEY**

**Part 1.** Find the volume of each figure:

Hypothesis: How will the volume change with a dilation of 2 or 3?
The correct answer is they will go up by 8 and 27, but as this is meant as a guess, anything should be acceptable here.

**Spheres:** Volume = \((4/3)\pi r^3\)

- radius = 3
  - \(36\pi\)
- radius = 6
  - \(288\pi\)
- radius = 9
  - \(972\pi\)

**Cylinders:** Volume = \(\pi r^2 h\)

- radius = 2, height = 3
  - \(12\pi\)
- radius = 4, height = 6
  - \(96\pi\)
- radius = 6, height = 9
  - \(324\pi\)

**Cones:** Volume = \(\pi r^2 h/3\)

- radius = 3, height = 4
  - \(12\pi\)
- radius = 6, height = 8
  - \(96\pi\)
- radius = 9, height = 12
  - \(324\pi\)
ANSWER KEY

Part 2. Find the surface area of each figure:

Hypothesis: How will the surface area change with a dilation of 2 or 3? They should find that it goes up by 4 and 9, but any guess is okay.

Spheres: Surface Area = $4\pi r^2$

- radius = 3
  - Surface Area = $36\pi$
- radius = 6
  - Surface Area = $144\pi$
- radius = 9
  - Surface Area = $324\pi$

Cylinders: Surface Area = $2\pi rh + 2\pi r^2$

- radius = 2, height = 3
  - Surface Area = $20\pi$
- radius = 4, height = 6
  - Surface Area = $90\pi$
- radius = 6, height = 9
  - Surface Area = $180\pi$

Cones: Surface Area = $\pi r \left( r + \sqrt{h^2 + r^2} \right)$

- radius = 3, height = 4
  - Surface Area = $24\pi$
- radius = 6, height = 8
  - Surface Area = $96\pi$
- radius = 9, height = 12
  - Surface Area = $216\pi$
**ANSWER KEY**

**Part 3.** Find the **surface area:volume ratio** of each figure:

Hypothesis: How will the surface area:volume ratio change with a dilation of 2 or 3? They should eventually find that it goes down by ½ and 1/3, but any guess is okay.

Spheres:

<table>
<thead>
<tr>
<th>Radius</th>
<th>Surface Area:Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>½</td>
</tr>
<tr>
<td>9</td>
<td>1/3</td>
</tr>
</tbody>
</table>

Cylinders:

<table>
<thead>
<tr>
<th>Radius</th>
<th>Surface Area:Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1 2/3</td>
</tr>
<tr>
<td>4</td>
<td>5/6 = .833333</td>
</tr>
<tr>
<td>6</td>
<td>5/9 = .555555</td>
</tr>
</tbody>
</table>

Cones:

<table>
<thead>
<tr>
<th>Radius</th>
<th>Surface Area:Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>2/3</td>
</tr>
</tbody>
</table>

Images from Wikipedia, authors: Dirk Hünniger, Ævar Arnórð Bjarmason, and Kf