Area

Area is a measure of how much space is occupied by a figure.

Area is measured in square units. For example, one square centimeter (cm²) is 1cm wide and 1cm tall.

![1cm square](image)

A figure’s area is the number of square units it would take to cover the figure. It is easy to see that it would take 15cm² to cover a rectangle that is 3cm by 5cm.

![15cm² rectangle](image)

The area of any rectangle is just the length of its base multiplied by its height.

\[ A = bh \]

Practice:
Find the area of each shaded region below. Angles are all 90 degrees.

1. \[ \text{Area} = 8 \times 5 = 40 \text{ cm}^2 \]

2. \[ \text{Area} = 12 \times 3\frac{1}{2} = 42 \text{ cm}^2 \]

3. \[ \text{Area} = \frac{2}{3} \times \frac{1}{2} = \frac{1}{3} \text{ cm}^2 \]

4. \[ \text{Area} = 2 \times 5 = 10 \text{ cm}^2 \]
Area and Perimeter

The formula for the area of any parallelogram is the same as the formula for the area of a rectangle:

\[ A = bh \]

Practice: Find each area.

1. 8cm \hspace{1cm} 12cm

Perimeter is just the distance around a figure. Perimeter is NOT measured in square units.

To find the perimeter of a figure, simply add the lengths of its sides.

Practice:
Find the perimeter and area of each shaded region below.

1. (square) 7cm

3. 3cm \hspace{1cm} 4cm \hspace{1cm} 7cm \hspace{1cm} 5cm
Area of a triangle:
The area of a triangle can be found with the following formula:

\[ A = \frac{1}{2} bh \text{ or } A = \frac{bh}{2} \]

Consider the diagram below to see why the formula works.

Practice: Find the area of each triangle.

1. \begin{align*}
\text{Base} &= 11 \text{in} \\
\text{Height} &= 4 \text{in} \\
\text{Area} &= \frac{1}{2} \times 11 \times 4 \\
&= 22 \text{in}^2
\end{align*}

2. \begin{align*}
\text{Base} &= 18 \text{in} \\
\text{Height} &= 11 \text{in} \\
\text{Area} &= \frac{1}{2} \times 18 \times 11 \\
&= 99 \text{in}^2
\end{align*}

3. \begin{align*}
\text{Base} &= 15 \text{in} \\
\text{Height} &= 9 \text{in} \\
\text{Area} &= \frac{1}{2} \times 15 \times 9 \\
&= 67.5 \text{in}^2
\end{align*}

Practice: Find each shaded area:

1. \begin{align*}
\text{Base} &= 4 \text{in} \\
\text{Height} &= 2 \text{in} \\
\text{Area} &= \frac{1}{2} \times 4 \times 2 \\
&= 4 \text{in}^2
\end{align*}

2. \begin{align*}
\text{Base} &= 21 \text{in} \\
\text{Height} &= 11 \text{in} \\
\text{Area} &= \frac{1}{2} \times 21 \times 11 \\
&= 115.5 \text{in}^2
\end{align*}

3. \begin{align*}
\text{Base} &= 20 \text{in} \\
\text{Height} &= 11 \text{in} \\
\text{Area} &= \frac{1}{2} \times 16 \times 11 \\
&= 93 \text{in}^2
\end{align*}
Area: Trapezoids

Area of a trapezoid:
The area of a trapezoid can be found with the following formula:

\[
\frac{1}{2} h(b_1 + b_2) \quad \text{or} \quad \frac{h(b_1 + b_2)}{2}
\]

Consider the diagram below to see why the formula works.

Practice: Find the area of each trapezoid.

1. 

2. 

3.
Determine the area and perimeter of each figure below.

1. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

2. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

3. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

4. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

5. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

6. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

7. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]

8. \[ \text{A: } \_\_\_\_ \quad \text{P: } \_\_\_\_ \]
Circles

Area and Circumference of a circle:
The Area of a circle can be found with the following formula: \( A = \pi r^2 \)

Circumference of a circle looks similar:
\[ C = 2\pi r \text{ or } C = \pi d \]

Area and circumference of a circle:
Find the area and circumference of each. Leave your answers in terms of \( \pi \).

1. \( \text{Area: } \pi \times 5^2 = 25\pi \text{ in}^2 \)
   \( \text{Circumference: } 2\pi \times 5 = 10\pi \text{ in} \)

2. \( \text{Area: } \pi \times 15^2 = 225\pi \text{ in}^2 \)
   \( \text{Circumference: } 2\pi \times 15 = 30\pi \text{ in} \)

3. \( \text{Area: } \pi \times 32^2 = 1024\pi \text{ in}^2 \)
   \( \text{Circumference: } 2\pi \times 32 = 64\pi \text{ in} \)

Combinations:
Find the area and perimeter of each. Round decimal answers to the tenth.

1. \( \text{Area: } \pi \times 5^2 = 25\pi \text{ in}^2 \)
   \( \text{Perimeter: } \pi \times 5 + 2 \times 5 = 15\pi \text{ in} \)

2. \( \text{Area: } \pi \times 8^2 = 64\pi \text{ in}^2 \)
   \( \text{Perimeter: } \pi \times 8 + 2 \times 8 = 24\pi \text{ in} \)

3. \( \text{Area: } \pi \times 6^2 = 36\pi \text{ in}^2 \)
   \( \text{Perimeter: } \pi \times 6 + 4 \times 6 = 18\pi \text{ in} \)
Review

Find the area of each figure. Order the areas from least to greatest to spell a question. Answer the question that is created. (Drawings are not to scale).
Practice Quiz: Area and Perimeter

Find the area and perimeter of each. Include units. All angles that appear to be right angles are right angles.

1-2.

1. Area ________
2. Perimeter ________

3-4.

3. Area ________
4. Perimeter ________

5-6.

5. Area ________
6. Perimeter ________

7-8.

7. Area ________
8. Perimeter ________

9-10.

9. Area ________
10. Perimeter ________
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Practice Quiz: Area and Perimeter

Answer each.

11. What is the formula for the area of a parallelogram?
   11. Area = __________

12. What is the formula for the area of a circle?
   12. Area = __________

13. What is the formula for the area of a trapezoid?
   13. Area = __________

14. What is the formula for the area of a triangle?
   14. Area = __________

15. What is the formula for the circumference of a circle, using the radius (r)?
   15. Circumference = __________

16-17. Answer in terms of pi.
   16. Area ________
   17. Circumference ________

18. Area. Round to the tenth.
   18. Area ________

19-20. Area/Perimeter. Round to the tenth.
   19. Area ________
   20. Perimeter ________
Working Backwards: Using Area

If we know the area of a figure, we can use it to find the dimensions of a figure.

Example:
The area of a parallelogram is 24cm$^2$ and its base is 6cm long. What is its height?

This can be especially useful when finding the altitude (height) of a right triangle.

Example:
A right triangle has sides of length 6, 8, and 10cm. What is the height (h) of the triangle marked below?

Given the area of a circle, you can find its radius. Write an equation and solve the following:

Example:
Approximate the radius of a circle whose area is 6cm$^2$.

Example:
A gallon of paint will cover 400ft$^2$. What is the radius of the largest circle that can be painted (and filled-in) with a gallon of paint. Round your answer in feet to the nearest tenth.

Challenge:
Find the length $x$ in the diagram:
Using Area

Practice: Solve each.

1-3. Approximate the side length of a square given each area to the tenth:

1. Area = 16cm\(^2\).
   1. side ________

2. Area = 90cm\(^2\).
   2. side ________

3. Area = 2cm\(^2\).
   3. side ________

4-6. Approximate the radius of each given the area to the tenth:

4. Area = 4\(\pi\) cm\(^2\).
   4. radius ________

5. Area = 13cm\(^2\).
   5. radius ________

6. Area = 250cm\(^2\).
   6. radius ________

7-9. Find each missing length \(x\). Round decimal answers to the tenth.

7. Area = 14cm\(^2\).
   \[x = \underline{\phantom{0}}\]

8. Area = 45cm\(^2\).
   \[x = \underline{\phantom{0}}\]

9. Area = 20cm\(^2\).
   \[x = \underline{\phantom{0}}\]
Using Area

Practice: Solve each.

1-3. Approximate the height of each rectangle given the area and the base. Fractional answers should be left improper and in simplest form.

1. Area = 80cm². \( b = 8\text{cm} \)
   \[ h = \underline{\underline{\quad}} \]

2. Area = 44cm². \( b = 5\text{cm} \)
   \[ h = \underline{\underline{\quad}} \]

3. Area = 22cm². \( b = 6\text{cm} \)
   \[ h = \underline{\underline{\quad}} \]

4-6. Approximate the radius of each given the area. Round decimal answers to the tenth. Use 3.14 for pi if you do not have a calculator with a pi button.

4. Area = \( 9\pi \text{ cm}^2 \).
   \[ \text{radius } \underline{\underline{\quad}} \]

5. Area = 30cm².
   \[ \text{radius } \underline{\underline{\quad}} \]

6. Area = 26.5cm².
   \[ \text{radius } \underline{\underline{\quad}} \]

7-9. Find each missing length \( x \). Round decimal answers to the tenth.

7. Area = 140cm².
   \[ x = \underline{\underline{\quad}} \]

8. Area = 84cm².
   \[ x = \underline{\underline{\quad}} \]

9. Find \( x \).
   \[ x = \underline{\underline{\quad}} \]
Review: Triangles and Trapezoids

Area of a triangle:
The area of a triangle can be found with the following formula:

\[ A = \frac{1}{2} bh \quad \text{or} \quad A = \frac{bh}{2} \]

Practice: Find the area of each:

1. Area ________

2. Area ________

3. Area ________

Area of a trapezoid:
The area of a trapezoid can be found with the following formula:

\[ \frac{1}{2} h(b_1 + b_2) \quad \text{or} \quad \frac{h(b_1 + b_2)}{2} \]

Practice: Find the area of each trapezoid below.

4. Area ________

5. Area ________

6. Area ________
Review: Circles

Area and Circumference of a circle:
The **Area** of a circle can be found with the following formula: \( A = \pi r^2 \)

**Circumference** of a circle looks similar:
\[
C = 2\pi r \quad \text{or} \quad C = \pi d
\]

**Practice:** Find the area and circumference for each circle described below. Leave answers in terms of \( \pi \).

**7-8.** A circle of radius 4cm.

7. Area ________

8. Circumference ________

**9-10.** A circle of diameter 18cm.

9. Area ________

10. Circumference ________

**11-12.** A circle of radius 9cm.

11. Area ________

12. Circumference ________

**Practice:** Find the area and perimeter/circumference for each circle described below. Round decimal answers to the tenth.

**13-14.** A circle of radius 10cm.

13. Area ________

14. Circumference ________

**15-16.** A circle of diameter 7cm.

15. Area ________

16. Circumference ________

**17-18.** A semi-circle of diameter 4cm

17. Area ________

18. Perimeter ________

**19-20.** A quarter-circle of radius 4cm

19. Area ________

20. Perimeter ________
Surface Area

Surface Area is the sum of the areas of all faces which enclose a solid.

Rectangular Prisms are easiest. A rectangular prism has six rectangular faces. To find its surface area, just add the area of all its faces.

Rectangular Prism:
Two ends: \(4 \times 5 \times 2 = 40ft^2\)
Front and back: \(10 \times 5 \times 2 = 100ft^2\)
Top and bottom: \(10 \times 4 \times 2 = 80ft^2\)
Surface area = \(40 + 100 + 80 = 220ft^2\)

Other Prisms:
Prisms can have bases which are not rectangular. Still, it is easy to just add the area of all the faces of a prism to find its surface area.

Triangular Prism:
Top and Bottom Triangles: \(2 \times (6 \times 8)/2 = 48in^2\)
Front Right: \(8 \times 7 = 56in^2\)
Front Left: \(6 \times 7 = 42in^2\)
Back: \(10 \times 7 = 70in^2\)
Surface Area: \(48 + 56 + 42 + 70 = 216in^2\)

Practice:
Find the surface area of each.

1. 
2. 
3. 
4. 

Name________________________ Period _____
Surface Area

Practice:
Find the surface area of each.

1. 

2. 

3. 

4. 

5. 

6. 

7. 

8.
Surface Area: Cylinders

Cut-out the three pieces below the dotted line and use them to build a cylinder.
Use this model to write the formula for the surface area of a cylinder, then use the formula to find the surface area of each figure below:

Name _____________________ Period _____

d \pi d

h

\pi d
Surface Area: Cylinders

Find the surface area of each:

1. A cylinder with a height of 10cm and diameter of 5cm. Express your answer in terms of pi.
   1. _____________

2. A cylinder with a height of 4cm and radius of 5cm. Express your answer in terms of pi.
   2. _____________

3. The lateral surface area of a cylinder does not include the top and bottom. What is the lateral surface area of a cylinder whose height and diameter are each 12cm?
   3. _____________

4. The lateral surface area of a certain cylinder is equal to the area of its bases (the circles on top and bottom). If the radius of the cylinder is 4cm, what is its height?
   4. _____________
Volume

The formula used to find the volume of a prism or cylinder:

\[ V = Bh \]

Where \( B \) is the area of the base and \( h \) is the height.

The base can be any of the six faces. We will use the 10 x 4 side. The volume is the area of the base times the height: \((10 \times 4) \times 5 = 200 \text{ft}^3\).

The base is a circle of area \( \pi (9)^2 = 81 \pi \). Multiply this by the height to get \( 20(81\pi) = 1620 \pi \text{ in}^3 \). As a decimal, this equals 5,089.4 \text{ in}^3, but we often leave answers in terms of \( \pi \) to avoid rounding.

Practice:

1. What is the surface area and volume of a 4 by 6 by 7 rectangular prism?

   \[ \text{SA: } \quad \text{V: } \] \( \text{in}^2 \quad \text{in}^3 \)

2. Find the surface area and volume of a 3-inch tall cylinder with a 7-inch radius?

   \[ \text{SA: } \quad \text{V: } \] \( \text{in}^2 \quad \text{in}^3 \)

3. What is the surface area and volume of the triangular prism below?

   \[ \text{SA: } \quad \text{V: } \] \( \text{in}^2 \quad \text{in}^3 \)
Surface Area and Volume

Determine the surface area and volume of each. These problems require careful notes. COMPLETE THE WORK ON A SEPARATE SHEET and round all decimal answers to the tenth.

1. SA: _____ Vol. _____
2. SA: _____ Vol. _____
3. SA: _____ Vol. _____
4. SA: _____ Vol. _____
5. SA: _____ Vol. _____
6. SA: _____ Vol. _____

note:
The portion removed is 1/4 of the total volume.
Surface Area and Volume Review

Determine the surface area and volume of each.
Round all decimal answers to the tenth.

1. SA: _____  Vol. _____
2. SA: _____  Vol. _____
3. SA: _____  Vol. _____
4. SA: _____  Vol. _____
Surface Area and Volume Review

Solve each:

5. Find the surface area and volume of a cube whose edges are 4cm long.

   5. S.A. _____________

   Vol. _____________

6. A triangular prism is 3cm tall and has a base whose area is 6cm².
   What is its volume?

   6. Vol. _____________

7. A cylinder has a radius of 5cm and a height of 6cm.
   Find its surface area and volume.

   7. S.A. _____________

   Vol. _____________

8. A circular above-ground swimming pool is 5 feet deep and has a radius of 12 feet.

   A. How many cubic feet of water will the swimming pool hold?

   8A. _____________

   B. There are about 7.5 gallons in a cubic foot. How many gallons does the pool hold?

   8B. _____________

   C. Your garden hose can fill the pool at a rate of 6 gallons per minute. How long will it take to fill the pool with a garden hose? Express your answer to the nearest hour.

   8C. _____________

   D. A rubber liner covers all of the interior walls of the pool as well as the bottom of the swimming pool. What is the total area of the liner?

   8D. _____________
Area and Volume Practice Quiz

Determine the surface area and volume of each. Round all decimal answers to the tenth.

1-2.

1. SA: _____ 2. Vol. _____

3-4.


5-6.

5. SA: _____ 6. Vol. _____

7-8.

7. SA: _____ 8. Vol. _____
Area and Volume Practice Quiz

Solve each.

9-11. Find each missing length \( x \). Round decimal answers to the tenth.

9. Area = 14cm\(^2\).
   \[ 4cm \]
   \[ 5cm \]

9. \( x = \) ________

10. Area = 30cm\(^2\).

10. radius \( x = \) ________

11. Area = 72cm\(^2\).

11. \( x = \) ________

12. A right triangle has side lengths of 8cm, 15cm, and 17cm. What is its area?

12. __________

13. A circle has a circumference of \( 10\pi \) cm. Express the circle’s area in terms of pi.

13. __________

14. The lateral surface area of a cylinder does not include the circles on top and bottom. What is the lateral surface area of a cylinder whose height is 6cm and whose diameter is 8cm?

14. __________

15. The sides of the square shown are 3cm long, and the radius of the circle is also 3cm. What is the area of the shaded region? Round your decimal answer to the tenth.

15. __________
Pyramid/Cone Volume

The formula used to find the volume of a pyramid or cone:

\[ V = \frac{1}{3} Bh \]

Where \( B \) is the area of the base and \( h \) is the height.

Practice:
Find the volume of each solid.

1. (square-based pyramid)

\[ \text{Volume} = \frac{1}{3} \times 5 \times 5 \times 6 = 50 \text{ cubic inches} \]

2. (triangle-based pyramid)

\[ \text{Volume} = \frac{1}{3} \times \frac{1}{2} \times 8 \times 10 \times 15 = 200 \text{ cubic inches} \]

3. (cone)

\[ \text{Volume} = \frac{1}{3} \times \frac{1}{2} \times 18 \times 24 \times 30 = 2160 \text{ cubic centimeters} \]

4. (cone on top of a cylinder)

\[ \text{Volume} = \frac{1}{3} \times \frac{1}{2} \times 4 \times 4 \times 6 + 3 \times 4 \times 4 \times 5 = 72 + 240 = 312 \text{ cubic centimeters} \]
Volume Practice

Determine the volume of each solid below:
Round all answers to the hundredth.
Work on a separate sheet.

1. \( V = \) ______
2. \( V = \) ______
3. \( V = \) ______

4. \( V = \) ______ (80in\(^2\) is incorrect)

5. \( V = \) ______

6. \( V = \) ______

7. \( V = \) ______

(This is just a cone with the top chopped off ... see if you can find a way to get the volume using subtraction.)
Changing Dimensions

Changing the dimensions of an object effects the area and volume. Here are some easy examples:

Ex: A square is enlarged so that the length of each side is doubled. If the area of the original square was 7 square inches, what will be the area of the enlarged square?

\[ 2 \times 2 = 4 \text{ times bigger (28 in}^2) \].

Ex: A cube has one-inch edges. How many times larger is the volume of a cube with edges that are three times longer?

\[ 3 \times 3 \times 3 = 27 \text{ times bigger.} \]

It is easy to see with a square or even a rectangle, but the same concept applies to all shapes and figures. If you increase the dimensions of an object, the area or volume increases by the product of those increases.

For example, if you double the base and height of a triangle, how many times greater will the area be?

This principle applies to ALL shapes.
Some more difficult shapes:

Circles.
What happens when you double the radius of the circle? Does its area double? Try a few examples.

Look at the example below. Does the large circle look like it has only twice the area of the smaller circle?

When we increase the radius of a circle by a factor \( x \), the area is increased by a factor \( x^2 \). In the formula for area, the radius is squared. Think of this as increasing not only the height, but the height AND width of the circle, or doubling two dimensions.

Other shapes.
Look at the following regular figures. Each has had its side lengths tripled. What do you think has happened to the area of each figure?

Pentagon Area Calculator:
http://www.math-prof.com/AreaVolume/Pentagon.aspx

If the area of the figure on the left is 9cm\(^2\), what is the area of the figure on the right?
Changing Dimensions

Complete the following area problems:

1. \(\frac{1}{2} \times 3\text{in} \times 4\text{in}\)

2. \(\frac{1}{2} \times 6\text{in} \times 8\text{in}\)

3. \(\frac{1}{2} \times 18\text{in} \times 24\text{in}\)

4. \(3\text{in} \times 5\text{in}\)

5. \(6\text{in} \times 5\text{in}\)

6. \(6\text{in} \times 15\text{in}\)

7. Leave answers below in terms of Pi.

8. Complete the following area problems:
   10. What happens to the area of a square when you:
       a. Double the side lengths.
       b. Triple the side lengths.
       c. Halve the sides.

11. What happens to the volume of a cylinder when you:
       a. Double the radius only.
       b. Triple the height only.
       c. Double the radius and triple the height.

12. A rectangle has an area of 12cm\(^2\). What will the area be if you:
       a. Triple all sides.
       b. Multiply all sides by 1.5.
1. A rectangular prism is 3x4x5 inches. How many times greater is the volume of a 6x8x15 rectangular prism? (If you are not sure, find each volume and divide).

2. When the sides of an equilateral triangle are 6 inches long, the area of the triangle is approximately 15.6 square inches. What would be the approximate area of an equilateral triangle whose sides are 12 inches long? (round to the tenth)

3. A large circle has 81 times the area of a small circle. If the radius of the large circle is 45 inches, what is the radius of the small circle? (Think, how many times greater is the radius of a large circle whose area is 81 times larger than a smaller circle?)

4. The radius and height of a cylinder are tripled. What effect does this have on the cylinder’s volume? (As an example, try finding the volume of a cylinder whose radius and height are 1cm, then find the volume of a cylinder whose radius and height are 3cm. Leave your answers in terms of pi. What happened to the volume? Is it 3 times bigger? 6 times? 9 times? 18? 27? 81?)

5. A circle has an area of $25\pi \text{ cm}^2$. If the radius of the circle is increased by 20%, by what percent will the area of the circle increase? (Think ... what is the radius of the original circle. What will be the new radius? The new area? It really doesn’t matter how big the circle is, but if you use an example it might make more sense to you in the beginning).

7. The length, width, and height of a rectangular pyramid are all multiplied by 5 to create a new pyramid. How many times larger is the new pyramid than the original?

8. The dimensions of a cube are increased by 50% (1.5 times). If the original cube had a volume of $16\text{in}^3$, what is the volume of the new cube?
Changing Dimensions

Practice:
The examples in part a should help you solve each problem b below.

1a. How many times greater is the volume of a cube that has 6-inch sides than a cube that has 2-inch sides?

1b. A cube has a volume of 5cm$^3$. What would be the volume of a cube whose edge lengths are three times as long?

2a. One right triangle has sides that are 3, 4, and 5cm long. A larger triangle has sides that are 12, 16, and 20cm long. How many times greater is the area of the large triangle than the small one?

2b. An equilateral triangle whose sides are 4cm long has an area of about 6.9cm$^2$. What is the approximate area of a triangle whose side lengths are 16cm long?

3a. How many times greater is the area of a circle whose radius is 14cm than a circle whose radius is 10cm?

3b. You want to double the area of a circle. Approximately what percent should be added to the radius of the circle?

4a. The square base of a pyramid has sides that are 3cm long. The pyramid is 4cm tall. Another square-based pyramid has 6-inch sides and is also 4cm tall. How many times greater is the volume of the larger pyramid?

4b. A pyramid with a rectangular base has a volume of 20cm$^3$. If the length and width of the base are doubled, what will be the volume of the new pyramid?
Changing Dimensions

Practice:
Solve each.

1. The area of a circle is 30in². If you triple the circle’s radius, what will its new area be?

2. When a hexagon has 2-inch sides, its area is about 10.4in². What will be the approximate area of a hexagon whose sides are 10 inches long??

3. A rectangular prism has a volume of 17cm². If you double the length and width, but leave the height unchanged, what will be the volume of the new prism?

4. If you want to double the area of a square, by what percent should you increase the length of its sides.
   hint: Try using a 10-inch square, double its area, and find the length of the sides of the new square. Use new/original to approximate the percent.

5. The volume of the regular dodecahedron below with an edge length of 4-inches is about 490 in³. What would be the volume of a regular dodecahedron whose edges are a foot long?

6. The volume of a cone is 3in³. What would be the volume after each modification below? (each part refers to the original figure).
   a. Double the radius only. ________________
   b. Triple the height only. ________________
   c. Double the height and triple the radius. ________________
   d. Increase the height and radius by 50%. ________________

7. If you want to double the volume of a cube, by what percent should you increase the edge length? (Try some examples).
   a.20%  b.23%  c.26%  d.30%  e.40%
Changing Dimensions

What works for a cube works for any other three-dimensional object.

Example:
If you double the edge length of a cube, what effect will this have on the:

Surface Area? __________
Volume? __________

Example:
If you double the edge length of the shape below (a cuboctahedron), what effect will this have on the surface area and volume?

Surface Area? __________
Volume? __________

What if you:
Triple the edge lengths?
Increase the edge lengths by 40%?

Practice:
1. The volume of a truncated cube (below) is 10cm³. What is the volume of a truncated cube whose edge lengths are:
   a. Twice as long?
   b. Five times as long?
   c. 50% longer? (Round to the hundredth.)
   d. 20% smaller? (Round to the hundredth.)

2. The surface area of the dodecahedron below is 20cm². What is the surface area of a dodecahedron whose edge lengths are:
   a. Twice as long?
   b. Five times as long?
   c. 50% longer? (Round to the tenth.)
   d. 20% smaller? (Round to the tenth.)
Dimensions Practice Quiz

Determine the SURFACE AREA of each figure below.
Round to the tenth. Figures not to scale.

1. What is the volume of the prism above?

2. What is the surface area of the prism above?

3. What would the volume be if all three dimensions were doubled?

4. What is the volume of the prism above?

5. What is the surface area of the prism above?

6. What would the surface area be if all three dimensions were tripled?

7. In terms of pi, what is the surface area of the cylinder above?

8. In terms of pi, what is the volume of the cylinder above?

9. If the radius is doubled and the height remains unchanged, how many times greater will the volume of the new cylinder be?
Dimensions Practice Quiz

Solve each problem involving changing dimensions:

10. A small pizza has a radius of 10 inches, and a medium pizza has a radius that is 20% larger. How much more pizza do you get with the medium pizza than with the small pizza? Express your answer as a percent.

11. A rectangular prism has a volume of 5cm³. If you triple the length, width, and height, what will the volume of the enlarged prism be?

12. When the radius of a circle is multiplied by 4, the area of the new circle is 40 in³. What was the area of the original circle?

13. The volume of a rectangular pyramid is 7m³. What is the volume of a pyramid that is twice as tall, three times as long, and four times as wide?

14. A cube has edges that are 6 centimeters long. How many times greater is the volume of a cube with 9 centimeter sides? Do not round your answer.
Area and Volume Word Problems

Many word problems involve comparing the volume between objects.

Example:
A large cylindrical plastic pitcher is 12 inches tall and has an 8-inch diameter. You use this pitcher to fill a small rectangular fish tank that is 24 inches long and 14 inches wide. How many pitchers will it take to fill the tank to a depth of 16 inches?

Example:
A palette of bricks is 29 inches wide, 24 inches long, and 27 inches tall. Each brick is 3.625” by 2.25” by 8”. How many bricks are in a palette?

Other problems may require that you solve for a missing variable.

Example:
The formula for the surface area of a sphere is \( A = 4\pi r^2 \). What is the radius of a sphere whose surface area is \( 36\pi \) square inches?

Example: The formula for the area of a trapezoid is \( A = \frac{1}{2} h(b_1 + b_2) \).

If a trapezoid has a height of 8cm, a long base of 12cm, and an area of 76cm\(^2\), what is the length of its short base?

Practice:
1. Cheese is made in large cylindrical shape and then cut into rectangular blocks. About how many 1” by 2” by 4” blocks can be cut from a cheese cylinder that is 18” tall with a 15” radius? (Assume for the problem that no cheese is wasted when the blocks are cut from the cylinder.)

Challenge: The formula for the area of an octagon is \( A = 2s^2(1 + \sqrt{2}) \). If the area of an octagon is 391.1cm\(^2\), how long are its sides?
Area/Volume Word Problems

Solve each:

1. A large box contains smaller boxes of tissues. The small tissue boxes are 3” tall, 5” wide, and 9” long. The large box is 27” wide, 25” long, and 24” tall. How many boxes of tissues are in the large box?

2. The formula for the volume of a cylinder is $\pi r^2 h$. What is the height of a cylinder whose radius is 6 inches and whose volume is $180\pi$ square inches?

3. A ream of paper is 8.5 inches wide, 11 inches long, and 3 inches tall. How many reams are contained within a box that is 17 x 11 x 15?

4. What is the side length of a square whose area is 54cm²? Round to the tenth.

5. A manufacturer is shipping boxes in an 18-wheeler. The truck is 40 feet long, 8 feet wide, and 10 feet tall. The boxes are 24 inches wide, 30 inches long, and 12 inches tall. How many boxes will fit in the truck?

6. You want to know how many windows (actually, pieces of glass) are on a building. The building is made entirely of glass, and each piece of glass is 10 feet tall and 8 feet wide. The building is a rectangle 56 feet wide, 80 feet long, and 240 feet tall. How many panes of glass were needed to construct the building, assuming the building is covered entirely in glass (except for the roof).

7. Thomas has an enormous stamp collection. He has wallpapered one wall of his house with stamps that are square with sides that are one and one-quarter inches long. How many stamps were used to cover the wall, which is 10 feet tall and 25 feet long?
Area/Volume Word Problems

Practice: Solve each.

8. The formula for the area of a hexagon with side length $s$ is $A = \frac{3s^2 \sqrt{3}}{2}$.
   a. What is the area of a hexagon of side length 6?  
      8a. _______
   b. What is the side length of a hexagon of area 40cm$^2$? 
      8b. _______

9. Ice cream is sold in a cylinder that is 8 inches tall and has a 3-inch radius. A perfect scoop of ice cream is a perfect sphere with a 2-inch diameter. The formula for the volume of a sphere is
   \[ V = \frac{4}{3} \pi r^3 \]
   a. How many scoops of ice cream are in the container?  
      9a. _______
   b. If an ice-cream cone is 3” tall with a 1” radius, how many cones could be filled (just to the top) with the container?  
      9b. _______
   c. Suppose you wanted to fill each cone and add 1/2 scoop (a hemisphere) on the top of each. How many ice cream cones could be made with the container full of ice cream?  
      9c. _______
Density is a measure of how much matter is in a given volume. You have probably seen the formula for density in science:

\[ d = \frac{m}{v} \]

The densities we will use will be in grams per cm\(^3\).

**Example:**
A core sample is a cylindrical tube of material cut from the earth. A core sample of stone cut from Mount Mitchell is 2 meters long (200cm), has a radius of 10cm, and a mass of 170 kilograms (440,000 grams). What is its density in grams/cm\(^3\)?

**You can also use a known density to determine the mass of an object.**

**Example:**
You are building a sand castle at the beach. You fill a bucket of wet sand at the water’s edge and carry it to where you are building your castle. Wet sand has a density of 1.9 g/cm\(^3\).

a. How much does your bucket weigh in kilograms (1kg = 1,000g) if it is 20cm tall and has a 11cm radius?

b. There are 2.2 pounds in a kilogram. How many pounds does your bucket weigh?

**Practice:**
1. What is the density in g/cm\(^3\) of an object that has a volume of 18cm\(^3\) and a mass of 24g?

2. What is the density of a cylindrical jar of peanut butter 12cm tall with a 8cm diameter that weighs 748 grams?

3. Granite has a density of 2.7g/cm\(^3\). You want a granite countertop installed on the island in your kitchen. The countertop is 2cm thick, 1.3m wide, and 2m long. How many kilograms will the countertop weigh? (note: 1m = 100cm)
Area/Volume Word Problems

Calculate each density in g/cm³.
Round to the tenth.
1kg = 1,000g. 1m = 100cm.

1. Mass = 80g, Volume = 115cm³.

2. Mass = 1,230g, Volume = 1,980cm³.

3. Mass = 50g, Volume = 42cm³.

4. Mass = 2.5 kg, Volume = 1,870cm³.

5. A cube has 6cm edges and a mass of 562 grams.

6. A cylinder is 3cm tall, has a 2cm radius, and weighs 190 grams.

7. A wood board that is 6cm wide, 18cm tall, and 2m long, weighing 18kg.

8. A lead cone that is 5cm tall and has a 3cm radius, weighing 535 grams.

Calculate each mass in grams.
Round to the tenth.
1kg = 1,000g. 1m = 100cm.

9. Silver has a density of 10.5g/cm³. A silver dollar has a 1.8cm radius and is 1/4 cm thick. How many grams does it weigh? Check your answer here:
http://wiki.answers.com/Q/What_is_the_weight_of_silver_dollar

10. A typical can of soup has a radius of 7cm and a height of 11cm. Its density is about 1.05g/cm³. How much does a can of soup weigh in grams? (note: You should know from the can drive that a can weighs about a pound. 453g = 1lb ... make sure your answer is somewhat close to this)

11. A gold brick is 5cm tall, 8cm wide, and 20cm long. Gold has a density of 1.932g/cm³. How many grams should the gold brick weigh if it is pure gold? 11b. Gold costs about $36 per gram. How much is the gold brick worth?