CALCULATING AREA

The ability to calculate area accurately is an important skill in the trades.

KEY POINTS

Area:

- is two-dimensional: it is the amount of space inside a flat object such as a rectangle or circle
- answers are expressed as "square" units, such as, square metres (m^2) or square feet (f^2)
- can only be accurately calculated when all measurements are in the same unit of measurement

Area of a straight-sided figure:

- is calculated as length (L) x width (W)
- the formula is *Area = length x width* which is written like this *A = L x W*

Area of a circle:

- is calculated using radius (r) and pi (π)
    - radius is half the length of the diameter
    - diameter is the length of a line through the center of the circle that touches the circumference on both sides
    - pi (π), is the ratio of a circle's circumference to its diameter
- the formula is *Area = pi x the radius squared* which is written like this $A = \pi r^2$

An Important Note about pi

The most accurate way to complete a calculation that includes pi is to use a calculator with the *π* key option. If you do not have access to this sort of calculator, you can use the value of 3.14 for pi, when practicing. However, 3.14 is not as accurate a measurement and should not be used in situations where accuracy is important.
An example is shown on page 4.

Area of a triangle:

- can be thought of as one half of a square or "parallelogram" (a four-sided shape with two pairs of sides of equal length)

- the height of a triangle is measured as a right-angled line from the bottom line to the top point (apex) of the triangle

- the formula is *Area = Base x Height divided by 2*, which is written like this *A = B x H ÷ 2*

STEPS

Calculate the area of a rectangle:

1. Measure the length and width of the rectangle.
2. Write the measurements into the formula: A = L x W
3. Express the answer as a squared number, for example, m^2 or cm^2.

Calculate the area of a circle:

1. Measure the diameter of the circle.
2. Calculate the radius of the circle by dividing the diameter by 2.
3. Write the measurements you know into the formula: A = πr^2
4. Multiply the radius by itself, for example, if r = 7 then multiply 7x7
5. Multiply the result by 3.14.
6. Express the answer as a squared number, for example, m^2 or cm^2.

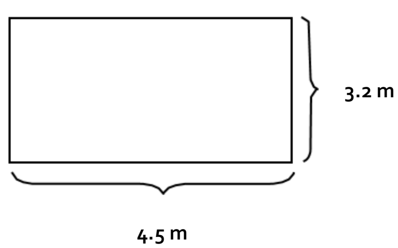
Calculate the area of a triangle:

1. Measure the base (width) and height of the triangle.
2. Write the measurements into the formula: A = B x H ÷ 2
3. Express the answer as a squared number, for example, m^2 or cm^2.

EXAMPLES

The area of the floor of a room must be calculated, in order that the correct amount of carpet can be purchased.

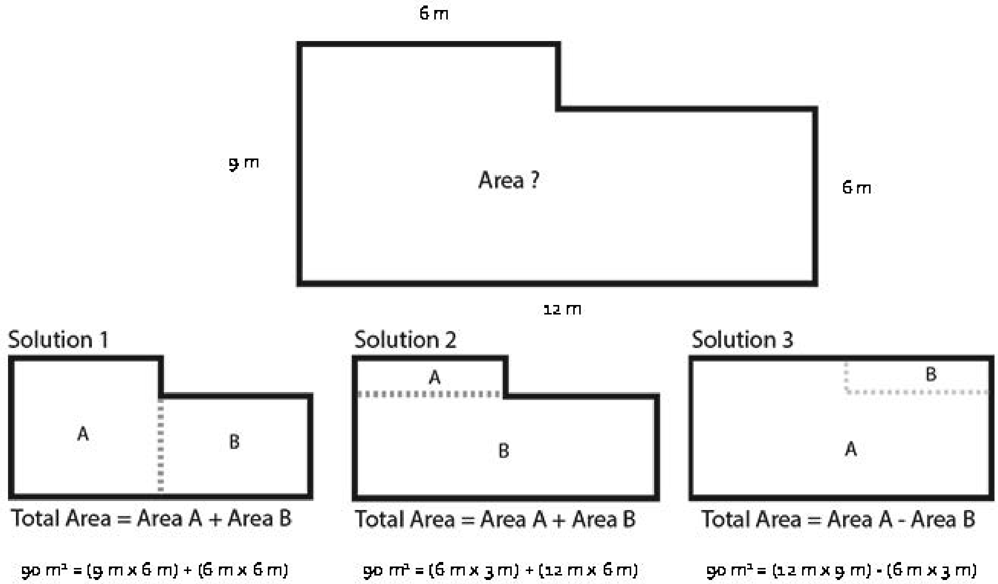
Area of a rectangle:
Calculate the area of a room that is 4.5 m long and 3.2 m wide.



A = L x W
A = 4.5 m x 3.2 m
A = 14.4 m^2

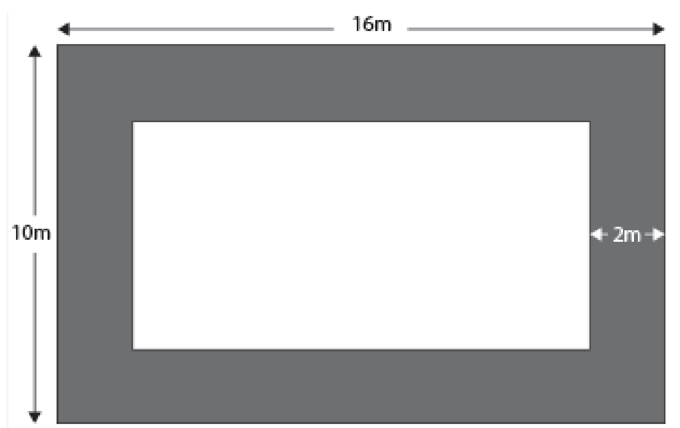
The area of the floor of this room is 14.4 square metres. Enough carpet to cover 14.4 m^2 will need to be purchased.

Area of more complex straight-sided shapes:
Very often the shape is not a simple rectangle or square. In that case you need to measure area by splitting the shape into more than one square or rectangle, as in the examples below. It does not matter how the shape is split up, in this case. As you can see, the result would be the same in each solution. Two of the solutions require adding the areas together and the third solution requires subtracting the area of the missing part of the rectangle.



Edited from source: https://www.skillsyouneed.com/num/area.html

Area of a shape around or within another shape:
The need to find the area of a border is also a common requirement. For example, the total area of a garden to be landscaped is to be 16 m x 10 m, but there is to be a 2 m brick pathway around the perimeter of the garden. In order to calculate materials needed for the pathway, it is necessary to calculate the area of it.

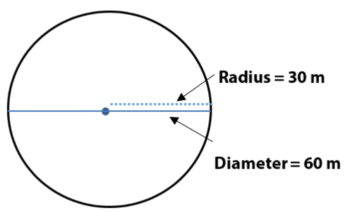


Edited from source: https://www.skillsyouneed.com/num/area.html

- Calculate the area of the whole shape - 16 m x 10 m
- Calculate the dimensions of the middle section

    - path around the edge is 2m wide on each side
    - length of the whole shape 16m - 4m of pathway (2m on the left of the shape and 2m on the right) 16m - 4m = **12m**
    - width of the whole shape is 10 m - 4 m (2m on the top of the shape and 2m on the bottom) 10 m – 4 m = **6 m**
    - middle rectangle is 12m × 6m.
- Area of the middle rectangle is 12 m × 6 m = 72 m^2
- Subtract the area of the middle rectangle from the area of the whole shape. 160 - 72 = 88 m^2
- Area of the pathway is 88 m^2

Area of a circle:
Find the area of a large circular patio for a new restaurant. The patio has a radius of 30 metres.

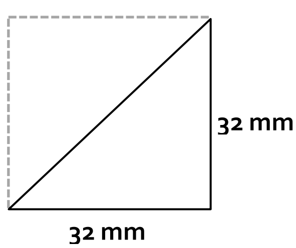


π by calculator
A = π r^2
A = π (30 m x 30 m) A = π (900 m^2)
A = π x 900 m^2
A = **2827.433 m^2**

π as 3.14
A = π r^2
A = 3.14(30 m x 30 m)
A = 3.14 (900 m^2)
A = 3.14 x 900 m^2
A = **2826 m^2**

The area of this patio is 2827.433 metres squared or 2826 metres squared. In this case, it is likely either result could be used to estimate the amount of materials to be ordered, however, the 3.14 result does leave more room for error.

Area of a triangle:
Find the area of the space for the glass in a triangular decorative window.



A = B x H ÷2
A = 32 x 32 ÷2
A = 512 mm^2

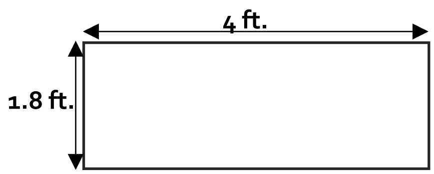
The area of the space for the glass is 512 mm^2.

Think you understand how to calculate area? Try it yourself on the next page.

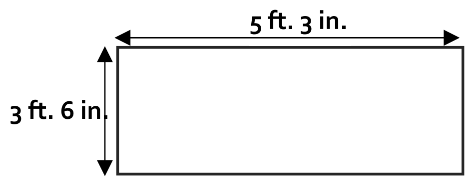
USING THE SKILL

In the Workplace: Calculations of area are often used to determine amounts of material required to cover the surface of various shapes. Accurate calculations save time and money.

Calculate the area of each of the shapes below. Remember to show the units in your answer (cm^2, m^2, etc.).



A =



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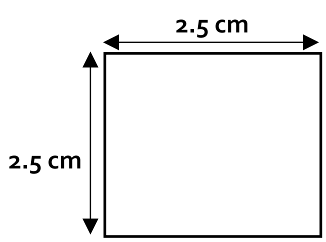

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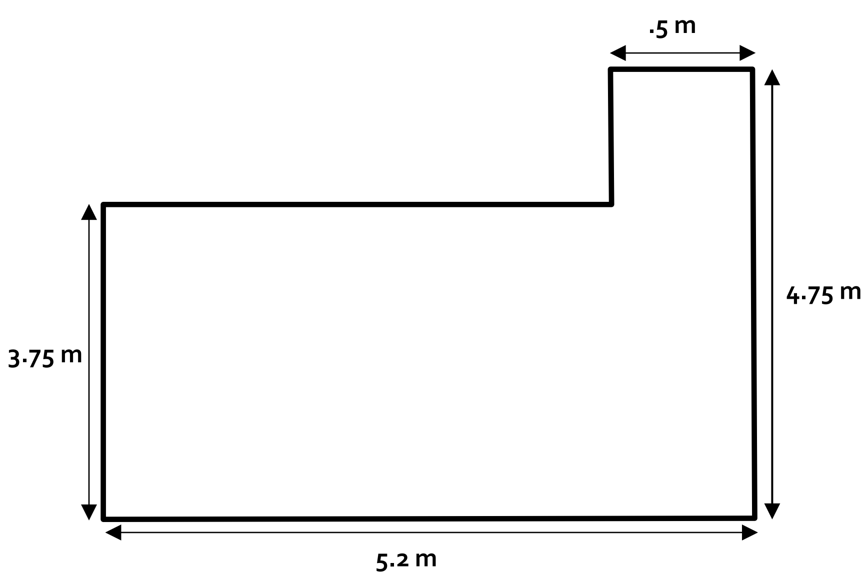

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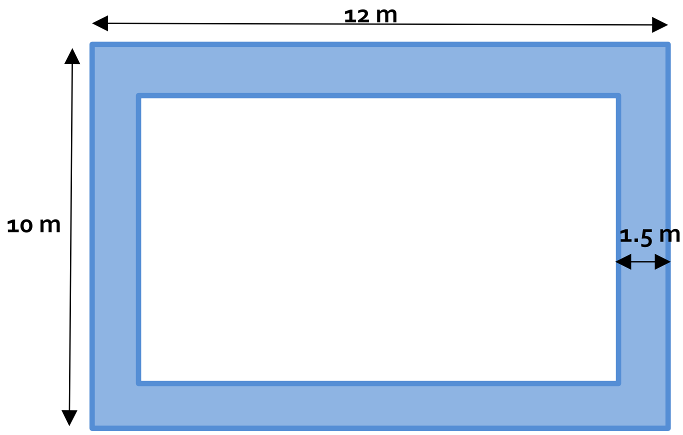
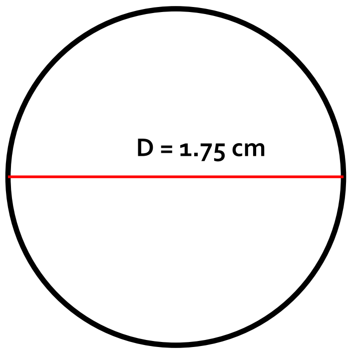


Area of the pathway
A =



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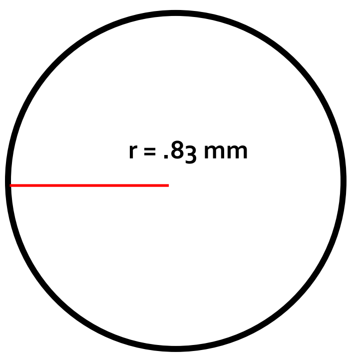

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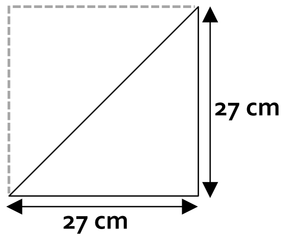

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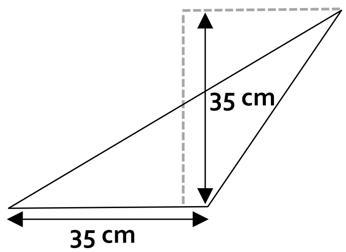


A =

REFLECTION

How do you use area at work? When do you use it?

CONVERSION

Metric is the official system of measurement in Canada, but industries in Canada frequently purchase materials and machinery made in the United States, one of the few remaining countries that uses the Imperial system of measurement. For this reason, tradespersons need to be able to convert between and within systems of measurement.

KEY POINTS

Conversion:

- in this context means to change between units of measurement. You can change between the systems (imperial and metric), or within the systems (imperial units to different imperial units, or metric units to different metric units).
- only changes how the measurement is expressed in relation to another measurement unit and does not change the measurement itself.
- uses known conversion ratios, for example, the conversion ratio of inches to centimetres is approximately 1 in. to 2.54 cm.
- can be calculated using an equation involving equivalent conversion ratios to determine unknown values.
- using an equation of equivalent ratios maintains an equivalent relationship between different measurement units. This method allows you to go back and forth between measurements and accurately find converted values.
- may involve using more than one conversion equation to find the final unknown value.
- can be applied to convert common types of measurements such as length (distance), area, weight (mass), or volume.
- of temperature, however, is calculated using a specific conversion formula.

STEPS

1. Decide what type of unit the conversion is for – length (distance), area, weight (mass) or volume.

> Conversion ratios can be written:
> - ✓ using a fraction $\frac{1\ in.}{2.54\ cm}$
> - ✓ using a colon **1 in. : 2.54 cm**
> - ✓ using the equal sign **1 in. = 2.54 cm**

2. Determine if you are converting *from* metric *to* imperial, or *from* imperial *to* metric, or converting units within the same measurement system.

3. Find the appropriate conversion ratio in the reference table. You may need to choose more than one appropriate conversion ratio to arrive at the final unknown value. For example, when you are converting cm to feet, you will use conversion ratios for inches to cm and feet to inches.

4. Write out an equation using equivalent ratios. The ratio containing the value to be converted is placed on the left-hand side of the equation and the appropriate conversion ratio chosen from the reference table is placed on the right-hand side of the equation, separated by an equal sign. Ensure corresponding units are on the top and bottom of both sides of the equation.

If converting 63.5 cm into inches use: $\frac{?\,in.}{63.5\,cm} = \frac{1\,in.}{2.54\,cm}$

If converting 25 inches to cm use: $\frac{?\,cm}{25\,in.} = \frac{2.54\,cm}{1\,in.}$

5. Isolate the unknown value. When isolating the unknown value, whatever is done to one side of the equation is also done to the other side.

a. $\frac{?\,in.}{63.5\,cm} = \frac{1\,in.}{2.54\,cm} \longrightarrow \frac{(?\,in. \times \mathbf{63.5\,cm})}{63.5\,cm} = \frac{(1\,in. \times \mathbf{63.5\,cm})}{2.54\,cm}$

b. $?\,in. = \frac{(1\,in. \times 63.5\,\cancel{cm})}{2.54\,\cancel{cm}}$

c. $?\,in. = \frac{(63.5\,in.)}{2.54}$

d. $?\,in. = 25\text{ in.}$

e. $25\text{ in.} = 63.5\text{ cm}\ \text{ or }\ \frac{\mathbf{25\,in.}}{\mathbf{63.5\,cm}}$

6. *If necessary*, complete another conversion equation to transform your converted value into the desired final unknown value. Choose a second appropriate conversion ratio from the reference table.

For example, to convert 63.5 cm to feet, you will first use the conversion ratio for inches to cm (as shown above, 63.5 cm = 25 inches) and then use the feet to inches conversion ratio to convert inches to feet.

a. $\frac{?ft.}{25\,in.} = \frac{1\,ft.}{12\,in.} \longrightarrow \frac{(?ft \times \mathbf{25\,in.})}{25\,in.} = \frac{(1\,ft. \times \mathbf{25\,in.})}{12\,in.}$

b. $?\,ft. = \frac{(1\,ft. \times 25\,\cancel{in.})}{12\,\cancel{in.}}$

c. $?\,ft. = \frac{(25\,ft.)}{12}$

d. $?\,ft. = 2.08\text{ ft.}$

e. $2.08\text{ ft.} = 25\text{ in.}\ \text{ or }\ \frac{\mathbf{2.08\,ft.}}{\mathbf{25\,in.}}$

7. If an instruction for rounding is given, round the answer to the required number of decimal places, (see the *Rounding Skill Builder* for help). Importantly, use original values when calculating and only round your answer in the last step.

For example, to convert 25 inches to feet rounded to the nearest hundredth.

$?\,ft. = \frac{(25\,ft.)}{12} \longrightarrow ?\,ft. = 2.08333\ldots\text{ ft.} \longrightarrow ?\,ft. = 2.08\text{ ft.}$

$2.08\text{ ft.} = 25\text{ in.}\ \text{ or }\ \frac{\mathbf{2.08\,ft.}}{\mathbf{25\,in.}}$ **rounded to the nearest hundredth.**

- For Temperature conversions follow the conversion formulas provided in the reference table.

Conversion Ratio Reference Tables:

Conversion ratios between measurement systems
Length or Distance
1 in. = 25.4 mm
1 in. = 2.54 cm
1 m = 39.37 in.
1 m = 3.28 ft.
1 m = 1.09 yd
1 mi = 1.61 km
Area
1 in² = 645 mm²
1 in² = 6.45 cm²
1 m² = 1,550 in²
1 m² = 10.76 ft.²
1 m² = 1.196 yd²
1 ac = 4,047 m²
1 ha = 2.471 ac
1 mi² = 2.59 km²
Weight or Mass
1 oz. = 28.35 g
1 kg = 2.2 lb.
1 metric tonne = 1.102 US ton
1 US ton = 907.2 kg
1 UK ton = 1016 kg
Volume
1 fl. oz. (US) = 29.57 mL
1 L = 1.06 qt. (US)
1 gal. (US) = 3.785 L

Imperial and Metric system conversion ratios	
Length or Distance	
Imperial System	**Metric System**
1 ft. = 12 in.	1 cm = 10 mm
1 yard (yd) = 36 in.	1 m = 100 cm
1 yd = 3 ft.	1 km = 1,000 m
1 mile (mi) = 1,760 yd	
1 mi = 5,280 ft.	
Area	
Imperial System	**Metric System**
1 ft.² = 144 in.²	1 m² = 10,000 cm²
1 yd² = 9 ft.²	1 hectare (ha) = 10,000 m²
1 acre (ac) = 4840 yd²	1 km² = 100 ha
1 ac = 43,560 ft.²	1 km² = 1,000,000 m²
1 mi² = 640 ac	
Weight or Mass	
Imperial System	**Metric System**
1 lb. = 16 oz.	1 g = 1,000 mg
1 US ton = 2, 000 lb.	1 kg = 1,000 g
1 UK ton = 2,240 lb.	1 metric tonne = 1,000 kg
Volume	
Imperial System	**Metric System**
1 pint (pt.) = 16 fl. oz. (US)	1 L = 1000 mL
1 quart (qt.) = 2 pt.	
1 qt. = 32 fl. oz. (US)	
1 gallon (gal.) (US) = 4 qt.	

Formulas for Temperature Conversion	
Celsius to Fahrenheit	
°F = (°C x 1.8) + 32	Convert 20° Celsius to Fahrenheit °F = (20 x 1.8) + 32 °F = 36 + 32 °F = 68
Fahrenheit to Celsius	
°C = (°F -32) ÷ 1.8	Convert 72° Fahrenheit to Celsius °C = (72 – 32) ÷ 1.8 °C = 40 ÷ 1.8 °C = 22.22°

EXAMPLES

Workplace examples of conversion include:
- converting imperial measurements of length of building materials to metric
- converting metric measurement of weight or volume to imperial

Convert 23.5 metres to yards and round to two decimal places:

1. Decide what type of unit the conversion is for: **length (distance)**
2. Determine if you are converting *from* metric *to* imperial or *from* imperial *to* metric or converting units within the same measurement system: **metric to imperial**
3. Find the corresponding conversion ratio in a reference table: **1 m =1.09 yd**
4. Write out an equation of equivalent conversion ratios where the conversion ratio containing the unknown value is placed on the left-hand side of the equation and the conversion ratio chosen from the reference table is placed on the right-hand side of the equation. Put the same unit as the unknown conversion value in the numerator position for each conversion ratio in the equation. Separate each conversion ratio using an equal sign.

$$\frac{?\,yd}{23.5\,m} = \frac{1.09\,yd}{1\,m}$$

5. Isolate the unknown value. When isolating the unknown value, whatever is done to one side of the equation is also done to the other side.

a. $\frac{?\,yd}{23.5\,m} = \frac{1.09\,yd}{1\,m} \longrightarrow \frac{(?\,yd \times 23.5\,m)}{23.5\,m} = \frac{(1.09\,yd \times 23.5\,m)}{1\,m}$

b. $?\,yd = \frac{(1.09\,yd \times 23.5\,\cancel{m})}{1\,\cancel{m}}$

c. $?\,yd = \frac{(25.615\,yd)}{1}$

d. $?\,yd = 25.615\,yd$

e. $23.5\,m = 25.615\,yd$ or $\frac{23.5\,m}{25.615\,yd}$

6. If an instruction for rounding is given, round the answer to the required number of decimal places, (see the *Rounding Skill Builder* for help). Importantly, use original values when calculating and only round your answer in the last step.

- *Convert 23.5 metres to yards and* ***round to two decimal places****.*

$?\,yd = \frac{(25.615\,yd)}{1} \longrightarrow ?\,yd = 25.615\,yd \longrightarrow ?\,yd = 25.62\,yd$

$?\,yd = 25.62\,yd$

$23.5\,m = 25.62\,yd$ **or** $\frac{23.5\,m}{25.62\,yd}$ **rounded to two decimal places.**

Convert 37 ½ square yards to square metres and round to nearest whole number:

1. Decide if the conversion is for length, area, weight or volume and find the corresponding conversion table: **Area.**
2. Determine if you are converting from metric to imperial or from imperial to metric: **imperial to metric**
3. Find the corresponding conversion ratio in a reference table: **1 m² =1.196 yd²**
4. Write out an equation of equivalent conversion ratios where the conversion ratio containing the unknown value is placed on the left-hand side of the equation and the conversion ratio chosen from the reference table is placed on the right-hand side of the equation. Put the same unit as the unknown conversion value in the numerator position for each conversion ratio in the equation. Separate each conversion ratio using an equal sign.

$$\frac{?\,m^2}{37.5\ yd^2} = \frac{1\ m^2}{1.196\ yd^2}$$

NOTE: Change the fraction 37 ½ yd² to a decimal (37.5 yd²).

5. Isolate the unknown value. When isolating the unknown value, whatever is done to one side of the equation is also done to the other side.

a. $\frac{?\,m^2}{37.5\ yd^2} = \frac{1\ m^2}{1.196\ yd^2} \longrightarrow \ ?\,m^2 = \frac{(1\ m^2 \times 37.5\ yd^2)}{1.196\ yd^2}$

b. $?\,m^2 = \frac{(1\ m^2 \times 37.5\ \cancel{yd^2})}{1.196\ \cancel{yd^2}}$

c. $?\,m^2 = \frac{(37.5\ m^2)}{1.196}$

d. $?\,m^2 = 31.354515\ m^2$

e. $37.5\ yd^2 = 31.354515\ m^2\ or\ \frac{37.5\ yd^2}{31.354515\ m^2}$

6. If an instruction for rounding is given, round the answer to the required number of decimal places, (see the *Rounding Skill Builder* for help). Importantly, use original values when calculating and only round your answer in the last step.

$$?\,m^2 = \frac{(37.5\ m^2)}{1.196} \longrightarrow\ ?\,m^2 = 31.354515\ m^2 \longrightarrow\ ?\,m^2 = 31\ m^2$$

$$?\,m^2 = 31\ m^2$$

$37.5\ yd^2 = 31\ m^2\ or\ \frac{37.5\ yd^2}{31\ m^2}$ **rounded to nearest whole number.**

Think you understand how to perform conversions?
Try it yourself on the next page.

USING THE SKILL

In the Workplace: Being able to use conversion effectively is a useful workplace skill.

NOTE: All resulting decimal values are carried through in full and rounded in the last step of the equation.

Convert 35,000 km to mi. *Round to the nearest whole number.*	Convert 537 mi. to km *Round to the nearest tenth.*
Convert 22 gal. (US) to L	Convert 14 oz. to g
Convert 75°F to °C *Round to the nearest whole number.*	Convert 8°C to °F *Round to the nearest whole number.*
Convert 27 in. to cm	Convert 231 yd. to m *Round to the nearest tenth.*
Convert 93 kg to lb.	Convert 37 in. to mm
Convert 17 ½ cm to ft. *Round to the nearest tenth.*	Convert 43,560 yd^2 to mi^2 *Round to the nearest thousandth.*
Convert 27 mL to fluid oz. (US) *Round to the nearest hundredth.*	Convert 17 L to gal. (US) *Round to the nearest tenth.*
Convert 133 lb. to kg *Round to the nearest hundredth.*	Convert 82 ft. to m

REFLECTION

How do you use conversion at work? When do you use it?

PERCENTAGES, DECIMALS & FRACTIONS

Percentages, decimals and fractions are different ways of writing number values. Some common uses of percentages are to describe exam scores, phone battery availability, and interest rates. A common use for decimals is to describe the measurements of objects and a couple of common uses of fractions are to describe amounts for cooking and for referring to money.

KEY POINTS

- A percentage is a description of how much of something there is, in relation to the whole of that thing. The whole will always be 100. For example, 30% means the same as saying 30 parts out of a total of 100.
- A decimal is a number written with a decimal point and a remainder that represents portions of 10. (0.30)
- A fraction is a measure of a part of something in relation to the whole of a certain size, such as, 3/8 or 7/10. (30/100)
- 30%, 0.30 and 30/100 all represent the same value.
- Being able to convert amongst the three expressions of values is an important skill for work.

Common Values in Percent, Decimal and Fraction Form:

Percent	Decimal	Fraction
1%	0.01	$^{1}/_{100}$
5%	0.05	$^{1}/_{20}$
10%	0.1	$^{1}/_{10}$
12½%	0.125	$^{1}/_{8}$
20%	0.2	$^{1}/_{5}$
25%	0.25	$^{1}/_{4}$
$33^{1}/_{3}$%	0.333…	$^{1}/_{3}$
50%	0.5	$^{1}/_{2}$
75%	0.75	$^{3}/_{4}$
80%	0.8	$^{4}/_{5}$
90%	0.9	$^{9}/_{10}$
99%	0.99	$^{99}/_{100}$
100%	1	--
125%	1.25	$^{5}/_{4}$
150%	1.5	$^{3}/_{2}$
200%	2	--

STEPS

Calculate percent:

1. State what you know in words.
   - "I fixed 57 out of 60 cars this month."
2. Turn the statement into a fraction.
   - 57/60
3. Change the fraction to a decimal by dividing the numerator (top number) by the denominator (bottom number).
   - 57 ÷ 60 = .95
4. Finally change the decimal to a percentage by multiplying it by 100. (move the decimal 2 places to the right)
   - .95 x 100 = 95
5. Add the percent sign.
   - ***95%***

Change percent to a decimal:

1. Convert a percentage to a decimal by **either**:
   a) moving the decimal 2 places to the left
   - 95% = .95%

   b) dividing the percent by 100
   - 95% to a decimal 95 ÷ 100
2. Write the decimal value without a percent sign.
   - ***.95***

Change a decimal to percent:

1. Convert a decimal to percent by **either**:
   1. moving the decimal 2 places to the right
   - .95 = 95

   2. multiplying the decimal by 100
   - .95 to a percent = .95 x 100
2. Write the value and add the percent sign.
   - ***95%***

Change percent to a fraction:

1. Convert the percentage to a decimal by dividing the percent by 100.
   - 95% to a decimal 95 ÷ 100 = .95
2. Write the decimal number over top of the number 1.
   - .95/1
3. Multiply the top and bottom numbers by 10, for every number after the decimal point.
   - .95 x 100 and 1 x 100
4. Look at the total. It will be a correctly formed fraction.
   - 95/100
5. Reduce the fraction to its simplest form by dividing the numerator and denominator by the highest number that can divide into both numbers evenly.
   - **95/100 can be reduced by a factor of 5.In its simplest form 95/100 equals 19/20**.

Change a fraction to percent:

1. Convert the fraction to percent by dividing the top number by the bottom number.
   - 95 ÷ 100
   - ***.95***
2. Multiply the result by 100 and add the % sign to the result.
   - .95 x 100
   - ***95%***

Change a decimal to a fraction:

1. Write the decimal number over top of the number 1.
   - .95/1
2. Multiply the top and bottom numbers by 10, for every number after the decimal point.
   - .95 x 100 and 1 x 100
3. Look at the total. It will be a correctly formed fraction.
   - 95/100
4. Reduce the fraction to its simplest form by dividing the numerator and denominator by the highest number that can divide into both numbers evenly.
   - 95/100 can be reduced by a factor of 5. **In its simplest form 95/100 equals 19/20.**

Change a fraction to a decimal:

1. Divide the top number of the fraction by the bottom number of the fraction.
   - 95/100 = 95÷100
   - ***.95***

EXAMPLES

I completed 27 of the 35 measurements needed for the floor plan, before noon.

1. Make it a fraction: 27/35
2. Divide the numerator by the denominator: 27 ÷ 35 = 0.7714
3. Multiply the answer by 100: 0.7714 x 100 = 77.14
4. Round to the nearest whole percentage and add the % sign: 77%

Rounded to the nearest whole percentage that is 77% of what I was asked to do for the day!

Think you understand how to calculate percentages, decimals and fractions?

Try it yourself on the next page.

USING THE SKILL

In the Workplace: Workers regularly use percentages, decimals and fractions. They may have to calculate and convert measurements from fractions to decimals/decimals to fractions. They may work with percent when handling invoices, calculating amounts of materials used, or reviewing yearly or quarterly sales data.

Convert 61% to a fraction.	Convert 5/8 to percent.
Convert 73% to a fraction.	Convert 15/16 to percent. *Round your answer to the nearest tenth.*
Convert 1.32 to a percentage.	Convert 25/32 to a decimal. *Round your answer to the nearest tenth.*
Convert .585 to a percentage.	Convert 7/16 to a decimal. *Round your answer to the nearest hundredth.*
Convert 187% to a decimal.	Convert .85 to a fraction.
Convert 77% to a decimal.	Convert 4.2 to a fraction.
Convert 17/32 to a decimal. *Round your answer to the nearest tenth.*	Convert 13/16 to a decimal. *Round your answer to the nearest tenth.*
Convert .67 to a fraction.	Convert .88 to a fraction.

REFLECTION

How do you use percentages, decimals and fractions at work? When do you use them?

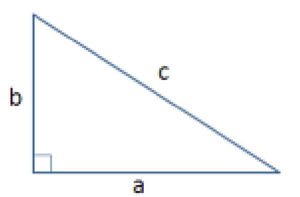
PYTHAGOREAN THEOREM

The Pythagorean theorem has many applications. One common application of the theorem is in the design and building of structures, in which case it is used wherever a "right", or 90-degree angle is required. The framing of roofs and the squaring of walls and foundations, where it is very important that the corners are square, are just some design and build tasks that rely on this basic principle of mathematics.

KEY POINTS

The Pythagorean theorem:

- describes the relationships among the sides of right-angled triangles
    - right-angled triangles are triangles that contain one angle of exactly 90 degrees
- states that:



In a right-angled triangle, the square of the hypotenuse (longest side of the triangle and usually called c) is equal to the sum of squares of the other two sides (a and b).

It is written as $a^2+b^2=c^2$

- allows workers to find the length of the third side of a right-angled triangle, provided the lengths of two of the sides are known.
- is sometimes called the "3, 4, 5" method because, if a side of a corner is measured as 3 (in., cm, ft., m etc.), and the other side is measured as 4 in the same units (in., cm, ft., m etc.), the hypotenuse will always be 5 (in., cm, ft., m etc.), *if the corner is square*.

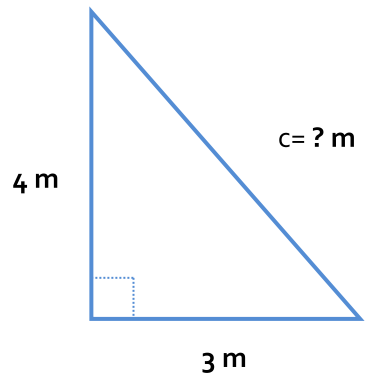
STEPS

1. Check that you have the measurements for 2 of the sides of the triangle.
2. Label the longest side of the triangle as "c".
3. Label the other 2 sides of the triangle as "a" and "b" (it doesn't matter which side is which).
4. Calculate the squared numbers by multiplying each number by itself, for example: 5^2 is the same as 5 x 5.
5. Insert the squares of the known numbers into the formula: $a^2+b^2=c^2$.
6. If the unknown number is for side "c", add $a^2 + b^2$ to find the value of c^2.
7. If the unknown number is side "a" or "b", subtract the *square* of the known number from the *square* of "c". (See the ladder example below.)
8. Calculate the square root of the missing number using a calculator. (Type in the number then press the square root (√) button.)

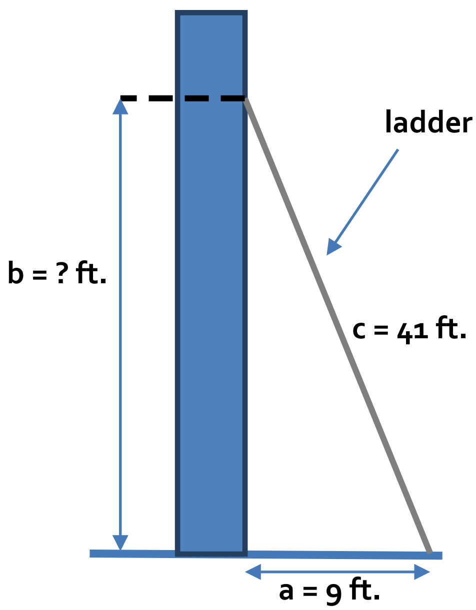
EXAMPLES

Here is an example of the Pythagorean theorem shown as the "3, 4, 5" method frequently used in construction. Remember, to be able to describe "c" you need to find the square root of c^2.

$a^2+b^2=c$
$3^2 + 4^2 = c^2$
$(3x3) + (4x4) = c^2$
$9 + 16 = c^2$
$c^2 = 25$
$\sqrt{25} = 5$
$c = 5$ m



Here is an example of the theorem used in the case of ladder placement.



A 41 ft. ladder is placed against a wall. The bottom of the ladder touches the ground 9 ft. from the base of the wall.

How high above the ground does the ladder touch the building?

$a^2+b^2=c^2$
$9^2 + b^2 = 41^2$
$81 + b^2 = 1681$
$b^2 = 1681 - 81$
$b^2 = 1600$
$b = \sqrt{1600}$
$b = 40$ ft.

The standard rule of safety when positioning a ladder is that for every 4 units of height, to the point where the ladder leans against the wall, the base of the ladder should be 1 unit away from the surface on which the top rests. This ladder is not properly positioned to be considered safe. It touches the wall at 40 ft. The base should be 10 ft. from the wall and it is only 9.

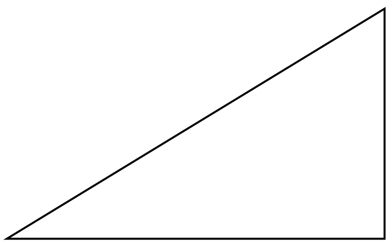
Think you understand how to use Pythagorean theorem?

Try it yourself on the next page.

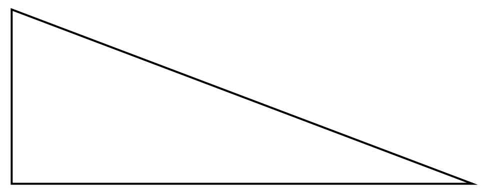
USING THE SKILL

In the Workplace: use the Pythagorean theorem any time you need to measure a shape to determine whether it has a 90° angle and you know the measurements of two of the sides or as part of the process to find the volume of shapes. This could be when you are working on a foundation, framing, planning a roof, building a staircase, or installing pipe to name just a few instances.

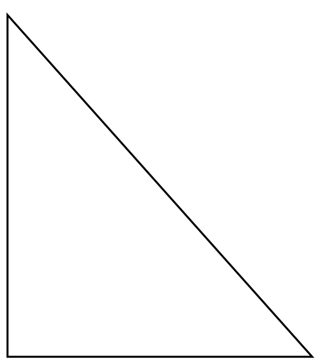
Practice the Pythagorean theorem calculation by completing the questions on the next two pages. Round your answers to the nearest tenth.



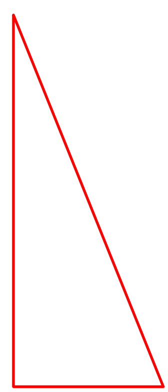
a = 8 cm
b = 5 cm
c= ? cm



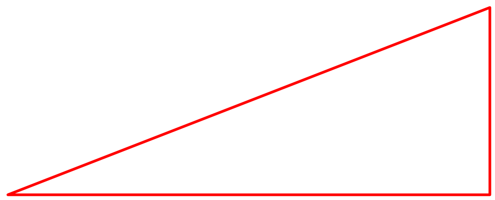
a = ? m
b = 3 m
c= 10 m



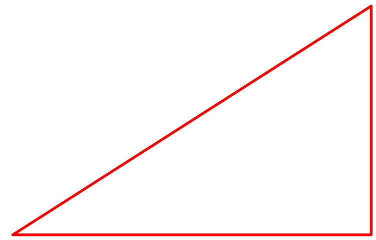
a = 12.5 cm
b = ? cm
c= 18.5 cm



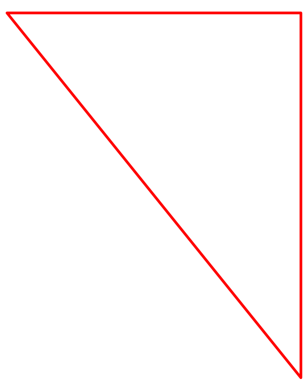
a = 12 ft.
b = 32 ft.
c= ? ft.



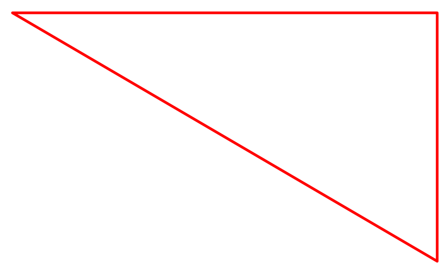
a = 36 mm
b = ? mm
c= 45 mm



a = 15 mm
b = 13mm
c= ? mm



a = 13 m
b = 17 m
c= ? m



a = ? m
b = 1.7 m
c= 3.3 m

REFLECTION

How do you use the Pythagorean theorem at work? When do you use it?

ROUNDING WHOLE NUMBERS & DECIMALS

Rounding makes numbers easier to use, especially when all you need is an estimate. A rounded number has about the same value as the number you start with but is less exact.

KEY POINTS

Rounding

- means to make a number slightly higher or lower than its stated value
- can be used with whole numbers or decimals
- rules:
  - If the number you are rounding to is followed by a 5, 6, 7, 8, or 9, round the number **up**.
  - If the number you are rounding to is followed by a 0,1,2,3 or 4, round the number **down**.
  - All numbers to the right of the place being rounded will be zeros.
- place value:
  - numbers to the left of the decimal are larger, further to the left
    - ones, tens, hundreds, thousands etc.
  - numbers to the right of the decimal are smaller, further to the right
    - tenths, hundredths, thousandths, ten thousandths etc.

PLACE	EXAMPLE
Millions	8,000,000
Hundred thousands	800,000
Ten thousands	80,000
Thousands	8,000
Hundreds	800
Tens	80
Ones	8
Tenths	0.8
Hundredths	0.08
Thousandths	0.008
Ten thousandths	0.0008
Hundred thousandths	0.00008
Millionths	0.000008

Whole numbers

Decimal numbers

Rounding whole numbers:

- means to estimate to the nearest ten, hundred, thousand, ten thousand, or higher power of ten
- means to round numbers to the left of the decimal
- the rule is:
  - if the number to be rounded is followed by **5 or higher**, round **UP**
  - if the number to be rounded is **followed by less than 5**, round **DOWN**

Rounding decimals:

- means to estimate to the nearest tenth, hundredth, thousandth or smaller power of ten
- means to round numbers to the right of the decimal
- the rule is the same as for whole numbers

Number lines:

- a number line is a useful tool for checking that a rounding answer is correct, or for practicing rounding
- to create a number line, draw a line and write the span of the number series in which you need to round
- for example, round 22 to the nearest unit of 10. Not sure?
  - draw a line and write the numbers between the two closest tens on the line (the closest units of ten are 20 and 30)
  - find 22 and circle it
  - decide which unit of ten 22 is closest to (20)

20 21 22 23 24 25 26 27 28 29 *30*

STEPS

1. Determine the place value you are rounding to, *tens*, *hundreds*, *tenths*, *hundredths*, *etc.*, then draw a line under the number in that place.
2. Check the number to the right of the underlined number.
   - If the number to the right is **less than 5** you will round down.
   - If the number to the right is **5 or more**, you will round up.
3. Change all numbers to the right of the underlined number to zeros.

EXAMPLES

1. **Round 234 to the nearest ten:** 234 is closer to 230 than to 240. Rounded to the nearest 10 the number is 230.

230 231 232 233 234 235 236 237 238 239 *240*

2. **Round 2456 to the nearest hundred:** 2456 is closer to 2500 than to 2400. Rounded to the nearest hundred the number is 2500.

2400 2410 2420 2430 2440 2450 2456 2460 2470 2480 2490 *2500*

3. **Round 4.56 to the nearest tenth:** 4.56 is closer to 4.6 than to 4.5. Rounded to the nearest tenth the number is 4.6

4.5 4.51 4.52 4.53 4.54 4.55 4.56 4.57 4.58 4.59 *4.6*

Think you understand rounding?

Try it yourself on the next page.

USING THE SKILL

In the Workplace: Workers use rounding when they need to quickly estimate or check amounts of materials, miles, costs or hours, etc.

Questions

Check your understanding of rounding by completing the tasks or answering the questions below.

1. Round 5.36 to the nearest whole number.

2. Round 32.74 to the nearest whole number.

3. Round 10.386 to the nearest tenth.

4. Round 0.4838 to the nearest hundredth.

5. You need a rough budget for construction materials. What is the nearest ten thousand dollars to $76,690.00?

6. You used $90.00 cash to pay $83.68 for some materials. To the nearest whole number, how much change should you have?

7. You need 7.82 cans of paint to cover 782 sq. ft. What is the nearest number of full cans you should buy?

REFLECTION

How do you use rounding at work? When do you use it?

VOLUME

Volume is the amount of space an object or substance takes up or the amount an object or substance can hold.

KEY POINTS

Volume:

- is an aspect of solid geometry
  - solid geometry is three dimensional (3D) because it has height, width and depth.
  - solid geometry shapes have either
    - straight edges, sharp corners and flat sides (e.g. polyhedrons such as cubes, cuboids and pyramids)
    - **or** some or all surfaces that are not flat (e.g. cylinders, cones and spheres)
- is described in cubic units, e.g., cm^3
- of a cube or cuboid is calculated as: length x width x height (lwh)
  - a cube is a square
  - a cuboid is a rectangle
- of a cylinder is calculated as: area of the base x height
- of a cone is calculated as: 1/3 of the area of the base x height

Steps

Straight-edged, flat-sided shapes

1. To calculate the volume of a polyhedron, such as a rectangle or square, measure the length, width and height of the shape.
   - height may also be referred to as depth
   - length is always the longest side, if there is one
2. Multiply the measurements using the formula $V = l \times w \times h$
3. Write the answer as a “cubic” number, e.g., 10 cm^3
4. Always include the units of measurement in your answer ($in.^3$, cm^3, etc.)

Curved-surface shapes

Cylinder: a 3D shape with curved sides and a top and bottom that are flat circles

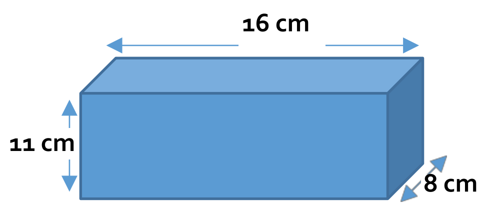
1. Measure the radius and height of the cylinder.
2. Multiply the measurements using the formula $V = \pi r^2 h$
   - πr^2 is the calculation for the area of one end
3. Write the answer as a cubic number, e.g., 10 cm^3
4. Always include the units of measurement in your answer ($in.^3$, cm^3, etc.)

An Important Note about pi
The most accurate way to complete a calculation that includes pi is to use a calculator with the π key option. If you do not have access to this sort of calculator, you can use the value of 3.14 for pi, when practicing. However, 3.14 is not as accurate a measurement and should not be used in work or assessment situations where accuracy is important.

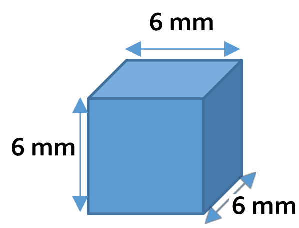
Cone: a 3D shape with a circle at one end, a point at the other and a curved side

1. Measure the radius and height of the cone.
2. Multiply the measurements using the formula $V = \frac{\pi r^2 h}{3}$
3. Write the answer as a cubic number, e.g., 10 cm^3
4. Always include the units of measurement in your answer ($in.^3$, cm^3, etc.)

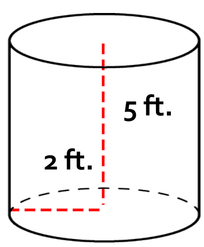
EXAMPLES



V = l x w x h
V = 16 x 8 x 11
V= 1408 cm^3

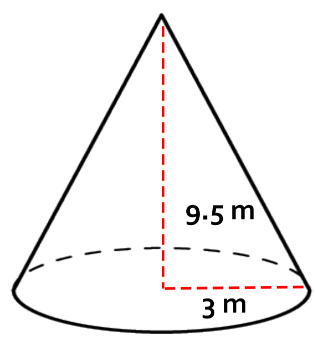


V = l x w x h
V = 6 x 6 x 6
V= 216 mm^3



V = π r² h
V = π (2x2) x 5
V = 62.83 $ft.^3$

V = π r² h
V = 3.14(2x2) x 5
V = 62.8 $ft.^3$



V = π r² h / 3
V = π (3x3) x 9.5 ÷ 3
V = 268.606 ÷ 3
V = 89.53 m^3

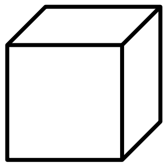
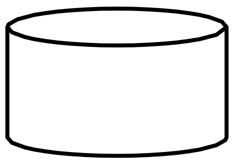
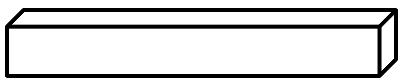
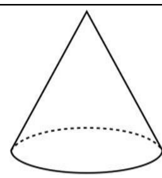
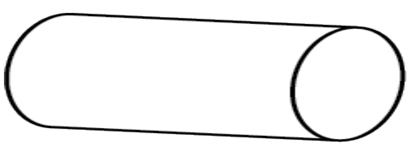
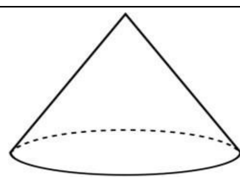
V = π r² h/3
V = 3.14 (3x3) x 9.5 ÷ 3
V = 268.47 ÷ 3
V = 89.5 m^3

Think you understand how to calculate volume?
Try it yourself on the next page.

USING THE SKILL

In the Workplace: Volume calculations are used for a variety of tasks. As examples, it may be necessary to determine the volume of land to remove or fill to add to a site, or the volume of material trucks can haul. Plumbers and pipefitters calculate the volume of pipe to determine which pipe to use or the best size of hot water tank to install.

Calculate volume for each of the shapes below. Write down the formula you use in each case. Remember to include units in your answers. Round to the nearest tenth if using 3.14 and the nearest hundredth if using pi.

	l ,w, h = 23 mm
	r = 16 m h = 13 m
	l = 37 cm w = 10 cm h = 8 cm
	r = 7 in. h = 15 in.
	r = 12 m h = 72 m
	r = 11 ft. h = 11 ft.

REFLECTION

How do you use volume at work? When do you use it?