

- A **formula** is a mathematical equation that relates two or more variables.
- $P = 25T - 800$ might give the profit from ticket sales, where P is the profit and T is the # of tickets sold
 - $E = mc^2$ (Einstein's theory of relativity) relates **Energy** to the **Mass** of an object and the **Speed of light**

KEY WORDS

Equation
Variables
Profit
tickets
backward
numerical
formula(s)
forward
convert
substitute

Solving Multi-Step Problems – Plan and organize your solution

- **PLAN** your solution by working backward from what you are trying to find to what you are given
 - Determine what numerical info is given and what you need to find
 - Decide what formulas to use
- **WRITE** the solution by working forward from what you are given to what you are trying to find
 - Convert quantities to similar units (if necessary)
 - substitute known values (given or calculated) to solve for the unknown

EXAMPLE 1 – SUBSTITUTING

The formula $S = 0.6T + 331.5$ gives the approximate speed of sound in air, S metres per second, when the temperature is T degrees Celsius. Determine the speed of sound at -40 °C.

Start writing the formula → $S = 0.6T + 331.5$

Substitute given values → $S = 0.6(-40) + 331.5$

Solve to find the answer → $S = 307.5$

Write a therefore statement → ∴ When the temperature is -40 °C, the speed of sound is 307.5 m per second.

EXAMPLE 2 – CHOOSING FORMULAS & CONVERTING MEASURES

A landscaper uses a bucket with radius 18 cm and height 18 cm to pour soil into a rectangular planter measuring 1.2 m by 40 cm by 20 cm. How many buckets of soil are needed to fill the planter?

Convert measures → $1.2\text{ m} = 120\text{ cm}$



Planter

$$\begin{aligned}
 V_{\text{planter}} &= w \times l \times h \\
 &= 20 \times 40 \times 120 \\
 &= 96000\text{ cm}^3
 \end{aligned}$$



Bucket

$$\begin{aligned}
 V_{\text{bucket}} &= \pi r^2 h \\
 &= \pi (18)^2 \times 18 \\
 &= 18,321.77\text{ cm}^3
 \end{aligned}$$

Decide on formulas to use →

Substitute given values →

Solve the problem →

$$\begin{aligned}
 \text{number of buckets} &= V_{\text{planter}} \div V_{\text{bucket}} \\
 &= 96000 \div 18321.77 \\
 &\approx 5.24
 \end{aligned}$$

Write a final statement →

∴ You'll need approximately 5 buckets.

EXAMPLE 3 – MULTI-STEP PROBLEMS

A landscaper wants to estimate the cost of fertilizing a triangular lawn with side lengths 150 m, 200 m, and 300 m. One bag of fertilizer costs \$19.98 and covers an area of 900 m². She uses Heron's formula to determine the area of the lawn:

The area A of a triangle with side lengths a , b , and c , is given by $A = \sqrt{s(s-a)(s-b)(s-c)}$, where $s = \frac{a+b+c}{2}$.

Estimate the cost to fertilize the lawn.

PLAN the solution: Work backwards

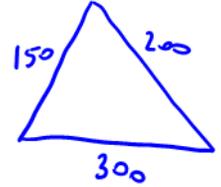
To find the cost of fertilizer, I need to know the number of bags needed

To find the # of bags needed I need to know the area of the triangular lawn

To find the area of the lawn I need to use the formula for the area

To use the formula for area I need to know the value of "s"

To find the value of s I need to know the lengths of sides a , b , c

**WRITE the solution: Work forwards**

$$\text{Find } s: \quad s = \frac{a+b+c}{2} = \frac{150+200+300}{2} = \frac{650}{2} = 325$$

$$\begin{aligned} \text{Find } A: \quad A &= \sqrt{s(s-a)(s-b)(s-c)} \\ &= \sqrt{325(325-150)(325-200)(325-300)} \\ &= \sqrt{325(175)(125)(25)} \\ A &= 13,331.71 \text{ m}^2 \end{aligned}$$

Find # bags needed:

$$\begin{aligned} \# &= \frac{13,331.71}{900} \\ &\approx 15 \text{ bags.} \end{aligned}$$

Find cost:

$$\begin{aligned} \text{Total Cost} &= 15 \times 19.98 \\ &\approx 299.70 \end{aligned}$$

\therefore Total cost is approximately \$299.70.