

Using a Five Step Process to Solve Problems

As you read problems, we encourage you to follow a **process**—a series of steps to solve the problem. We propose a **five step process**. We will use this process to do a break even analysis for an example problem.

Step I. Identify information that will help you solve the problem.

As you read the problem, circle the **quantitative information** (information involving numbers).

Put a rectangle around the **unknowns of the problem** (what you are trying to determine).

List any **knowledge** you have that may be relevant to the problem (formulas, definitions, and so on).

Step II. Write verbal statements for the **unknowns**; then give each **unknown** an algebraic name. The **unknowns** are in the rectangle.

Step III. Translate verbal statements or formulas from your **knowledge list** into algebraic statements (equations).

Step IV. Solve for the **unknowns**.

Step V. Check your work.

In the example problem, we use color to distinguish the **quantitative information**, **unknowns**, and **knowledge list**. In setting up your problems, you may want to use circles and rectangles to distinguish this information. The objective is to identify and organize the information in a manner that fits your thinking style so it helps you solve the problem.

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Step I. Identify the **quantitative information**, **unknowns**, and **knowledge list**.

Below we show you the problem we will use to do a break even analysis. The “before” view looks like how problems are typically presented, without any sorting of information or highlighting. The “after” view shows how the problem looks when information has been organized and highlighted.

Problem “before” applying Step I

After surveying potential customers, Marketing indicates a new widget can be priced at \$200. Production indicates the labor cost to build one widget will be \$30; the material cost will be \$20. Quality Control (QC) indicates the cost to check one widget will be \$2. Purchasing indicates that they will spend \$60,000 for equipment to build the widget. Research & Development (R&D) spent \$80,000 to design the widget. Facilities spent \$156,000 to build a production facility.

How many widgets will have to be sold to break even?

After identifying the problem’s **quantitative information**, **unknown(s)**, and your **knowledge list**, you could have the following:

Problem “after” applying Step I

- After surveying potential customers, Marketing indicates a new widget can be priced at **\$200**.
- Production indicates the labor cost to build one widget will be **\$30**; the material cost will be **\$20**.
- Quality Control (QC) indicates the cost to check one widget will be **\$2**.
- Purchasing indicates that they will spend **\$60,000** for equipment to build the widget.
- Research & Development (R&D) spent **\$80,000** to design the widget.
- Facilities spent **\$156,000** to build a production facility.

How many widgets will have to be sold to break even?

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Knowledge: List formulas and definitions you know that may be pertinent to the problem.

- **Revenue** = (Selling Price)(Quantity Sold)
- **Cost** = (Variable Costs)(Quantity Sold) + Fixed Cost
- **Variable Costs:** Variable costs are the costs incurred to build one widget: labor costs, material costs, and quality control costs.
- **Fixed Cost:** Fixed costs are the costs present even if no widgets are produced: equipment costs, R&D costs, and facility costs.
- **Break Even:** Revenue = Cost. Break even occurs when Revenue equals Cost.

Or, the formulas below can be used to determine the break even quantity.

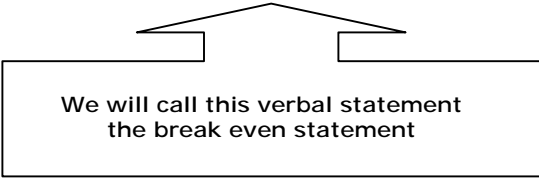
- **Formulas**

Verbal: $Break\ Even\ Quantity = \frac{Fixed\ Costs}{Selling\ price\ per\ unit - Variable\ Costs\ per\ unit}$

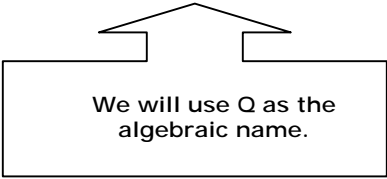
Symbolic: $Q = \frac{FC}{P - VC}$

Step II. Write verbal statements for the **unknowns**; then give each **unknown** an algebraic name. The unknowns are highlighted in **red**.

Quantity of widgets you need to sell to break even: **Q**



We will call this verbal statement
the break even statement



We will use Q as the
algebraic name.

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Step III. Translate verbal statements or formulas from your **knowledge list** into algebraic statements (equations).

Below we show two ways to set up the problem. The first involves “algebraic thinking.” The second uses a formula that comes from the algebraic thinking. The advantage of using a formula is that generally you can determine the answer more quickly.

“Algebraic Thinking”

- **Revenue** = (Selling Price)(Quantity Sold)

$$R = 200Q$$

- **Variable Costs Per Item** = (Labor Cost + Material Cost + Quality Control Cost)

$$VC = (30 + 20 + 2) = 52$$

- **Fixed Cost** = (R&D Cost + Facility Cost + Equipment Cost)

$$FC = (80,000 + 156,000 + 60,000) = 296,000$$

- **Total Cost** = (Variable Costs)(Quantity Sold) + Fixed Cost

$$C = 52Q + 296,000$$

- **Break Even Statement:** Revenue = Cost

$$200Q = 52Q + 296,000$$

“Formula”

$$\text{Break Even Quantity} = \frac{\text{Fixed Costs}}{\text{Selling price per unit} - \text{Variable Costs per unit}}$$

$$\text{Break Even Quantity} = \frac{R \& D \text{ Cost} + \text{Facility Setup Cost} + \text{Equipment Cost}}{\text{Selling price per unit} - (\text{Labor Cost} + \text{Material Cost} + \text{QC Cost})}$$

$$Q = \frac{FC}{P - VC}$$

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Step IV. Solve for the **unknowns**.

Below we show two ways to set up the problem and solve for the **unknown**. Can you see how they relate? The results are the same. The formula is an example of how we changed the format of the problem but not the meaning.

Use the algebraic thinking in Step III to solve for **Q**.

We know that at break even,

Revenue = Cost

$$200Q = 52Q + 296,000$$

$$200Q - 52Q = 296,000$$

$$148Q = 296,000$$

$$\frac{148Q}{148} = \frac{296,000}{148}$$

$$Q = 2,000$$

At the **break even point (Q)**, the amount of money coming in from widget sales equals the amount of money going out. To break even, 2,000 widgets must be sold.

Use the formula in Step III to solve for **Q**. Replace verbal text with the appropriate numbers from the problem.

$$Q = \frac{\$80,000 + \$156,000 + \$60,000}{\$200 - (\$30 + \$20 + \$2)} = \frac{\$296,000}{\$148} = \$2,000$$

Using the formula, you can solve the problem faster.

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Step V. Check your work.

- **Money coming in:** If 2,000 widgets are sold,

$$\text{Revenue} = 200(2,000) = \mathbf{\$400,000}$$

- **Money going out:** If 2,000 widgets are sold,

| | | | |
|----------------------|----------|--------------|---------|
| Variable Costs: | Labor | 30 x 2,000 = | 60,000 |
| | Material | 20 x 2,000 = | 40,000 |
| | QC | 2 x 2,000 = | 4,000 |
| Total Variable Cost: | | | 104,000 |

| | | |
|-------------------|-----------|---------|
| Fixed Cost: | Equipment | 60,000 |
| | R&D | 80,000 |
| | Facility | 156,000 |
| Total Fixed Cost: | | 296,000 |

| | |
|-----------------------|------------------|
| Total Cost = VC + FC: | \$400,000 |
|-----------------------|------------------|

- **Revenue = Cost** when 2,000 widgets are sold

$$\mathbf{\$400,000} = \mathbf{\$400,000}$$

The company breaks even when **money flowing in** equals **money flowing out**.

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