

Algebra 1 · Units, Quantities and Modeling · Lesson

Common Core N-Q.A.1, N-Q.A.2, N-Q.A.3 · mathovore.fr

Unit analysis uses units to guide and check multi-step problems. Multiply by conversion factors, which are fractions equal to 1, so unwanted units cancel. Define each quantity with its unit, choose a graph scale and origin that fit the data, and report answers with no more accuracy than the measurements allow.

Algebra 1 Common Core: N-Q.A.1 · N-Q.A.2 · N-Q.A.3

Key facts:

- Standards N-Q.A.1, N-Q.A.2 and N-Q.A.3: use units to solve problems, define quantities for modeling, and choose a level of accuracy.
- A conversion factor equals 1, so it changes units without changing the value.
- Square the factor for area units and cube it for volume units.
- A scale and origin that fit the data make a graph readable, and labels keep it honest.
- A measurement to the nearest tenth has a possible error of 0.05.

What is unit analysis?

Unit analysis (also called dimensional analysis) treats units as part of the algebra. Units multiply, divide and cancel just like numbers do, so they show whether a calculation is set up correctly before any arithmetic happens.

Vocabulary

Quantity: a measurable amount with a unit, such as 12 gal or 55 mi/h.

Conversion factor: a fraction equal to 1, such as $\frac{5280 \text{ ft}}{1 \text{ mi}}$.

Rate: a quantity with a ratio of units, such as dollars per gallon.

Quantity	Equality	Conversion factor
Length	1 mi = 5,280 ft	5,280 ft / 1 mi
Time	1 h = 60 min = 3,600 s	60 min / 1 h
Liquid	1 gal = 4 qt = 16 cups	4 qt / 1 gal
Area	1 acre = 43,560 sq ft	43,560 sq ft / 1 acre

Common equalities and the conversion factors they produce. Flip a factor to cancel the other unit.

How do you convert units with dimensional analysis?

1. Write the starting quantity as a fraction.
2. Multiply by a conversion factor with the unit to remove in the denominator.
3. Repeat until only the target unit remains.
4. Multiply the numbers and check that the answer's size is reasonable.

Worked example. Convert 60 mi/h to feet per second:

$$60 \frac{\text{mi}}{\text{h}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{1 \text{ h}}{3600 \text{ s}} = 88 \frac{\text{ft}}{\text{s}}$$



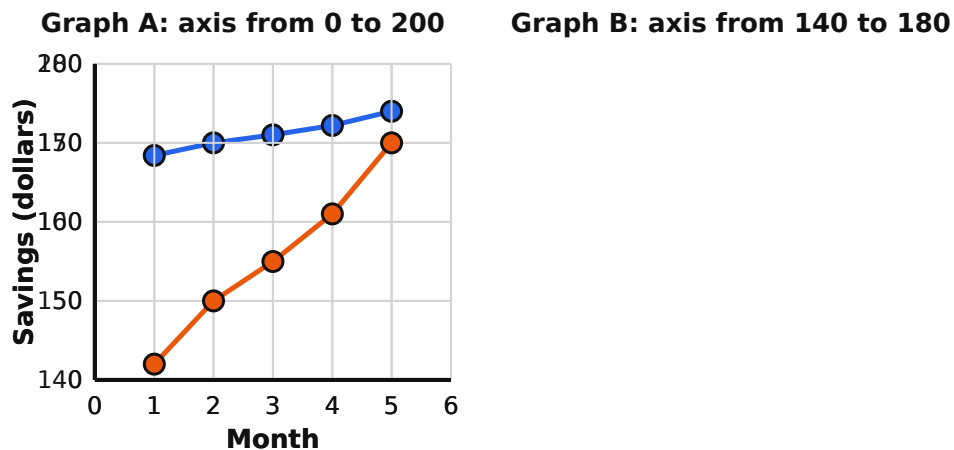
Each factor equals 1, so the value is unchanged while the units change.

How do units guide a multi-step problem?

Suppose a car gets 28 mi/gal and gas costs \$3.50 per gal. To find the cost per mile, arrange the units so that gallons cancel: $\frac{\$3.50}{1 \text{ gal}} \times \frac{1 \text{ gal}}{28 \text{ mi}} = \$0.125 \text{ per mi}$. If the units left over are not the units you wanted, the setup needs to change.

How do you choose a scale and an origin for a graph?

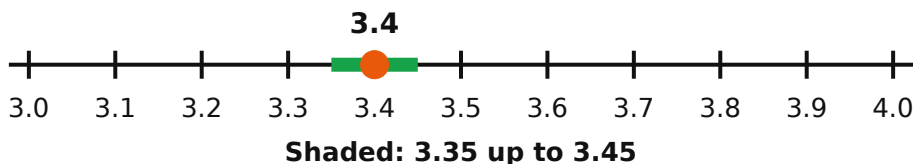
The **scale** is the value of each grid step and the **origin** is where the axes start. Choose them so the data fill most of the graph and the tick marks land on friendly numbers. An axis that starts at a number other than 0 shows small changes clearly, but it exaggerates them, so label it honestly.



The same data on two scales. Graph A fills 14% of the height; Graph B fills 70%.

How accurate should an answer be?

A measurement is only as precise as the tool. A length of 3.4 in measured to the nearest tenth could be anywhere from 3.35 up to (but not including) 3.45 inches. A calculated result should not claim more precision than its least precise input, so $24.5 \times 18.2 = 445.9$ is reported as about 446 in².



A reading of 3.4 means the true length lies in the shaded interval.

Units, Quantities and Modeling: frequently asked questions

What is a conversion factor?

A conversion factor is a fraction whose top and bottom describe the same amount in different units, such as $\frac{60 \text{ min}}{1 \text{ h}}$. Since it equals 1, multiplying by it changes the units but not the value.

How do you convert a rate like miles per hour?

Convert each unit one at a time, using one factor for the numerator unit and one for the denominator unit. For example, miles become feet with $\frac{5280 \text{ ft}}{1 \text{ mi}}$ and hours become seconds with $\frac{1 \text{ h}}{3600 \text{ s}}$.

How do you convert square or cubic units?

Square the conversion factor for area and cube it for volume. Since 1 yd = 3 ft, one square

yard is $3^2 = 9$ square feet and one cubic yard is $3^3 = 27$ cubic feet.

Why does the starting value of a graph's axis matter?

The origin and scale change how steep a change looks. A graph starting at 0 shows true proportions, while a graph that starts near the lowest data value shows small differences more clearly. Always label the axis so readers are not misled.

How many digits should a final answer have?

Keep no more precision than the least precise measurement used. Do all the calculating with full values, then round only the final answer, for example to the nearest tenth when the inputs were measured to the nearest tenth.