

Part 1 - Sample Problems

A unit multiplier (or conversion factor) is a fraction with value 1 that we use to convert quantities. Because the value of every unit multiplier is 1, we can multiply any quantity by them, without changing their value.

Principles behind the technique:

- We never change the value of a quantity if we multiply it by 1.
- To multiply two fractions, we multiply the numerator by the numerator and the denominator by the denominator.
- When multiplying two fractions, we are allowed to cancel out the same factor from upstairs and downstairs, even if they appear in different fractions. For example,

$$\frac{\cancel{3}}{20} \cdot \frac{7}{\cancel{3}} = \frac{1}{20} \cdot \frac{7}{1} = \frac{7}{20}$$

Consider the statement $1 \text{ hr} = 60 \text{ min}$. We can obtain two unit multipliers from this: $\frac{1 \text{ hr}}{60 \text{ min}}$ and $\frac{60 \text{ min}}{1 \text{ hr}}$. Clearly, the value of both of these fractions is 1. We use one to convert hours to minutes, and the other one to convert minutes to hours.

Example 1 Convert 720 minutes into hours.

Solution: Step 1. We re-write the quantity as a fraction by "growing" a 1.

$$720 \text{ min} = \frac{720 \text{ min}}{1}$$

Step 2. We indicate multiplication and draw a fraction bar for the unit multiplier.

$$720 \text{ min} = \frac{720 \text{ min}}{1} \cdot \frac{\quad}{\quad}$$

Step 3. To "get rid" of the initial unit, we enter it in the denominator of the unit multiplier to be prepared. Using fraction multiplication, this unit (in our case, minutes) will cancel out.

$$720 \text{ min} = \frac{720 \text{ min}}{1} \cdot \frac{\quad}{\text{min}}$$

Step 4. To obtain the unit requested (in our case, hours), we enter it in the numerator of the unit multiplier to be prepared.

$$720 \text{ min} = \frac{720 \text{ min}}{1} \cdot \frac{\text{hr}}{\text{min}}$$

Step 5. We obtain the unit multiplier by entering numbers in the unit multiplier, to make its value 1. Since $1 \text{ hr} = 60 \text{ min}$, we have

$$720 \text{ min} = \frac{720 \text{ min}}{1} \cdot \frac{1 \text{ hr}}{60 \text{ min}}$$

Step 6. We cancel out the units. In this step we should eliminate the original unit.

$$720 \text{ min} = \frac{720}{1} \cdot \frac{1 \text{ hr}}{60}$$

Step 7. We apply fraction multiplication: top by top, bottom by bottom and simplify the fraction.

$$720 \text{ min} = \frac{720 \cdot 1 \text{ hr}}{1 \cdot 60} = \frac{720 \text{ hr}}{60} = \frac{720}{60} \text{ hr} = 12 \text{ hr}$$

The entire computation looks like this:

$$720 \text{ min} = \frac{720 \text{ min}}{1} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = \frac{720 \cdot 1 \text{ hr}}{1 \cdot 60} = \frac{720}{60} \text{ hr} = 12 \text{ hr}$$

Example 2 Convert 40 minutes to hours.

Solution:

$$40 \text{ min} = \frac{40 \text{ min}}{1} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = \frac{40 \cdot 1 \text{ hr}}{1 \cdot 60} = \frac{40}{60} \text{ hr} = \frac{2}{3} \text{ hr}$$

Example 3 Convert 3.4 hours to minutes.

Solution:

$$3.40 \text{ hr} = \frac{3.4 \text{ hr}}{1} \cdot \frac{60 \text{ min}}{1 \text{ hr}} = \frac{3.4 \cdot 60 \text{ min}}{1 \cdot 1} = \frac{204}{1} \text{ min} = 204 \text{ min}$$

Example 4 Given that 12 in = 1 ft, (12 inches = 1 foot), convert 420 inches to feet.

Solution:

$$420 \text{ in} = \frac{420 \text{ in}}{1} \cdot \frac{1 \text{ ft}}{12 \text{ in}} = \frac{420 \cdot 1 \text{ ft}}{1 \cdot 12} = \frac{420}{12} \text{ ft} = 35 \text{ ft}$$

Example 5 Given that 12 in = 1 ft, (12 inches = 1 foot), convert 31 feet to inches.

Solution:

$$31 \text{ ft} = \frac{31 \text{ ft}}{1} \cdot \frac{12 \text{ in}}{1 \text{ ft}} = \frac{31 \cdot 12 \text{ in}}{1 \cdot 1} = \frac{372}{1} \text{ in} = 372 \text{ in}$$

One advantage of unit multipliers is that we can use more than one in one line.

Example 6 Convert 840 hours to weeks.

Solution:

$$840 \text{ hr} = \frac{840 \text{ hr}}{1} \cdot \frac{1 \text{ day}}{24 \text{ hr}} \cdot \frac{1 \text{ week}}{7 \text{ day}} = \frac{840 \cdot 1 \cdot 1}{1 \cdot 24 \cdot 7} \text{ week} = \frac{840}{168} \text{ week} = 5 \text{ week}$$

Part 2 - Practice Problems

1. Convert 3840 inches to feet.
2. Convert 3840 feet to inches.
3. Convert 3840 minutes to hours.
4. Convert 3840 hours to minutes.
5. Convert 3840 minutes to days.

Part 3 - Answers for Practice Problems

1. Convert 3840 inches to feet. 320 ft
2. Convert 3840 feet to inches. 46 080 in
3. Convert 3840 minutes to hours. 64 hr
4. Convert 3840 hours to minutes. 230 400 min
5. Convert 3840 minutes to days. $\frac{8}{3}$ days or $2\frac{2}{3}$ days