

Title: Unit Conversion

Class: Math 1 or Math 4 or Math 100

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Instructions to tutor: Read instructions and follow all steps for each problem exactly as given.

Keywords/Tags: unit conversion, unit analysis, units

Unit Conversion

Purpose:

This is intended to refresh your skills in unit conversion or unit analysis.

Activity: Work through the following activity/problems. You may use your book to help you, but do not consult a tutor until you have completed through problem #9 on this activity.

Here are some equivalencies that you might find useful on this worksheet and in this course. Write down any that you don't know in your notes for future reference.

$1000 \text{ mm} = 1 \text{ m}$

$1 \text{ hr} = 60 \text{ min}$

$5280 \text{ ft} = 1 \text{ mi}$

$2 \text{ cups} = 1 \text{ pint}$

$1 \text{ lb} = 16 \text{ oz}$

$100 \text{ cm} = 1 \text{ m}$

$1 \text{ min} = 60 \text{ sec}$

$3 \text{ ft} = 1 \text{ yd}$

$2 \text{ pints} = 1 \text{ qt}$

$2000 \text{ lb} = 1 \text{ ton}$

$1000 \text{ m} = 1 \text{ km}$

$1 \text{ day} = 24 \text{ hr}$

$12 \text{ in} = 1 \text{ ft}$

$4 \text{ qt} = 1 \text{ gal}$

$1 \text{ year} = 365 \text{ days}$

Sometimes we are given a number that is in one unit and we need it in another. These unit conversions can be quite simple or very complicated. In general, to do unit conversions, we write our given information as a fraction (over 1, if necessary), and then multiply that fraction by 1 (so we do not change its "value"). However, the 1 that we multiply by is very special. Use an equivalence, writing one side as the "numerator" and the other as the "denominator". Since these are an equivalence, the fraction is really "1". It doesn't matter for the equivalence which part you write in the numerator or denominator. The result is still "1". Write it whichever way will *cancel* the unit that you want to change in your original expression.

$$\text{How many ounces (oz) are in 5 pounds (lb)? } \frac{5 \text{ lb}}{1} \cdot \frac{16 \text{ oz}}{1 \text{ lb}} = 80 \text{ oz}$$

$$\text{How many miles (mi) are in 100 feet (ft)? } \frac{100 \text{ ft}}{1} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} = .019 \text{ mi}$$

(notice that I have rounded off this answer to the thousandths place.)

1.
 - a. How many centimeters (cm) are in 20 meters (m)?
 - b. How many kilometers (km) are in a meter?
 - c. How many feet are in a half of a mile?
 - d. How many gallons (gal) are in 10 quarts (qt)?

We can use this process of unit conversion even if we do not have a direct equivalence between our desired units. We can multiply by as many equivalent fractions as we need to, remembering to set-up each fraction so the appropriate units will cancel. At the end, make sure you are left with the units asked for.

$$\text{How many inches are in a mile? } \frac{1 \text{ mi}}{1} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{12 \text{ in}}{1 \text{ ft}} = 63360 \text{ in}$$

How many kilometers are in 5 cm?

$$\frac{5 \text{ cm}}{1} \cdot \frac{1 \text{ m}}{100 \text{ cm}} \cdot \frac{1 \text{ km}}{1000 \text{ m}} = \frac{5 \text{ km}}{100000} = .00005 \text{ km}$$

- 2.
- a. How many seconds in a day?

 - b. How many yards in one mile?

 - c. How many cups in one gallon?

- 3.
- a. One billion (= 1,000,000,000) feet is how many miles?

 - b. One billion ounces is how many tons?

 - c. One billion centimeters is how many kilometers?

 - d. One billion quarts is how many gallons?

Example: Suppose one nickel weighs about 0.01111 pounds, and is about 0.1889 centimeters thick. An ounce of nickels has about how many nickels?

$$\frac{1 \text{ oz}}{1} \cdot \frac{1 \text{ lb}}{16 \text{ oz}} \cdot \frac{1 \text{ nickel}}{.011111 \text{ lb}} = \frac{1 \text{ nickel}}{.177776} = 5.63 \text{ nickels} \approx 6 \text{ nickels}$$

- 4.
- A pound of nickels has about how many nickels?
 - The thickness of one nickel in millimeters (mm) is?
 - The thickness of one nickel in meters is?
 - One billion nickels are in a single stack. How thick is the stack in kilometers?

5. Suppose one gallon of water weighs about 7.5 pounds.
- How many pounds does one quart of water weigh?
 - How many ounces does one quart of water weigh?
 - How many quarts are in one pound of water?
 - How many gallons are in one ton of water?

We can also do unit conversions with *rates*. Rates can always be written as fractions, with the units following the word "per" going in the denominator.

Convert 60 miles per hour (mph or mi/hr) into feet per second (ft/sec):

$$\frac{60 \text{ mi}}{\text{hr}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = \frac{316800 \text{ ft}}{3600 \text{ sec}} = \frac{88 \text{ ft}}{\text{sec}} = 88 \text{ ft/sec}$$

6. Convert:
- 100 mph to ft/sec
 - 100 ft/sec to mph
 - 80 km/hr to m/sec

- d. Suppose a pool is being filled at the rate of 3 gallons per minute. Convert this into quarts per second.
- e. One billion feet per second into miles per year

After you go over the previous problems with a tutor, try the following on your own, then check with a tutor to make sure you did them correctly.

7. The Great Wall of China is the only human-built structure that can be seen from the space shuttle with the naked eye. When completed, the wall was over 3700 miles long.

- a. How many feet long is the Great Wall?
- b. Suppose $1 \text{ km} \approx 0.6 \text{ mi}$. How many kilometers long is the Great Wall? How many meters? Give your answers in both standard and scientific notation.

8. The U.S. population in 1993 was reported to be 258,245,000.

- a. If the average American consumes 1 cup of fruit juice in a day, how many gallons were consumed in America in 1993? Give your answers in both standard and scientific notation.
- b. If the per capita consumption of fresh fruits in the United States in 1993 was 98.7 pounds per year, how many tons of fruit were consumed in the U.S. in 1993?
- c. The rate of consumption of fresh fruit was given in part b as 98.7 pounds per year. How many ounces per day is this? Give your answers in both standard and scientific notation.

Review: Meet with a tutor to verify your work on this worksheet and discuss some of the areas that were more challenging for you. If necessary, choose more problems from the homework to practice and discuss with the tutor.

For tutor use: Please check the appropriate box.

- Student has completed worksheet but may need further assistance. Recommend a follow-up with instructor.
- Student has mastered topic.