PLTW | Engineering

Activity 3.3 Unit Conversion Answer Key

Introduction

Engineers of all disciplines are constantly required to work with measurements of a variety of quantities – length, area, volume, mass, force, time, temperature, electric current, etc. It is often necessary to be able to express those measurements in different units. For example, when designing a water distribution piping system, it is important to know how much water pressure is lost as the fluid flows through the pipe. The pressure loss depends on the length of the pipe which is often measured in *miles*. One formula that is sometimes used to calculate pressure loss requires that the pipe length be input in *feet*. Therefore, it is necessary to be able to convert miles to feet.

In other situations you may be forced to work between the SI and U S Customary measurement systems. Say, for example, that as a U S company, your product is manufactured and produced based on U S Customary units. However, a European company would like a proposal to incorporate your system into their existing assembly line, the characteristics of which are based on SI units. You must be able to convert between the two systems in order to provide a proposal for a design which includes your company's U S product.

In this activity you will convert measurements among units in both the U S Customary System and the SI system, and you will convert quantities between the two systems of measurement. You will also gain experience with converting units among units that are not specific to one measurement system (such as people and tanks of water) and use the skills you learn to solve everyday problems (such as calculating the cost of gas to travel a given distance).

Equipment

- Engineering notebook
- Pencil
- Ruler – U S Customary and metric
- Tape measure
- PLTW Engineering Formula Sheet

Procedure

Complete each of the following. When a calculation is required, show your work.

1. Convert each of the following quantities to the indicated units. Use the appropriate number of significant figures to express your answer unless directed otherwise.

a. 6.30 yards to feet.

$$6.30\ \text{yd}\left(\frac{3\ \text{ft}}{1\ \text{yd}}\right) = 18.9\ \text{ft}$$

b. 0.55 feet to inches.

$$0.55\ \text{ft}\left(\frac{12\ \text{in.}}{1\ \text{ft}}\right) = 6.6\ \text{in.}$$

c. 4.567 trillion (4,567,000,000,000) meters to Gigameters.

$$4{,}567{,}000{,}000{,}000\left(\frac{1\ \text{Gm}}{10^9\ \text{m}}\right) = 4567\ \text{Gm}$$

d. 14520 liters to milliliters. Report to the nearest hundredth of a liter.

$$14{,}520{,}000\ \text{mL}$$

e. 43 thousand microseconds to seconds. Report to the nearest thousandth of a second.

$$43000\ \mu\text{m}\left(\frac{10^{-6}\ \text{s}}{1\ \mu\text{s}}\right) = 0.043\ \text{s}$$

f. 9 ft – 2 ½ in. to inches..

$$9\ \text{ft} - 2\tfrac{1}{2}\text{in.} = 9\ \text{ft}\left(\frac{12\ \text{in.}}{1\ \text{ft}}\right) + 2\tfrac{1}{2}\text{in.} = 110\ \tfrac{1}{2}\text{in. or } 110.5\ \text{in}$$

g. 3 ft – 5 inches to decimal feet. Report to the nearest hundredth of a foot.

$$3\ \text{ft} - 5\ \text{in.} = 3\ \text{ft} + 5\ \text{in.}\left(\frac{1\ \text{ft}}{12\ \text{in.}}\right) = 3.42\ \text{ft}$$

h. 59.2 cm to inches.

$$59.2\text{cm}\left(\frac{1\ \text{in.}}{2.54\ \text{cm}}\right) = 23.3\ \text{in.}$$

i. 5.174 kg to lb.

5.174 kg $\left(\frac{2.205\ \text{lb}}{1\ \text{kg}}\right) = 11.409$

j. 3.20 yards to inches.

$3.20\text{d}\left(\frac{3\ \text{ft}}{1\ \text{yd}}\right)\left(\frac{12\ \text{in.}}{1\ \text{ft}}\right) = 115\ \text{in.}$

k. 350.0 billion nanoliters to decaliters.

$$350{,}000{,}000{,}000\ \text{nL}\left(\frac{10^{-9}\text{L}}{1\ \text{nL}}\right)\left(\frac{1\ \text{dL}}{10^{1}\text{L}}\right) = 35.00\ \text{dL}$$

2. A village on a Caribbean island was devastated by a hurricane. The supply of fresh water was contaminated when the storm surge washed over the island, inundating the wells. Several tanks of fresh water were delivered to the village. Each tank contains 10.5 hectoliters of water.

a. How many liters of water does each tank contain?

$10.5\ \text{hL}\left(\frac{10^{2}\text{L}}{1\ \text{hL}}\right) = 1050\ \text{L}$

b. On any given day, one person needs an average of 2.5 liters of water to survive. How many *people* will a tank supply for the day? Hint: Create a conversion factor to convert from liters to people.

$$1050\ \text{L}\left(\frac{1\ \text{person / day}}{2.5\ \text{L}}\right) = 420\ \text{people / day}$$

c. If the village (which includes people and livestock) requires a total of 430 liters of water each day, approximately how long (in *days*) will one tank provide an adequate supply for the village? Give your answer to the nearest tenth of a day. Hint: Create a conversion factor to convert form liters to days.

$$1050\ \text{L}\left(\frac{1\ \text{day}}{430\ \text{L}}\right) = 2.4\ \text{days}$$

d. Convert the result to days and hours. Give your answer to the nearest hour.

$2.44\ \text{days} = 2\ \text{days} + 0.44\ \text{days}\left(\frac{24\ \text{hours}}{1\ \text{day}}\right) =$ **2 days + 11 hours**

or 58 – 59 hours hours

3. It is 3.67 miles to your grandparents' home.

a. If you can walk 4 miles in one hour, how long will it take for you to walk to your grandparents' home? Express your answer in decimal hours and then convert the time to minutes (to the nearest minute).

$$3.67\ \text{mi}\left(\frac{1\ \text{h}}{4.0\ \text{mi}}\right) = 0.92\ \text{h}$$

Hours: **0.92 hours**

$$0.92\ \text{h}\left(\frac{60\ \text{min}}{1\ \text{h}}\right) = 55\ \text{min}$$

Minutes: **55 minutes**

b. If your average stride length is 2.6 feet, how many strides will it take you to walk to your grandparents' home? Hint: You will need two conversion factors.

$$3.67 \text{ mi}\left(\frac{5280 \text{ ft}}{1.0 \text{ mi}}\right)\left(\frac{1 \text{ stride}}{2.6 \text{ ft}}\right) = 7453 \text{ strides}$$

c. If you ride your bike at an average speed of 15 mph, how long will it take you to ride to your grandparents' home? Express your answer in hours (to the nearest hundredth of an hour). Convert to minutes (to the nearest minute).

$$3.67 \text{ mi}\left(\frac{\text{h}}{15 \text{ mi}}\right) = 0.24 \text{ h}$$

$$0.24 \text{ h}\left(\frac{60 \text{ min}}{1 \text{ h}}\right) = 14 \text{ min}$$

d. If the circumference of each wheel on your bicycle is 82.6 inches, how many revolutions of a bicycle wheel will it take to get to your grandparents' home? Give your answer to the nearest revolution. Hint: You need to convert miles to inches and create a conversion factor to convert inches to revolutions of a wheel.

$$3.67 \text{ mi}\left(\frac{5280 \text{ ft}}{\text{mi}}\right)\left(\frac{12 \text{ in.}}{1 \text{ ft}}\right)\left(\frac{1 \text{ rev.}}{82.6 \text{ in.}}\right) = 2815 \text{ rev.}$$

4. Measure the size of your desk (length, width, and height) using a tape measure. Record the measurement in feet and inches, and then convert the measurements to decimal feet and decimal inches. Answer will vary.

Measurement	Feet-inches	Decimal feet	Decimal inches
width			
height			
depth			

5. Measure and record additional items in your classroom and then convert each measurement to an alternate unit as directed by your instructor.

   Answers will vary.

Object	Description of Measurement	Original Measurement	Original Measurement Units	Converted Measurement	Converted Measurement Units
room	length x width	25'-6" x 30'-0"	ft-in.	7.77 x 9.15	m
CD	diameter	4 5/8	in.	11.75	cm

6. Many track and field events are measured in metric units.
   a. In the long jump, if you can jump 5.92 meters, what is your jump length in feet? In yards?

$$5.92\text{ m}\left(\frac{1\text{ cm}}{10^{-2}\text{m}}\right)\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in.}}\right) = 19.42\text{ ft}$$

$$19.42\text{ ft}\left(\frac{1\text{ yd}}{3\text{ ft}}\right) = 6.47\text{ yd}$$

   b. How many yards must you run to complete a 100 meter dash?

$$100.0\text{ m}\left(\frac{1\text{ cm}}{10^{-2}\text{m}}\right)\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right)\left(\frac{1\text{ ft}}{12\text{ in.}}\right)\left(\frac{1\text{ yd}}{3\text{ ft}}\right) = 109.4\text{ yd}$$

   c. The women's world record high jump is 6 feet, 10 ¼ inches. What is the record in meters? Record your answer to the nearest hundredth of a meter.

$$6\text{ ft} - 10\tfrac{1}{4}\text{ in.} = 6\text{ ft} + 10.25\text{ in.}\left(\frac{1\text{ ft}}{12\text{ in.}}\right) = 6.85\text{ ft}$$

$$6.85\text{ ft}\left(\frac{12\text{ in.}}{1\text{ ft}}\right)\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)\left(\frac{10^{-2}\text{ m}}{1\text{ cm}}\right) = \mathbf{2.09\text{ m}}$$

   d. How many meters is equivalent to a mile? Give your answer to the nearest meter.

$$1\text{ mi}\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{12\text{ in.}}{1\text{ ft}}\right)\left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)\left(\frac{10^{-2}\text{ m}}{1\text{ cm}}\right) = 1609\text{ m}$$

   Alternatively,

$$1\text{ mi}\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{1\text{ m}}{3.28\text{ ft}}\right) = 1610\text{ m}$$

e. What is the length of a marathon (26.2 miles) in kilometers?

$$26.2\text{ mi}\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{1\text{ m}}{3.28\text{ ft}}\right)\left(\frac{1\text{ km}}{1000\text{ m}}\right) = 42.2\text{ km}$$

7. A European car manufacturer reports that the fuel efficiency of the new MicroCar is 28.5 km/L highway and 22.0 km/L city. What are the equivalent fuel efficiency rates in miles per gal?

$$28.5\frac{\text{km}}{\text{L}}\left(\frac{0.621\text{ mi}}{1\text{ km}}\right)\left(\frac{1\text{ L}}{0.264\text{ gal}}\right) = 67.0\frac{\text{mi}}{\text{gal}} = 67.0\text{ mpg highway}$$

$$22.0\frac{\text{km}}{\text{L}}\left(\frac{0.621\text{ mi}}{1\text{ km}}\right)\left(\frac{1\text{ L}}{0.264\text{ gal}}\right) = 51.8\frac{\text{mi}}{\text{gal}} = 51.8\text{ mpg city}$$

If gas costs $3.50 per gal, how much would it cost to drive 500 miles in the city in this car (assuming the fuel efficiency rating is accurate)?

$$500\text{ mi}\left(\frac{1\text{ gal}}{51.8\text{ mi}}\right)\left(\frac{\$3.50}{1\text{ gal}}\right) = \$33.78$$

Conclusion

1. Why is important to be able to convert measurements?

2. How do you convert measurements?