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Date: ______

Physics
Cork/Dickson

Measurement Conversions

How do you cross the metric bridge?

Why?

Units, units, everywhere, and not a soul who understands them! Not everyone uses the same units, and we often have to change our measurements into a different format so that other people can understand them. Not all units are the same size, however: a gallon, for example, is larger than a liter. Because of this, we need to know how to *convert* from one unit to another.

Model 1. *The English System*

3 teaspoons = 1 tablespoon
16 tablespoons = 1 cup
2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

1. What does the information in Model 1 show you how to do?

   The model shows us how to convert between English units.

2. Under what circumstances would you use the information in Model 1?

   I would use the information above if I were cooking and wanted to measure volume.

3. How many teaspoons are in:

   a. 1 tablespoon? 1 Tablespoon = 3 teaspoons, because $\frac{1 \text{ Table}}{} \Big| \frac{3 \text{ tea}}{1 \text{ table}}$

   b. 2 tablespoons? $\frac{2 \text{ Table}}{} \Big| \frac{3 \text{ Tea}}{1 \text{ Table}} = 6$ Teaspoons

   c. 5 tablespoons? $\frac{5 \text{ Table}}{} \Big| \frac{3 \text{ Tea}}{1 \text{ Table}} = 15$ Teaspoons

4. Based on your answers to #3, what is the overall procedure for determining the number of teaspoons in a given number of tablespoons?

   You need to set up conversion factors to convert between units.

5. How many tablespoons are in:

   a. 1 teaspoon?

   $$\frac{1 \text{ Tea}}{} \Big| \frac{1 \text{ Table}}{3 \text{ Tea}} = \frac{1}{3} \text{ Table}$$

   b. 2 teaspoons?

   $$\frac{2 \text{ Tea}}{} \Big| \frac{1 \text{ Table}}{3 \text{ Tea}} = \frac{2}{3} \text{ Table}$$

   c. 5 teaspoons?

   $$\frac{5 \text{ Tea}}{} \Big| \frac{1 \text{ Table}}{3 \text{ Tea}} = \frac{5}{3} \text{ Table} = 1\tfrac{2}{3} \text{ Table}$$

6. Based on your answers to #5, what is the overall procedure for determining the number of tablespoons in a given number of teaspoons?

   You need to set up conversion factors to convert between units.

7. Look at your answers to #4 and #6. How does converting from a large unit to a small unit (#4) differ from converting a small unit to a large unit (#6)?

   You have to invert the conversion factor.

8. How many cups are in:

   a. 1 quart?

   $$\frac{1 \text{ qt}}{} \Big| \frac{2 \text{ pt.}}{1 \text{ qt.}} \Big| \frac{2 \text{ cup}}{1 \text{ pt.}} = \frac{(1 \times 2 \times 2)}{(1 \times 1)} = \frac{4}{1} = 4 \text{ cups}$$

   b. 1 gallon?

   $$\frac{1 \text{ gal}}{} \Big| \frac{4 \text{ qt.}}{1 \text{ gal}} \Big| \frac{2 \text{ pt.}}{1 \text{ qt.}} \Big| \frac{2 \text{ cups}}{1 \text{ pt.}} = \frac{(1 \times 4 \times 2 \times 2)}{(1 \times 1 \times 1)} = \frac{16}{1} = 16 \text{ cups}$$

   c. 2 gallons?

   $$\frac{2 \text{ gal}}{} \Big| \frac{4 \text{ qt.}}{1 \text{ gal}} \Big| \frac{2 \text{ pt.}}{1 \text{ qt.}} \Big| \frac{2 \text{ cups}}{1 \text{ pt.}} = \frac{(2 \times 4 \times 2 \times 2)}{(1 \times 1 \times 1)} = \frac{32}{1} = 32 \text{ cups}$$

9. Based on your answer to #8, what is the procedure for performing a series of conversions?

   Set up a series of conversions with similar units cancelling each other out.

10. How do you think your procedure in #9 would differ if you were performing a series of conversions from small units to large units?

    You would have to invert the conversion factors.

STOP

Model 2. *The Metric System*

1000 millimeters =	100 centimeters =	1 meter =	0.001 kilometers
1000 milliseconds =	100 centiseconds =	1 second =	0.001 kiloseconds
1000 milligrams =	100 centigrams=	1 gram =	0.001 kilograms

11. What is the information in Model 2 used for?

These are conversion factors

12. What stays the same in each line? What do you think the prefixes are used for?

The type of measurement (distance, time, or mass) stays the same. The prefixes indicate the size of the sub-units.

13. What changes from line to line?

The type of measurement (distance, time, or mass changes from line to line.

14. What is larger:

a. A millimeter or a kilometer?

A Kilometer (1000 m) is larger than an millimeter (0.001 m).

b. A second or a kilosecond?

A kilosecond (1000 s) is larger than a second.

c. A centigram or a milligram?

A centigram (0.01 g) is larger than a milligram (0.001 g).

15. How many centigrams are in:

a. 2 grams? $2\,g\left(\frac{100\,cg}{1\,g}\right) = 200\,cg$.

b. 3 grams? $3\,g\left(\frac{100\,cg}{1\,g}\right) = 300\,cg$.

c. 4.49 grams? $4.49\,g\left(\frac{100\,cg}{1\,g}\right) = 449\,cg$

16. How many meters are in:

a. 200 centimeters? $200\,cm\left(\frac{1\,m}{100\,cm}\right) = 2\,m$

b. 250 centimeters? $250\,cm\left(\frac{1\,m}{100\,cm}\right) = 2.5\,m$

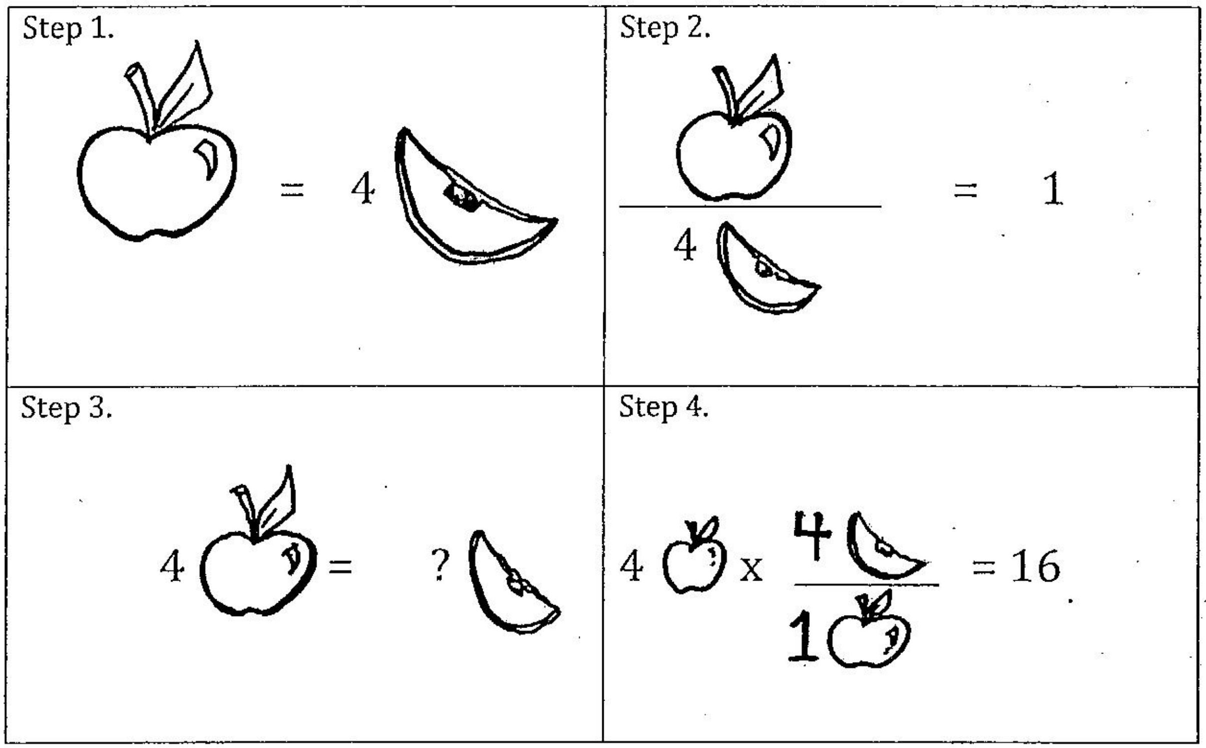
c. 9.2 centimeters? $9.2\,cm\left(\frac{1\,m}{100\,cm}\right) = 0.092\,m$

17. Compare your process in #15 and #16 to what you did with the English system of measurement in Model 1. What makes the metric system easier to use?

The metric system is base 10. You don't have to memorize conversion factors.

STOP

Model 3. *Conversion Factors*



18. In Step 1, what enables us to say that these two quantities are equal?

Equivalency. One whole apple equals four quarter apples

19. In Step 2, why is this fraction equal to 1? (*Hint: Why is 2 divided by 2 equal to 1?*)

$\frac{1}{4(\frac{1}{4})} = \frac{1}{1} = 1$

Read This!

A statement like the one in Step 1 of is known as an ***equivalence statement***. An equivalence statement tells us that a certain amount of one unit is *equal* to a certain amount of another unit.

We can use equivalence statements to create ***conversion factors*** such as the one on the left side of the equation in Step 2. Conversion factors allow us to convert from one unit to another...without getting lost in the math.

20. What unit are we converting from in step 3? What unit are we converting to?

We are converting from whole apples to quarter apples.

21. Why do we place the "whole apple" unit on the bottom of the fraction in step 4?

The whole apple on the bottom will cancel with the whole apple on the top.

22. Why do we place the "apple wedge" unit on the top of the fraction in step 4?

The apple wedge is the unit we are converting to, so it stays up top.

23. Looking at #21 and #22, what general rule can you and your group come up with about which unit goes 'on top' of the conversion factor and which unit goes 'on bottom' of the conversion factor?

The unit on the top is the unit you want to keep and the one on the bottom is the one that cancels out.


24. How could we convert the 16 apple wedges back to whole apples? How would our conversion factor have to be arranged?

$16 \text{ wedges} \times \frac{1 \text{ apple}}{4 \text{ wedges}} = 4 \text{ apples}$

25. Look back at the information contained in Model 2. Set up conversion factors for converting from:

a. Centimeters to meters

$\text{cm}\left(\frac{1 \text{ m}}{100 \text{ cm}}\right)$

b. Seconds to milliseconds

$\text{s}\left(\frac{1000 \text{ ms}}{1 \text{ s}}\right)$

c. Kilograms to centigrams (*hint: you will need to use two conversion factors*)

$\text{Kg}\left(\frac{1 \text{ g}}{0.001 \text{ Kg}}\right)\left(\frac{100 \text{ cg}}{1 \text{ g}}\right)$

26. Using your conversion factors from #25, convert:

a. 24.9 centimeters to meters

$24.9 \text{ cm}\left(\frac{1 \text{ m}}{100 \text{ cm}}\right) = 0.249 \text{ m}$

b. 8002 meters to centimeters

$8002 \text{ m}\left(\frac{100 \text{ cm}}{1 \text{ m}}\right) = 800{,}200 \text{ cm}$

c. 99 seconds to milliseconds

$99 \text{ sec}\left(\frac{1000 \text{ ms}}{1 \text{ sec}}\right) = 99000 \text{ ms}$

d. 8.9 milliseconds to seconds

$8.9 \text{ ms}\left(\frac{1 \text{ s}}{1000 \text{ ms}}\right) = 0.0089 \text{ s}$

e. 9.0 kilograms to centigrams

$9.0 \text{ Kg}\left(\frac{1 \text{ g}}{0.001 \text{ Kg}}\right)\left(\frac{100 \text{ cg}}{1 \text{ g}}\right) = 900{,}000 \text{ cg}$

f. 1,087,952 centigrams to kilograms

$$1{,}087{,}952\ \text{cg}\left(\frac{1\ \text{g}}{100\ \text{cg}}\right)\left(\frac{0.001\ \text{Kg}}{1\ \text{g}}\right) = \frac{1087.952}{100} = 10.87952\ \text{Kg}$$

Extension Question

A certain snail (whose name is Sammi) travels at a speed of 0.02 mi/hr. If there are 5280 feet in a mile, 12 inches in a foot, and 2.54 centimeters in 1 inch, then what is Sammi's speed in meters per second?

$$\left(\frac{0.02\ \text{mi}}{\text{hr}}\right)\left(\frac{5280\ \text{ft}}{1\ \text{mi}}\right)\left(\frac{12\ \text{in}}{1\ \text{ft.}}\right)\left(\frac{2.54\ \text{cm}}{1\ \text{in.}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)\left(\frac{1\ \text{hr}}{60\ \text{min}}\right)\left(\frac{1\ \text{min}}{60\ \text{sec}}\right)$$

$$\frac{3218.688}{360{,}000} = 0.009\ \frac{\text{m}}{\text{sec}}$$