Name: _____ Period: _____

'Swapping Units'

'Swap Meet' is a game about trading one thing for another. In the game, we are not trying to end up with stuff that is worth MORE than what we started with. Instead, we simply want to trade stuff we don't want for stuff we do want.

When we convert units in science class, we are trying to do the same thing. We don't want to change the value of the measurement. For example, say that you measured a sidewalk to be 38 feet long, but needed to convert that to meters. When you're done, you still want to have a measurement that accurately represents the same sidewalk; you just want it in different units. Just like the card game, you are trading something you don't want for an equal value of something you do.

MULTIPLYING BY 'ONE'

If you multiply any number by 'one', you end up with the same value. That may not seem like a very useful piece of information, but it is super-important when converting units. Let's see why…

What is the product of these equations?

	Original Fraction		Multiply by		Answer (Calculator)		Answer (Reduce the Fraction)
1)	$\frac{2}{3}$	X	$\frac{2}{2}$	=	$\frac{4}{6}$	=	$\frac{2}{3}$
2)	$\frac{2}{3}$	X	$\frac{(1+2)}{3}$	=		=	
3)	$\frac{2}{3}$	X	$\frac{(2\times 2)}{(12\div 3)}$	=		=	
4)	$\frac{2}{3}$	X	$\frac{(2+3)}{(10\div 2)}$	=		=	

Notice that the fraction in the 'multiplied by' column always has an equivalent value on the top and bottom. That doesn't mean that the top and bottom LOOK identical! However, when the value on the top of the fraction is equal to the value on the bottom of the fraction that fraction has an overall value of 'one'.

Multiplying by 'one' does not change the value of your original measurement. Multiplying by a fraction that is equal to 'one' does not change the value of your original measurement either, though it may change how it looks.

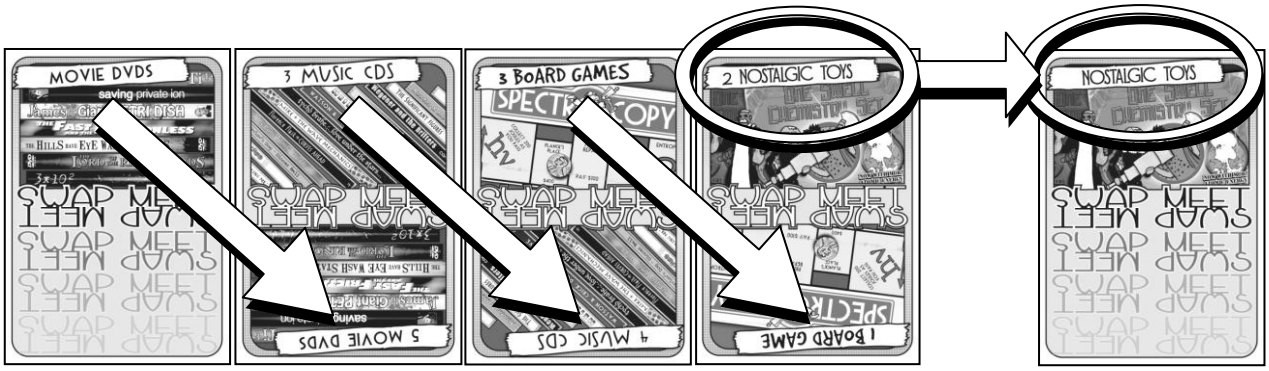
FLIPPING SWAP MEET CARDS

We can use Swap Cards to change the original stuff to new stuff without changing the overall value of what you own. The cards in the Swap Meet game are designed to have the same value on the top as on the bottom.

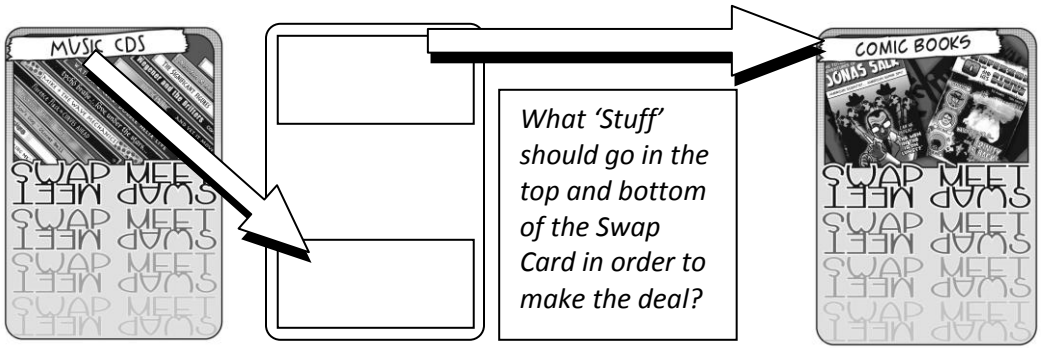
When you look at the cards in a bit more detail, you notice the numbers in front of each item. These numbers represent how much of each object you need to make one equal to the other. If you were going to really swap items, you would want to make sure what you end up with (on the top of the card) is equal to what you traded (on the bottom of the card). **The value of the items on the top of the fraction is equal to the value of the items on the bottom of the fraction.**

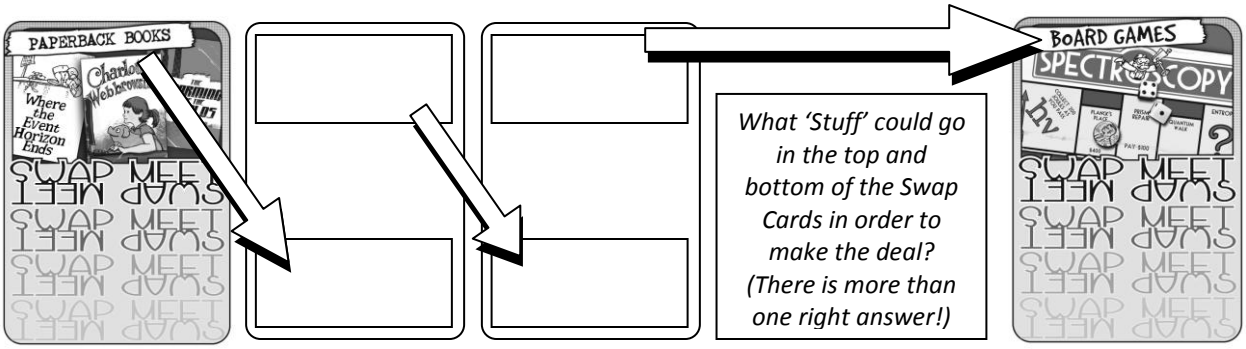
Remember what we discussed in the last section, if the value on the top of the fraction equals the value on the bottom of the fraction, the overall value of the fraction is equal to 'one'. This is a special relationship and enables us to use them to 'swap'.

When we pick a 'Swap Card', we want to use it to change something we have into something else, so both of those things need to be on the card. However, we need to do more than pick a fraction that has the 'right stuff'. We need to make sure they are oriented correctly!



We lined up the cards correctly by making sure the 'stuff' we want to get rid of 'crosses out' with the card we've already played. In the simplest version, if you have 'stuff' on the top of a card that you've played, you will need to play a card that has that stuff on the bottom of the new card. Values cross out diagonally (top with bottom or bottom with top).





COMBINING IT ALL TOGETHER

Now you are ready to convert a measurement from one unit to another. We just need to remember two important rules:

1) The "One" Rule

Your fraction must equal ONE; the value on its top must equal the value on its bottom.

2) The "Two" Rule

The fraction must be flipped so that you can diagonally cross out TWO things that are the same.

If you use these two rules correctly, you can convert any measurement to a new value! You might need to repeat as necessary!

EXAMPLE ONE: CONVERTING 34 INCHES TO CENTIMETERS

Before you can convert any units you need to know something about how they are related. There is usually more than one way to write this. It doesn't matter which one you choose as long as the two values are really equal to each other.

For inches and centimeters we could use:

1 inch = 2.54 cm OR 1 cm = .394 inches

Remember that each one of these can be written as two different fractions. So we have these to choose from…

$$\frac{1\ inch}{2.54\ cm} \qquad \frac{2.54\ cm}{1\ inch} \qquad \frac{1\ cm}{0.394\ inches} \qquad \frac{0.394\ inches}{1\ cm}$$

Now we're ready to set up our conversion. When you are converting a simple measurement, it helps to imagine it on the top of a fraction that has a bottom value of one. This keeps everything lined up!

Set-up 'A':

$$\frac{34\ inches}{1} \times \frac{2.54\ cm}{1\ inch} = \frac{\qquad cm}{1}$$

Enter '34' into your calculator

Multiply by '2.54'

What do you get?

Set-up 'B':

$$\frac{34\ inches}{1} \times \frac{1\ cm}{0.394\ inches} = \frac{cm}{1}$$

Enter '34' into your calculator | Divide by '0.394' | What do you get?

Notice how you get the same answer either way! As long as you follow the rules, your solution doesn't need to look like the person's next to you.

EXAMPLE TWO: CONVERTING 180 SECONDS TO MINUTES

Now YOU try setting one up! You need to know that there are 60 seconds per minute (but you probably already did…)

$$\frac{180\ seconds}{1} \times \frac{\qquad}{\qquad} = \frac{minutes}{1}$$

Enter '180' into your calculator | Swap it for minutes | What do you get?

EXAMPLE THREE: DOING A CONVERSION IN TWO STEPS!

If you want to, you can take more than one step to change a unit.

$$\frac{2\ kilometers}{1} \times \frac{\qquad}{\qquad} \times \frac{\qquad}{\qquad} = \frac{centimeters}{1}$$

Enter '2' into your calculator | Swap kilometers for meters. (1000 meters in 1 kilometer.) | Swap meters for centimeters. (100 centimeters are in 1 meter.) | What do you get?

Name: _____ Period: _____

'Swapping Units' - Practice

1) Convert 75 centimeters to meters. (1 m = _____ cm)

$$\frac{75\ cm}{1} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} = \frac{\_\_\_\_\_}{1}$$

2) Convert 2.5 kilograms to pounds. (1 kg = _____ lbs)

$$\frac{2.5\ kg}{1} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} = \frac{\_\_\_\_\_}{1}$$

3) Convert 2.5 pounds to kilograms. (1 lb = _____ kg)

$$\frac{2.5\ lb}{1} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} = \frac{\_\_\_\_\_}{1}$$

4) Convert 10,000 seconds to hours (2 steps).

$$\frac{10{,}000\ s}{1} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} = \frac{\_\_\_\_\_}{1}$$

5) Convert 12 kilometers to feet (2 steps). (1 km = _____ m) (1 m = _____ft)

$$\frac{12\ km}{1} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} \times \frac{\_\_\_\_\_}{\_\_\_\_\_} = \frac{\_\_\_\_\_}{1}$$

6) Convert 2 centuries to hours.

‘Swapping Units’ - Enrichment

‘Squared’ and ‘Cubed’ Units

The key to success is realizing that a ‘squared’ or ‘cubed’ unit is nothing more than the same unit multiplied by itself. For squared units, that means you’ve got double the units to cancel out with fractions. Note in the example below, that ‘centimeters squared’ is the same as ‘centimeters x centimeters’. If you cancel out ‘centimeters twice, you’re left with ‘meters x meters’ in your conversion, which is the same as ‘meters squared’!

EXAMPLE: Convert 10,000 square centimeters to square meters. (1 m = _____ cm)

$$\frac{10{,}000\ cm^2}{1} = \frac{10{,}000\ cm\ x\ cm}{1} \times \frac{m}{cm} \times \frac{m}{cm} = \frac{m^2}{1}$$

1) Convert 25 cubic meters to cubic feet. (1 m = _____ ft)

$$\frac{25\ m^3}{1} = \frac{25\ m\ x\ m\ x\ m}{1} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} = \frac{ft^3}{1}$$

‘Stacked’ Units

Some units have values on the top AND bottom of the fraction. No problem! Just adopt the ‘diagonal cancel’ technique to the new challenge. The unit still needs to cancel diagonally with units in another fraction that are on the opposite level, in this case ‘bottom’ to ‘top’. Whatever units are left on the top and bottom after all the cancelling is done shift over to the final fraction on the right.

Try converting the ‘top’ half of a stacked unit first. Then continue on and convert with the ‘bottom’ half.

Example: Convert 25 centimeters per second to inches per minute (1 in = _____ cm)

$$\frac{25\ cm}{s} \times \frac{in}{cm} \times \frac{s}{min} = \frac{in}{min}$$

2) Convert 650 grams per milliliter to kilograms per liter. (1 l = _____ ml)

$$\frac{650\ g}{ml} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} = \frac{kg}{l}$$

3) **SUPERCHALLENGE COMBO!** Convert 0.85 kilograms per cubic meter to grams per cubic centimeter.