Name: ______________________

**Cupcake Conversions, from Bench to Bakery**

**Background**
All consumer products start as a small batch to formulate ideal qualities but are scaled up to mass production for consumer purchase. In this process troubleshooting is essential to maintain quality and consistency of product.

You will take on the role of a successful baker who has an award winning recipe for cupcakes which is going to be scaled up to commercial baking. To achieve this end goal you will look at conversions from English units to Metric units and then standardize all units to grams regardless of ingredients. Finally you will look at issues on a microscale of production and see how they would affect macroscale baking of the product.

**Objectives**
- Convert measurements from English to the International Units of Measurement (Metric).
- Scale up measurements for a standard recipe to a larger quantity.
- Troubleshoot problems encountered with scaling up a product from bench to bakery (small to larger quantities).

**Activity 1**
1. Read the recipe for a vanilla cupcake below:

<table>
<thead>
<tr>
<th><strong>Vanilla Cupcakes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The following recipe yields 20-25 cupcakes.</td>
</tr>
</tbody>
</table>

**Ingredients:**
- 2 cups of flour
- ½ teaspoon of salt
- 2 teaspoons of baking powder
- ½ cup of unsalted butter, softened
- ¾ cup of sugar
- 2 eggs
- 1 cup of whole milk
- 1 teaspoon vanilla extract (optional)

**Directions for baking:**
- Preheat oven to 375°F; line muffin cups with papers.
- Beat and mix butter and sugar until it becomes a light and fluffy homogenous mixture. Beat in eggs one at a time.
- Mix baking powder, salt and flour.
- Add the flour mixture alternating with milk; beat well.
- Stir in the vanilla.
- Divide evenly among pans and bake for 18 minutes.
- Let cool in pans.
2. You live in a global society and you realize that this recipe should be out there for the rest of the world. Unfortunately, the rest of the world (except for the United States, Liberia and Myanmar) doesn’t use the English Standard of measurement. They all use the International System of Measurement, or the Metric scale. Please convert each of the measurements below from English Standard to Metric.

a. How many grams are in 2 cups of wheat flour if 1 cup is 120.00 grams? Remember to use dimensional analysis to solve this problem.

   Example:
   Starting unit x Conversion = Answer

   \[ \frac{2.00 \text{ Cups of Flour}}{1.00 \text{ Cup of Flour}} \times \frac{120.00 \text{ grams}}{1.00 \text{ Cup of Flour}} = 240. \text{ g} \]

   Note that the units are cancelled because anything divided by itself is the value of 1.00.

b. How many grams are in \( \frac{1}{2} \) teaspoon of salt if 5.00 grams of salt are in 1.00 teaspoon?

c. How many grams are in 2 teaspoons of baking powder if 4.60 grams of baking powder are in 1.00 teaspoon?

d. How many grams are in \( \frac{1}{2} \) cup of unsalted butter if there are 227.00 grams of butter in 1.00 cup?

e. How many grams of sugar are in \( \frac{3}{4} \) cup of sugar if there are 200.00 grams of sugar in 1.00 cup?

f. What is the mass of 2 eggs if the mass of an average egg is 2.00 ounces? There are 28.50 grams per ounce. You must first convert from the number of eggs to ounces and then the number of ounces to grams.
g. How many grams of milk are in 1 cup of milk if there are 473.176 mL of milk in 2.00 cups and the density of milk is 1.027 grams/mL? You must first convert the cups of milk to milliliters and then convert milliliters to grams using the density. Remember use dimensional analysis.

h. How many grams of vanilla extract are in 1 teaspoon vanilla extract if 1.00 teaspoon is 0.15 fluid ounces and 1.00 fluid ounce is 28.35 grams? You must first convert the teaspoon to fluid ounces and then the fluid ounces to grams. Remember to use dimensional analysis.

i. Convert the baking temperature of 375 °F to Celsius.
   a. Why Celsius? Watch the Temperature Guys video to understand the difference between the two scales.
   b. Use the following formula for the conversion:
      \[ T(°C) = (T(°F) - 32) \times \frac{5}{9} \]

j. Successful bakeries don’t just make one batch of anything. In order to be competitive this recipe must be scaled up. How much of each ingredient would be required to make 200 cupcakes? Fill in the table below with your scale up information.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount Calculated (g) for Single Batch or 24 Cupcakes</th>
<th>Amount Calculated (g) for 8.33 Batches or 200 Cupcakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour</td>
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<tr>
<td>Salt</td>
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<td>Baking Powder</td>
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<td>Unsalted Butter</td>
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<td>Sugar</td>
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<td>Eggs</td>
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<td>Milk</td>
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<tr>
<td>Vanilla Extract</td>
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</table>
Activity 2
Scaling up is not as simple as taking the basic ingredients and then multiplying by a factor to get the total quantity. So many variables can affect the outcome.

1. Using the graphic organizer below, brainstorm at least three issues that could arise when baking cupcakes (i.e. what could go wrong) at the micro-level (home/test kitchen).

<table>
<thead>
<tr>
<th>Heating</th>
<th>Ingredients</th>
<th>Mixing</th>
<th>Pan Selection</th>
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2. Using the graphic organizer below, brainstorm at least three issues that could arise when baking cupcakes (i.e. what could go wrong) at the macro-level (commercial bakery).

<table>
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<tr>
<th>Heating</th>
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3. Share your thoughts with at least one other person in class. Fill in ideas that you didn’t have in your graphic organizer.

4. Be prepared to share your ideas during the teacher lead discussion.
5. Answer the following questions:
   a. After listening to other students and watching the slide show summarize your findings in a concise set of directives to the bakery manager to:
      i. Ensure that the final product (the 200 cupcakes) maintains its quality and consistency.
      ii. Provide the final recipe, in grams, to the bakery manager.

   b. Putting yourself in the role of the bakery manager explain why you will still need to do testing to ensure quality control.