Solutions to the Extra Problems for Chapter 2

1. a. This is a homogeneous mixture. The soda water and juice are mixed together, and the composition will be the same throughout.

b. This is a heterogeneous mixture, since there are chunks of cookie dough. You can have one spoonful with several chunks (yum), but the next spoonful could have fewer chunks.

c. This is an element. When you can't break something down into simpler substances, it is an element.

d. This is a compound. Since it is a pure substance, it is made of only one chemical. Since the chemical is made of two elements, it is a compound.

e. This is an element. The text gave sulfur as an example of an element.

f. This is a homogeneous mixture. Tea is made by dissolving chemicals from tea leaves into water. That makes it a mixture, and tea is the same throughout.

g. This is a heterogeneous mixture. One bite of cookie might have several chocolate chips in it (yum), while the next might have fewer.

h. This is a compound, since it can be broken down into simpler substances.

2. She has some contamination, because the Law of Mass Conservation says the mass cannot change. The mass is 0.8 g. Since there is more mass now, something had to be added during the course of the experiment. Since she started with 17.0 g, she should only have 17.0 grams at the end. The excess (0.8 g) is the mass of the contaminants.

3. a. The answer is 236.3 g of copper and 263.7 g of chlorine. First, we need to find out the mass of leftover chlorine so we know the correct recipe.

$$\text{Initial mass} = 63.55\text{ g} + 100.00\text{ g} = 163.55\text{ g}$$

$$\text{Mass of leftover chlorine} = 163.55\text{ g} - 134.45\text{ g} = 29.10\text{ g}$$

$$\text{Actual mass of chlorine used: } 100.00\text{ g} - 29.10\text{ g} = 70.90\text{ g}$$

That means the actual recipe is 63.55 g + 70.90 g.

Now we just need to scale up:

$$\text{Factor} = \frac{500.0\ \cancel{\text{g}}}{134.45\ \cancel{\text{g}}} = 3.719$$

$$\text{Mass of copper} = 3.719 \times 63.55\text{ g} = 236.3\text{ g}$$

$$\text{Mass of chlorine} = 3.719 \times 70.90\text{ g} = 263.7\text{ g}$$

b. It is the same compound. To determine whether or not it is the same compound, we have to determine the proportions of the compounds. Thus, we need the ratio of copper to chlorine for the light blue powder. We can use either the original recipe or the scaled-up one. I will use the original:

$$\text{Ratio of copper to chlorine for the compound made in a: } \frac{63.55 \text{ g}}{70.90 \text{ g}} = 0.8963$$

Now we need the ratio for this new solid:

$$\text{Ratio of copper to chlorine in the new solid: : } \frac{100.00 \text{ g}}{111.57 \text{ g}} = 0.89630$$

This is the same ratio, so it is the same compound.

c. It is a different compound. We know the ratio of copper to chlorine for the compound made in a (0.8963). For the compound discussed here:

$$\text{Ratio of copper to chlorine in the new solid: } \frac{63.55 \text{ g}}{35.45 \text{ g}} = 1.793$$

This is a different ratio, so it is a different compound.

d. It must have one chlorine atom. For this we use the Law of Multiple Proportions. 63.55 grams is the same in both a and c. So, there is a fixed mass of copper. The ratio of chlorine masses that react to that fixed mass of copper is:

$$\text{Ratio of chlorine masses: } \frac{70.90 \text{ g}}{35.45 \text{ g}} = 2.000$$

There is twice as much chlorine in the compound made in a, so there are twice as many atoms. Since the problem told you that compound had two chlorine atoms, the compound in c must have one chlorine atom.

4. 70.11 grams of silicon must be reacted with 79.87 grams of oxygen. First, we need to find out the mass of leftover silicon so we know the correct recipe.

$$\text{Initial mass} = 30.00 \text{ g} + 32.00 \text{ g} = 62.00 \text{ g}$$

$$\text{Mass of leftover silicon} = 62.00 \text{ g} - 60.09 \text{ g} = 1.91 \text{ g}$$

$$\text{Actual mass of silicon used: } 30.00 \text{ g} - 1.91 \text{ g} = 28.09 \text{ g}$$

That means the actual recipe is 28.09 g + 32.00 g. Now we just need to scale up:

$$\text{Factor} = \frac{150.0 \text{ g}}{60.09 \text{ g}} = 2.496$$

$$\text{Mass of silicon} = 2.496 \times 28.09 \text{ g} = 70.11 \text{ g}$$

$$\text{Mass of oxygen} = 2.496 \times 32.00 \text{ g} = 79.87 \text{ g}$$

5. This compound has one oxygen atom. In #4, the mass of silicon used was 28.09 g. Thus, we have a fixed mass of silicon. The Law of Multiple Proportions says that the ratio of masses of oxygen to a fixed mass of silicon is the ratio of atoms in the molecule.

$$\text{Ratio of oxygen masses: } \frac{32.00 \cancel{\text{g}}}{16.00 \cancel{\text{g}}} = 2.000$$

If the compound that used 32.00 grams of oxygen has two oxygen atoms, that's twice as many as the oxygen atoms in this compound. Thus, this compound has one oxygen atom.

6. She should use 48.00 grams of oxygen. We know there aren't any leftovers in the first experiment, since the mass of the gas is equal to the mass of the two elements. Thus, the masses given are the actual ones used in the recipe. The mass of nitrogen is the same in both cases (14.01 g). The Law of Multiple Proportions tells us that the ratio of masses of the other element (oxygen) is the same as the ratio of atoms. If the first gas has one atom of oxygen, we need three times as many atoms to make the second gas, which means three times the mass.

7. Choices (a) and (b) are isotopes. Isotopes must be from the same element but have different numbers of neutrons. Thus, they must have the same number of protons. Choices (a) and (b) have the same number of protons but different numbers of neutrons. That makes them isotopes. Choices (c) and (d) have the same number of protons but also the same number of neutrons and electrons. They are identical atoms, not isotopes.

8. Choice (b) is the lightest. The fewer the number of neutrons, the lighter the atom.