**The Empirical Formula of Manganese Chloride Lab Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Background Information:** The Law of Definite Proportions, first proposed by Joseph Proust in 1799, states that a pure compound always consists of the same elements combined in the same proportion by mass. In this experiment, you are going to confirm this law by preparing a manganese-chlorine compound by dissolving manganese metal in hydrochloric acid. From the mass of each element that has reacted, you can calculate the number of atoms which have combined. From the ratio of the atoms combined, you can calculate the empirical, or simplest, formula.

**Materials:**

Crushed Manganese metal 15 x 150 mm test tube Goggles

Dropper bottle Test tube holder Aprons

12M hydrochloric acid Bunsen burner Parafilm

**Procedure Day 1:**

1. Label and take the mass of your test tube.
2. Measure out 0.15 to 0.20 grams of manganese metal put it into the test tube and then mass the test tube and its contents. ALL of you record the measurement in a data table in your data book or notes (ask instructor).
3. REMEMBER THE SAFETY RULES!!!! Go outside and add 20 drops of concentrated hydrochloric acid, 12M HCl, to the manganese metal. Be careful not to breath in any of the vapors that are being produced, they are caustic and can be quite an irritant.
4. If there are any small pieces of Mn metal remaining, you may have to add another single drop of HCl to complete the reaction. Repeat until all of the metal has reacted.
5. When the reaction has slowed considerably, bring the test tube back into the classroom and let it sit in a test tube rack in the fume hood for several minutes. *Wait until teacher instructs you, then add parafilm to the top of your test tube.*



**Procedure Day 2:**

1. Unwrap your test tube. Set up and light a Bunsen Burner. Slowly dry the product by
WARMING the solution in a flame. Be gentle and go slow.
2. When the solution has been reduced to a wet paste, the material may be heated directly
(it will be a pink color). Hold the test tube horizontally, and move the test tube over the very tip of the burner flame (the coolest part). Carefully heat the entire test tube to remove condensation that will form on the cooler top of the tube. Once the inside of the tube appears completely dry and no longer crackles, heat the product to drive out the last traces of water. **Take care that the product has a uniform color and texture**. If it begins to turn *brown or black****,*** you are overheating the compound, converting it into a
manganese oxide, and messing up your data.
3. As soon as the material appears completely dry, there is no steam leaving the mouth of
the test tube, and no condensation is present on the top of the test tube, allow the test
tube to cool until its temperature is room temperature. Mass the test tube and its contents and enter this in your data table.
4. Repeat the heating and cooling process until the mass of the test tube and its contents is constant (it has not changed by more than 0.01 gram between measurements).

**Data Table:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | **Products** | **Qualitative Observations** | **Quantitative Data** |
|  |  | Before | After | Mass of Test Tube \_\_\_\_\_\_\_\_\_Mass of Mn Metal \_\_\_\_\_\_\_\_\_Mass of Test Tube + Mn Metal 1. \_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_
6. \_\_\_\_\_\_\_\_\_\_\_\_\_
 |

**Calculations:** Show all of your work (units conversions!) keeping this neat, clear, and organized **on a separate piece of paper.**

1. What is the mass of the manganese that reacted with the chlorine?
2. Calculate the mass of the chlorine that reacted with the manganese metal.
3. Determine the number of moles of manganese that reacted.
4. Calculate the number of moles of chlorine that reacted.
5. Calculate the ratio of the number of moles of chlorine to the number of moles of manganese that are present in the manganese chloride product. This should be the lowest whole number ratio of moles.
6. Calculate the number of atoms of manganese and chlorine atoms.
7. Calculate the ratio of the number of atoms of manganese to the number of atoms of chlorine that are present in the manganese chloride product. This should be the lowest whole number ratio.
8. What is the empirical formula of this manganese chloride?
9. The periodic table lists at least five different potential charges for manganese (+1, +2, +3, +5, +7) . According to your results, what must be the charge of the manganese in your compound? Explain.

**Discussion -** Please discuss the following questions in your group and then **write down your answers in full sentences on a separate piece of paper.**

1. How did you create MnCl?
2. Describe how your group determined the type of MnCl you created?
3. What kind of error do you think may have affected your results?
4. What did your MnCl look like when it was created? How would that have affected your results?
5. Did you see the presence of MnO? How may have that affected your results?
6. How would the results have changed if the product was not dried enough?
7. Do you think adding more HCl to the Mn metal might have affected your results?
8. What procedural changes might you implement to reduce error?
9. How might knowing and determining the empirical formula for a compound help a scanner technician at the airport?

**Error Analysis-** Please discuss the following questions in your group and then **write down your answers in full sentences on a separate piece of paper.**

1. The true identity of the pink solid is manganese (II) chloride, MnCl2. How many moles of chlorine should have reacted with the manganese you used in your experiment?
2. How many grams of chlorine should have reacted with the manganese.
3. Calculate the percent error of your experiment using the following equation. Use the grams of chlorine that reacted (experimental amount) and the amount that should have reacted (predicted amount)

Percent error = (Experimental amount – Predicted amount) x 100

Predicted amount

1. Propose a reasonable source of your error. Explain how it could lead to the error you have observed.