Experiment 2: Percentage purity and the ideal gas law

Notes

The percentage purity of metal ores is an important quantity to know for economic viability in mining an ore body. It is often necessary to know the percentage purity of a refined metal. If the metals will react with acid, such as zinc and magnesium, we can use a simple experiment to collect the hydrogen produced in this reaction. The ideal gas law can then be used to determine the number of moles of hydrogen. The number of moles of hydrogen can then be used to determine the number of moles of metal, then its mass and finally its percentage purity.

In this experiment you will be using the ideal gas law to determine the percentage purity of a sample of magnesium.

Equipment

coil of copper wire (about 10 cm)

hydrochloric acid [HCℓ] 3 mol L^{-1} (15 mL)

gas measuring tube or burette (50 mL). If a burette is used in place of a gas measuring tube you will need to determine the volume between the 50 mL mark and the tap.

one-holed stopper to fit the gas measuring tube

magnesium ribbon, [Mg] (about 4 cm)

stand and clamp

graduated cylinder (250 mL)

thermometer (-10 to 110 °C)

barometer

beaker (500 mL)

rule

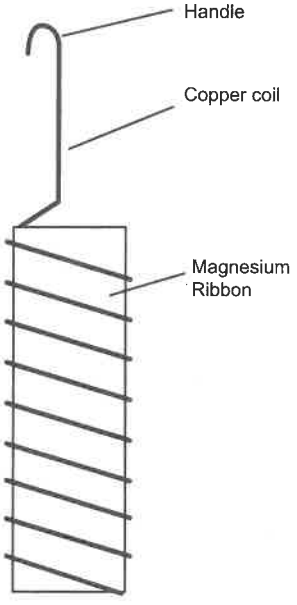

Figure 2.1

Procedure

1. Obtain some clean magnesium and carefully measure its length, recording the value to the nearest 0.05 cm. Your teacher will give you the mass of 50.00 cm of clean ribbon so that you can calculate the mass of your magnesium. If you have a balance that measures to 0.001 g, it is more accurate to measure the mass of the magnesium used.

2. Fold the magnesium ribbon and place it in the coil as shown in Figure 2.1.

3. Set up a retort stand and clamp to hold the gas measuring tube fitted with a one hole rubber stopper. Pour about 400 mL of tap water into a 500 mL beaker.

4. Pour 15 mL of 3 mol L^{-1} hydrochloric acid into the gas measuring tube. Carefully fill the tube with tap water from the beaker so that the acid layer remains at the bottom of the tube as shown in Figure 2.2.

5. Hold the copper coil by the handle and insert it into the tube. Place the hook in the handle over the edge of the gas measuring tube and fix it in position by inserting the one-hole rubber stopper as shown in Figure 2.2. The tube should contain no air bubbles and water should fill the hole in the stopper.

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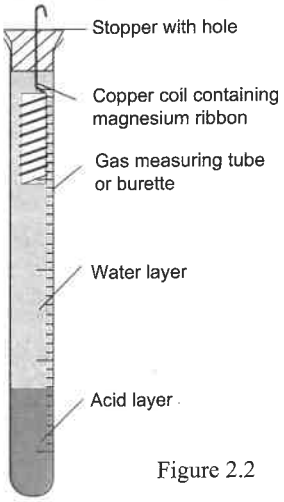

Figure 2.2

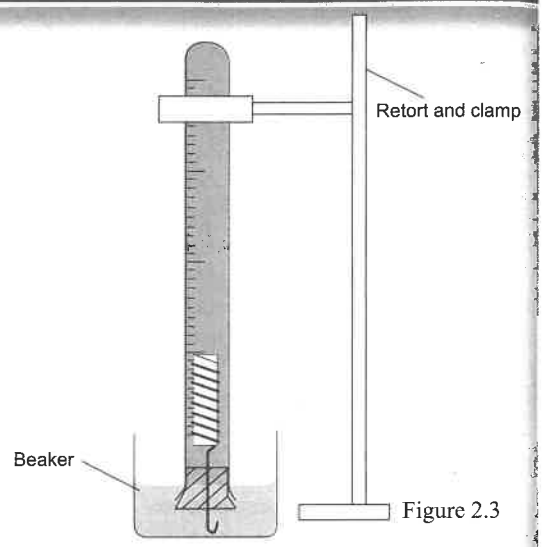

Figure 2.3

6. Cover the hole with a finger, invert the gas measuring tube and place it in the beaker as shown in Figure 2.3. Clamp the tube in place. The acid, being more dense than water, will move down through the water and start to react with the magnesium.

7. When the reaction is complete, as shown in Figure 2.4, allow a few minutes for the solution and hydrogen to come to room temperature. Tap the tube gently to dislodge any gas bubbles that are still attached to the coil or to the sides of the gas measuring tube.

8. Cover the hole in the stopper with your finger and transfer the gas measuring tube to a 250 mL graduated cylinder which must be almost filled with tap water as shown in Figure 2.5. Adjust the position of the tube until the level of the acid solution inside the tube is the same as that of the water in the cylinder. Read the volume of hydrogen gas, taking care to observe the calibration marks on the tube. Record the volume to the nearest 0.1 mL.

9. Record the temperature of the laboratory, and obtain the barometric pressure.

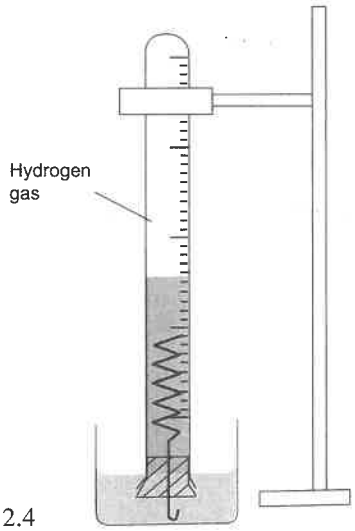

Figure 2.4

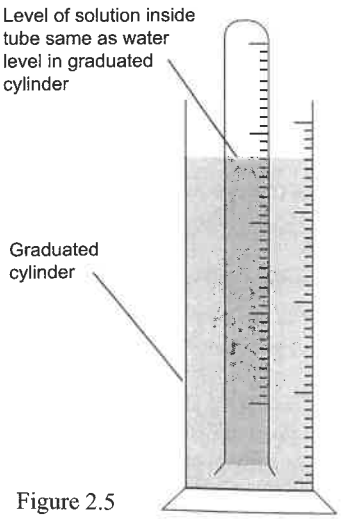

Figure 2.5