Lab: Determining Molar Volume

Purpose: To determine the molar volume (volume of 1 mole) of H_2 at STP.
Procedure: Read each step completely before following the directions within it.

1. Obtain a strip of Mg ribbon that is exactly 3.00 cm long.
2. Get the value for the per cm weight of Mg from your instructor. **(Record below as b)**
3. Obtain about 20 cm of Cu wire. Wrap the Mg ribbon with the Cu wire so that the Mg is securely encased in Cu. Leave about 5 cm of Cu wire to serve as a handle.
4. Obtain a 250 mL beaker, fill it ½ full with tap water. Put on safety goggles.
5. Get an empty 50 mL gas collecting tube. Bring it to your instructor so that 10 ml of 6 M hydrochloric acid can be placed in the tube. Use caution when handling this acid.
6. Tilt the tube slightly. *Slowly* poor tap water down the side of the tube until the tube is filled with water. Try to avoid stirring up the acid layer at the bottom of the tube.
7. Fill the 250 mL beaker about ½ full with tap water.
8. Steps 9 – 10 should be done in quick succession; read and understand these steps before you begin.
9. Holding the copper wire by the handle, insert the Mg about 4 cm down into the tube. Hook the Cu wire over the edge of the tube. Place a one-holed stopper firmly into the end of the tube to hold the wire in place.
10. Cover the hole(s) in the stopper with your finger and invert the end of the tube into the beaker of H_2O. Remove your finger. Carefully place the beaker with tube into a sink. The acid (being more dense than water) will sink and react with the Mg, producing H_2. As H_2 collects, water will be displaced from the tube and beaker.
11. After the reaction stops, run water into the beaker (about 1-2 minutes) to dilute any remaining acid. Ensure that no air bubbles from the running water get into the tube. Turn the water off. You can remove your safety goggles at this point. Wait an additional 2-3 minutes to allow the tube to come to room temperature. Gently tap the side of the tube to dislodge any bubbles clinging to the tube. **Record** volume of gas (f).
12. The following should be done under the surface of the water to avoid losing any liquid from the tube. Use tongs to remove the one-holed stopper. Remove wire. Firmly place a stopper without holes into the end of the tube.
13. Transfer the tube and contents to a large cylinder filled with H_2O at room temp. Using tongs, remove the stopper under the surface of the water. Raise or lower the tube until the water level inside and outside the tube is equal. This permits you to measure the volume at room pressure. **Record** volume (g). Give this value to your teacher.
14. Stopper the tube and remove it from the cylinder. Pour liquid from the tube down the sink. **Rinse all equipment 3 times** & return (to rinse the gas collecting tube use water from a beaker). Throw out Cu. Wipe off your bench.
15. Today's atmospheric pressure should be written on the blackboard. **Record** (i).
16. **Record** (j) the room temperature in °C (written on blackboard). Calculate the Kelvin temperature.

Hydrochloric acid reacts with Magnesium as follows: $Mg(s) + 2HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$

Observations and calculations: Bold underlines are for observations or values you need to record or look up. You will need to make calculations to complete the other spaces. ***Show your calculations on a separate sheet of paper***.

(a) Length of Mg used = **3.00** cm **(b)** Mass of Mg per cm = ________ g/cm (c) Mass of Mg used = _______ g

(d) Moles of Mg used = _________ mol (e) Moles of H_2 produced (see balanced equation above) = _______ mol

(f) Volume of gas before adjustment to room pressure = ________________ mL

(g) Volume of gas after adjustment to room pressure = _________________ mL **(h)** Class average =_________ mL

(i) Atmospheric pressure = ___________ kPa **(j)** Room (and water) temperature = ________ °C, _________ K

(k) Vapour pressure of H_2O = ______ kPa (l) Pressure of dry gas = (__) – (__) = ______kPa (place letters in brackets)

(m) Volume of dry gas at STP (V_2) = _______ mL hint: what are the values for V_1, P_1, T_1, V_2, P_2, T_2? Use (h) for V_1.

(n) Molar volume: if (e) __________ moles of H_2 has a volume of (m) ___________ mL, then 1 mole has a volume of ________ mL In other words the molar volume of H_2 at S.T.P is ____________ mL or ___________ L

(o) % error = |(molar volume - 22.4 L)| / 22.4 L x 100% = _______ % Note: | | means absolute value (no negatives).