KEY

Alka Seltzer and the Ideal Gas Law

Purpose – When Alka Seltzer reacts with water, CO_2 gas is produced. In this lab, you will collect the gas given off from this reaction Using the mass difference, you will determine the mass lost by the process, and thus the mass of CO_2 produced. You will use the ideal gas law to calculate the number of moles of gas produced, and from this, the molar mass of CO_2.

Materials: Erlenmeyer flask, Alka Seltzer tablets, mortar and pestle, 9-inch round balloon, scoop, thermometer, barometer, scissors
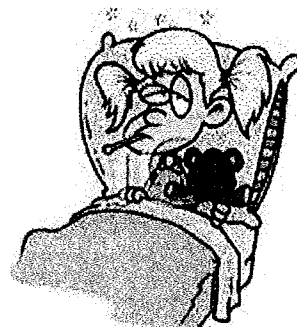
Procedure

1. Fill a flask to overflowing with tap water.

2. Obtain 3 Alka Seltzer tablets and crush.

3. Get a large, round balloon and remove the air from it.

4. Place the tablets in the balloon and attach carefully to the flask (balloon hangs to side).

5. Use electrical tape or duct tape to secure the balloon tightly to the flask.

6. Place the balloon upright to start the reaction.

7. As the reaction continues, hold the balloon and invert the tube several times to ensure completion.

8. After all bubbling stops, measure the circumference of the balloon with a string. If the balloon is misshapen, try to push it into the shape of a sphere while measuring the circumference.

9. Place the system on the electronic balance. Record this mass.

10. Grab the top of the balloon and flatten a small section. Make a small cut in the balloon and slowly release the gas. Record the new mass. Be sure that no water leaves the balance.

11. Record the room temperature and the barometric pressure below.

Data (Sample)

1. Circumference of balloon: 27.5 cm

2. Mass of system before releasing gas: 225.55 g

3. Mass of system after puncturing balloon: 224.97 g

4. Mass of gas (subtract 1 from 2 above): .58 g

5. Room temperature (in Kelvin): 296.9 K

6. Atmospheric Pressure (in mm Hg):

$$765.05$$

Calculations

1. The pressure inside the balloon is equal to atmospheric pressure, which includes both CO_2 and water vapor. Ask your teacher for the value for water vapor at this temperature and subtract this from atmospheric pressure. You now have the pressure of your gas. Convert this to atmospheres:

$$p H_2O = 22.4 \text{ mm Hg} \qquad \frac{765.05 - 22.4}{760} = .9774 \text{ atm}$$

2. Using the circumference of the balloon, calculate the volume of the gas produced.
   $\underline{Circumference} = radius)$ Volume of a sphere = $(4/3) \pi r^3$ Convert cm^3 to liters.
   2π

$$\frac{27.5 \text{ cm}}{2\pi} = 4.38 \text{ cm} \qquad 4/3 \pi (4.38 cm)^3 = 351.2 \text{ cm}^3$$

$$.351 \ell$$

3. You now have all the values needed to solve for "n" with the ideal gas law. The value for R is 0.0821 liter-atm/mol K. (PV = nRT) Solve for "n".

$$(.977_{atm})(.351\ell) = n (.0821 \frac{\ell \cdot atm}{mol \ K})(296.9 \ K)$$

$$n = .0140$$

4. The gas is in the balloon is CO_2. Using your value for n and the mass of the gas you generated, what is your value for the molar mass of CO_2? (n = your mass/molar mass) Remember, molar mass is the unknown in this equation!

$$.0140 \ moles = \frac{.58 \ g}{x}$$

$$x = 41.4 \ \frac{g}{mol}$$

Questions

1. Find the actual molar mass of CO_2 using the periodic table.

$$44 \text{ g/mol}$$

2. What is your percent error for your value of the molar mass of CO_2 ?

$$\frac{\text{your value} - \text{periodic table value}}{\text{periodic table value}} \quad X \quad 100 =$$

$$\frac{41.4 - 44}{44} \times 100 = 5.8 \%$$

3. What do you think is the biggest source of error in this lab?

Possibilities

→ Volume measurement, misshapen balloons

→ Loss of water when deflating balloon

→ Reaction not complete

4. Look at your answer to #3 above. Would this error make your value come out too high or too low? Explain.

→ Volume could go either way

→ Loss of water makes CO_2 mass too high, which makes molar mass too high

→ As long as you take all correct measurements, you should still get correct value for the volume of gas collected.

5. CO_2 is quite soluble in water. Would this fact make your value for molar mass too low or too high?

Mass and volume would both be less so calculations should still work for CO_2 collected.

6. If the balloon full of gas that you produced were brought out into a cold day (-20 °C) and put under 3.5 atm of pressure, what would the new volume be?

$$P_1 = .977 \text{ atm}$$

$$V_1 = .351 \text{ l}$$

$$T_1 = 296.9 \text{ K}$$

$$P_2 = 3.5 \text{ atm}$$

$$V_2 = ?$$

$$T_2 = -20 + 273 = 253 \text{ K}$$

$$\frac{(.977 \text{ atm})(.357 \text{ l})}{294.9 \text{ K}} = \frac{(3.5 \text{ atm})(V_2)}{253 \text{ K}}$$

$$V_2 = .083 \text{ l}$$