Topic B.3 – Modelling a gas

Learning objectives:

- I can:
  - Explain the relationship between pressure, volume, temperature, and the number of moles of a substance.
  - Determine changes to a system based on my observations
  - Describe sources of random and systematic error

Apparatus and materials

- 250 ml round-bottomed flask with intubated bung
- 500 ml beaker
- Hot plates
- Thermometer
- Balance

$$pV = nRT$$

Health and Safety

- The hot plate may be hot enough to cause burns.
- Care should be taken not to heat the water beyond ~50°C.
- Eye protection and lab coats are not necessary for this experiment.

Procedure

1. In a lab sink, completely fill a 500ml beaker with water.
2. Turn the round-bottomed flask upside down and run water over it. Make sure that the flask is plugged tightly (don't push too hard, Hulk-strength is not useful here).
3. Carefully place a thermometer and the round-bottomed flask upside down in the beaker of water. No gas should escape the flask.
4. Tip a small amount of water out of the 500 ml beaker and place it onto the hot plate.
5. Turn the hot plate to the maximum heat setting (10), and heat the water until it reaches approximately 50°C.
6. Turn off the hot plate and let the system rest for a few moments. Record the final temperature.
7. Carefully remove the 500 ml beaker and place it back into the sink, taking care not to touch the hot surface of the heating plate.
8. Without removing the flask from the beaker, run cold water over the flask and into the beaker until the system has returned to the initial temperature.

Fill in this table:

temperature of water (°C)	mass of full flask (g)	mass of empty flask (g)	difference in mass (g)	volume of gas in empty beaker (cm^3)	temperature of water (°C)	mass of flask and water (g)	volume of gas in beaker (cm^3)

Questions and observations

Heating the system up will take some time. While it is heating, please consider the following questions, and be sure to record your observations. Keep them simple!

1. As you are heating the system, what variables are kept constant? Think about the equation for the universal gas law.
2. We are measuring the temperature of the water, but we are mostly interested in the temperature of the gas. Is our temperature measurement accurate? Why or why not?
3. What are some sources of systematic and random error in the system? Try to come up with at least 2 or 3.
4. After our system has cooled down again, what variables have changed from the initial conditions before we started heating? Again, you will want to think about this in terms of the universal gas law.
5. Is it possible to measure the variables that have changed using the apparatus provided?
6. At atmospheric pressure and room temperature, one mole of air occupies 22.7 L. Your round-bottomed flask has a volume of about 275 cm3.
    a. Based on your initial temperature measurement, how many moles of air were contained in your flask when you started?
    b. How many moles of air remain in your flask after cooling?