Course and Section_____ Names _____

Date_____ _____

IDEAL GAS LAW

Introduction

This experiment explores the relation between pressure *P*, volume *V* and temperature *T* of a gas. You will measure the pressure and relative volume of a gas confined in a plastic syringe in order to find the numbers of mole contained.

Equipment

Wireless pressure sensor + ubs cable. Syringe. One thermometer.

Theory

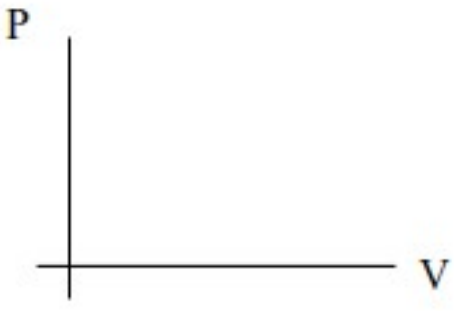
Many real gases behave like an ideal gas under various conditions (for example high temperature or low pressure). An ideal gas is a gas which obeys the equation

$$PV = nRT$$

With units *P* (Pa), *V* (m^3), *T* (K), *n* is the number of moles and *R* = 8.3145 J/mole·K is the gas constant.
The gas of this experiment is the atmosphere of the Earth, commonly referred as the 'air' which is a mixture of nitrogen (about 78%), oxygen (about 21%), argon (about 0.9%), carbon dioxide (about 0.04%) and other gases in trace amounts. We assume the air to be an ideal gas.

Preliminary Questions

1. For a fixed temperature, draw below how the plot *P vs V* should look.



2. One mole of a gas at temperature T = 45 ^{0}C and gauge pressure 3 atm is present inside a plastic container of volume V = 0.8 liters. A valve present on the container is open and some gas leaks out. If the temperature of the gas drops to T = 34 ^{0}C and the gauge pressure to 2.3 atm, find the number of mole *n'* of the gas remaining inside the container. Assume that the volume does not change. Show your calculations.

n' = ____

Procedure

Step 1. Open the data studio file "**P-V.cap**" located in the T:\Capstone folder. The Capstone software will display a table to input pressure and volume and a graph of *P* vs *V*.

Step 2. Click on 'Hardware Setup' to check the pressure sensor is connected. Click again in 'Hardware Setup' to return to display the table.

Step 3. Connect the plastic syringe, without the plunger in it, to the pressure sensor. Do not input any volume in the table. Click on the red circle 'Preview' located at the bottom left of the screen. A reading of the current atmospheric pressure is given.

3. What is the reading of the pressure? P = _____ kPa

The reading should correspond to about 100 kPa (1 atm = 101.325 kPa). If not check with the TA for technical issue. Then press 'Stop'

Step 4. Insert the plunger into the syringe and compress to a volume of 60 ml. Input the volume of 60 + 5.6 ml into the first column. The reason of the +5.6 ml is to account for the volume of the plastic tube connecting the syringe to the the pressure sensor. You will have to always add this +5.6 ml in your data for the volume.
Click on 'Keep Sample' to record the pressure in the second column.

Step 5. Repeat. Decrease the volume and record the pressure for about 10 data entries. You should be able to reach the volume of 30 ml. Use the following table to collect your data.
Do not remove the plunger from the syringe, you are not done yet with this experiment.

Analysis

4. Use this table to input volume (reading on the syringe + 5.6 ml) and pressure.

Volume (mL)	Volume (m^3)	P (Pa)	PV (Pa· m^3)	Number of Moles n

5. The software generates automatically a *P* vs *V* graph on the right of the table. Do your data agree with the graph in your prediction?

6. What is the current room temperature? The TA provides this information.

T = _____ ºC

7. Fit your data to an inverse function (no offset) and record the value of the constant *A*

A = _____ (kPA· mL) A = _____ (Pa· m^3)

8. The proportionality constant *A* is equal to *nRT*. Calculate the number of moles from the numerical value of *A, R* and *T*.

n_{Fit} = _____

9. Calculate the number of moles for each volume and use the last column to input the results. Are the values for the number of moles constant, increasing or decreasing?

10. Why do you think this happens?

11. Which number of moles do you think is the most accurate?

n_{Best} = _____

12. Pull the plunger back to the initial volume of 60 mL and record the pressure

P =____kPa.

13. Compare this value of the pressure with the previous value of the pressure taken at 60 mL and explain the difference.

14. The expected value of the number moles for the air can be calculated from the standard information that one mole at ambient temperature $T = 25\ ^0$C and pressure = 1atm occupies a volume of 24.5 liters. Calculate the expected value of *n* by comparing your values of *T* and *V* at *P* = 1atm with the the standard information. Show your calculations. (This problem is similar to question 2)

$n_{Expected}$ = ____

15. What is the percentage error between $n_{Expected}$ and n_{Fit} ?

16. What is the percentage error between $n_{Expected}$ and n_{Best} ?

17. List down the possible sources of error in this experiment.

18. How can the errors be minimized?

19. Consider the plot P *vs* V^{α}. If you wanted to get a straight-line graph in this experiment as we usually do, which value of α will allow for this?

α = _____