Name: ______________________________ **Date** __________ **Section** _________

Lab Partner: _____ONLINE_______________

Experimental Observations

Part 1:

T = _____21.2_____ °C   P = ___740.3______ torr   V = ____0.500___L

T = _____________ K   P = ____________ atm

Molar Mass of Butane (C_4H_{10}) = ___________________ g/mole

Initial weight of cartridge;   ____67.485__________ g

final weight of cartridge: _____66.352__________ g

mass of butane: ____________ g ; n = _____________ moles

Simplistic Calculations:

1. apparent molar volume ($V_m = V/n$) of butane at experimental T & P: V_m = ______ L/mole

2. apparent molar volume of butane at- STP: V_m = _______ L/mole

Rigorous Calculations:

3. Partial Pressure of water vapor in flask*: P_w = _______ torr

4. Partial Pressure of butane in flask: $P_B = P_{total} - P_w$ = _______ torr

   = _______ atm

5. Partial Pressure of butane (calc with vdW equation**): P_{vdw} = ________ atm

6. Compressibility Factor for Butane: $Z_B = P_BV/n_BRT$ = _________

7. Estimated Second Virial Coefficient for Butane at room temperature:

$Z_B = 1 + B_Bn_B/V$; B_B = ________ L/mole.

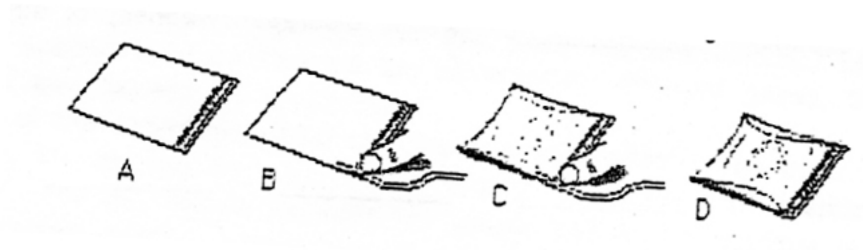
*Equilibrium Vapor Pressure of Water: ln Pw(torr) = 20.943 - 5300/T (20 - 30"C).

** $P_{vdw} = nRT/(V - nb) - an^2/V^2$; R = 0.08206 L-atm/mol-K; a = 14.47 atm-L^2/mole^2 , b =0.1226 L/mole

Part 2. Buoyancy Effects:

(Note: This part of the experiment requires about 1 gram of butane.)

Record the initial weights of the deflated zip-lock bag (A, below) and the butane cartridge. In the fume hood, zip the bag as snugly as possible around the Tygon tubing (B). Connect the butane cartridge and inflate the bag to at least half, but no more than 80% of its capacity (C). Quickly remove the tubing and seal the bag (D). Record the final weights of the bag and the cartridge.



Initial:	cartridge ___66.352___g	Bag ___4.903____g	
Final:	___63.572___g	___6.192____g	
Change:	___________g	___________g	
Discrepancy:	___________g	(buoyancy effect of displaced volume of air)	

moles of butane in bag: n = ___________ moles (from mass loss of cartridge)

calculated vol. of butane in bag (use second virial coefficient) ___________ L

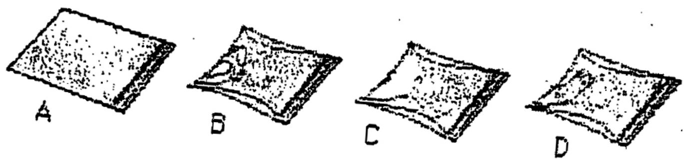
estimated density of air at experimental T and P: d = __________g/L
(buoyancy effect/volume)

estimated molar mass of air: M = dRT/P = ____________ g/mole

Empty the Ziploc bag under the fume hood.

Part 3. Conservation of Mass:

Weigh the ziploc bag (A, below). Determine if the weight is affected by whether or not the bag is inflated with air <u>(fill with air NOT your breath).</u> Tare the bag, add **2.5 - 2.8 grams** of sodium bicarbonate ($NaHCO_3$) to the bag (B), and record the mass. Seal **8 - 10 ml** of 50% acetic acid in snap-cap 10- ml vial. Put the vial in the bag, add about 10 ml of distilled water to dissolve the sodium bicarbonate (D), expel as much air *as* possible, seal, and record the mass of the bag



with its contents. Without unsealing the bag, open the vial and mix the acetic acid with the bicarbonate solution. Place the bag on the balance and observe the change in weight. After the effervescence has essentially ceased, record the weight of the bag and its contents.

Calculate the volume of gas expected from the reaction of sodium bicarbonate with excess acid.

mass of $NaHCO_3$ ___2.685____g

molar mass of $NaHCO_3$ _______________g/mole

moles of $NaHCO_3$ _______________moles.

Weight of bag and reaction components:

before reaction: ___38.566_____g

after reaction: ___37.352_____g

discrepancy: ______________g

Using the density of air determined in Part 2, estimate the volume of gas produced by the reaction.

Estimated volume of expansion: _____________ L (weight discrepancy/density of air)

<u>**Reaction:**</u>

$NaHCO_3(aq) + CH_3CO_2H(aq)$ -> _______________ + _____________ + __________________

Calculate the volume of gas expected from the reaction of sodium bicarbonate with excess acid.

Expected moles of $CO_2(g)$: ____________ moles

Expected volume of gas at laboratory T & P: ____________ L

$$\Delta V_{GAS} = (nCO_2RT/P_{ATM}) / [1 - (P_W/P_{ATM})]$$