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CHM. 121.004
Inst. Mark Novak
Lab Report – Experiment 12
12/5/17

Experiment Objective

The objective of this experiment was to determine the molar mass of a substance using the density of a vapor. The first two trials will be done using cyclohexane. The next two trials will be done using an unknown. This unknown will be determined by the data we collect through our testing.

Conclusion

There were a lot factors that could of went wrong. The most difficult part of the lab was trying to see the liquid at the bottom of the beaker when it was submerged into the boiling distilled water. In our first trial with cyclohexane, the tinfoil that kept the vapor in the flask came off which means a lot of that trapped vaper, that was originally going to condense, was released to the air and lost. This could be one of the biggest reasons our calculated mass of gas that was in the flask was so low. In the second trial with cyclohexane, we made sure that the tinfoil did not come off, this allowed us to get much closer to the correct molar mass of cyclohexane. We actually calculated a higher molar mass that what cyclohexane actually is; a reason for this could be that we needed to keep the flask submerged into the boiling water for a slightly longer amount of time. For the first unknow trial, the liquid at the bottom of the flask evaporated very fast, within a few minutes. Because of this, we calculated a low mass of gas that was contained in the flask. The calculated molar mass for this first trial was 32.6 g/mol. This matched up almost perfectly with methanol, leading us to believe that this is what we had. The second trial was a lot of the

same, we left the liquid to evaporate for too long and calculated a molar mass of 44.05 g/mol; this matched up with ethanol. My lab partner and I were still not convinced that we had either one of those two. We ended up wafting the smell of our unknown and, by simply smelling the unknown, we concluded that our unknown was actually acetone. After confirming this with our instructor; we are positive that unknown #41 is acetone even though the data that we collected does not prove that.

Name _____

Advance Study Assignment

1) 0.5844 grams of a gas occupied 260.7 mL at 99.7°C, when the barometer read 741.8 mm Hg. If the simplest formula is CH_2, what is its molecular formula?

mass = .5844g

V = 260.7 mL = .2607 L

99.7 °C = 372.85°K

$P = 741.8 \text{ mmHg} \cdot \frac{1 \text{ atm}}{760 \text{ mmHg}} = .976 \text{ atm}$

$PV = \left(\frac{\text{mass}}{mw}\right) RT \rightarrow (.976)(.2607) mw = (.5844)(.0821)(372.85)$

$mw = 70.30 \text{ g/mol}$

$\frac{70.3 \text{ g/mol}}{14} = 5$ $\boxed{C_5H_{10}}$ ✓

2) Solve for T from the ideal gas law, when n is replaced with grams/molar mass.

$PV = nRT$

$\frac{PV}{nR} = T$

$\boxed{T = \frac{PV}{\left(\frac{m}{m}\right)R}}$ ✓

CHM121 E12:
Molar Mass by Vapor Density

Name: George Pappas

DATA AND CALCULATION TABLE

USING CYCLOHEXANE

		Trial 1	Trial 2
1)	Temperature of boiling water (°C)	99.9	100.1
2)	Temperature of boiling water (K) [(#1) + 273.2]	373.1	373.3
3)	Barometric pressure (cm Hg) Read from meter	74.75	74.75
4)	Barometric pressure (mm Hg)	747.5	747.5
5)	Barometric pressure (atm) [(#4) / 760.0]	.984	.984
6)	Mass of flask, foil, and contents (g)	124.827	125.152
7)	Initial mass of empty flask and foil (g)	124.345	124.345
8)	Mass of gas in flask (g) [(#6) – (#7)]	.482	.807
9)	Flask volume (mL)	268 =	268
10)	Flask volume (L) [(#9) * 10^{-3}]	.286	.286
11)	Molar mass = gRT/PV = $\frac{(\#8) \times (8.206 \times 10^{-2}) \times (\#2)}{(\#5) \times (\#10)}$	52.43	87.84

1
low
-2

Name:_____

DATA AND CALCULATION TABLE

USING UNKNOWN

	Unknown Number	41		
		Trial 1	Trial 2	~~Trial 3~~
11)	Temperature of boiling water (°C)	99.9	99.5	
12)	Temperature of boiling water (K) [(#11) + 273.2]	373.1	372.7	
13)	Barometric pressure (cm Hg) Read from meter	74.75	74.75	
14)	Barometric pressure (mm Hg)	747.5	747.5	
15)	Barometric pressure (atm) [(#14) / 760.0]	.984	.984	
16)	Mass of flask, foil, and contents (g)	92.540	92.638	
17)	Initial mass of empty flask and foil (g)	92.261	92.261	
18)	Mass of gas in flask (g) [(#16) – (#17)]	.279	.377	
19)	Flask volume (mL)	266	= 266 =	
20)	Flask volume (L) [(#19) * 10^{-3}]	.266	.266	
21)	Molar mass = gRT/PV = $\frac{(\#18) \times (8.206 \times 10^{-2}) \times (\#12)}{(\#15) \times (\#20)}$	32.6	44.05	

Acetone

Name:_____

CALCULATIONS SUMMARY AND QUESTIONS

	Molar mass Results	
21)	Cyclohexane Trial 1 (g/mol)	52.43
22)	Cyclohexane Trial 2 (g/mol)	87.84
23)	Average Cyclohexane (g/mol) [(#21) + (#22)] / 2	70.135
24)	Average cyclohexane deviation (g/mol) [the absolute value of (#23) – (84.16 g/mol)]	14.025
25)	Unknown molar mass Trial 1 (g/mol)	32.6
26)	Unknown molar mass Trial 2 (g/mol)	44.05
27)	Unknown molar mass Trial 3 (g/mol)	
28)	Average Unknown molar mass (g/mol) [(#25) + (#26) + (#27)] / 3	38.325 – low (-5)

Unknown Number	41
Unknown Identity	Acetone

Answer the two questions on the back of this page.

Name:_____

1) Show how the value of the gas constant R in the ideal gas law equation can be determined by the vapor density method with a gas of known molar mass. [Hint: set n= g/mm and then solve for R.]

$$PV = \frac{(\text{grams})RT}{(\text{molar mass})}$$

$$(\text{molar mass})PV = (\text{grams})RT$$

$$R = \frac{(\text{molar mass})PV}{(\text{grams})\cdot T}$$

2) A compound has the empirical formula of CH_2. 250.0 mL of it vapor at STP weigh 0.960 g. What is its molecular formula?

22.4 L

$$.250\ L \div 22.4\ L/m = .01116\ \text{moles}$$

$$.960\ g \div .01116\ m = 86.4\ g/mol$$

CH_2

$12 + (1 \cdot 2) = 14$

$$86.4\ g/mol \div 14 = 6$$

$$\boxed{C_6H_{12}}$$