Chemistry 10: Gas Laws

May 4- May 8

Time Allotment: 40 minutes per day

Student Name: ________________________________

Teacher Name: ________________________________

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

____

I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

____

Packet Overview

Date	Objective(s)	Page Number
Monday, May 4	*Relating density to the known variables of gases*	3
Tuesday, May 5	*More practice – putting it together*	8
Wednesday, May 6	*"Partial" pressure (when you have a mixture of gases)*	10
Thursday, May 7	*Kinetic-molecular theory*	12
Friday, May 8	*"Real" vs. "ideal" gases. More practice problems.*	14

Additional Notes:

Hi all,

This week you'll be doing more work with gases. I want you to get very good at converting between units, using equations, and solving problems, so this week you'll be working a number of practice problems, as well as learning and thinking more about how molecules behave when they're floating around in the gas phase.

Please feel free to email any time you have a question, and attack this packet with diligence, approaching tough problems in more than one way. If you feel that you come up against a wall, try another way! Use lots of scratch paper.

Missing you,

Mr. Luke

Monday, May 4

Chemistry Unit: Gas Laws
Lesson 1: Relating density to the known variables of gases

Unit Overview

A Question for Lesson 1: What does the mass of a gas' molecules have to do with its pressure, temperature, and volume?

Objective

Be able to answer all questions below.

Introduction to Lesson 1

Read and take notes on Section 10.5 in your textbook (pages 413 to 416). Scan through the sample exercises.

1. How do you find density from the PV = *n*RT equation? Write the equation for *d* below.

2. Without changing anything in a canister filled with gas except the type of gas inside, how would the pressure change if you filled the canister with a denser gas?

3. Without changing anything in a balloon filled with gas except the type of gas inside, how would the volume change if you filled the balloon with a denser gas?

4. What would the units of density be if the units of P, V, *n*, R, and T were kPa, Liters, moles, (kPa-Liters/moles-K), and Kelvins, respectively?

Complete the practice problems below.

Conversions:

1. Convert 0.875 atm to mmHg

2. Convert 745.0 mmHg to atm.

3. Convert 0.955 atm to kPa.

4. Convert 98.35 kPa to atm.

5. Convert 740.0 mmHg to kPa.

6. Convert 99.25 kPa to mmHg.

7. Convert 1.69 atm to torr

8. Convert 0.3587 atm to Pa

9. Convert 820.1 torr to kPa

10. Convert 689 mmHg to Pa

11. Convert 660.37 °C to Kelvins

12. Convert 302.93 Kelvins to °C

13. Convert 27 °C to K

Check your answers on page 4 of this packet.

Show all work below:

10.41 In an experiment reported by scientists in a recent journal entry, male cockroaches were made to run at different speeds on a miniature treadmill while their oxygen consumption was measured. In one hour the average cockroach, weighing 1.0 grams, running at 0.08 km/hour consumed 0.8 mL of O_2 at 1atm of pressure and 24 °C.

a. If a cockroach weighing 5.2 grams ran for an hour at this speed, how many moles of O_2 would it consume?

b. Another cockroach weighing 5.2 grams was trapped in a jar with a volume of 946.35 mL. It ran for 48 hours. How many moles of oxygen did it consume?

a. If air is composed of 20% oxygen, did the cockroach use up all the oxygen in the jar?

10.45 (see on page 435; write answer here)

10.46 (see on page 435; write answer here)

10.47 a. Calculate the density of NO_2 gas at 0.970 atm and 35 ^oC.

b. Calculate the molar mass of a gas (not NO_2) if 2.50 g occupies 0.875 L of space at 685 torr when the temperature is 35 ^oC.

Conversions Solutions (for review only)

I. Converting between atmospheres and millimeters of mercury.

One atm. equals 760.0 mm Hg, so there will be a multiplication or division based on the direction of the change.

Example #1: Convert 0.875 atm to mmHg.

Solution: multiply the atm value by 760.0 mmHg / atm.

$$0.875 \text{ atm} \times \frac{760.0 \text{ mmHg}}{1 \text{ atm}}$$

Notice that the atm values (one in the numerator and one in the denominator) cancel, leaving mmHg.

Example #2: Convert 745.0 mmHg to atm.

Solution: divide the mmHg value by 760.0 mmHg / atm

$$\frac{745.0 \text{ mmHg}}{760.0 \text{ mmHg / atm}} = 0.980 \text{ atm}$$

Notice that the mmHg values cancel and the atm, in the denominator of the denominator, moves to the numerator. Note also that the answer of 0.980 atm has been rounded off to three significant figures.

II. Converting between atmospheres and kilopascals.

One atm equals 101.325 kPa, so there will be a multiplication or division based on the direction of the change.

Example #3: Convert 0.955 atm to kPa.

Solution: multiply the atm value by 101.325 kPa / atm.

$$0.955 \text{ atm} \times \frac{101.325 \text{ kPa}}{1 \text{ atm}} = 96.8 \text{ atm (to three sig figs)}$$

Notice that the atm values(one in the numerator and one in the denominator) cancel, leaving kPa. Sometimes the 1 in front of atm is eliminated. In that case, think of the 1 as being understood to be there.

Example #4: Convert 98.35 kPa to atm.

Solution: divide the kPa value by 101.325 kPa / atm.

$$\frac{98.35 \text{ kPa}}{101.325 \text{ kPa / atm}} = 0.9706 \text{ atm}$$

Notice that the kPa values cancel and the atm, in the denominator of the denominator, moves to the numerator. The answer is rounded to four significant figures.

III. Converting between millimeters of mercury and kilopascals.

760.0 mmHg equals 101.325 kPa, so both values will be involved. This situation is slighly unusual because most conversions involve a one, usually in the denominator. The conversion examples above are examples of a one being involved. For example, 760.0 mmHg / 1 atm in examples 1 and 2. The 1 was assumed to be present.

By the way, the 1 (as in 1 atm) has no influence on significant figures.

In this conversion, both 760.0 and 101.325 will be involved and the location of each (numerator or denominator) will depend on the conversion.

Example #5: Convert 740.0 mmHg to kPa.

$$740.0 \text{ mmHg} \times \frac{101.325 \text{ kPa}}{760.0 \text{ mmHg}} = 98.66 \text{ atm (to four sig figs)}$$

Notice that the mmHg will cancel, since one is in the numerator and one is in the denominator, leaving kPa as the unit on the answer.

Example #6: Convert 99.25 kPa to mmHg.

$$99.25 \text{ kPa} \times \frac{760.0 \text{ mmHg}}{101.325 \text{ kPa}} = 744.4 \text{ mmHg (to four sig figs)}$$

Notice that the kPa will cancel, since one is in the numerator and one is in the denominator, leaving mmHg as the unit on the answer.

Example #7: Convert 1.69 atm to torr

$$1.69 \text{ atm} \times \frac{760.0 \text{ torr}}{1 \text{ atm}} = 1280 \text{ torr (to three sig figs)}$$

torr is the same as mmHg. It was intended as a replacement for mmHg, however, mmHg did not fade away. You need to know what torr is. By the way, it is a lowercase t, not a capital, as in Torr.

If your instructor insists in using Torr, just follow his/her practice. Don't tell 'em some guy on the Internet (me!) said they were wrong.

Example #8: Convert 0.3587 atm to Pa

$$0.3587 \text{ atm} \times \frac{101{,}325 \text{ Pa}}{1 \text{ atm}} = 36340 \text{ Pa (to four sig figs)}$$

<--- note the comma, not decimal point

kPa (kilopascals) is the more commonly used unit, but Pa is used from time to time. 101.325 kPa = 101,325 Pa.

Example #9: Convert 820.1 torr to kPa

$$820.1 \text{ torr} \times \frac{101.325 \text{ kPa}}{760.0 \text{ torr}} = 109.3 \text{ kPa (to four sig figs)}$$

Example #10: Convert 689 mmHg to Pa

$$689 \text{ mmHg} \times \frac{101{,}325 \text{ Pa}}{760.0 \text{ mmHg}} = 91800 \text{ Pa (to three sig figs)}$$

Temperature conversions (answers)

11. 933.52 K
12. 29.78 C
13. 300 K

Please, reach out if you struggled on any problem today!

<u>Tuesday, May 5</u>

Chemistry Unit: Gas Laws
Lesson 2: More practice – putting it together

Unit Overview

Objective:

Be able to answer all questions below.

Introduction to Lesson 2

Practice problems:

For all textbook problems in this packet, once you have finished go ahead and check your answers as you go along or after you've finished the day's work. Solutions can be found under Week 7 on the Google Classroom site. If you don't have access to Google Classroom, you'll receive a copy of the solutions at the email address I found on file. Please email me if you didn't receive the solutions.

For most of the problems below, you will use the PV=*n*RT equation (look up the value and units of *R* if you have to) and the information given in the question in order to solve for P, V, *n*, or T.

10.32 For an ideal gas, calculate:

For gas A, calculate the amount of space it takes up (in Liters) if there is 1.75 moles of it, the pressure in the chamber is 0.985 atm, and the temperature is -6 ºC.

Don't forget, you must convert ºC to Kelvins and make sure your units match the units of *R* before you solve!

For gas B, calculate **the temperature**, in Kelvins, of the gas when 3.33×10^{-3} moles of the gas occupies 255mL of space in a chamber, producing a pressure of 720 torr.

For gas C, calculate **the pressure**, in atmospheres, that it produces inside a chamber that has a volume of 413 mL when 0.0467 moles of the gas is present. The temperature is 122 ºC.

For gas D, calculate **the quantity** of gas (in moles) if 67.5 L at 54 ºC has a pressure of 11.25 kPa.

10.33 The *Hindenburg*, a hydrogen-filled dirigible that exploded in 1937, was filled with 2.0×10^5 m^3 of hydrogen gas at 23 ºC at 1 atmosphere of pressure. How much hydrogen, in grams, did the *Hindenburg* contain?

Molar mass of hydrogen gas (H_2): __________

Calculate the number of moles (*n*) of H_2 given the information above and the PV=*n*RT equation:

Convert moles of H_2 to grams using the molar mass above:

10.43 Which gas is most dense at 1.00 atm and 298 K? Explain.

Gases: a) CO_2, b) N_2O, and c) Cl_2

10.48 What is the density, in grams per Liter, of sulfur hexafluoride gas, if there is enough of it to produce a pressure of 678 torr in a chamber at 28 ^{o}C?

b. (For another gas) Calculate the molar mass of an uknown vapor, if you know that it has a density of 7.135 g/L at a temperature of 12 ^{o}C and a pressure of 743 torr.

Nice work today! Please, again, email if you are having trouble.

Wednesday, May 6

Chemistry Unit: Gas Laws
Lesson 3: "Partial" pressure (when you have a mixture of gases)

Unit Overview

Objective:

Be able to answer all questions below.

A Question for Lesson 3: Will two different gases always exert a different pressure, if the temperature and volume of their containers is kept the same?

Introduction to Lesson 3

Read pages 417 to the end of the sample problem box on page 418. Scan the sample problem boxes. Then, take careful notes on page 418 below:

Dalton's law of partial pressures:
____.

If the composition of air in a tube is 80% N_2 and 20% O_2, and the pressure inside the tube is 1 atm (the same as outside the tube), what is the pressure, in atm, exerted by…

i. The N_2 gas: _________ atm
ii. The O_2 gas: _________ atm

Practice problems:

10.59 A mixture containing 0.538 moles of He (g), 0.315 moles of Ne (g), and 0.103 moles of Ar (g) is confined in a vessel with 7.00 L of space inside at 25 °C.

Rearrange the PV = nRT equation to solve for P:
Plug in numbers for all variables you know:
Solve for P:
Repeat for the other two gases:

a. What is the partial pressure of the He gas? ______________ atm

   The Ne gas? _____________ atm

   The Ar gas? ______________ atm

b. Given the calculated pressures above, what is the total pressure in the chamber?
   _______________ atm

10.61 A piece of solid CO_2 (dry ice) is placed in a 10.0 Liter vessel that contains air. When the dry ice is placed in the chamber, the pressure is 705 torr and the temperature is 24 °C.

When the dry ice has turned into CO_2 (g), what is the partial pressure of the new CO_2 gas? (follow the steps for the last problem to solve) Answer: ______________atm

Given the pressures above, what is the total pressure in the chamber after the dry ice has sublimated?

10.63 A mixture of gases contains 0.75 mol N_2, 0.30 mol O_2, and 0.15 mol CO_2. If the total pressure of the mixture is 1.56 atm, what is the partial pressure of each component?

Partial pressure of N_2: _________________atm

Partial pressure of O_2: _________________atm

Partial pressure of CO_2: ________________atm

Be sure that you can do these problems and be totally comfortable with them. Sometimes you will have to do conversions to get the units that you want, and there can be many steps involved. Use a lot of scratch paper if needed and, again, email if you're having trouble with any of these problems.

Thursday, May 7

Chemistry Unit: Gas Laws
Lesson 4: Kinetic-molecular theory

Unit Overview

Lesson 4 Socratic Question: Do the rules I've developed work for all gases?

Objective:

Be able to answer all questions below.

Introduction to Lesson 4

Read section 10.7 (page 420 to 422). Take bullet point notes on the important points.

- ____
- ____
- ____
- ____

- ____
- ____
- ____

- ____
- ____
- ____
- Effects of a volume increase if temperature remains the same:

- Effects of a temperature increase if the volume remains the same:

Practice problems:

10.69_____________

10.70

a. (skip)

b. ________________

c. ________________

d. ________________

10.72

____
____
____

10.75

a. ____

10.76

a. ____

Friday, May 8

Chemistry Unit: Application of knowledge to elements, periodic trends
Lesson 5: "Real" vs. "ideal" gases. More practice problems.

Unit Overview

Two Socratic Questions: In what ways do the rules I've developed work well? In what ways should I be aware of their limitations?

Objective: Be able to complete the problems below by the end of this lesson.

Introduction to Lesson 5

Rephrase, in your own words, the five statements summarizing the kinetic-molecular theory:

1. ____
    a. Would a monoatomic particle, like Ne or He, qualify as a gas? Does a gas particle need to have more than one atom?______________________________

2. ____
    a. Do you think this is true with all gases? __________

3. ____
    a. Do you think this is always true? Why or why not?

       ____

4. ____
    a. Do you think this is always true? ______________
    b. Can you think of a real-life game, sport, or other physical phenomenon that is similar to what this statement describes? ___________________________

5. ____
    a. Do you think this is true? ______________

Now, read the first section of section 10.9 (page 427 to "The van der Waals Equation" on page 429), and answer the question below.

6. Would you expect helium gas to deviate from ideal behavior more at a) 100 K and 1 atm, b) 100 K and 5 atm, or c) 300 K and 2 atm?

7. Why do real gases deviate from ideal behavior? Give at least two answers.
   -
   -

8. How do intermolecular forces affect gas pressure in a chamber?

____

9. How will the fact that gases actually do take up space affect our calculation of pressure for a gas in a rigid canister?

____

____

   a. Will the pressure actually be higher or lower?
      ____

Practice problems (find on page 437 of your textbook):

10.82

____

____

10.52 (show work below)

10.53 (show work below)

Convert g of glucose to moles of glucose.

Use the coefficients in the equation to determine how much CO_2 will be produced:

Use the moles of CO_2 produced to predict the volume of CO_2 produced:

10.54

Balance the equation.
See process for above problem.

Choose one of the integrative problems (page 439 and 440) and solve it below.