Name: ___________________________
Period: ___________

Unit 2 Packet – Energy and States of Matter

Unit 2 Packet Contents Sheet **(This Paper!)**	
Unit 2 Objectives	
Notes: Kinetic Molecular Theory of Gases- 3 pgs (with Behavior of Gases Reading, and Notes completed)	
Pressure Conversions (DA Practice)	
Unit 2 w/s # 2- Measuring Pressure	
Unit 2 Worksheet # 1	
Gas Laws- Graphing to Determine Relationships	
Boyle's Law Notes	
Boyle's Law Practice Problems	
Diver's Law Notes	
Diver's Law Practice Problems	
Charles' Law Notes	
Charles' Law Practice Problems	
Gay-Lussac Law Notes	
Gay-Lussac Law Practice Problems	
Unit 2 w/s #3- PVTn Problems- 2 pgs	
Unit 2 Review Guide- this isn't all questions to answer- more of an outline. You need to personally make sure you understand all the parts!	

DO NOT, under any circumstances, throw this away!
This packet MUST be saved for the final exam.

Unit 2: Learning Goal:

Students understand how gasses behave and the relationship between pressure, volume, number of particles, and temperature (P, V, n, & T). Students are able to solve quantitative P, V, n, T problems.

Scale

Score	Comment
Score 4	Students show mastery of score 3 without any errors plus: • Apply quantitative problem solving to real-world situations
Score 3	Without any major errors, students can: • Understand how gasses behave and the relationship between pressure, volume, number of particles, and temperature (P, V, n, & T). Students are able to solve quantitative P, V, n, T problems.
Score 2	Without any major errors, students can: • Recognize how gasses behave and the relationship between pressure, volume, number of particles, and temperature (P, V, n, & T). Students are able to solve quantitative P, V, n, T problems.
Score 1	With help from the teacher, students can: • Understand how gasses behave and the relationship between pressure, volume, number of particles, and temperature (P, V, n, & T). Students are able to solve quantitative P, V, n, T problems.
Score 0	Even with the teachers help, students show no understanding of how gasses behave and the relationship between P, V, n, & T. Students are not able to solve quantitative P, V, n, T problems.

Behavior of Gases and a few words about Pressure

Ideally, nearly all substances exhibit similar behavior in the gas phase due to the large relative distances and negligible interaction between the particles. This results in predictable relationships between the **variables that describe gas behavior: pressure (P), volume (V), temperature (T), and quantity of gas (n).**

Pressure:
Pressure is defined as force/unit area. In a filled balloon pressure is created by the collisions of molecules with the walls of the balloon. The more air there is in the balloon, the more collisions against the walls of the balloon, and the higher the pressure inside. Atmospheric pressure or air pressure is caused by the collision of atmospheric gas particles with the earth.

There are many ways to measure pressure and it is often necessary to convert from one way to another (using dimensional analysis). Examples of different pressure measurements are:

Pressure Unit	Abbreviation	Definition	Equivalence to 1 atm
Atmosphere	**atm**	1 atm is the pressure of the atmosphere at sea level at 0ºC	
Millimeters of mercury (Hg) Torr	**mmHg** **torr**	1 mmHg (1 torr) is the pressure that supports a column of mercury 1mm high at 0ºC	760 mmHg = 1 atm 760 torr = 1 atm
Pascals	**Pa**	1 Pa is the force of 1 Newton/m^2 Pascals use metric prefixes	101325 Pa = 1 atm 101.325 kPa = 1 atm
Pounds per square inch	**psi**	1 psi is the force of 1 pound (lb)/in^2	14.7 psi = 1 atm

1atm = 760 mmHg = 760 torr = 101325 Pa = 14.7 psi

It is important that you recognize that when you see the above abbreviations pressure (P) is what is being discussed.

Remember: to convert from one pressure unit to another use dimensional analysis.

Kinetic Molecular Theory of Gases (KMT- Gas Behavior) and Pressure

Kinetic Molecular Theory of Gases (KMT) (Pg 383 in the Zumdahl textbook)	• • • • •
Variables that describe gas behavior…. (Behavior of Gases Reading)	**Variable** **Abbreviation** **Unit(s)** • Pressure • V • • Particles, atoms, etc.
The variable…. Pressure! Definition: Ways to measure pressure:	• **Pressure Unit:** **Abbreviation:** • Atmosphere • mmHg • • • 1 atm = _____ mmHg = ______torr = ______ Pa = ______ psi
Sample Problem:	How many atm are in 950 mmHg? Use Dimensional Analysis, Show work!!

Pressure Conversions

Use dimensional analysis to solve the following pressure conversions:

1. 1 atm to mmHg
2. 795 mmHg to torr
3. 795 mmHg to atm
4. 795 mmHg to Pa
5. 795 mmHg to psi
6. 105600 Pa to kPa
7. 105600 Pa to atm
8. 105800 Pa to mmHg
9. 105800 Pa to torr
10. 105800 Pa to psi
11. 25.2 psi to atm
12. 730 mmHg to atm
13. 800 torr to atm
14. 101700 Pa to atm

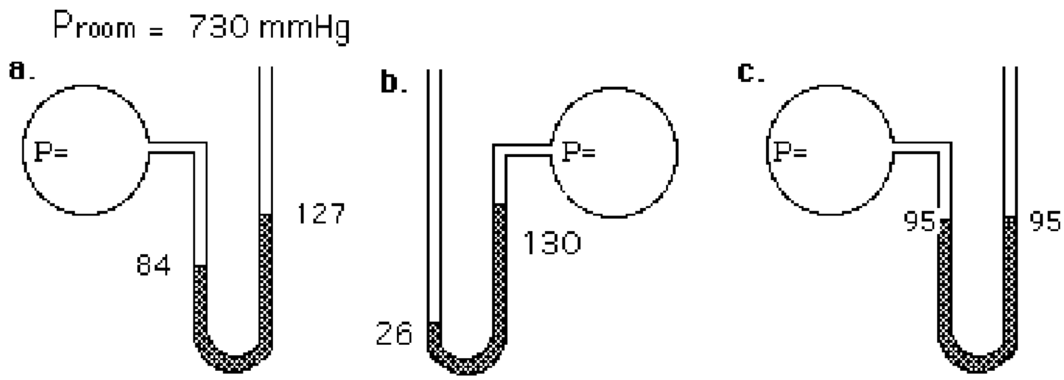
Name ____

Date ________________ Pd ____

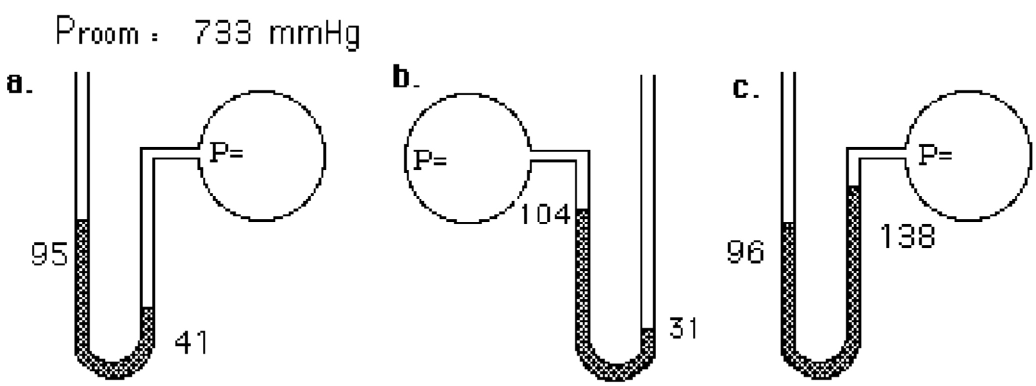
Unit 2 Worksheet 2 - Measuring Pressure

Problems 1 and 2. Calculate the pressure of the gas in the flask connected to the manometer.

1.



2.

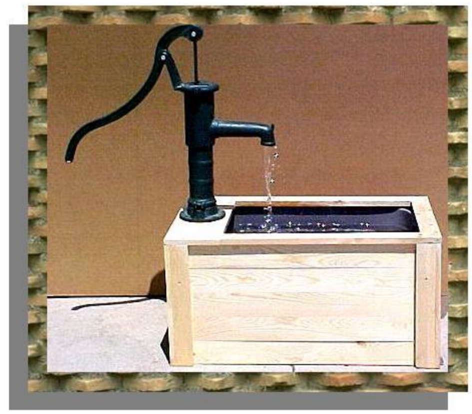


3. What do we mean by atmospheric pressure? What causes this pressure?

4. How do we measure atmospheric pressure? Is atmospheric pressure the same everywhere on the surface of the earth?

5. Why is the fluid in a barometer mercury, rather than water or another liquid?

6. Explain why you cannot use a pump like the one at the right to lift water up to the 3rd floor of an apartment complex.



7. One standard atmosphere of pressure (SP) is equivalent to ________mmHg.

8. Convert pressure measurements from one system of units to another in the following problems.

   1 atmosphere = 760 mmHg = 14.7 psi (pounds per square inch)

   a. 320 mmHg x _____________ = atm

   b. 30.0 psi x _______________ = mmHg

   c. The barometric pressure in Breckenridge, Colorado (elevation 9600 feet) is 580 mm Hg. How many atmospheres is this?

Name______________________________________

Date__________ **Pd**____

Unit 2 Worksheet 1

1. You decide to boil water to cook noodles. You place the pan of water on the stove and turn on the burner.
   a. How does the behavior of the water molecules change as the pan of water is heated?

   b. What about your answer to (a) would change if there were more water in the pan?

2. What property of matter best describes the way a typical alcohol thermometer works? Explain (in terms of energy transfer) why the alcohol level in the thermometer rises (or falls) when you place the thermometer in contact with both warmer (or colder) objects.

3. Does the concept of temperature apply to a single molecule? Explain.

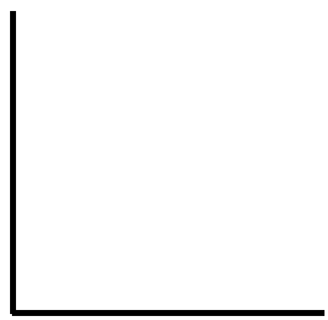
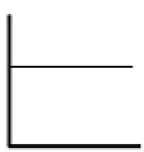
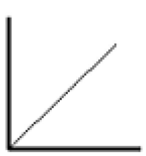
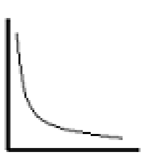
4. If you feel feverish, why can't you take your own temperature with your hand?

5. Your older brother announces that the lid to a jar of pickles from the refrigerator is "impossible" to loosen. You take the jar, hold the lid under the hot water from your sink's faucet for a few seconds, and calmly open the jar. Your brother, when faced with this blow to his pride, claims that he loosened it for you. What knowledge of materials have you applied in this situation that really explains how you were able to open the lid?

6. Describe how Anders Celsius devised the temperature scale that bears his name.

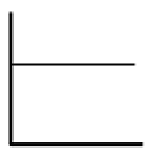
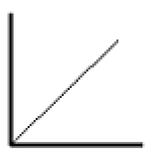
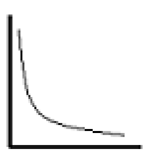
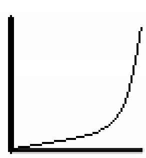
7. Which would feel warmer to the touch - a bucket of water at 50˚C or a bathtub filled with water at 25˚C? Which of these contains more energy? Account for any differences in your answers to these questions.

Gas Laws- Graphing to Determine Relationship between Variables

Independent Variable Axis on Graph	• •
Dependent Variable Axis on Graph	• •
	
  	• As x increases, y _______________ • • As x increases, y _______________ • • As x increases, y _______________ •

Graphical Methods- Summary

A graph is one of the most effective representations of the relationship between two variables. The independent variable (one controlled by the experimenter) is usually placed on the x-axis. The dependent variable (one that responds to changes in the interpret a graphical relationship and express it in a written statement and by means of an algebraic expression.

Graph Shape	Written Relationship	Modification required to linearize graph	Algebraic representation
	As x . There is no relationship between the variables	None	y = b, or y is constant
	As x increases, y increases proportionally. Y is directly proportional to x.	None	y = mx + b
	As x increases, y decreases. Y is inversely proportional to x.	Graph y vs 1/x, or y vs x^{-1}	y = m(1/x) + b
	Y is proportional to the square of x	Graph y vs x^2	y = mx^2 + b
	The square of y is proportional to x	Graph y^2 vs x	y^2 = mx + b

When you state the relationship, tell how y depends on x (e.g., as x increases, y …)

Boyles' Law: The relationship between _________ and ______________.

Variables / Units	• •
Held Constant	• •
Relationship (direct or inverse) **Relationship in words**	• • **P α _________** • **As ________________goes ______, _____________goes ___________.**
Pressure Units Reminder…	
Graph of Relationship	
Particle Diagram	
Boyles' Law Practice Problem	• A sample of oxygen gas occupies a volume of 250. mL at 740 torr pressure. What volume will it occupy at 800torr pressure?

	P	T	V	n
Initial				
Final				
Effect				

Boyle's Law Practice Problems Name:______________________________
Date:_________________ Period: _______

Solve each of the following problems using Boyle's Law. Show all work and put a box around your answer to receive full credit.

1. If 9.5 atms of pressure were increased to 25 atms of pressure, what would be the final volume of a gas that originally occupied a space of 95 L?

2. If 760. mmHg of pressure were decreased to 458 mmHg, what would be the original volume of a gas that ended up occupying a space of 1072 mL?

3. If the volume of a gas expanded from 958 mL to 1548 mL, what was the initial pressure applied to it if the final pressure is 96.5 pounds per square inch?

4. If the volume of a gas contracted from 648 mL to 0.15 L, what was its final pressure if it started at a pressure of 485 kPa?

5. If 95 lbs/in^2 of pressure changed to 958.7 kPa, what would b the final volume of a gas that originally occupied a space of 736.45 mL?

Diver's Law: The relationship between _________ and _______________.

Variables / Units	• •
Held Constant	• •
Relationship (direct or inverse) Relationship in words	• • P α ________ • As _________________goes ______, _____________goes ___________.
1 mole is…	
Graph of Relationship	
Particle Diagram	
Diver's Practice Problem	If .105 moles of helium gas exerts a pressure of 1.5 atm, what pressure would 0.337 moles exert.

	P	T	V	n
Initial				
Final				
Effect				

Diver's Law Practice Problems Name:______________________________
Date:_________________ Period: _______

Solve each of the following problems using Diver's Law. Show all work and put a box around your answer to receive full credit.

1. If 3.94 atms of pressure were increased to 11.62 atms, what would be the final quantity of a gas that originally had 1.92 x 10^{20} molecules?

2. If 820. mmHg of pressure were decreased to 692.5 mmHg, what would be the initial quantity of a gas that measured 2.2 moles after the change?

3. If 938 torr of pressure changed to 213060 Pa, what would be the final quantity of a gas that was originally .56 moles?

4. If the amount of a gas lowered from 2.00 moles to 3.91 x 10^{23} atoms, what was its final pressure if it started at STP?

5. If the amount of a gas rose from 4.16 x 10^{23} molecules to 1.6 moles, what was the initial pressure applied to it if the final pressure is 792.3 torr?

Charles' Law: The relationship between _________ and ______________.

Variables / Units	• •
Held Constant	• •
Relationship (direct or inverse) **Relationship in words**	• • **V α _______** • **As _______________goes ______, ____________goes __________.**
Kelvin is…	
Graph of Relationship	
Particle Diagram	
Charles' Law Practice Problem	The volume of a sample of gas is 2.50L at 45K. What is the volume when it is heated to 125K at a constant pressure?

	P	T	V	n
Initial				
Final				
Effect				

Charles' Law Practice Problems Name:______________________________
Date:_________________ Period: _______

Solve each of the following problems using Charles' Law. Show all work and put a box around your answer to receive full credit.

6. If 135 mL of a gas were expanded to take up 258 mL, what would be the final temperature of a gas that originally measured a 300. K?

7. If 359 mL of a gas were contracted to only 268 mL, what would be the initial temperature of a gas that measured 422 K after the change?

8. If a gas occupying a space of 526 mL changed to 1.1 L, what would be the final temperature of a gas that was originally at standard temperature?

9. If the temperature of a gas lowered from 526 K to 98.25 °C, what was its final volume if it started at 16.3 mL?

10. If the temperature of a gas rose from standard temperature to 48.1 °C, what was the initial volume occupied if the final space was 0.680 mL?

Gay-Lussac's Law: The relationship between _________ and ______________.

Variables / Units	• •
Held Constant	• •
Relationship (direct or inverse) **Relationship in words**	• • **P α _______** • **As ________________goes ______, _____________goes ___________.**
Graph of Relationship	
Particle Diagram	
Gay-Lussac Practice Problem	A collapsible cylinder contains a gas at 765mmHg pressure. As external force causes the cylinder to collapse, the pressure reaches 966mmHg. The final temperature in the cylinder is 86.2^{o} C. What was the original temperature of the gas in the cylinder before it collapsed?

	P	**T**	**V**	**n**
Initial				
Final				
Effect				

Gay-Lussac's Law Practice Problems Name:______________________________
Date:_________________ Period: _______

Solve each of the following problems using Gay-Lussac's Law. Show all work and put a box around your answer to receive full credit.

11. If 6.24 atms of pressure were increased to 23 atms of pressure, what would be the final temperature of a gas that originally measured a comfortable 295 K?

12. If 780. mmHg of pressure were decreased to 528 mmHg, what would be the initial temperature of a gas that measured 456 K after the change?

13. If 36 lbs/in^2 of pressure changed to 861.6 kPa, what would be the final temperature of a gas that was originally -113 °C?

14. If the temperature of a gas increased to 50 °C, what was its final pressure if it started at STP (standard temperature and pressure)?

15. If the temperature of a gas rose from standard temperature to 35 °C, what was the initial pressure applied to it if the final pressure is 72.5 pounds per square inch?

Name ____________________________________

Date ____________ Pd ____

Unit 2 Worksheet 3 – PVTn Problems

On each of the problems below, start with the given P, V, T, or n; then make a decision as to how a change in P, V, T, or n will affect the starting quantity, and then multiply by the appropriate factor. Draw particle diagrams of the initial and final conditions.

1. A sample of gas occupies 150 mL at 25 ˚C. What is its volume when the temperature is increased to 50˚C? (P and n = constant)

	P	T	V	n
Initial				
Final				
Effect				

2. The pressure in a bicycle tire is 105 psi at 25˚C in Fresno. You take the bicycle up to Huntington, where the temperature is – 5˚C. What is the pressure in the tire?
(V and n = constant)

	P	T	V	n
Initial				
Final				
Effect				

3. What would be the new pressure if 250 cm^3 of gas at standard pressure is compressed to a volume of 150 cm^3 ? (__________ = constant)

	P	T	V	n
Initial				
Final				
Effect				

4. What would be the new volume if 250 cm^3 of gas at 25˚C and 730 mm pressure were changed to standard conditions of temperature and pressure? (_____= constant)

	P	T	V	n
Initial				
Final				
Effect				

5. Sam's bike tire contains 15 units of air particles and has a volume of 160mL. Under these conditions the pressure reads 13 psi. The tire develops a leak. Now it contains 10 units of air and has contracted to a volume of 150mL). What would the tire pressure be now?

	P	T	V	n
Initial				
Final				
Effect				

6. A closed flask of air (0.250L) contains 5.0 "puffs" of particles. The pressure probe on the flask reads 93 kPa. A student uses a syringe to add an additional 3.0 "puffs" of air through the stopper. Find the new pressure inside the flask.

	P	T	V	n
Initial				
Final				
Effect				

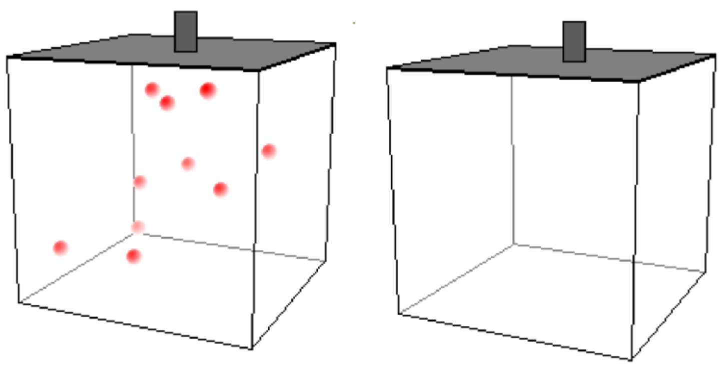
7. A 350 mL sample of gas has a temperature of 30˚C and a pressure of 1.20 atm. What temperature would needed for the same amount of gas to fit into a 250 mL flask at standard pressure?

	P	T	V	n
Initial				
Final				
Effect				

8. A 475 cm^3 sample of gas at standard temperature and pressure is allowed to expand until it occupies a volume of 600. cm^3. What temperature would be needed to return the gas to standard pressure?

	P	T	V	n
Initial				
Final				
Effect				

9. The diagram below left shows a box containing gas molecules at 25˚C and 1 atm pressure. The piston is free to move.



In the box at right, sketch the arrangement of molecules and the position of the piston at *standard* temperature and pressure. Does the volume decrease significantly? Why or why not?

Chemistry – Unit 2 Review

To prepare to do well on the Unit 2 test, you should assemble your packet to review, as well as your lab book, preferably in a small group where you can draw from each other's understanding. Here are the **key points** you should know. These are not a set of questions to work out, more of an outline- make sure you **understand** all aspects!

Energy

Think of energy as a quantity that is always involved when there is a *change* in the state of matter. When a substance gets hotter or colder or changes phase, energy is either transferred into or out of the system. One way energy is stored in a system is **kinetic energy** (due to the motion of the particles). As particles move faster, their kinetic energy increases. As the particles move faster, they tend to move farther apart from one another. Temperature is a measure of the kinetic energy of the system.

1. Explain why the alcohol level in a thermometer rises when it is placed in a warmer fluid. (4-step process)

2. Explain why the alcohol level in a thermometer falls when it is placed in a cooler fluid. (4-step process)

3. Explain how the Celsius scale was devised and why it is not appropriate to use it when describing the behavior of gases. (review ws 1, PVTn lab)

Kinetic Molecular Theory

This theory describes all matter as being composed of tiny particles in endless random motion. In a solid, the particles vibrate, but are locked into an orderly array. In a liquid, the particles are still touching but are free to move around past one another. In a gas, the particles are moving very rapidly and are widely separated. Using a series of particle diagrams, represent samples of a solid, liquid, cold gas and hot gas.

Gas behavior

Gas pressure is a measure of the collisions of the molecules with the sides of the container. A barometer is used to measure atmospheric pressure; a manometer is used to measure the pressure in a container. (review ws 3)

The 4 variables P, V, n, and T are interrelated. Any factor that affects the number of collisions has effect on the pressure. You should be able to:

4. Predict the effect of changing P, V, n, or T on **all** of the other variables.

   Remember: $P \alpha {}^1/_V$ $P \alpha n$ $T \alpha V$ $P \alpha T$

5. Explain (in terms of the collisions of particles) why the change has the effect you predicted.

6. Explain why one must use the absolute temperature scale to solve gas problems.

7. Use factors to calculate the new P, V, n, or T (review ws 3). Make a decision as to how the change affects the variable you are looking for.

8. Suppose that you lowered the temperature of a gas from 100˚C to 50 ˚C. By what factor do you change the volume of the gas?

9. Suppose that 25.0 mL of a gas at 725 mm Hg and 20˚C is converted to standard pressure and temperature. What would be the new volume?