KEY

Chemistry 20 FINAL REVIEW (2015)

Unit B: Gases

General Outcome 1
Students will explain molecular behaviour, using models of the gaseous state of matter.

Students will:
20–B1.1k describe and compare the behaviour of real and ideal gases in terms of kinetic molecular theory

State the 3 Laws of the Kinetic Molecular Theory Below:
1. everything is made of molecules
2. molecules are always moving
3. there are forces of attraction b/w molecules

Compare Ideal vs Real Gases by completing the table below

Ideal Gases	Real Gases
straight line	curved lines
no point mass	have mass
no forces present	forces present
perfectly elastic collisions	inelastic collisions

20–B1.2k convert between the Celsius and Kelvin temperature scales

Complete the following conversion table below

Kelvin	Celsius
200K	-73°C
275.385 K	2.385C
12.29K	-260.71
∅ K	-273.15C

20–B1.3k explain the law of combining volumes

Gay Lussac's Law is the idea that if a gas's temperature increases, then so does its pressure if the mass and volume of the gas are held constant.

Using this information, determine the formula for Gay Lussac's law of combining volumes. ↑T ↑P

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

20–B1.4k illustrate how Boyle's and Charles's laws, individually and combined, are related to the ideal gas law (PV = nRT)
• express pressure in a variety of ways, including units of kilopascals, atmospheres and millimetres of mercury
• perform calculations, based on the gas laws, under STP, SATP and other defined conditions.

20–B1.2sts explain that the goal of science is knowledge about the natural world
• describe examples of natural phenomena and processes and products (such as breathing, diffusion, weather, hot air balloons, scuba diving equipment, automobile air bags, gas turbines and internal combustion engines) that illustrate the properties of gases.

Complete the chart below:

Gas Law	Formula	Simple Explanation	Everyday Life Example
Boyle's Law	$P_1V_1 = P_2V_2$	↑P ↓V	syringe
Charles' Law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	↑T ↑V	hot air balloon
Combined Gas Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	↑T ↑V ↓P	bubble in ocean
Ideal Gas Law	$PV = nRT$	= mol @ same T/P	popcorn

Solve the following problems:

1. At a birthday party a child sits on a partially filled balloon, decreasing its volume by 1/2. What is the new pressure inside the balloon?

P_1 = 1 kPa
P_2 = ??
V_1 = 1 L
V_2 = 0.5 L

$P_1V_1 = P_2V_2$
(1 kPa)(1 L) = P_2 (0.5)
P_2 = 2 kPa

Pressure is doubled.

2. In a cryogenics (extreme cold) demonstration, a scientist takes a small, partially inflated balloon out of liquid nitrogen (at a very low temperature). As the balloon rests on the table, it begins to grow in size. Explain this phenomenon.

As temp ↑ volume ↑ according to Charles' Law b/c the molecules ↑ energy and move faster so they spread out!

3. Huge weather balloons partially filled with helium are sent high into the earth's atmosphere to examine the air. As a balloon rises into the air, the air pressure outside the balloon decreases rapidly. If the atmospheric pressure becomes one-third of its original pressure, what will happen to the balloon volume? Explain.

$P_1 = 1$ kPa
$P_2 = 0.333$ kPa
$V_1 = 1$ L
$V_2 = ?$

$P_1V_1 = P_2V_2$

$(1\text{ kPa})(1\text{ L}) = (0.\overline{33}\text{ kPa})V_2$

$V_2 = 3$ L

↑ x 3 Volume

4. Use the kinetic molecular theory to explain why on a cold autumn morning a camper's air mattress may appear to be somewhat flatter than it was when blown up the afternoon before. Assume no leaks.

Overnight Temp ↓ and Pressure ↑ so volume will ↓ according to the combined gas Law! (Molecules slow down)

5. The gas inside a piston was heated from 125 mL to 250 mL. If the temperature inside the piston was originally 15°C, calculate the new temperature in °C.

$V_1 = 125$ mL
$V_2 = 250$ mL
$T_1 = 15°C + 273$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{125\text{ mL}}{288\text{ K}} = \frac{250\text{ mL}}{T_2}$

$T_2 = 576$ K

$T_2 = 303°C$

6. One of the cylinders in an automobile engine is heated and the piston moves. Allowing the gas inside to expand, The original pressure was 1.85 atm, while its original volume was 175 mL, measured at 18°C. The final measured pressure was 0.86 atm and the temperature was measured at 382°C. Calculate the final volume of the cylinder.

$P_2 = 0.86$ atm
$T_2 = 382°C$
$V_2 = ??$

$P_1 = 1.85$ atm
$V_1 = 175$ mL
$T_1 = 18°C$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{(1.85\text{ atm})(175\text{ mL})}{(291\text{ K})} = \frac{(0.86\text{ atm})V_2}{(655\text{ K})}$

$V_2 = 847.34$ mL

$V_2 = 850$ mL

7. a. Carbon monoxide gas reacts with oxygen gas to form carbon dioxide gas. Write a balanced equation for the reaction.

$2CO(g) + 1O_2(g) \longrightarrow 2CO_2(g)$

b. Given Avagadro's Hypothesis, what volume of oxygen will you expect to completely react with 4.0 L of carbon monoxide, if both gases are at the same temperature and pressure?

8 L b/c the mole ratio = x 2

c. If the 4.0 L of carbon monoxide above contains 1.08 x 10^23 molecules, how many molecules of oxygen will you find in 2.6 L of oxygen gas at the same temperature and pressure?

$\#\text{ molec} = \frac{1.08 \times 10^{23}}{\text{molec CO}} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molec}} \times \frac{1\text{ }O_2}{2\text{ CO}} \times \frac{6.02 \times 10^{23}\text{ molec}}{1\text{ mol}} = 5.4 \times 10^{2}$ molecules

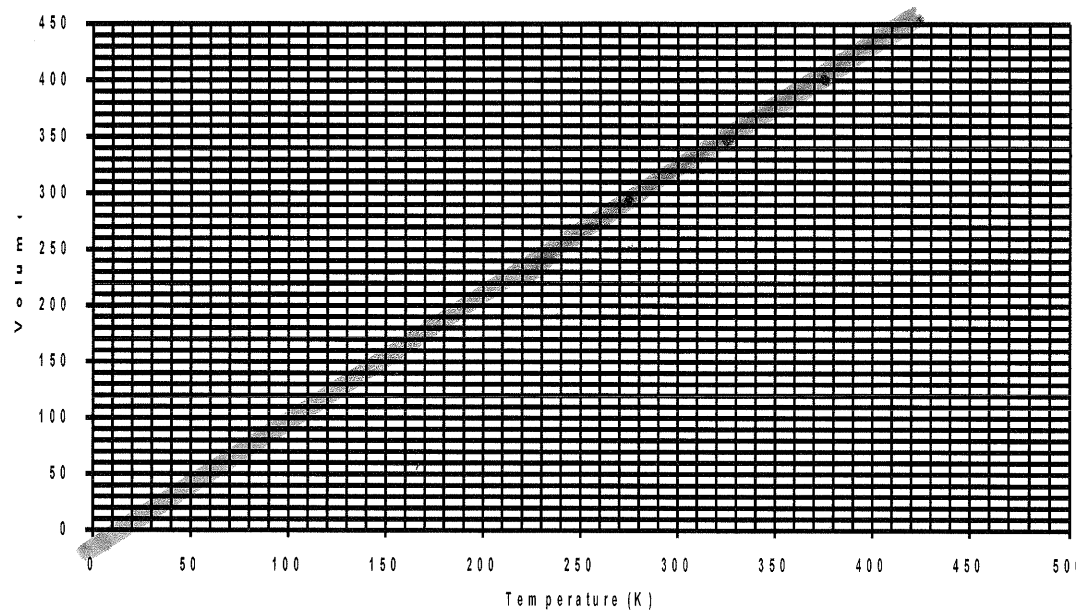
d. Avogadro's Hypothesis states that equal volumes of gases (at the same temperature and pressure) contain equal numbers of particles. If instead you have equal masses of the three gases in the reaction above, which gas will occupy the largest volume assuming the gasses are all at the same temperature and pressure?

The gas with the largest molar mass will take up the most space

8. An expandable container is filled with a given volume of gas. While the pressure of the gas is kept constant, the container is heated. The temperature is recorded in degrees Celsius, and the volume of the contained gas is recorded as well. The data are shown in the following table.

Temperature (°C)	**Temperature (K)**	**Volume**
0°C	273	293 mL
50°C	323	347 mL
100°C	373	401 mL
150°C	423	455 mL

Convert °C into Kelvin and write these values into the table. Then plot the data on the grid supplied.



a. What type of proportion does this graph illustrate? Explain.

Directly Proportional

b. What is the value of V/T for this experiment?

Slope = 0.0906

c. To what graphical quantity does V/T correspond?

Slope

d. Is V/T constant or does it vary?

~ Constant

e. Extrapolate values for the volume occupied by the gas at

150 K ___150 L

75 K ___70 L

0 K ___∅ L

f. What gas law does the graph illustrate?

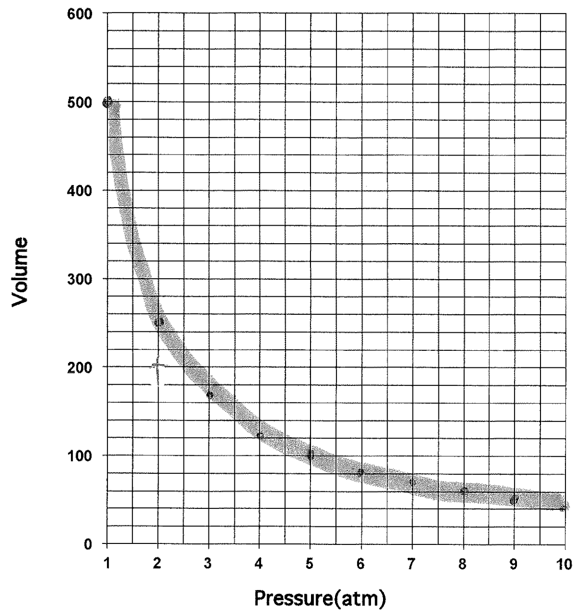
Charle's Law ↑T ↑V

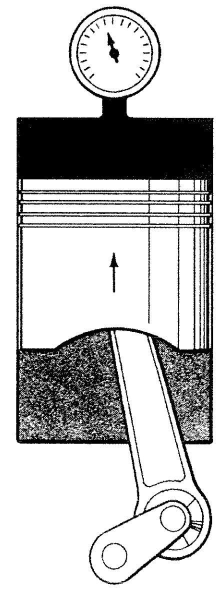
g. Express this relationship in the form of a mathematical equation.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

9. The piston in the following figure is moving further into the cylinder. As it moves both volume and the pressure of the gas are measured. Graph the data on the grid provided and answer the following questions.

Volume	Pressure
500 cm^3	1 atm
250 cm^3	2 atm
167 cm^3	3 atm
125 cm^3	4 atm
100 cm^3	5 atm
83 cm^3	6 atm
71 cm^3	7 atm
63 cm^3	8 atm
56 cm^3	9 atm
50 cm^3	10 atm





a. What type of proportion does this graph illustrate? Explain.

Inversely Proportional As P↑ V↓

b. If the cylinder can suddenly accommodate a volume of 1000 cm^3. Predict the corresponding pressure value.

Ø atm

c. What pressure will be observed if the volume of the contained gas equals 375 cm^3?

0.5 atm

d. Which gas law does the graph illustrate?

Boyle's Law P↑ V↓

e. Express this relationship in the form of a mathematical equation.

$P_1V_1 = P_2V_2$

Students will:
20–B1.1sts explain that science provides a conceptual and theoretical basis for predicting, interpreting and explaining natural and technological phenomena
• describe how the development of technologies capable of precise measurements of temperature and pressure (such as thermocouples, thermistors and Bourdon gauges) led to a better understanding of gases and to the formulation of the gas laws

Students will:
20–B1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• state hypotheses and make predictions based on information about the pressure, temperature and volume of a gas
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information
• design an experiment to illustrate Boyle's and/or Charles's gas laws
• design an investigation to determine the universal gas constant (R) or absolute zero
• explore how people who are connected with the land, such as Aboriginal peoples and agricultural workers, have used plant and animal responses to changes in atmospheric pressure as indicators of changing weather

Students will:
20–B1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• perform an experiment, in which variables are identified and controlled, to illustrate gas laws
• use thermometers, balances and other measuring devices effectively to collect data on gases
• use library and electronic research tools to collect information on real and ideal gases and on applications of gases, such as hot air and weather balloons
• perform an investigation to determine molar mass from gaseous volume

Using your previous knowledge, complete the chart below

	Boyle's Law	Charles' Law	Combined Gas Law	Avogadro's Hypothesis	Ideal Gas Law
Manipulated Variable	↑ P	↑ T	↓ T	Add Vinegar	↑ T
Responding Variable	↓ V	↑ V	↓ V ↑ P	CO_2 produce	↑ V
Controlled Variables (min 3)	Mass of Book Syringe STP/SATP	# moles gas Balloon STP/SATP	STP/SATP	Amounts Temp of Sub STP/SATP	STP/SATP
Summary of Experiment	↑ Pressure on Syringe by Adding Mass	Place PoP Bottle w/ Balloon in warm H2O and see what balloon does as temp ↑	Light candle under cup as it goes out gas cools, H2O enters cup.	Baking Soda Vinegar measure mass change to find # molec produced	Popcorn to determine Volume and Pressure
Expected Results	↓ V	↑ V	↓ V	# g → molec	↑ V ↓ P
Real Life Application	Making Pop.	Hot Air Balloon	Mattress goes flat	Everything	Popcorn, Yeast

Students will:
20–B1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• graph and analyze experimental data that relate pressure and temperature to gas volume
• identify the limitations of measurement
• identify a gas based on an analysis of experimental data