Name: Date:

GAS LAWS - REVIEW

Part A: Definitions

Changes in State	Molecular Theory	Pressure
Volume	Temperature	Standard Pressure
Standard Temperature	STP	

Part B: Unit Conversions

1. Convert the following pressures to kPa

a. 1.3 atm

$\frac{1.3 \text{ atm}}{1 \text{ atm}} \times 101.3 \text{ kPa} = 131.7 \text{ kPa}$

b. 692 mm Hg

$\frac{692 \text{ mm Hg}}{760 \text{ mm Hg}} \times 101.3 \text{ kPa} = 92.2 \text{ kPa}$

c. 1.15×10^5 Pa

$\frac{115000 \text{ Pa}}{1000} = 115 \text{ kPa}$

d. 777 torr

$\frac{777 \text{ torr}}{760 \text{ torr}} \times 101.3 \text{ kPa} = 103.5 \text{ kPa}$

2. Convert the following temperatures:

a. 32°C to Kelvin

$32 + 273 = 305 \text{ K}$

b. 303 K to °C

$303 - 273 = 30^\circ\text{C}$

c. -21°C to Kelvin

$-21 + 273 = 252 \text{ K}$

d. 189 K to °C

$189 - 273 = -84^\circ\text{C}$

Part C: Variable Relationships

1. Using proper notation, describe the relationship between the following variables:

a. Volume and Temperature

$V \uparrow \quad T \uparrow$

b. Pressure and Volume

$P \uparrow \quad V \downarrow$

c. Moles and Volume

$n \uparrow \quad V \uparrow$

d. Pressure and Temperature

$P \uparrow \quad T \uparrow$

2. People say that you should be worried about storing a propane bbq tank in your car on a hot summer day. Using your knowledge of gases, why should we be worried?

Inside of car gets hot. increased temp will increase pressure of gas inside tank. Tank may EXPLODE.

3. Regardless of warnings, people still leave their tanks exposed to high temperatures. As a person that knows better, what do you think the propane tank fillers do to keep the tanks from rupturing?

The propane man doesn't completely fill the tank, leaving room for expansion

4. During commercial air flight, air liners pump air into the airplane to "pressurize" the cabin. When this happens, the passengers generally feel a sense of discomfort as their ears pop. It also causes babies to cry (very annoying). What do you think would happen if the pilots failed to pressurize? Would this be better or worse than minor ear discomfort?

If the pilots don't pressurize then there will be no air in the airplane

Part C: *Gas Laws*

Boyle's

1. A 25.0 cm^3 sample of oxygen gas is collected at 1 atm. The oxygen is then compressed to a pressure of 15 atm. What is the final volume of the oxygen if the temperature remains constant?

$V_1 = 25 cm^3 = 25 mL$
$P_1 = 1 atm$
$P_2 = 15 atm$

$P_1V_1 = P_2V_2$
$(1)(25) = (15)V_2$
$V_2 = 1.67 mL$

2. A 56.2 mL sample of gas at 590 torr is compressed to a certain volume at 3 atm. What is the new volume in litres?

$V = 56.2 mL = 0.0562 L$
$P_1 = 590 torr$
$P_2 = 3 atm = 2280 torr$

$P_1V_1 = P_2V_2$
$(590)(0.0562) = 2280 V_2$
$V_2 = 0.015 L$

Charles'

1. A 12.5 mL sample of nitrogen gas at 26.4°C is collected in 50 mL container. What temperature must the gas be subjected to before the sample completely fills the 50 mL?

$V_1 = 12.5 mL$
$T_1 = 26.4°C = 299.4 K$
$V_2 = 50 mL$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
$\frac{12.5}{299.4} = \frac{50}{T_2}$
$T_2 = 1197.6 K$

2. A sample of gas occupies a volume of 300 mL at 18°C and 100 kPa. What volume will the gas occupy if the temperatre is raised by 82°C and the pressure remains constant?

$V_1 = 300mL$
$T_1 = 18°C = 291\ K$
$T_2 = 18 + 82 = 100°C = 373\ K$

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

$\frac{300}{291} = \frac{V_2}{373}$

$V_2 = 384.5mL$ or $0.3845L$

Gay-Lussac's

1. At 19°C, a sample of gas is stored in a metal cylinder and exerts a pressure of 14.3 atm. What will the temperature be if the cylinder's pressure climes to 2000 kPa?

$T_1 = 19°C = 292K$
$P_1 = 14.3atm = 1448.6\ kPa$
$P_2 = 2000\ kPa$

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

$\frac{1448.6}{292} = \frac{2000}{T_2}$

$T_2 = 403\ K$

Combined Gas Law

1. A 100 W light bulb has a volume of 180.0 cm^3 at STP. The light bulb is turned on and the heated glass expands slightly, changing the volume of the bulb to 181.5 cm^3 with an internal pressure of 214.5 kPa. What is the temperature of the light bulb (in °C)

$V_1 = 180cm^3$
$P_1 = 101.3kPa$
$T_1 = 273K$

$V_2 = 181.5cm^3$
$P_2 = 214.5kPa$

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

$\frac{(101.3)(180)}{273} = \frac{(214.5)(181.5)}{T_2}$

$T_2 = 582.8\ K$

2. A cylinder at 52 atm pressure and 310 K releases 42 mL of gas into a 3 L container at 289 K. What is the pressure inside the container?

$P_1 = 52atm$
$T_1 = 310K$
$V_1 = 42mL = 0.042L$

$P_2 = ?$
$V_2 = 3L$
$T_2 = 289K$

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

$\frac{(52)(0.042)}{310} = \frac{P_2(3)}{289}$

$P_2 = 0.68\ atm$

Ideal Gas Law

1. Calculate the volume of 3.03 g of hydrogen gas at a pressure of 560 torr and a temperature of 139 K.

$m = 3.03g$ so $mol = \frac{3.03}{2} = 1.5mol$

$P = 560\ torr = 74.6\ kPa$

$T = 139K$

$PV = nRT$

$(74.6)V = (1.5)(8.314)(139)$

$V = 23.2L$

2. A 500 L tank contains 4.0 mol of carbon dioxide and 16.0 mol of chlorine gas. If the temperature is 79°C, what is the pressure of the carbon dioxide in kPa? (***Hint: Use percentages to calculate how many litres of CO_2 there are***)

$V = 500\ L$
$n = 20\ mol$
$T = 79°C = 352$

$PV = nRT$
$P(500) = (20)(8.314)(352)$
$P = 117\ kPa$

OR

$\frac{4\ mol}{20\ mol} = 20\%$
$20\%\ of\ 500\ L = 100\ L$

$PV = nRT$
$P(100) = (4)(8.314)(352)$
$P = 117\ kPa$

3. Air is comprised of 20% oxygen. This room is filled with air (I hope) and has a volume of 7m x 9m x 3m. There are 1000 L of gas in every cubic metre. If the room has a temperature of 20°C and a pressure of 102 kPa, how many moles of oxygen are in this room?

$V = 189\ m^3 = 189\ 000\ L$
$T = 20°C = 293\ K$
$P = 102\ kPa$

$PV = nRT$
$(102)(189\ 000) = n(8.314)(293)$
$n = 7913.8\ mol$

$n_{O_2} = 0.2 \times 7913.8$
$= 1582.7\ mol$

- That is 6300 breaths of air (250 for each of us)

Gas Stoichiometry

1. Oxygen, O_2, reacts with magnesium, Mg, to produce 243 g of magnesium oxide, MgO, at 101.3 kPa and 45°C. How many litres of oxygen are consumed?

$2Mg + O_2 \rightarrow 2MgO$

$n = \frac{6}{2} \times 1 = 3\ mol$

$PV = nRT$
$(101.3)(V) = (3)(8.314)(318)$
$V = 78.3\ L$

$m = 243\ g$
$Mm = 40.3$
$n = \frac{m}{Mm} = \frac{243}{40.3} = 6\ mol$

2. Zinc reacts with nitric acid to produce 34 L of dry hydrogen gas at 900 torr and 20°C. How many grams of zinc are consumed?

$Zn + 2HNO_3 \rightarrow H_2 + Zn(NO_3)_2$

$V = 34\ L$
$P = 119.9\ kPa$
$T = 293\ K$
$PV = nRT$
$n = 1.67\ mol$

$n = 1.67$

$m = nMm$
$= 1.67 \times 65.4$
$m = 109\ g$