Name ______________
Teacher ______________
Class ________ Block ___
Date ________

(28)

Gas Problems WS

Show all work, unit cancellation, and sig. figs. Your answer must have a unit. 2 sig. fig.

1. The pressure in a tire is 35 psi. What is that pressure in

3

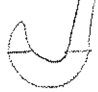
a. atmospheres — 35psi x 1atm / 15psi = **2.3atm**

b. torr — 2.33atm x 760torr / 1atm = **1800torr** [1700 using 2.3]

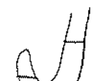
c. pascals — 2.33atm x 101300Pa / 1atm = **240000Pa** (crossed out) **230000Pa** using 2.3

2. Draw a J-tube that shows a gas at 1 atm. Draw a J-tube with a gas at 0.5 atm.

1



levels at the same spot



open tube level is higher

3. A sample of neon has a volume of 1.51 L at a pressure of 635 torr. Calculate the volume of the gas after it is pumped into glass tubes of a sign, where it shows a pressure of 785 torr.

1

$P_1V_1 = P_2V_2$ $P_1 = 635$ torr, $V_1 = 1.51$ L, $P_2 = 785$ torr

$(635)(1.51) = (785)V_2$

$V_2 = 1.22$ L — 3 sig. fig.

4. A sample of helium gas has a pressure of 3.54 atm in a container with a volume of 23.1 L. This sample is transferred to a new container and the pressure is measured to be 1.87 atm. What is the volume of the new container? Assume constant temperature.

3

$P_1V_1 = P_2V_2$ $P_1 = 3.54$ atm, $V_1 = 23.1$ L, $P_2 = 1.87$ atm

$(3.54)(23.1) = (1.87)V_2$

$V_2 = 43.7$ L — 3 sig. fig.

5. A child blows a soap bubble that contains air at 28°C and has a volume of 23 cm^3 at ~~1 atm~~. As the bubble rises, it encounters a pocket of cold air (temp. = 18°C). If there is no change in pressure, will the bubble get larger or smaller as the air inside cools to 18°C? Calculate the new volume.

1

$V_1T_2 = V_2T_1$ $V_1 = 23\ cm^3$, $T_1 = 28°C$, $T_2 = 18°C$

$(23)(18) = (V_2)(28)$

$V_2 = 15\ cm^3$ — 2 sig. fig.

6. A sample of oxygen gas has a volume of 4.55 L at 25°C. Calculate the volume of the oxygen gas when the temperature is raised to 45°C. Assume constant pressure.

3

$V_1T_2 = V_2T_1$ $V_1 = 4.55$ L, $T_1 = 25°C$, $T_2 = 45°C$

$(4.55)(45) = V_2(25)$

$V_2 = 8.2$ L — 2 sig. figs.

7. Consider two samples of nitrogen gas (composed of N_2 molecules). Sample 1 contains 1.5 mol of N_2 and has a volume of 36.7 L at ~~25°C~~ and ~~1 atm~~. Sample 2 has a volume of 16.5 L at ~~25°C~~ and ~~1 atm~~. Calculate the number of moles of N_2 in Sample 2.

1

$V_1n_2 = V_2n_1$ $V_1 = 36.7$ L, $n_1 = 1.5$ mol, $V_2 = 16.5$ L

$(36.7)n_2 = (16.5)(1.5)$

$n_2 = 0.67$ mol — 2 sig. fig.

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8. If 2.55 mol of helium gas occupies a volume of 59.5 L at a particular temp. and pressure, what volume does 7.83 mol of He occupy under the same conditions?

$V_1 n_2 = V_2 n_1$ $V_1 = 59.5L$ $n_1 = 2.55mol$ $n_2 = 7.83mol$

$(59.5)(7.83) = V_2 (2.55)$

$V_2 = 183L$ 3 sig. fig.

1

9. A weather balloon contains 1.10 x 10^5 mol of helium and has a volume of 2.70 x 10^6 L at 1.00 atm pressure. Calculate the temperature of the helium in the balloon in kelvins and in °C.

$PV = nRT$ $(1.00)(2.70\times10^6) = (1.10\times10^5)(.08206)(T)$

$R = .08206$ because P=1atm T is Kelvin originally

$P = 1.00atm$ $V = 2.70\times10^6 L$ $n = 1.10\times10^5 mol$

$T = 299\ K$ 3 sig. fig.

$K - 273 = °C$

$299 - 273 = 26°C = T$ ones place

2

10. A 2.50 mol sample of nitrogen gas has a volume of 5.50 L at a temp. of 27°C. Calculate the pressure of the gas.

$PV = nRT$ $V = 5.50L$ $n = 2.50mol$

$P(5.50) = (2.50)(.08206)(300)$

$P(5.50) = (2.50)(8.31)(300)$

$R = .08206$ or 8.31

$T = 27°C + 273$ $T = 300K$

$P = 11.2\ atm$ or $P = 1130\ kPa$ 3 sig. fig.

3

11. Radon, a radioactive gas formed naturally in the soil, can cause lung cancer. It can pose a hazard to humans seeping into houses, and there is concern about this problem in many areas. A 1.5 mol sample of radon gas has a volume of 21.0 L at 33°C. What is the pressure of the gas?

$PV = nRT$ $V = 21.0L$ $n = 1.5mol$

$P(21.0) = (1.5)(.08206)(306)$

$P(21.0) = (1.5)(8.31)(306)$

$R = .08206$ or 8.31

$T = 33°C + 273$ $T = 306K$

$P = 1.8\ atm$ $P = 180\ kPa$ 2 sig. fig.

3

12. A sample of neon gas has a volume of 3.45 L at 25°C and a pressure of 565 torr. Calculate the number of moles of neon present in this sample.

$PV = nRT$ $R = .08206$

$P = 565 torr \times \frac{1 atm}{760 torr}$ $P = 0.743atm$ $V = 3.45L$

$T = 25°C + 273$ $T = 298K$

$(0.743)(3.45) = n(.08206)(298)$

$n = 0.105mol$ 3 sig. fig.

3

13. A sample of methane gas that has a volume of 3.8 L at 5°C is heated to 86°C at constant pressure. Calculate its new volume.

$V_1 T_2 = V_2 T_1$ $V_1 = 3.8L$ $T_1 = 5°C$ $T_2 = 86°C$

$(3.8)(86) = V_2 (5)$

$V_2 = 70L$ 1 sig. fig.

3

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Conversions
1 atm @ sea level
< 1 atm in mountains
> 1 atm below sea level
1 atm = 760 mm Hg
1 atm = 760 torr
1 torr = 1 mm Hg
1 atm = 101.3 kPa
1 atm = 15 PSI (pounds per inch^2)
K = °C + 273
1 mL = 1 cm^3

Constants
Avogadro's number = 6.022×10^{23}
R = ideal gas constant = 8.31 (L · kPa)/(K · mol)
R = ideal gas constant = .08206 (L · atm)/(K · mol)
ideal gas molar volume = 22.4 L/mol at STP
STP = standard temp. and pressure
liquids do **not** compress
solids and gases do compress
diffusion = movement from high to low concentration
effusion = escaping gas through a tiny hole
absolute zero = 0K = -273°C

Variables
P = pressure (atm)
V = volume (L)
n = moles (mol)
T = temp (K)
v = velocity (m/s)
m = mass (g)

Law	Boyle's	Charles'	Avogadro's	Gay-Lussac's	Combined	Ideal	Dalton's
Constants	n, T	P, n	P, T	V,n	n	R	V, n, T
Equations	$P_1V_1 = P_2V_2$	$V_1T_2 = V_2T_1$	$V_1n_2 = V_2n_1$	$P_1T_2 = P_2T_1$	$P_1V_1T_2 = P_2V_2T_1$	PV = nRT	$P_{total} = P_1 + P_2 + P_3$
		$V_1/T_1 = V_2/T_2$	$V_1/n_1 = V_2/n_2$	$P_1/T_1 = P_2/T_2$			
Examples	marshmallows	light bulbs	balloons	pressure cooker	hot bulb pops	@ STP	1 L + 1 L = 1 L
	large P = small V small P = small V	hotter = bigger colder = smaller	more air = bigger less air = smaller	hot = large P cold = small P	hot = large P large P → pops	only one unknown	2 atm + 3 atm = 5 atm in 1 L
Container	rigid	changing	changing	rigid	changing	changing	rigid

Factor	Pressure	Volume	Temperature	# of Particles
Pressure		indirect	direct	direct
Volume	indirect		direct	direct
Temperature	direct	direct		direct
# of Particles	direct	direct	direct	

Law	Graham's
Constants	moving particles
Equations	$v_1/v_2 = \sqrt{m_2/m_1}$
Examples	e=Air Zooka, d=Black Friday Shopping
Container	rigid with a hole

Boyle's Law	Charles' Law	Guy-Lassac's Law	Combined Gas Law
For a given mass of gas at constant temperature, the volume of a gas varies inversely with pressure	The volume of a fixed mass of gas is directly proportional to its Kelvin temperature if the pressure is kept constant.	The pressure of a gas is directly proportional to the Kelvin temperature if the volume is kept constant.	Combines Boyle's, Charles', and the Temperature-Pressure relationship into one equation. Each of these laws can be derived from this law.
$PV = k$ $P_1V_1 = P_2V_2$	$\frac{V}{T} = k$ $V_1T_2 = V_2T_1$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\frac{P}{T} = k$ $P_1T_2 = P_2T_1$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$\frac{PV}{T} = k$ $V_1P_1T_2 = V_2P_2T_1$ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Dalton's Law	Ideal Gas Law	Graham's Law
At constant volume and temperature, the total pressure exerted by a mixture of gases is equal to the sum of the pressures exerted by each gas,	The Ideal Gas Law relates the pressure, temperature, volume, and mass of a gas through the gas constant "R".	The rate of effusion/diffusion of two gases (A and B) are inversely proportional to the square roots of their formula masses. [*It can be a ratio of molecular speeds, effusion /diffusion times, distance traveled by molecules, or amount of gas effused*]
$P_{total} = P_1 + P_2 + P_3 + \ldots P_n$	$PV = nRT$	$\frac{Rate_A}{Rate_B} = \frac{\sqrt{molar\ mass_B}}{\sqrt{molar\ mass_A}}$

Abbreviations	Standard Conditions
atm = atmosphere mm Hg = millimeters of mercury torr = another name for mm Hg Pa = Pascal kPa = kilopascal K = Kelvin °C = degrees Celsius	0°C = 273 K 1.00 atm = 760.0 mm Hg = 76 cm Hg =101.325 kPa = 101, 325 Pa = 29.9 in Hg
Conversions	**Gas Law's Equation Symbols**
$K = °C + 273$ $F° = 1.8C° + 32$ $C° = \frac{F° - 32}{1.8}$ 1 cm^3 (cubic centimeter) = 1 mL (milliliter) 1 dm^3 (cubic decimeter) = 1 L (liter) = 1000 mL	Subscript (1) = old condition or initial condition Subscript (2) = new condition or final condition Temperature must be in Kelvins n = number of moles = grams/Molar mass R = 8.31 L-kPa/ mol-K = 0.0821 L-atm/mol-K = 62.4 L-Torr/mol-K You must have a common set of units in the problem