Gas Laws Classwork
Boyle's Law worksheet WS #1

Boyle's Law states volume and pressure are inversely **proportional, when** temp **is held constant.**

The formula used to show this relationship is $P_1V_1 = P_2V_2$.

1. Some oxygen occupies 250 mL when its pressure is 720 mm Hg. How many mL will it occupy when its pressure is 750 mm?

	1	2
P	720mmHg	750mmHg
V	250mL	x
T		

$P_1V_1 = P_2V_2$

$(720mmHg)(250mL) = (750mmHg)\ x$

$240\ mL = x$

2. A gas has a volume of 100 mL when the pressure is .856 atm. How many liters will the gas occupy at 1.55 atm of pressure?

	1	2
P	0.856atm	1.55atm
V	100 mL	x L
T		

$100mL \left| \frac{1\ L}{1000\ mL} \right. = 0.1\ L$

$P_1V_1 = P_2V_2$

$(0.856atm)(0.1L) = (1.55atm)(x)$

$0.06\ L = x$

3. A gas occupying 500 mL at a pressure of 650 torr is compressed to a new volume of 300 mL. What is the new pressure of the gas in atm?

	1	2
P	650 torr	x atm
V	500mL	300mL
T		

$650\ torr \left| \frac{1\ atm}{760\ torr} \right. = 0.86\ atm$

$P_1V_1 = P_2V_2$

$(0.86atm)(500mL) = (x)(300mL)$

$1.4atm = x$

4. A quantity of gas under a pressure of 700 mm Hg has ~~a volume of 380 L.~~ What is its volume at standard pressure (temperature constant)?

	1	2
P	700mmHg	760mmHg
V	380 L	?
T		

$P_1V_1 = P_2V_2$

$(700mmHg)(380L) = (760mmHg)(x)$

$400\ L = x$

5. Some nitrogen occupies 375 mL when its pressure is 650 mm Hg. How many mL will it occupy when its pressure is 725 torr?

	1	2
P	650mmHg	725 torr
V	375mL	x
T		

$P_1V_1 = P_2V_2$

$(650mmHg)(375mL) = (725\ torr)(x)$

$340mL = x$

mmHg = torr

Charles's Law worksheet WS #2

Charles' Law states volume and temperature are directly proportional, when pressure is held constant. Temperature must always be in Kelvin.

The formula used to show this relationship is $\frac{V_1}{T_1} = \frac{V_2}{T_2}$.

1. Given 90 mL of hydrogen gas collected when the temperature is 2°C, how many mL will the hydrogen occupy at 42°C?

	1	2
P		
V	90 mL	X
T	2°C + 273 = 275K	42°C + 273 = 315 K

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

$\frac{90mL}{275K} = \frac{X}{315K}$

$1.0 \times 10^2 mL$

2. A gas measured 500 mL at a temperature of -23°C. What will be its volume in mL at 23°C?

	1	2
P		
V	500mL	X
T	-23 + 273 = 250K	23 + 273 = 296 K

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{500mL}{250K} = \frac{X}{296K}$

$X = 600 mL$

3. A certain mass of gas measures 0.300 L at 15°C. At what Celsius temperature does this gas measure 0.25 L keeping pressure constant?

	1	2
P		
V	0.300L	0.25L
T	15°C + 273 = 288K	X

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{(0.300L)}{288K} = \frac{0.25L}{X}$

$X = 240K - 273$

$-33°C$

4. A sample of gas at 25°C occupies 2.34 L. What will be its volume at 300°C?

	1	2
P		
V	2.34L	X.
T	25°C + 273 = 298K	300 + 273 = 573 K

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{(2.34L)}{298K} = \frac{X}{573K}$

$X = 4.50 L$

5. At constant pressure, the volume of a gas is increased from 130 L to 250 L by heating it. If the original temperature of the gas was 20°C, what will its final temperature be?

	1	2
P		
V	130L	250L
T	20°C + 273 = 293K	X

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{(130L)}{293K} = \frac{250L}{X}$

$X = 560 K$

Gay Lussac's Law states temperature and pressure are directly proportional, when volume is held constant. Temperature must always be in Kelvin.

The formula used to show this relationship is $\frac{P_1}{T_1} = \frac{P_2}{V_2}$.

Combined Gas Law worksheet WS#3

The formula used to show this relationship is $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$. **Temperature must always be in** Kelvin.

1. A gas collected when the temperature is 27°C and the pressure is 80.0 cm Hg measures 500 mL. Calculate the volume in milliliters at -3.0°C and 75.0 cm Hg of pressure.

	1	2
P	80.0cmHg	75.0cmHg
V	500mL	?
T	300K	270.0 K

$$\frac{(80.0\text{cmHg})(500\text{mL})}{300\text{K}} = \frac{(75.0\text{cmHg})(x)}{270.0\text{K}}$$

$X = 500\text{mL}$

2. A sample of gas has a volume of 200 L when its temperature is 20.0°C and its pressure is 300.0 mm Hg. What volume will the gas occupy at STP?

	1	2
P	300.0mmHg	760mmHg
V	200mL	x
T	293.0K	273K

$$\frac{(300.0\text{mmHg})(200\text{mL})}{293.0\text{K}} = \frac{(760.0\text{mmHg})(x)}{273\text{K}}$$

$X = 70\text{ mL}$

3. A quantity of oxygen gas has a volume of 850.0 mL when measured at 27°C and 730.0 torr. Determine the volume at STP.

	1	2
P	730.0 torr	760.0 torr
V	850.0mL	x
T	300K	273K

$$\frac{(730.0\text{torr})(850.0\text{mL})}{300\text{K}} = \frac{(760.0\text{torr})(x)}{273\text{K}}$$

$X = 700\text{mL}$

4. At STP a gas has a volume of 500.0 L. What volume will it occupy at 10.0°C and 700.0 mm Hg?

	1	2
P	760mmHg	700.0mmHg
V	500.0L	x
T	273K	283.0 K

$$\frac{(760.0\text{mmHg})(500.0\text{L})}{273\text{K}} = \frac{(700.0\text{mmHg})(x)}{283.0\text{K}}$$

$X = 562.7\text{L}$

5. A quantity of gas has a volume of 200.0 L at 17.0°C and 800.0 mm of Hg. To what temperature must the gas be cooled for its volume to be reduced to 150.0 L at a pressure of 740.0 mm Hg?

	1	2
P	800.0mmHg	740.0mmHg
V	200.0L	150.0L
T	290.0K	x

$$\frac{(800.0\text{mmHg})(200.0\text{L})}{290.0\text{K}} = \frac{(740.0\text{mmHg})(150.0\text{L})}{x}$$

$X = 201.2\text{K}$

6. If 200 mL of a gas at 27°C and 760 mm Hg are warmed to 327°C, what pressure on the gas will maintain the original volume? *can do either G-L law or combined gas since volume is held constant*

	1	2
P	760mmHg	X
V	200mL	200mL
T	300K	600K

$$\frac{(760\text{mmHg})(200\text{mL})}{300\text{K}} = \frac{x\,(200\text{mL})}{600\text{K}}$$

$X = 2000\text{mmHg}$

Ideal Gas Law WS #4

Is used to find the number of moles when the gas is not at STP. Volume must always be in L. Temperature must always be in K. The pressure unit must match with the gas constant (R).

The equation used to show this relationship is PV=nRT.

1. How many moles of carbon monoxide are contained in a 372.2 mL bulb at 48.1°C if the pressure is 149.3 kPa?

P = 149.3 kPa
V = 372.2mL → 0.3722L
n = ?
R = 8.314 $\frac{L\,kPa}{mol\,K}$
T = 48.1°C → 321.1 K

(149.3 kPa)(0.3722L) = x(8.314)(321.1K)

0.0208 mol CO

2. A small cylinder of neon used in chemistry lectures has a volume of 340 mL. How many grams of neon are contained in such a cylinder at a pressure of 151 atm and a temperature of 27°C?

P: 151 atm
V: 340mL → 0.34L
n: X
R: 0.0821
T: 27°C → 300K

(151atm)(0.34L) = X (0.0821 $\frac{L\,atm}{mol\,K}$)(300K)

$x = \frac{2\,mol\,Ne}{1\,mol\,Ne} \left| \frac{20.18\,g\,Ne}{} \right.$

40 g Ne

3. What is the temperature of a 0.274 g sample of methane, CH_4, confined in a 300.0 mL bulb at a pressure of 198.7 kPa?

p: 198.7 kPa
V: 300.0mL → 0.3000 L
n: 0.0171 mol
R: 8.314 $\frac{L\,kPa}{mol\,K}$
T: X

$0.274g\,CH_4 \left| \frac{1\,mol}{16.042g} \right. = 0.0171\,mol$

(198.7 kPa)(0.3000L) = (0.0171 mol)(8.314 $\frac{L\,kPa}{mol\,K}$)(x)

x = 419 K

4. What is the volume of a bulb that contains 8.17 g of helium at 13°C and a pressure of 8.73 atm?

$8.17g\,He \left| \frac{1\,mol}{4.003g\,He} \right. = 2.04mol$

P = 8.73 atm
V = ?
n = 2.04 mol
R = 0.0821
T = 286 K

(8.73atm)(x) = (2.04mol)(0.0821)(286K)

x = 5.49 L

5. Calculate the volume occupied by 0.54 mol of nitrogen at 15°C and 0.967 atm.

P: 0.967 atm
V: X
n: 0.54 mol N_2
R: 0.0821
T: 288 K

(0.967atm)(x) = (0.54mol)(0.0821)(288K)

x = 13 L

6. Methane CH_4, can be used as fuel for an automobile; however, it is a gas at normal temperatures and pressures, which causes some problems with storage. One gallon of gasoline could be replaced by 655 g of CH_4. What is the volume of this much methane at 25°C and 745 torr.?

$655g\,CH_4 \left| \frac{1\,mol}{16.042g} \right. = 40.8mol$

P: 745 torr
V = X
n = 40.8 mol
R = 62.4
T = 298 K

(745 torr)(x) = (40.8mol)(62.4)(298K)

x = 1020 L

Ideal Gas Law to find Density & Molar Mass

The equations used to show these relationships are:

$$D = \frac{MP}{RT}$$

7. Calculate the density of ethane, C_2H_6, at a pressure of 183.4 kPa and at a temperature of 25°C.

D = X
M = 30.068 g/mol
P = 183.4 kPa
R = 8.314
T = 298K

↳ (30.068)

$$D = \frac{(30.068\ g/mol)(183.4\ kPa)}{(8.314)(298\ K)}$$

D = 2.23 g/L

8. Calculate the density of chlorine gas, Cl_2, at STP.

D = X
M = 70.9 g/mol
P = 1.00 atm
R = 0.0821
T = 273K

↳ 70.9

$$D = \frac{(70.9\ g/mol)(1.00\ atm)}{\left(0.0821 \frac{L\,atm}{mol\,K}\right)(273\ K)}$$

D = 3.16 g/L

9. Calculate the density of nitrogen, N_2, at a temperature of 373 K and a pressure of 108.3 kPa.

D = X
M = 28.01 g/mol
P = 108.3 kPa
$R = 8.314 \frac{L\,kPa}{mol\,K}$
T = 373K

↳ 28.01

$$D = \frac{(28.01\ g/mol)(108.3\ kPa)}{\left(8.314 \frac{L\,kPa}{mol\,K}\right)(373\ K)}$$

D = 0.978 g/L

10. If the density of carbon dioxide is 5.0g/mL, what temperature will the gas be under a pressure of 1.5 atm?

↳

$$\frac{5.0\ g}{mL} \left| \frac{1000\ mL}{1\ L} \right. = 5.0 \times 10^3 \frac{g}{L}$$

D = 5.0×10^3 g/L
M = 44.01 g/mol
P = 1.5 atm
R = 0.0821
T = X

$$\frac{5.0 \times 10^3\ g}{1\ L} = \frac{(44.01)(1.5\ atm)}{(0.0821)(L\ X)}$$

X = 0.16 K

11. At room temperature (25°C) a canister of CO_2 has a density of 236.3 g/L. What is the pressure (in atm) inside the canister?

D = 236.3 g/L
M = 44.01 g/mol
P = X
R = 0.0821
T = 298K

$$\frac{236.3\ g}{1\ L} = \frac{(44.01)(X)}{(0.0821)(298)}$$

X = 131 atm

12. Find the molar mass of a gas that has a density of 1.18 g/L at 25°C and 1 atm.

D = 1.18 g/L
M = X
P = 1 atm
R = 0.0821
T = 298K

$$\frac{(1.18\ g/L)}{1} = \frac{X\ (1\ atm)}{(0.0821)(298\ K)}$$

X = 30 g/mol

13. An unknown vapor had a mass of 0.846 g; the volume was 354 mL, pressure 752 torr, and temperature 100°C. Calculate the molar mass of the unknown vapor. → convert to Liters

$$D = \frac{m}{V} = \frac{0.846\ g}{.354\ L} = 2.39\ g/L$$

D = 2.39 g/L
M = X
P = 752 torr
R = 62.4
T = 373 K

$$\frac{2.39\ g/L}{1} = \frac{(x)(752\ torr)}{(62.4)(373\ K)}$$

X = 74.0 g/mol

14. At 27°C, 2.40 g of a gas occupies a volume of 9.84 L at a pressure of 172 torr. Calculate the molar mass of the gas.

$$D = \frac{2.40\ g}{9.84\ L} = 0.244\ \frac{g}{L}$$

D = 0.244 g/L
M = X
P = 172 torr
R = 62.4
T = 300 K

$$\frac{(0.244\ \frac{g}{L})}{1} = \frac{X\ (172\ torr)}{(62.4)(300K)}$$

X = 30 g/mol

Dalton's Law worksheet WS #5

Dalton's Law states that the sum **of the pressures of a mixture of gases is equal to the** total pressure **of the mixture.**

The equation that shows this relationship is $P_{total} = P_1 + P_2 + P_3 + \ldots$. **All pressures must have the same** unit of pressure

1. In a mixture of He, O_2, and N_2 gases, He exerts a partial pressure of 14.68 mm Hg and the partial pressure of O_2 is 36.5 mm Hg. What is the partial pressure of N_2 if the total pressure is 83.5 mm Hg?

$P_{total} = 83.5 mmHg$
$P_{He} = 14.68 mmHg$
$P_{O_2} = 36.5 mmHg$
$P_{N_2} = X$

$83.5 mmHg = 14.68 mmHg + 36.5 mmHg + P_{N_2}$

$P_{N_2} = 32.3 mmHg$

2. Suppose you have a one-liter container of hydrogen gas at two atmospheres pressure and a two-liter container of nitrogen gas at one atmosphere pressure. If you transfer the hydrogen to the container holding the nitrogen:

a) draw a diagram of the two containers and the transfer of gases.

b) What pressure would the hydrogen exert?

$(2atm)(1L) = X(2L)$
$X = 1 atm$

need to do this because volume is changing

c) What pressure would the nitrogen exert?

$P_{N_2} = 1 atm$

no conditions are changing for N_2, so its pressure stays the same

d) What would be the total pressure exerted by the mixture?

$P_{total} = 1 atm + 1 atm = 2 atm$

3. Suppose you have one liter of oxygen gas at a pressure of two atmospheres, one liter of nitrogen gas at a pressure of four atmospheres, and one liter of hydrogen gas at a pressure of six atmospheres. All three samples are at room temperature. If you transfer the oxygen and nitrogen to the container occupied by the hydrogen:

a) What pressure would the oxygen exert? 2 atm
b) What pressure would the nitrogen exert? 4 atm
c) What pressure would the hydrogen exert? 6 atm
d) What would be the total pressure exerted by the mixture? 12 atm

$P_{total} = 2atm + 4atm + 6atm$

Graham's Law Worksheet WS #6

Graham's Law states that the square root of the molar mass and rate of effusion/diffusion are inversely proportional. This means that the smaller the mass the faster the rate of effusion/diffusion.

The equation used to represent this relationship is:

$$\frac{\text{Rate A}}{\text{Rate B}} = \frac{\sqrt{mm_B}}{\sqrt{mm_A}}$$

1. Calculate the ratio of the speed of helium atoms to that of neon atoms at the same temperature.

↳ 4.003 ↳ 20.18

$$\frac{\sqrt{20.18}}{\sqrt{4.003}} = 2.245$$

Helium travels 2.245 times faster than Neon.

2. Calculate the ratio of the speed of helium atoms to that of fluorine molecules at the same temperature.

4.003 F_2 38.00

$$\frac{\sqrt{38.00}}{\sqrt{4.003}} = 3.081$$

Helium travels 3.081 times faster than fluoline.

3. The diffusion rate of an unknown gas is measured and found to be 31.50 mL/min. Under identical experimental conditions, the diffusion rate of O_2 is found to be 30.50 mL/min. If the choices are CH_4, CO, NO, CO_2, and NO_2, what is the identify of the unknown gas?

28.01 ↙ ↓ 16.042

30.01

$$\frac{\text{Rate A}}{\text{Rate B}} = \frac{\sqrt{mm_B}}{\sqrt{mm_A}} \qquad \frac{31.50\ mL/min}{30.50\ mL/min} = \frac{\sqrt{32.00}}{\sqrt{X}}$$

X = 30.00 g/mol NO

4. The rate of diffusion of a particular gas was measured and found to be 24.0 mL/min. Under the same conditions, the rate of diffusion of pure methane (CH_4) gas is 47.8 mL/min. What is the molar mass of the unknown gas?

$$\frac{\text{Rate A}}{\text{Rate B}} = \frac{\sqrt{mm_B}}{\sqrt{mm_A}} \qquad \frac{47.8\ mL/min}{24.0\ mL/min} = \frac{\sqrt{X}}{\sqrt{16.042}}$$

X = 63.6 g/mol

Mixed Gas Laws WS #7

1. If 400 mL of oxygen is collected at a pressure of 780 mm Hg, what volume will the gas occupy if the pressure is changed to 740 mm Hg?

a) What law is this? Boyle's law

b) What is the relationship? inverse

c) Predict if the variable asked for will increase or decrease. increase

d) Solve the problem.

	1	2
P	780mmHg	740mmHg
V	400mL	X
T		

$P_1V_1 = P_2V_2$

$(780mmHg)(400mL) = (740mmHg)\,x$

$x = 421mL$

→ 400mL

2. What is the volume of hydrogen at a pressure of 800 mm Hg if 200 mL of the hydrogen is collected at a pressure of 760 mm Hg?

a) What law is this? Boyle's law

b) What is the relationship? inverse

c) Predict if the variable asked for will increase or decrease. decrease

d) Solve the problem.

	1	2
P	800mmHg	760mmHg
V	X	200 mL
T		

$P_1V_1 = P_2V_2$

$(800mmHg)(X)\ x) = (760mmHg)(200mL)$

$X = 190\,mL$

→ 200 mL

3. Calculate the pressure of a gas which occupies a volume of 100 mL if it occupies a volume of 200 mL at a pressure of 700 mm Hg.

a) What law is this? Boyle's law

b) What is the relationship? inverse

c) Predict if the variable asked for will increase or decrease. ~~decrease~~ increase

d) Solve the problem.

	1	2
P	X	700mmHg
V	100 mL	200mL
T		

$P_1V_1 = P_2V_2$

$(x)(100mL) = (700mmHg)(200mL)$

$x = 1400mmHg$

→ 1000 mmHg

4. What volume will an amount of nitrogen occupy at 27°C if the gas occupies a volume of 400 mL at a temperature of 0°C?

a) What law is this? Charle's law

b) What is the relationship? direct

c) Predict if the variable asked for will increase or decrease. increase

d) Solve the problem.

	1	2
P		
V	X	400mL
T	27+273=300K	0+273=273K

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

$\frac{X}{300K} = \frac{400mL}{273k}$ $X = 440\ mL$

400mL

5. What is the volume of a gas at -20°C if the gas occupies 50.0 mL at 0°C?

a) What law is this? Charle's law

b) What is the relationship? direct

c) Predict if the variable asked for will increase or decrease. decrease

d) Solve the problem.

	1	2
P		
V	50.0mL	X
T	273K	253K

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

$\frac{50.0mL}{273.0K} = \frac{X}{253\ K}$ $X = 46.3\ mL$

6. If a gas occupies a volume of 700 mL at 10°C, at what temperature will it occupy a volume of 1 L if the pressure remains constant? 4.7 L

a) What law is this? Charle's law

b) What is the relationship? direct

c) Predict if the variable asked for will increase or decrease. increase

d) Solve the problem.

	1	2
P		
V	0.7 L	1 L
T	283K	X

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

$\frac{0.7L}{283k} = \frac{1L}{X}$

$X = 404\ K \rightarrow 400\ K$

7. Calculate the volume of a gas at STP if 500 mL of the gas is collected at 27°C and 75 cm Hg.

a) What law is this? Combined

b) Solve the problem.

	1	2
P	75 cmHg	76 cmHg
V	500 mL	x
T	300 K	273 K

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

$$\frac{(75\text{cmHg})(500\text{mL})}{300\text{K}} = \frac{(76\text{cmHg})x}{273\text{K}}$$

$x = 449\text{mL} \rightarrow 400\text{mL}$

8. If a gas occupies a volume of 100 mL at a pressure of 76 cm Hg and 27°C, what volume will the gas occupy at 800 mm Hg and 50°C?

a) What law is this? Combined

b) Solve the problem.

	1	2
P	76 cm Hg	80 cmHg
V	100 mL	x
T	27 +273 = 300K	323K

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

$$\frac{(76\text{cmHg})(100\text{mL})}{300\text{K}} = \frac{(80\text{cmHg})(x)}{323\text{K}}$$

$x = 102\text{ mL} \rightarrow 100\text{mL}$

9. If the pressure on 100 mL of gas is doubled, what volume does the gas occupy, assuming no other changes?

a) What law is this? Boyle's law

b) What is the relationship? inverse

c) Predict if the variable asked for will increase or decrease. decrease

d) Solve the problem.

	1	2
P	1atm	2atm
V	100mL	
T		

$$P_1V_1 = P_2V_2$$

$$(1\text{atm})(100\text{mL}) = (2\text{atm})(x)$$

$50\text{mL} = x$

10. If the temperature of a gas is 0°C and the temperature is changed so that the gas volume doubles, what is the new temperature of the gas?

a) What law is this? Charle's law

b) What is the relationship? direct

c) Predict if the variable asked for will increase or decrease. increase

d) Solve the problem.

	1	2
P		
V	100 mL	200 mL
T	273K	x

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

$$\frac{100\text{mL}}{273\text{K}} = \frac{200\text{mL}}{x}$$

$x = 546\text{ K}$

11. The volume of a gas at a pressure of 700 mm Hg is doubled and the temperature remains constant. What is the final pressure exerted by the gas?

a) What law is this? Boyle's

b) What is the relationship? inverse

c) Predict if the variable asked for will increase or decrease. decrease

d) Solve the problem.

	1	2
P	700mmHg	x
V	1L	2L
T		

$P_1V_1 = P_2V_2$

$(700mmHg)(1L) = x\,(2L)$

$350mmHg$ X

→ 400mm Hg

12. A certain volume of gas occupies 100 mL at 1520 mm Hg and 0° C. How could its volume be lowered to 80 mL at constant pressure?

a) What law is this? Charle's

b) What is the relationship? direct

c) Predict if the variable asked for will increase or decrease. decrease

d) Solve the problem.

	1	2
P		
V	100mL	80mL
T	273K	X

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

$\frac{(100mL)}{273K} = \frac{80mL}{X}$

$X = 218K$

→ 200 K

13. Calculate the density of oxygen, O_2, at STP.

a) What law is this? Ideal w/ density + molar mass

b) Solve the problem.

D = ?
M = 32.00
P = 1 atm
R = 0.0821
T = 273 K

$D = \frac{(32.00\ g/mol)(1\ atm)}{(0.0821)(273K)}$

D = 1.43 g/L