Key

Boyles Law Problems 1

1. $P_1 = 400$ mm, $V_1 = 3$ liters, $V_2 = 7.5$ liters; find P_2.

160 mmHg

2. $P_1 = 4.8$ atm, $V_1 = 2000$ mL, $P_2 = 1.6$ atm; find V_2.

6000 mL

3. If 3 liters of hydrogen gas has its initial pressure tripled, what new volume will it occupy when the temperature is constant?

$3L\, P_1 = V_2\, 3P_1$

1 L

4. If 10 liters of a gas at a pressure of 700 torr is confined to a volume of only 1 liter, what is the new pressure?

7000 torr

5. 100 cubic cm of air at 30 in. of pressure will have what volume at 25 in. of pressure?

$120\ cm^3$

6. 2 quarts of CO_2 at 760 torr will occupy what volume (in quarts) at 1520 mm of pressure?

$1520\ mmHg \times \frac{760}{760} =$

$2qt\ (760) = x\ 1520\ torr$

1 qt

7. 50 mLs of sulfur dioxide at 380 mm of pressure will take up what volume at STP? (1 atm, 0°C)

$380\ mmHg\ (0.05L) = 760\ mmHg\ x$

0.025 L

25 mL

8. If 6 cubic feet of natural gas has its pressure doubled, what will its volume become?

$6ft^3\ P = V_2\ 2P$

$3ft^3$

9. How does the volume of an automobile tire inflated at 742 mm Hg compare with its volume at STP, if the temperature doesn't change?

$742\ mmHg\ V_1 = 760\ mmHg\ V_2$

$V_1 = 1.02\, V_2$

10. 1.25 mL of water vapor with a pressure of 1.1 atm will occupy what volume at standard pressure?

$1.1\ atm\ (1.25\ mL) = 1\ atm\ V_2$

1.375 mL

1.4 mL

Charles' Law Problems

1. $V_1 = 64\ ft^3$, $T_1 = 120\ K$, $T_2 = 600\ K$; what is V_2?

$\frac{64}{120} = \frac{x}{600}$ 320 ft³

2. $V_1 = 330$ liters, $T_1 = 1500\ K$, $V_2 = 110$ liters; what is T_2?

$\frac{330}{1500} = \frac{110}{x}$ 500 K

3. 50 quarts of air at 127°C will occupy what volume at 327°C?

$\frac{50qt}{400} = \frac{x}{600}$ 80 qt

4. 72 mL of hydrogen gas at -163°C will have what Kelvin temperature at a volume of 7.2 mL?

$\frac{72}{110K} = \frac{7.2}{x}$ 11 K

5. Tripling the volume of air at 300 K will cause what new Kelvin temperature?

$\frac{V}{300} = \frac{3V}{x}$ 900 K

6. If the Kelvin temperature of 520 mL of helium gas is dropped to one-fourth of what it was, what is the resulting new volume?

$\frac{520mL}{T} = \frac{x}{0.25T}$ 130 mL

7. 86 cubic meters of argon at -73°C will have what Kelvin temperature when the volume becomes 215 m^3?

$\frac{86}{200} = \frac{215}{x}$ 500 K

8. 4×10^3 liters of chlorine at 47°C will have what Kelvin temperature when the volume is 8×10^2 liters?

$\frac{4\times10^3}{320} = \frac{8\times10^2}{x}$ 64 K

9. 2.8 quarts of fluorine at 450 K will occupy what volume at standard temperature?

$\frac{2.8}{450} = \frac{x}{273}$ $x = 1.7$ qt

10. 100 cubic centimeters of xenon at -33°C will have what Celsius temperature when the volume is quadrupled?

$\frac{100cc}{240} = \frac{400}{x}$ 960 K = 687°C

Gay-Lussac's Law Probems 1

1. A sample of hydrogen at 47°C exerts a pressure of 0.329 atm. The gas is heated to 77°C at constant volume. What will its new pressure be?

$\frac{0.329}{320} = \frac{x}{350}$ 0.360 atm

2. To what temperature must a sample of nitrogen at 27°C and 0.625 atm be taken so that its pressure become 1.125 atm at constant volume?

$\frac{0.625}{300} = \frac{1.125}{x}$ x = 540 K

3. The pressure on a gas at -73°C is doubled, but its volume is held constant. What will the final temperature be in degrees Celsius?

$\frac{P}{200K} = \frac{2P}{x}$ 127°C

4. Calculate the final pressure inside a scuba tank after it cools from 1.00×10^3 °C to 25.0 °C. The initial pressure in the tank is 130.0 atm.

$\frac{130}{1273} = \frac{\quad}{298}$ 30.4 atm

5. A 30.0 L sample of nitrogen inside a rigid, metal container at 20.0 °C is placed inside an oven whose temperature is 50.0 °C. The pressure inside the container at 20.0 °C was at 3.00 atm. What is the pressure of the nitrogen after its temperature is increased?

30L

$\frac{3atm}{293} = \frac{\quad}{323}$ 3.31 atm

6. The temperature of a sample of gas in a steel container at 30.0 kPa is increased from -100.0 °C to 1.00×10^3 °C. What is the final pressure inside the tank?

$\frac{30 kPa}{173} = \frac{x}{1273}$ x = 221 kPa

7. A sample of gas at 3.00×10^3 mm Hg inside a steel tank is cooled from 500.0 °C to 0.00 °C. What is the final pressure of the gas in the steel tank?

$\frac{3 \times 10^3}{773} = \frac{P_2}{273}$ P_2 = 1059.5 mmHg

1060 mmHg

See other side →

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Combined Gas Law Problems 1

1. P_1 = 1200 torr, V_1 = 8 liters, T_1 = 200 K and P_2 = 600 torr, T_2 = 1000 K; what is V_2?

$$\frac{1200(8)}{200} = \frac{600\ V_2}{1000} \qquad V_2 = 80$$

2. P_1 = 3 atm, V_1 = 45 quarts, T_1 = 990 K and V_2 = 15 quarts, T_2 = 110 K; what is P_2?

$$\frac{3\text{atm} \cdot 45\text{qt}}{990\text{K}} = \frac{15\text{qts} \cdot P_2}{110\text{K}} \qquad 14850 = 14850\ P_2 \qquad P_2 = 1\text{ atm}$$

3. 50 mL of oxygen gas at 15 inches of pressure and 27°C will occupy what new volume at 25 inches of pressure and 127°C?

$$\frac{15\text{in} \cdot 50\text{mL}}{300} = \frac{25 \cdot V_2}{400} \qquad V_2 = 40\text{mL}$$

4. 35 cubic cm of methane at 1520 mm Hg and 240 K will have what temperature at 7 cubic cm and standard pressure?

$$\frac{35\text{cm}^3 \cdot 1520\text{mmHg}}{240\text{K}} = \frac{7\text{cm}^3 \cdot 760\text{mmHg}}{T_2} \qquad T_2 = 24\text{ K}$$

5. 1000 cu. ft of CO_2 at 19 p.s.i. at -173°C will occupy what volume at 24 p.s.i. and 727°C?

$$\frac{1000\text{ft}^3 \cdot 19\text{psi}}{100\text{K}} = \frac{V_2 \cdot 24\text{psi}}{1000\text{K}} \qquad V_2 = 7917\text{ ft}^3$$

6. 12 in^3 of sulfur dioxide at 600 torr and 200 K will have what temperature at a volume of 3 in^3 and a pressure of 1000 mm Hg?

$$\frac{12\text{in}^3 \cdot 600\text{ torr}}{200\text{K}} = \frac{3\text{in}^3 \cdot 1000\text{ torr}}{T_2} \qquad T_2 = 83\text{ K}$$

7. 9 liters of air will have what volume when its Kelvin temperature is 4 times as high and its pressure is increased to 8 times what it was?

$$\frac{9\text{L} \cdot P_1}{T_1} = \frac{8P_1 V_2}{4T_1} \qquad 36\ P_1 T_1 = 8 P_1 T_1 V_2 \qquad 4.5\text{L} = V_2$$

8. A gas with an original temperature of 17°C will have what new temperature when its pressure and its volume is doubled?

$$\frac{P_1 V_1}{290\text{K}} = \frac{2P_1 2V_1}{T_2} \qquad T_2 = 1160\text{K}$$

Key

$PV = nRT$

Ideal Gas Law Problems 1

1. What volume would 25.00 g of O_2 occupy at STP?

$25g \times \frac{1mol}{32g} = 0.78125mol$

$1atm(V) = (0.78125mol)(0.0821\frac{L \cdot atm}{mol \cdot K})(273K)$

$V = 17.51L$

2. Calculate the volume of 0.3000 moles of a gas at 60°C and 0.821 atm.

$0.821atm(V) = 0.3000mol(0.0821)(333K)$

$V = 9.99L = 10L$

3. Compute the weight of 6.00 L of ammonia gas, NH_3, at STP.

$1atm(6.00L) = (0.0821)(mol)(273K)$

$n = 0.267698mol \times \frac{17g}{1mol} = 4.55g$

4. What volume will 1.216 g of SO_2 gas occupy at 18°C and 755 torr?

$32 + 32 = 64$

$1.216g \times \frac{1mol}{64g} = 0.019mol$

$755torr \times \frac{1atm}{760torr} = 0.99342atm$

$0.99342atm(V) = (0.019mol)(0.0821)(291)$

$V = 0.457L$

0.46L

5. If you have 4 moles of a gas at a pressure of 5.6 atm and a volume of 12 liters, what is the Celsius temperature?

$5.6atm(12L) = 4mol(0.0821)(T)$

$204.628K = T$

$-68.37°C$ | $-70°C$

6. If there are 3 moles of a gas in a container with a volume of 60 liters and a temperature of 400 K, what is the pressure inside the container?

$P(60L) = 3mol(0.0821)(400K)$

$P = 1.64atm$

2 atm

7. What Kelvin temperature would 1.9 moles of a gas held at a pressure of 5 atm in a container with a volume of 50 liters have?

$5\,atm \cdot 50L = 0.0821 \frac{L \cdot atm}{mol \cdot K} (1.9\,mol)\, T$

$T = 1602.6668\,K$ $\boxed{2000\,K}$

8. If your have 2.4 moles of a gas at a temperature of 97°C in a container with a volume of 45 liters, what would its pressure be?

$P(45L) = 2.4(0.0821)(370)$

$P = 1.6\,atm$

9. Determine the approximate molecular weight of a gas if 560 mL has a mass of 1.80 g at STP.

$1\,atm(0.560L) = 0.0821(n)(273K)$

$n = 0.024985\,mol$

$\frac{1.80g}{n} = 72\,g/mol$ Ge

10. The pressure exerted on a diver by the water increases by about 100 kPa for every 10 m of depth. A scuba diver uses air at the rate of 8 L/min at a depth of 10 m where the pressure is 200 kPa (100 kPa due to the atmosphere and 100 kPa due to the water pressure) and the temperature is 8°C. If the diver's 10 L air tank is filled to a pressure of 2.1×10^4 kPa at a dockside temperature of 32°C, how long can the diver remain safely submerged?

10m 100kPa H_2O

8 L/min @ 10m ($P = 200\,kPa$, $T = 281\,K$)

tank

$V = 10L$

$P = 21000\,kPa$

$T = 32°C = 305K$

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{(21000\,kPa)(10L)}{(8.314 \frac{L \cdot kPa}{mol \cdot K})(305K)}$

$n = 82.815\,mol$ of air

$PV = nRT$

$V = \frac{nRT}{P} = \frac{82.815\,mol\,(8.314)(281)}{200}$

$V = 967.376L$

$967.376L \cdot \frac{1\,min}{8L} = 120.92\,min$

~2 hrs

Name: ________________________________

Date: ______________________

$\frac{V_1}{n_1} = \frac{V_2}{n_2}$

Avogadro's Law

1. n1= 3.40 mol V1= 3.50 L n2 = 1.50 mol V2= ?

$\frac{3.50L}{3.40mol} = \frac{V_2}{1.50mol}$ 5.25 = 3.40 V_2 $V_2 = 1.54L$

2. n1= 1.50 mol V1= 30.0 L n2 = ? mol V2= 10.0 L

$\frac{30.0L}{1.50mol} = \frac{10.0L}{n_2}$ 0.50 mol

3. n1= 1.10 mol V1= 7.70 L n2 = 3.30 mol V2= ?

$\frac{7.70L}{1.10mol} = \frac{V_2}{3.30mol} =$ 23.1 L

4. n1= 0.500 mol V1= 11.2 L n2 = ? mol V2= 44.8 L

$\frac{11.2L}{0.500mol} = \frac{44.8L}{n_2} =$ 2.00 mol

5. If 0.50 mol of oxygen occupies a volume of 7.20 L at STP, what volume does 1.5 moles of O2 occupy at STP?

$\frac{7.20L}{0.5mol} = \frac{x}{1.5mol}$ V = 21.6L

6.If 3.25 mole of argon gas occupies a volume of 1.00 L at STP, what volume does 14.15 mol of argon occupy?

$\frac{1L}{3.25mol} = \frac{V_2}{14.15mol} =$ V_2 = 4.35L

7. If 12.40 mol of CO2 occupies a volume of 96.8 L, how many moles occupy 72.6 L?

96.8x = 900.24 $\frac{96.8L}{12.40mol} = \frac{72.6L}{x}$ n_2 = 9.30mol

8. If 0.40 g of Helium has a volume of 6.2 L, how many grams of helium would occupy 15.5 L?

6.2x = 6.2 $\frac{6.2L}{0.40g} = \frac{15.5L}{x}$ x = 1.0 g

$0.40g \times \frac{1mol}{4.00g}$

0.1mol

$\frac{6.2L}{0.1mol} = \frac{15.5L}{x}$

$x = 0.25mol \times \frac{4g}{1mol}$

= 1g

9.If 14.0 g of nitrogen occupies a volume of 16.8 L, what volume will 49.0 g of nitrogen have?

$\frac{16.8L}{14.0g} = \frac{x}{49.0g}$ V_2 = 58.8L

$\frac{1mol}{28g} \times 14.0g$ $49.0g \times \frac{1mol}{28g}$

Dalton's Law of Partial Pressures Problems 1

1. Three of the primary components of air are carbon dioxide, nitrogen, and oxygen. In a sample containing a mixture of only these gases at exactly one atmosphere pressure, the partial pressures of carbon dioxide and nitrogen are given as P_{CO_2} = 0.285 torr and P_{N_2} = 593.525 torr. What is the partial pressure of oxygen?

1 atm = 760 torr

$760 = 0.285 + 593.525 + P_{O_2}$

$760 = 593.81 + P_{O_2}$

$P_{O_2} = 166.190$ torr

2. Determine the partial pressure of oxygen collected by water displacement if the water temperature is 20.0°C and the total pressure of the gases in the collection bottle is 730.0 torr.

p196

H_2O: 17.54 mm Hg

730.0 torr = 17.54 torr + P_{O_2}

$P_{O_2} = 712.46$

712.5 torr

3. A sample of gas is collected over water at a temperature of 35.0°C when the barometric pressure reading is 742.0 torr. What is the partial pressure of the dry gas?

P_{H_2O} = 42.18 torr

742.0 torr = 42.18 torr + P_{gas}

P_{gas} = 699.8 torr

4. A sample of oxygen is collected in a 175 mL container over water at 15°C, and the barometer reads 752.0 torr. What volume would the dry gas occupy at 770.0 torr and 15°C?

$P_{gas} = P_{O_2} + P_{H_2O}$

dry gas = no H_2O

752.0 torr = P_{O_2} + 12.79 torr

P_{O_2} = 739.2 torr

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{(739.2)(175\text{ mL})}{288.15} = \frac{(770.0) V_2}{288.15}$

V_2 = 168 mL

15+273.15

$r_1^2 M_1 = r_2^2 M_2$ $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$ → longer = must be heavier

Graham's Law

r↑ M↓

1. In an experiment, it takes an unknown gas 1.5 times longer to diffuse than the same amount of oxygen gas, O_2. Find the molar mass of the unknown gas.

rate = how fast

1.5 = how long

$r_1 = O_2 = x$

$r_2 =$

$\frac{0.67x}{x} = \sqrt{\frac{32.0 g/mol}{mm}}$ $0.4489 = \frac{32.0}{mm}$ $1/1.5 = 0.67$

$O_2 = r$ $U = 0.67r$

mm = 71 g/mol

2. Suppose a gas diffuses 1.4 times as fast as sulfur dioxide at the same temperature and pressure. What is the molar mass of the unknown gas?

32.06
3200
64.06

$\frac{1.4 r_{SO_2}}{r_{SO_2}} = \sqrt{\frac{64.02}{M_1}}$

$M_1 = 32.66$ g/mol

3. At the same temperature and pressure, which gas moves faster: oxygen or nitrogen? How many times is the speed of the faster gas greater than that of the slower gas?

$\frac{r_{O_2}}{r_{N_2}} = \sqrt{\frac{28 g/mol}{32 g/mol}}$ $\frac{r_{O_2}}{r_{N_2}} = \sqrt{0.875}$ $r_{O_2} = 0.94 r_{N_2}$

$\frac{r_{O_2}}{r_{N_2}} = 0.94$ r_{O_2} is faster

1.06 x faster

4. What is the ratio of the rates of diffusion of hydrogen gas to ethane gas, C_2H_6?

24
6.06

$\frac{r_{H_2}}{r_{C_2H_6}} = \sqrt{\frac{30.06}{2.02}}$ $\frac{r_{H_2}}{r_{C_2H_6}} = 3.86$

5. Oxygen gas diffuses 1.41 times faster than an unknown gas. What is the molar mass of the unknown gas?

$\frac{r_u}{1.41 r_u} = \sqrt{\frac{32.0}{mm}}$ $\frac{1}{1.41} = \frac{\sqrt{32.0}}{\sqrt{mm}}$

$7.976 = \sqrt{mm}$

mm = 63.62 g/mol

6. Methane (CH_4) diffuses 1.66 times faster than another alkane (simplest straight chained carbon hydrogen compounds containing only single bonds). What is the mass of the unknown alkane? Can you predict the formula if you know that the compound contains 3 carbon atoms?

C_3H_8

$\frac{1.66r}{r} = \sqrt{\frac{mm}{16.04}}$

12
4.04

mm = 44.20 g/mol

C 3 × 12 = 36

44.20
− 36
8.2

C_3H_8