KEY

Gas Law Calculations Using STP

Name_____

Boyle's Law Charles' Law	$P_1V_1 = P_2V_2$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Combined Gas Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Ideal Gas Law	$PV=nRT$ $(R = 0.0806\ L\cdot atm/mol\cdot K)$

What is STP? STP stands for standard temperature and pressure. Standard temperature is always 273K. Standard pressure is always 1.00atm.

Example #1: How many moles of oxygen will occupy a volume of 2.50 L at STP?

Standard temperature = 273K Standard pressure = 1.00 atm, so plug in to ideal gas law.

(1.00atm)(2.50L) = n(.08206)(298K) n = .102 mol oxygen

1. What is the volume of gas at 2.00 atm and 200.0 K if its original volume was 200.0 L at STP?

$P_1 = 1.00atm$
$T_1 = 273k$
$V_1 = 200.0L$

$P_2 = 2.00atm$
$T_2 = 200.0K$
$V_2 = ?$

$\left(\frac{200k}{2.00atm}\right)\frac{(1.00atm)(200.0L)}{273k} = \frac{(2.00atm)\,V_2}{200.0k}\left(\frac{200k}{2.00atm}\right)$

$V_2 = 73.3L$

2. How many moles of nitrogen gas will occupy a volume of 150 L at STP?

$n = \frac{PV}{RT}$ $\frac{(1.00atm)(150L)}{(0.08206)(273k)} = 6.6957$ or

6.70 mol N_2

3. At conditions of 1.50 atm of pressure and 15.0 °C temperature, a gas occupies a volume of 45.5 ml. What will be the volume of the same gas at STP?

$P_1 = 1.50atm$ $P_2 = 1.00atm$
$V_1 = 45.5mL$ $V_2 = ?$
$T_1 = 288K$ $T_2 = 273K$

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

$\left(\frac{273k}{1.00atm}\right)\frac{(1.50atm)(45.5mL)}{288k} = \frac{1.00atm\ V_2}{273k}\left(\frac{273k}{1.00atm}\right)$

$V_2 = 64.7mL$

4. A sample of neon is collected at 2.70 atm and 12.0°c. It has a volume of 2250 mL. What would be the volume of this gas at STP?

$P_1 = 2.70\ atm$ $T_1 = 285K$ $V_1 = 2250mL$ $P_2 = 1.00\ atm$ $T_2 = 273K$ $V_2 = ?$

$$\frac{(2.70\ atm)(2250\ mL)}{285K} = \frac{(1.00\ atm)(V_2)}{273K}$$

$$\frac{(2.70\ atm)(2250\ mL)(273K)}{(285K)(1.00\ atm)} = V_2 = 5819$$

5820 mL

5. A gas has a pressure of 0.370 atm at 50.0°C. What is the pressure at standard temperature?

$P_1 = 0.370\ atm$ $T_1 = 323K$ $P_2 = ?$ $T_2 = 273K$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \qquad \frac{0.370\ atm}{323K} = \frac{?}{273K}$$

$$\frac{(0.370\ atm)(273K)}{323K} = .313\ atm$$

6. A gas has a volume of 450.0 mL at STP. What volume will it occupy if the temperature is increased to 35.0°C?

$P = 1.00\ atm$ $T = 273K$ $V = 450.0mL$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \frac{450.0mL}{273K} = \frac{V_2}{308K}$$

$$\frac{(450.0mL)(308K)}{273K} = V_2 = 507.7\ mL \text{ or } 508\ mL$$

7. What volume would a gas occupy 2.50 atm, if it occupied 1.40 L at STP?

$P_1 = 1.00\ atm$ $V_1 = 1.40L$ $P_2 = 2.50\ atm$ $V_2 = ?$

$$\frac{(1.00\ atm)(1.40L)}{2.50\ atm} = \frac{2.50\ atm \cdot V_2}{2.50\ atm} \qquad V_2 = 0.560L$$

8. What is the mass of 5.00 L of NO_2 gas at STP?

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

$$n = \frac{(1.00\ atm)(5.00L)}{\left(\frac{0.08206\ L \cdot atm}{mol \cdot K}\right)(273K)} = 0.223\ mol\ NO_2 = n$$

Now convert moles to mass

$$\frac{0.223\ mol\ NO_2}{1} \left| \frac{46.01\ g\ NO_2}{1\ mol\ NO_2} \right. = 10.3g\ NO_2$$

9. A sample of oxygen gas occupies 5.60 L at STP. How many moles of oxygen are present? What is the mass of the oxygen sample?

$$n = \frac{PV}{RT} = \frac{(1.00\ atm)(5.60L)}{\left(\frac{.08206\ L \cdot atm}{mol \cdot K}\right)(273K)} = 0.250\ mol\ O_2$$

$$\frac{0.250\ mol\ O_2}{1} \left| \frac{32.00\ g\ O_2}{1\ mol\ O_2} \right. = 8.00g\ O_2$$