QUESTION #3

Helium occupies 3.8 L at -45°C.
What volume will it occupy at 45°C?

ANSWER #3

V_1 = 3.8 L
T_1 = -45°C (228 K)
V_2 = ?
T_2 = 45°C (318 K)

QUESTION #4

Chlorine gas has a pressure of 1.05 atm at 25°C. What pressure will it exert at 75°C?

ANSWER #4

P_1 = 1.05 atm

T_1 = 25°C = 298 K

P_2 = ?

T_2 = 75°C = 348 K

QUESTION #5

A gas occupies 256 mL at 720 torr and 25°C. What will its volume be at STP?

ANSWER #5

V_1 = 256 mL
P_1 = 720 torr
T_1 = 25°C = 298 K
V_2 = ?
P_2 = 760. torr
T_2 = 273 K

QUESTION #6

A gas occupies 1.5 L at 850 mm Hg and 15°C. At what pressure will this gas occupy 2.5 L at 30.0°C?

ANSWER #6

V_1 = 1.5 L
P_1 = 850 mm Hg
T_1 = 15°C = 288 K
P_2 = ?
V_2 = 2.5 L
T_2 = 30.0°C = 303 K

QUESTION #8

A gas occupies 125 mL at 125 kPa. After being heated to 75°C and depressurized to 100.0 kPa, it occupies 0.100 L. What was the original temperature of the gas?

ANSWER #8

V_1 = 125 mL
P_1 = 125 kPa
T_2 = 75°C = 348 K
P_2 = 100.0 kPa
V_2 = 0.100 L = 100. mL
T_1 = ?

QUESTION #9

A 3.2-L sample of gas has a pressure of 102 kPa. If the volume is reduced to 0.65 L, what pressure will the gas exert?

ANSWER #9

$V_1 = 3.2$ L
$P_1 = 102$ kPa
$V_2 = 0.65$ L
$P_2 = ?$

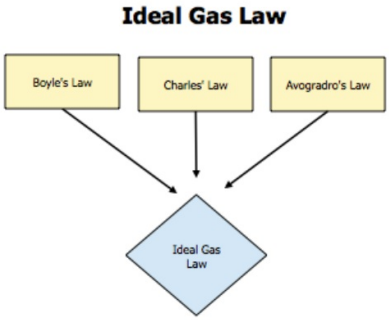
QUESTION #10

A gas at 2.5 atm and 25°C expands to 750 mL after being cooled to 0.0°C and depressurized to 122 kPa. What was the original volume of the gas?

ANSWER #10

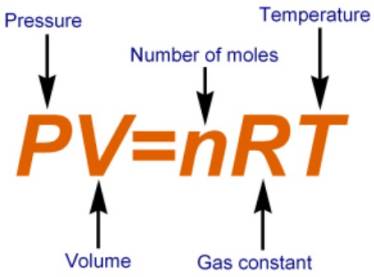
P_1 = 2.5 atm
T_1 = 25°C = 298 K
V_2 = 750 mL
T_2 = 0.0°C = 273 K
P_2 = 122 kPa = 1.20 atm
V_1 = ?

The Ideal Gas Law



PV = nRT

P = Pressure (in kPa)
V = Volume (in Liters)
n = # of moles of gas (mol)
T = temperature (in K)
R = universal gas constant = 8.314 $\frac{\text{L-kPa}}{\text{mol-K}}$



Example #1

There is 32 g of Oxygen at 0° is under 101.3 kPa of pressure. Find the sample's volume.

Answer: [redacted]

Example #2

0.25 g of carbon dioxide fills a 350 mL container at 127 °C. Find the pressure.

Answer: [redacted]

Example #3

If I have four moles of a gas at a pressure of 5.6 atm and a volume of 12 liters, what is the temperature?

Answer: [redacted]

Example #4

If I have an unknow quanitity of a gas at a pressure of 1.2 atm, a volume of 31 liters, and a temperature of 87 ^{o}C, how many moles of a gas do I have?

Answer: [redacted]

Example #5

If I contain 3 moles of gas in a container with a volume of 60 liters and at a temperature of 400 K, what is the pressure inside the container?

Answer: [redacted]

Example #6

If I have 7.7 moles of gas at a pressure of 9.12 kPa and at a temperature of 56 °C, what is the volume of the container that the gas is in?

Answer: [redacted]

Gas Stoichiometry

Moles ↔ Liters of a Gas:

- STP - use 22.4 L/mol
- Non-STP - use ideal gas law

Non-STP

- Given liters of gas?
  - start with ideal gas law
- Looking for liters of gas?
  - start with stoichiometry conversion

Gas Stoichiometry Problem

What volume of CO_2 forms from 5.25 g of $CaCO_3$ at 103 kPa & 25ºC?

$$CaCO_3 \rightarrow CaO + CO_2$$

5.25 g ? L non-STP

Looking for liters: Start with stoich and calculate moles of CO_2.

$$\frac{5.25\text{ g } CaCO_3}{} \times \frac{1\text{ mol } CaCO_3}{} \times \frac{1\text{ mol } CO_2}{} = \textbf{1.26 mol } CO_2$$

$$\frac{}{100.09\text{g } CaCO_3} \times \frac{}{1\text{ mol } CaCO_3}$$

Plug this into the Ideal Gas Law to find liters.

Courtesy Christy Johannesson www.nisd.net/communicationsarts/pages/chem

Gas Stoichiometry Problem

- What volume of CO_2 forms from 5.25 g of $CaCO_3$ at 103 kPa & 25ºC?

GIVEN:	WORK:
P = 103 kPa V = ? n = 1.26 mol T = 25°C = 298 K R = 8.315 L·kPa/mol·K	PV = nRT (103 kPa)V =(1mol)(8.315 L·kPa/mol·K)(298K) **V = 1.26 dm³ CO_2**

Courtesy Christy Johannesson www.nisd.net/communicationsarts/pages/chem

Gas Stoichiometry Problem

How many grams of Al_2O_3 are formed from 15.0 L of O_2 at 97.3 kPa & 21°C?

$$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$$

15.0 L non-STP ? g

GIVEN:	WORK:
P = 97.3 kPa V = 15.0 L n = ? T = 21°C = 294 K R = 8.315 L·kPa/mol·K	PV = nRT (97.3 kPa) (15.0 L) = n (8.315 L·kPa/mol·K) (294K) n = 0.597 mol O_2

Given liters: Start with Ideal Gas Law and calculate moles of O_2.

NEXT →

Gas Stoichiometry Problem

How many grams of Al_2O_3 are formed from 15.0 L of O_2 at 97.3 kPa & 21°C?

$$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$$

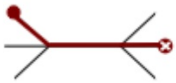
15.0L non-STP ? g

Use stoich to convert moles of O_2 to grams Al_2O_3.

$$\frac{0.597\ \text{mol } O_2}{} \times \frac{2\ \text{mol } Al_2O_3}{3\ \text{mol } O_2} \times \frac{101.96\ \text{g } Al_2O_3}{1\ \text{mol } Al_2O_3} = 40.6\ \text{g } Al_2O_3$$

Find vol. hydrogen gas made when 38.2 g zinc react w/excess hydrochloric acid.
Pres. = 107.3 kPa; temp.= 88°C.

$$\underset{38.2\ g}{Zn\ (s)} + \underset{excess}{2\ HCl\ (aq)} \longrightarrow ZnCl_2(aq) + \underset{\substack{X\ L \\ (13.1\ L)}}{H_2(g)}$$



$$x\ L\ H_2 = 38.2\ \cancel{g\ Zn}\left(\frac{1\ \cancel{mol\ Zn}}{65.4\ \cancel{g\ Zn}}\right)\left(\frac{1\ \cancel{mol\ H_2}}{1\ \cancel{mol\ Zn}}\right)\left(\frac{22.4\ L\ H_2}{1\ \cancel{mol\ H_2}}\right) = 13.1\ L\ H_2$$

BUT NOT AT STP!!!

Gas Stoichiometry

Find vol. hydrogen gas made when 38.2 g zinc react w/excess hydrochloric acid.
Pres. = 107.3 kPa; temp.= 88°C.

$$\underset{38.2\ g}{Zn\ (s)} + \underset{excess}{2\ HCl\ (aq)} \longrightarrow ZnCl_2(aq) + \underset{\substack{X\ L \\ (13.1\ L)}}{H_2(g)}$$

At STP, we'd use 22.4 L per 1 mol, but we aren't at STP.

$$x\ mol\ H_2 = 38.2\ \cancel{g\ Zn}\left(\frac{1\ \cancel{mol\ Zn}}{65.4\ \cancel{g\ Zn}}\right)\left(\frac{1\ mol\ H_2}{1\ \cancel{mol\ Zn}}\right) = 0.584\ mol\ H_2$$

$88°C + 273 = 361\ K$

$$PV = nRT \longrightarrow V = \frac{nRT}{P} = \frac{0.584\ mol\ (8.314\ L{\cdot}kPa/mol{\cdot}K)(361\ K)}{107.3\ kPa} = \boxed{16.3\ L}$$

Gas Stoichiometry

Find vol. hydrogen gas made when 38.2 g zinc react w/excess hydrochloric acid.
Pres. = 107.3 kPa; temp.= 88°C.

$$\underset{38.2\ g}{Zn\ (s)} + \underset{excess}{2\ HCl\ (aq)} \longrightarrow ZnCl_2(aq) + \underset{\substack{X\ L \\ (13.1\ L)}}{H_2(g)}$$

$P_1 = 101.3$ kPa
$T_1 = 273$ K
$V_1 = 13.1$ L
$P_2 = 107.3$ kPa
$T_2 = 88\ ^oC + 273 = 361$ K
$V_2 = X$ L

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2} \qquad \frac{(101.3\ kPa) \times (13.1\ L)}{273\ K} = \frac{(107.3\ kPa) \times (V_2)}{361\ K}$$

$$V_2 = \boxed{16.3\ L}$$

Gas Stoichiometry

How many liters of chlorine gas are needed to react with excess sodium metal to yield 5.0 g of sodium chloride when T = 25°C and P = 0.95 atm?