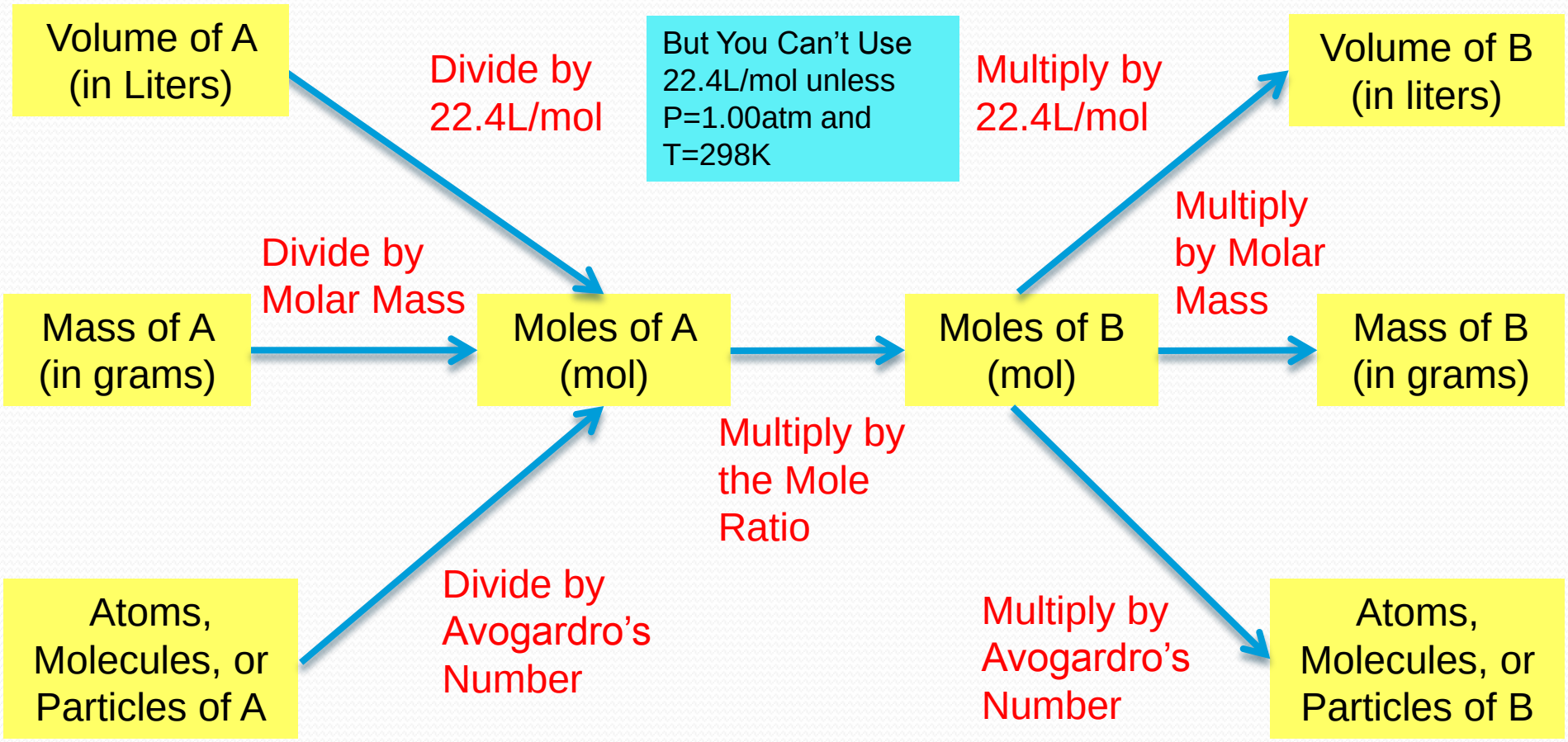
Ideal Gas Law Stoichiometry

Assume you had the following, simple, chemical reaction: A → B



Ideal Gas Law Conversions

As moles of a gas are used in the ideal gas laws, these problems can also involve gram to mole, liter to mole, and molecule to mole conversions too (and vice versa!)

Ideal Gas Law Conversions

A 4.45L container holds 15.4g of oxygen gas (O_2) at 295K. What is the pressure in atm of the gas in the container?

1. Convert Grams of Oxygen to Moles

$$15.4\text{g } O_2 \times \frac{1\text{ mol } O_2}{32.00\text{g } O_2} = 0.481\text{mol } O_2$$

Ideal Gas Law Conversions

Temperature

A 4.45L container holds 15.4g of oxygen gas (O_2) at 295K. What is the pressure in atm of the gas in the container?

Volume (V)

Moles of the Gas (Convert Grams to Moles)

Pressure ?

2. Identify Givens

P = unknown T1 = 295K V1 = 4.45L
n = 0.481mol R = 0.0821 (Lxatm/molxK)

3. Substitute Into the Equation

PV = nRT

(P)(4.45L)=(0.481mol)(0.0821Lxatm/molxK)(295K)

4. Solve For The Unknown Variable

(P)(4.45) = (11.65)
P = 2.62atm

Ideal Gas Law Conversions

Temperature

How many grams of SO_2 gas are contained in a 4.0L container at 450K and 5.0kPa?

Volume

Pressure

Number of Moles ?

1. Identify Givens

P = 5.0kPa T1 = 450K V1 = 4.0L
n = unknown R = 8.314 (LxkPa/molxK)

2. Substitute Into the Equation

PV = nRT

(5.0kPa)(4.0L)=(n)(8.314LxkPa/molxK)(450K)

3. Solve For The Unknown Variable

(20) = (n)(3741.3)
0.0053mol = n

Ideal Gas Law Conversions

How many grams of SO_2 gas are contained in a 4.0L container at 450K and 5.0kPa?

4. Multiply By Molar Mass to Convert Answer to Grams

$$0.0053\text{mol } SO_2 \times \frac{64.06\text{g } SO_2}{1\text{mol } SO_2} = 0.342\text{g } SO_2$$

Ideal Gas Law Conversions

You have a 3.48L container of CO_2 gas held at a pressure of 1.30atm. If the container holds 5.80g of CO_2 gas, what is the temperature of the gas in the container?

1. Convert Grams of Carbon Dioxide to Moles

$$5.80\text{g } CO_2 \times \frac{1\text{ mol } CO_2}{44.01\text{g } CO_2} = 0.132\text{mol } CO_2$$

Ideal Gas Law Conversions

Temperature ?

You have a 3.48L container of CO_2 gas held at a pressure of 1.30atm. If the container holds 5.80g of CO_2 gas, what is the temperature of the gas in the container?

Volume (V)

Pressure

Moles of the Gas (Convert Grams to Moles)

2. Identify Givens

P = 1.30atm T1 = unknown V1 = 3.48L
n = 0.132mol R = 0.0821 (Lxatm/molxK)

3. Substitute Into the Equation

PV = nRT

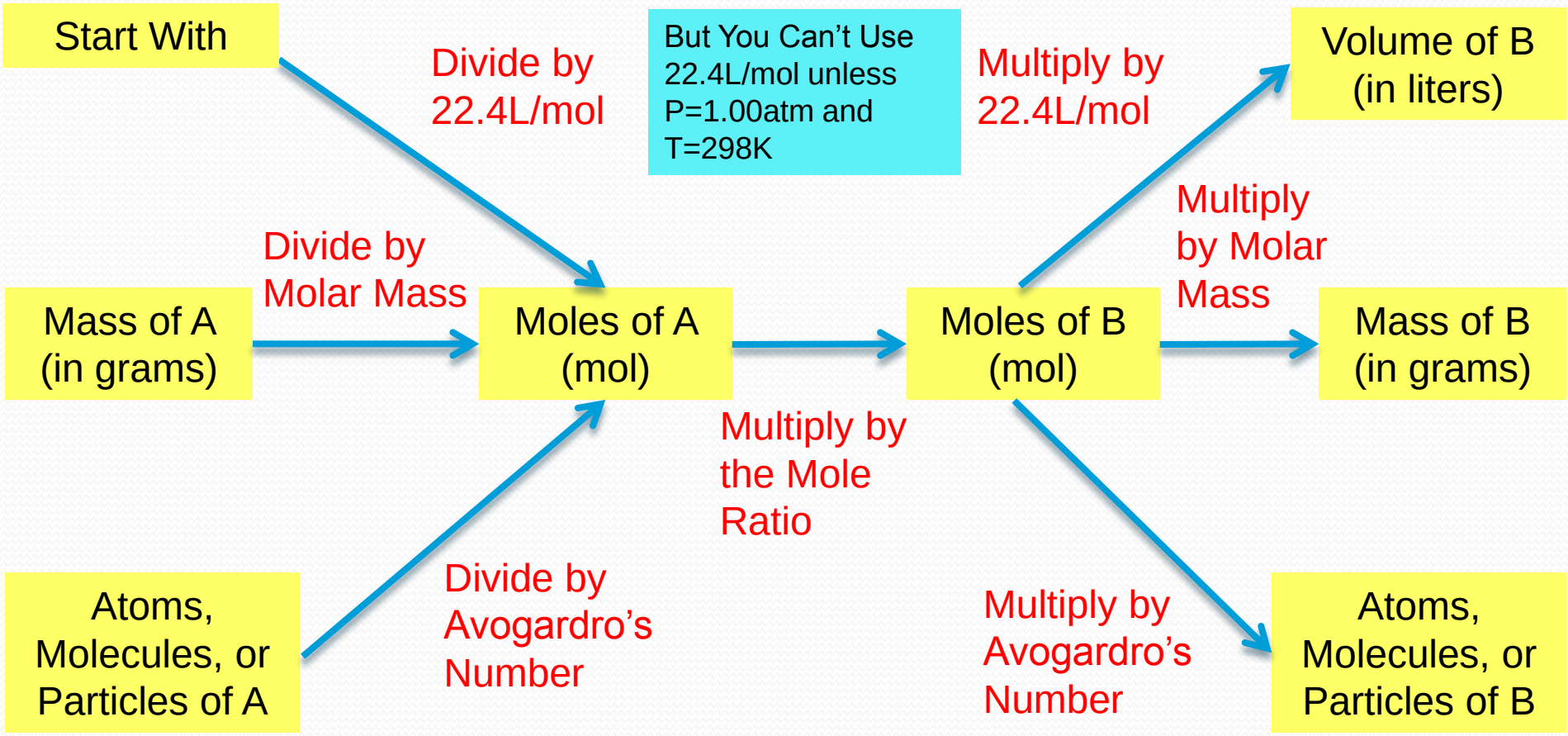
(1.30atm)(3.48L)=(0.132mol)(0.0821Lxatm/molxK)(T)

4. Solve For The Unknown Variable

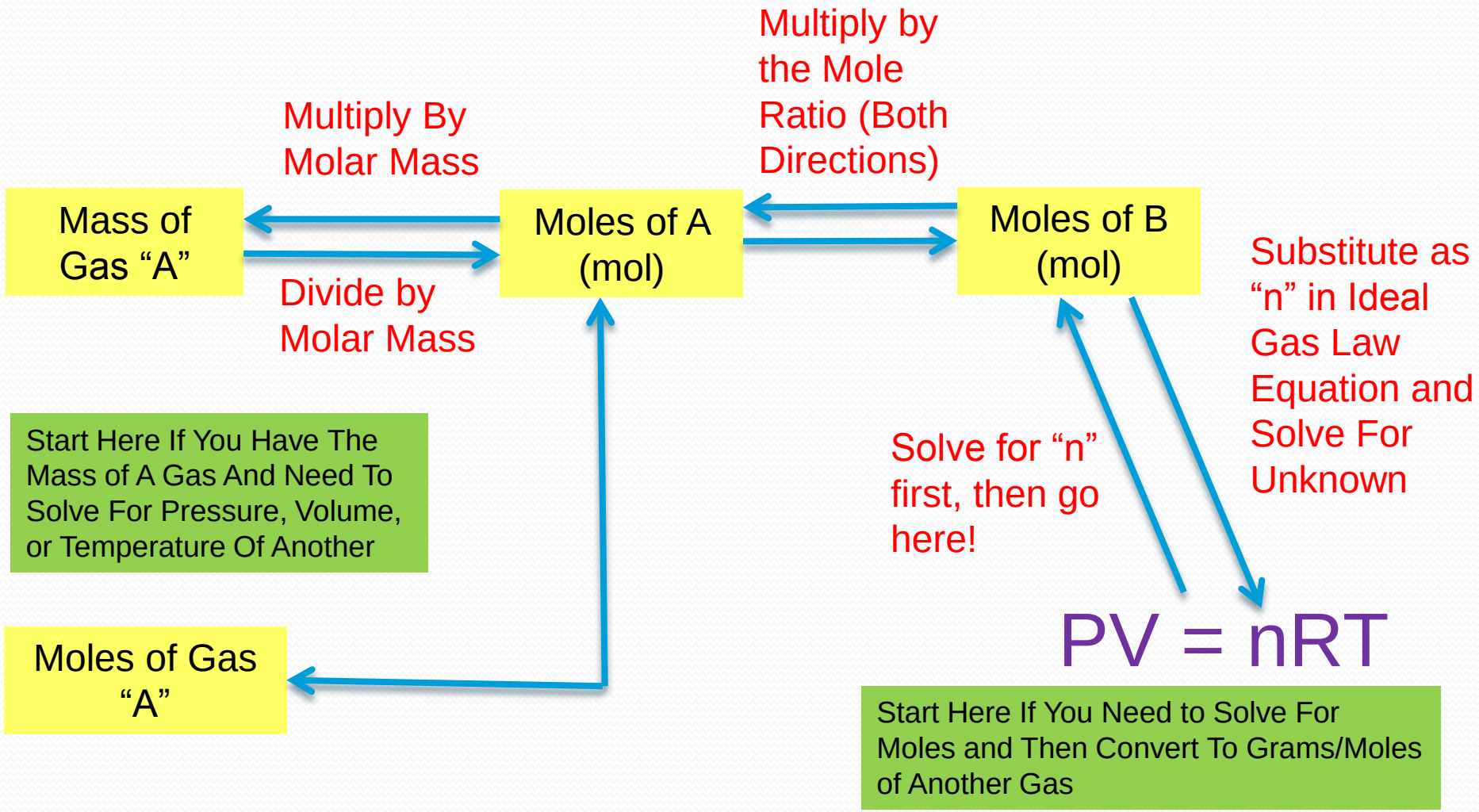
(4.52) = (0.0108)(T)
418.52K = T

Ideal Gas Law Stoichiometry

Assume you had the following, simple, chemical reaction: A → B



Ideal Gas Law Stoichiometry Chart



Ideal Gas Law Stoichiometry

How many liters of hydrogen gas will be produced at 280.0K and 96.0kPa if 1.74mol of sodium reacts with excess water in the following equation?

$$Na + H_2O \rightarrow NaOH + H_2$$

Step #1: Balance the equation

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Step #2: Identify What You Start With

1.74mol of Na

Step #3: Identify What You Want to Find

Liters of Hydrogen Gas

Step #4: Determine the Mole Ratio

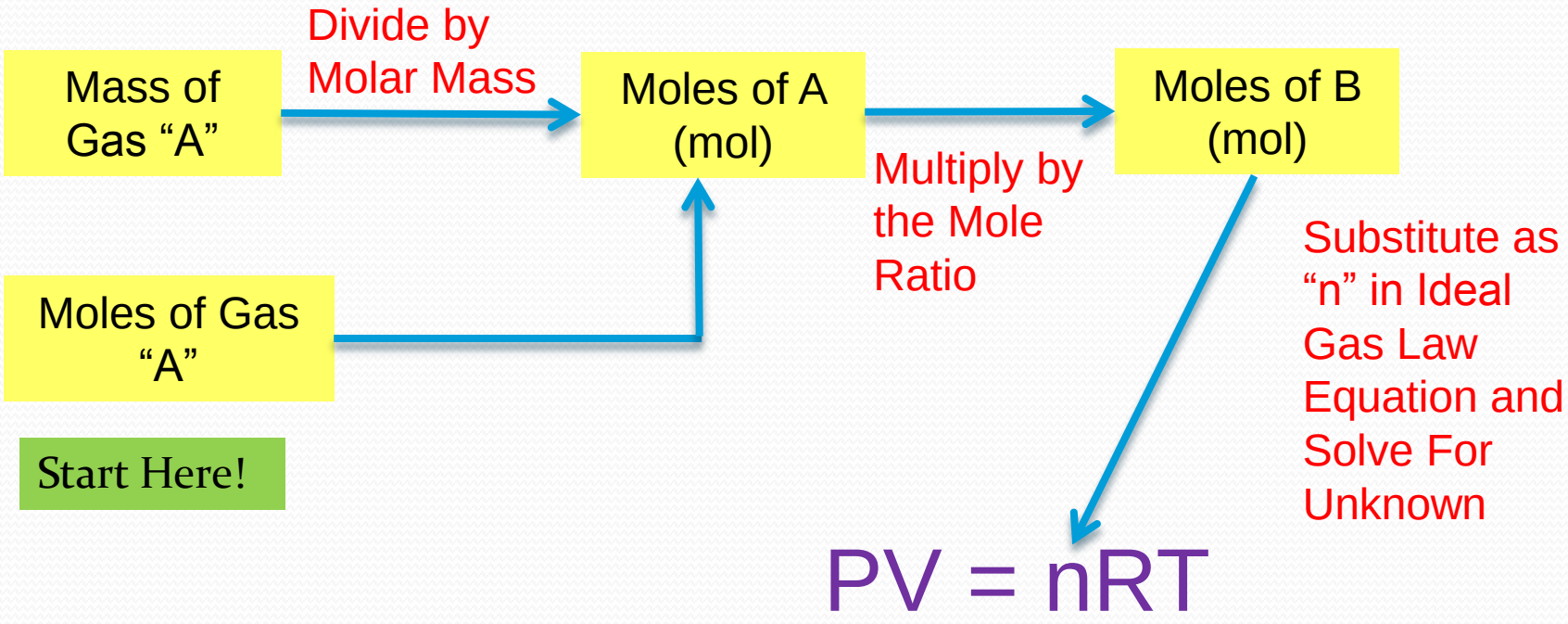
$$\frac{\text{“Finish”}}{\text{“Start”}} \Rightarrow \frac{1 \text{ mol } H_2}{2 \text{ mol Na}}$$

Ideal Gas Law Stoichiometry

How many liters of hydrogen gas will be produced at 280.0K and 96.0kPa if 1.74mol of sodium reacts with excess water in the following equation?

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Step #5: Identify the Steps Needed



Therefore, you need to multiply by the mole ratio, and then substitute moles of "B" as "n" in the ideal gas law equation!

Ideal Gas Law Stoichiometry

How many liters of hydrogen gas will be produced at 280.0K and 96.0kPa if 1.74mol of sodium reacts with excess water in the following equation?

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Step #6: Complete the steps and solve for the problem

$$\frac{1.74\text{mol Na}}{1} \left| \frac{1\text{ mol } H_2}{2\text{ mol Na}} \right. = 0.87\text{mol } H_2$$

$PV = nRT$

$(96.0kPa)(V) = (0.87mol)(8.314kpa*L/mol*K)(280.0K)$

$(96.0)(V) = (2025.29)$

$V = 21.1L$

Ideal Gas Law Stoichiometry

How many grams of water would be produced if 20.0 liters of oxygen were burned at a temperature of -10.0°C and a pressure of 1.3 atm?

$$C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$$

Step #1: Balance the equation

$$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$$

Step #2: Identify What You Start With

20.0L of O_2

Step #3: Identify What You Want to Find

Grams of Water

Step #4: Determine the Mole Ratio

$$\frac{\text{“Finish”}}{\text{“Start”}} \rightarrow \frac{18\ \text{mol}\ H_2O}{25\ \text{mol}\ O_2}$$

Ideal Gas Law Stoichiometry

How many grams of water would be produced if 20.0 liters of oxygen were burned at a temperature of -10.0°C and a pressure of 1.3 atm?

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

Step #5: Identify the Steps Needed

Moles of B (mol)

Substitute as "n" in Ideal Gas Law Equation and Solve For Unknown

$PV = nRT$

Start Here!

Multiply by the Mole Ratio

Moles of A (mol)

Multiply by Molar Mass

Mass of Gas "A"

Therefore, you need to solve for "n", or moles of oxygen, and then convert the moles of oxygen into grams of water.

Ideal Gas Law Stoichiometry

How many grams of water would be produced if 20.0 liters of oxygen were burned at a temperature of -10.0°C and a pressure of 1.3 atm?

$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

Step #6: Complete the steps and solve for the problem

$PV = nRT$

$(1.3atm)(20.0L) = (n)(0.0821L*atm/mol*K)(263.0K)$

$(26.0) = (21.59)(n)$

$n = 1.20mol\ O_2$

$$\frac{1.20mol\ O_2}{} \times \frac{18\ mol\ H_2O}{25\ mol\ O_2} \times \frac{18.02g\ H_2O}{1\ mol\ H_2O} = 15.57g\ H_2O$$

Ideal Gas Law Stoichiometry

Given the following chemical reaction.

$$Na + H_2O \rightarrow NaOH + H_2$$

What is the pressure, in atm, of H_2 gas produced from 16.0g of H_2O at an environmental condition of 30.0L and a temperature of 273K

Step #1: Balance the equation

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

Step #2: Identify What You Start With

16.0g of H_2O

Step #3: Identify What You Want to Find

Liters of Hydrogen Gas

Step #4: Determine the Mole Ratio

$$\frac{\text{“Finish”}}{\text{“Start”}} \Rightarrow \frac{1 \text{ mol } H_2}{2 \text{ mol } H_2O}$$

Given the following chemical reaction.

$$Na + H_2O \rightarrow NaOH + H_2$$

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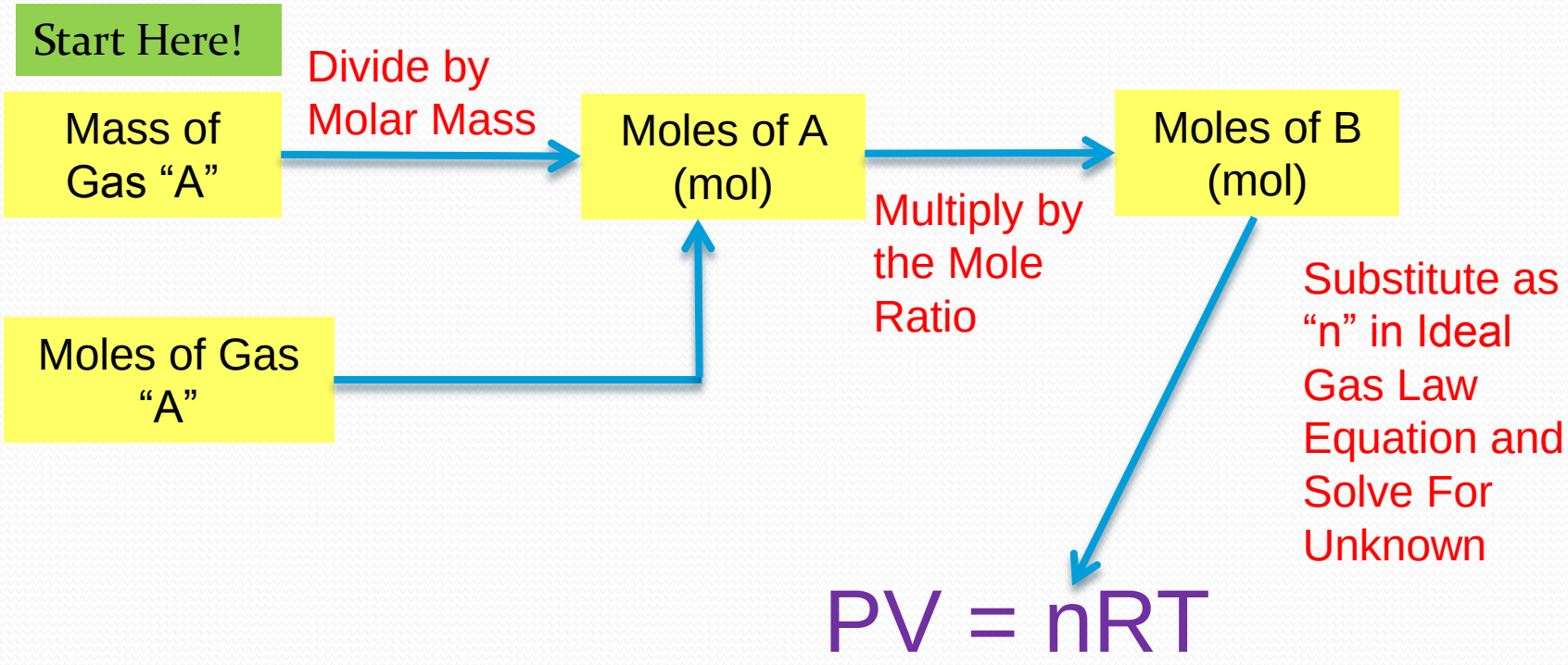

Therefore, you need to multiply by the mole ratio, and then substitute moles of "B" as "n" in the ideal gas law equation!

Ideal Gas Law Stoichiometry

Given the following chemical reaction.

$$Na + H_2O \rightarrow NaOH + H_2$$

What is the pressure, in atm, of H_2 gas produced from 16.0g of H_2O at an environmental condition of 30.0L and a temperature of 273K

Step #6: Complete the steps and solve for the problem

$$\frac{16.00g\ H_2O}{18.02g\ H_2O} \times \frac{1\ mol\ H_2O}{2\ mol\ H_2O} \times \frac{1\ mol\ H_2}{} = 0.87mol\ H_2$$

$PV = nRT$

$(P)(30.0) = (0.443mol)(0.0821L*atm/mol*K)(273.0K)$

$(P) = 0.331atm$