Combined Gas Law

- This is made by combining Charles' and Boyle's Law.
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$
- Temperature has to be in Kelvin (so it can never be 0)
- volume and pressure can be in any unit as long as it is the same on both sides.

A problem

- If a gas occupies 34 L at 1.2 atm and 290 K, what volume will it occupy at 1.1 atm and 280 K?
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$

A problem

- If a gas occupies 34 L at 1.2 atm and 290 K, what volume will it occupy at 1.1 atm and 280 K?
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$
- 34L (1.2atm) / 290 K = V (1.1atm)/280K
- V = 36 L

A problem

- If a gas occupies 24 mL at 115 kPa and 13° C, what volume will it occupy at 101 kPa and 0° C?

A problem

- If a gas occupies 24 mL at 115 kPa and 13° C, what volume will it occupy at 101 kPa and 0° C?
- 24 mL (115kPa)/286 K
  = V (101kPa)/273 K
- V = 26 mL (don't forget to convert temp to K)

Standard Temperature and Pressure

- Normally volumes are reported at standard conditions.
- It is normally abbreviated STP (standard temperature and pressure)
- Standard temperature is 273 K or 0° C
- Standard pressure is 1.00 atm, 101 kPa, or 760 torr, or 760 mmHg

Avogadro's Law

- Avogadro discovered that the size or type of molecule or atom of a gas had no effect on the volume of that gas.
- His law states…
- ~equal volumes of <u>different</u> gases at the same temperature and pressure contain the same number of molecules.
- 1.00 mol of **<u>any</u>** gas at STP will occupy 22.4 L

To convert…

- What volume will .67 mol of a gas occupy at STP?
- $.67\text{mol} \left| \frac{22.4\ \text{L (at STP)}}{1\ \text{mol}} \right.$
- = 15.008
- 15 L at STP
- What volume will .67 mol of a gas occupy at 740 torr and 295 K?

Add this into combined gas law

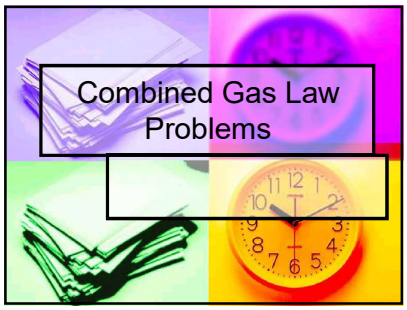
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$
- What volume will .67 mol of a gas occupy at 740 torr and 295 K?
- 15.008 L (760 torr)/273 K
  = V (740 torr)/295K
- V = 17 L

More

- What volume will .83 mol of a gas occupy at .82 atm and 264 K?

More

- What volume will .83 mol of a gas occupy at .82 atm and 264 K?
- $\frac{.83 \text{ mol}}{} \left| \frac{22.4 \text{ L (at STP)}}{1 \text{ mol}} \right.$
- = 18.592 L at STP
- 18.592 L (1.00 atm)/273 K = V (.82 atm)/264 K
- V = 22 L



Number 1

- 126 mL of nitrogen at 113 kPa and 39° C will occupy what volume at STP?
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$

Number 1

- 126 mL of nitrogen at 113 kPa and 39° C will occupy what volume at STP?
- VP/T = VP/T
- 126 mL (113 kPa)/312K = V 101 kPa/273K
- V = **123 mL**

Number 2

- 1.54 mol of helium will occupy what volume at 92 kPa and 315 K?

Number 2

- 1.54 mol of helium will occupy what volume at 92 kPa and 315 K?
- 1.54 mol x 22.4 L/1 mol
- =34.496 L at STP
- VP/T = VP/T
- 34.496…L (101 kPa)/273K = V 92 kPa/315K
- V = **44 L**

Number 3

- 2.14 g of NH_3 ammonia will occupy what volume at 795 torr and 315 K?

Number 3

- 2.14 g of NH_3 ammonia will occupy what volume at 795 torr and 315 K?
- 2.14 g x 1 mol/17.034 g = .125mol
- .1256… mol x 22.4 L/1 mol
- =2.81… L at STP
- VP/T = VP/T
- 2.81…L (760 torr)/273K = V 795 torr/315K
- V = **3.10 L**

Number 4

- 126 mL of nitrogen at 143 kPa and 39° C will occupy 154 mL at 101 kPa and what temperature?
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$

Number 4

- 126 mL of nitrogen at 143 kPa and 39° C will occupy 154 mL at 101 kPa and what temperature?
- $\frac{V_i P_i}{T_i} = \frac{V_f P_f}{T_f}$
- 126 mL (143 kPa)/312K
  = 154 mL 101 kPa/ T
- T = **269 K or -4° C**

Number 5

- $CH_3OH + O_2 \rightarrow H_2O + CO_2$
- What volume of carbon dioxide will 5.2 g oxygen produce at 1.2 atm and 299 K?

Number 5

- $2\ CH_3OH + 3O_2 \rightarrow 4H_2O + 2\ CO_2$
- What volume of carbon dioxide will 5.2 g oxygen produce at 1.2 atm and 299 K?

5.2 g O_2	1 mol O_2	2 mol CO_2
	32.00 g O_2	3 mol O_2

- .108.. mol x 22.4 L/1 mol=2.42… L
- 2.426…L (1.00 atm)/273K
  = V 1.2 atm/299K
- V = **2.2 L**

Number 6

- $HCl + Co \rightarrow CoCl_3 + H_2$
- What volume of hydrogen gas will 5.2 g cobalt produce at 97 kPa and 285 K?

Number 6

- $6HCl + 2\,Co \rightarrow 2\,CoCl_3 + 3H_2$
- What volume of hydrogen gas will 5.2 g cobalt produce at 97 kPa and 285 K?

5.2 g Co	1 mol Co	3 mol H_2
	58.93 g Co	2 mol Co

- .132.. mol x 22.4 L/1 mol=2.96… L
- 2.966…L (101 kPa)/273K
  = V 97 KPa/285K
- V = **3.2 L**