Announcements

Wednesday, October 14, 2009

Quiz 2 is next Wed, Oct 21 (ch 4 and most of 5)

MasteringChemistry due dates (all at 11:59pm)

- Ch 5: Fri, Oct 23
- Ch 6: Fri, Oct 30

Lab report due dates (at 3:00pm):

- Exp 7 (Interface): Mon, Oct 19

Boyle's law

$V = \text{constant} \times \frac{1}{P}$

$P\uparrow V\downarrow = \text{constant}$ for a closed container

$\boxed{P_1 V_1 = P_2 V_2}$ (= constant)

for a single closed container

6.2 L air at 760 mmHg is compressed to 4.4 L. What is the new pressure (assuming constant temperature)?

$$\frac{P_1 V_1}{V_2} = \frac{P_2 \cancel{V_2}}{\cancel{V_2}}$$

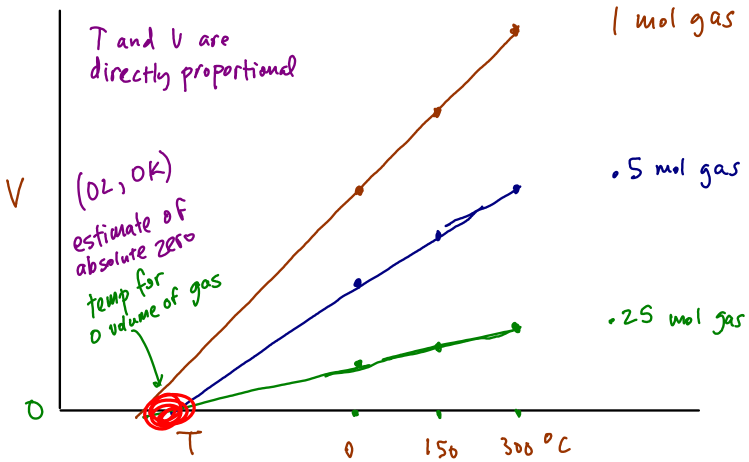
$$P_2 = \frac{P_1 V_1}{V_2} = \frac{(760\text{ mmHg})(6.2\text{ L})}{(4.4\text{ L})}$$

$$= 1100 \text{ mmHg}$$

$$= 1.1 \times 10^3 \text{ mmHg}$$

Charles's Law

Charles's Law relates *V* and *T* for a fixed amount of gas
at a constant pressure



Charles's law: $V \propto T$ $\quad V = \text{constant} \times T$

$$\frac{V}{T} = \text{constant} \qquad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

A balloon has a volume of 1.0 L at 298 K. What is its volume at 77.4 K? assume constant P, assume constant moles of gas

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{(1.0L)(77.4\,k)}{(298\,k)} = \boxed{0.26\ L}$$

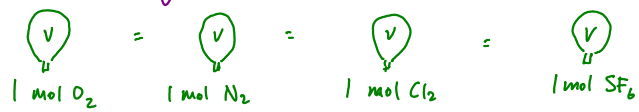
Would this calculation work in °C? NO must use absolute temperature.

Avogadro's Law

Avogadro's law relates amount (in mol) with volume, assuming constant temperature and pressure

n = amount (in mol)

Avogadro's law: $V \propto n$



identity of gas does not affect vol.

$PV = \text{constant}$ (Boyle's) $\qquad \frac{V}{T} = \text{constant}$ (Charles's)

$$\frac{PV}{T} = \text{constant}$$

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

Sealed container: double volume and double temperature, what happens to P?

$$\boxed{P_2 = P_1}$$

Ideal Gas Law

Boyle's law: $V \propto \frac{1}{P}$

Charles's law: $V \propto T$

Avogadro's law: $V \propto n$

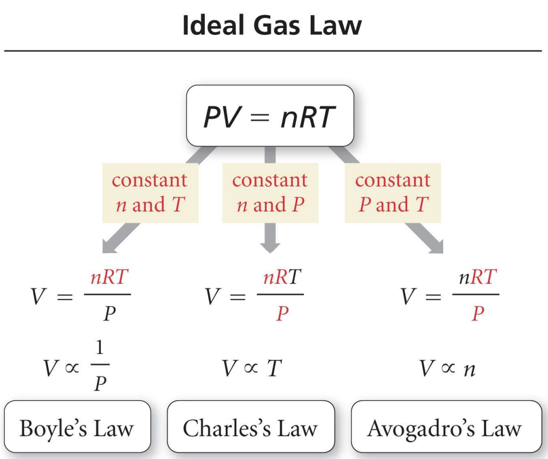
Combined: $V \propto \frac{nT}{P}$ or $V = \frac{nT}{P} \times (\text{constant})$ R

$R = 0.08206 \dfrac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$ = ideal gas constant

V, n, T, and P must have these units to use this value of R

Ideal gas law:

$\boxed{PV = nRT}$



Ideal gas law problem

A 438 L gas cylinder contains 0.885 kg $O_2(g)$ at 21.0 °C. What is the pressure (in atm and mmHg) inside this container?

$PV = nRT$ $\quad (K = °C + 273.15)$

$P = ?$ (atm)

$V = 438\ L$

$n = 0.885\ kg\ O_2 \times \frac{1000\ g\ O_2}{1\ kg} \times \frac{1\ mol\ O_2}{32.00\ g\ O_2} = 27.656\ mol\ O_2$

$R = 0.08206 \frac{L \cdot atm}{K \cdot mol}$

$T = 21.0°C + 273.15 = 294.15\ K$

$$P = \frac{nRT}{V} = \frac{(27.656\ \cancel{mol})(.08206 \frac{\cancel{L} \cdot atm}{\cancel{K} \cdot \cancel{mol}})(294.15\ \cancel{K})}{(438\ \cancel{L})}$$

$$P = \boxed{1.52\ atm} \times \frac{760\ mmHg}{1\ atm} = \boxed{1160\ mmHg}$$

Molar volume at STP

Standard temperature and pressure (STP):

- T = 0 °C = 273 K
- P = 1.00 atm

memorize

if

At STP, solve $PV = nRT$ for V ~~and for~~ n = 1.00 mol:

$P = 1$ atm

$V = ?$

$n = 1$ mol

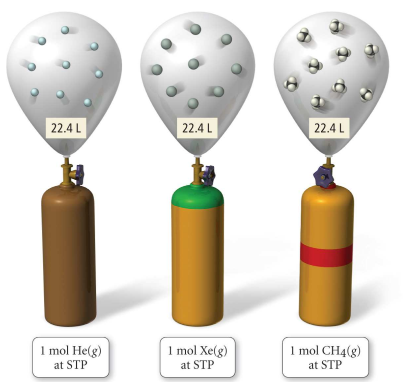
$R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

$T = 273$ K

$$V = \frac{nRT}{P} = \frac{(1\ \cancel{mol})(.08206 \frac{L \cdot \cancel{atm}}{\cancel{mol} \cdot \cancel{K}})(273\ \cancel{K})}{(1.00\ \cancel{atm})}$$

$$= 22.40238 = \boxed{22.4\ L}$$

V = 22.4 L for 1.00 mol of **any** gas at STP.



molar volume at STP = 22.4 L/mol