CH 14 Gases

I. Gases Laws

A. More Kinetic Molecular Theory of Gases - a close fit to real behavior

1. particles do not attract nor repel each other

2. particles have no volume

3. constant random motion

4. all gases have same KE at same temp.

B. Boyle's Law - at constant temp, volume and pressure vary inversely

1. P1 x V1 = P2 x V2

ex) If a gas occupies 100 mL at a pressure of 2 atm, what volume will it occupy at 4 atm? 2 atm x 100 mL = 4 atm x V2

50 mL = V2

C. Charles' Law - at constant pressure, volume and temp. vary directly

1. V1 / T1 = V2 / T2

2. temp must be in Kelvin

a. K = oC + 273

ex) At 1 atm of pressure, a gas occupies a volume of 10 mL at a temp of 20oC. What volume will it occupy at 40oC?

10 mL / 20 + 273 = V2 / 40 + 273

10/ 293 = V2 / 313

10.7 mL = V2

D. Gay - Lussac's Law - at constant volume, pressure and temp. varies directly

1. P1 / T1 = P2 / T2

2. temp must be in Kelvin

ex) p 426

II. Combined Gas Law + Avagadro's Principle

A. Combined Gas Law - combines 3 gas laws above

1. P1V1/T1 = P2 V2 / T2

2. all variables must change

ex) A gas occupies 4 L at 1 atm and a temp of 298 K. What will be the temp if the gas occupies 6 L at 2 atm?

1 atm x 4 L / 298K = 2 atm x 6 L / T2

3657 = 4T2

894 K = T2

B. Avagadro's Principle - a volume of any 2 gases occupies the same volume if the temp and pressure are the same.

1. STP - standard temp and pressure

a. temp = 0oC, pressure = 1 atm

2. one mol of any gas occupies 22.4 L at STP

Problem: What volume will 3 mol of neon occupy at STP?

3 mol Ne x 22.4 L/ mol = 67.2 L Ne

III. Ideal Gas Law - combines all gas laws so far

A. Formula: PV = nRT

1. n = # mol

2. R - Universal Gas Constant - see Chart M on tables

a. depends on units for pressure

1) if pres. in atm, R= 0.0821 atm . L/K . mol

2) if pres. in kPa, R=8.31 kPa . L/K . mol

ex1) What is the vol. of 2.00 mol of NH3 at 4.00 atm of pres. and 300. K?

4.00 atm x V = 2.00 mol x 0.0821 atm . L/K . mol x 300. K

V = 12.3 L

3. if given mass of gas (m), divide by molar mass (M) to get mol.

a. formula becomes PV = (m/M)RT, since n = m/M

ex2) What vol. will 50.0 g of NH3 occupy at 2.00 kPa and 200.K?

M for NH3 = 17.0 g/mol (periodic table)

20.0 kPa x V =( 50.0g/17.0 g/mol) 8.31 kPa . L/K . mol x 200K

V = 244 L

B. Behavior of Real Gases - reasons Ideal Gas Law works poorly at times

1. particles have volume

2. intermolecular forces act when particles very close

a. Law works worst with:

1) high pressure

2) low temp.

3) very polar molecules

4) very large molecules - more polarity

IV. Gas Stoichiometry - finding vol. of gas made in chem rxn.

A. Mol to vol. conversions at STP

1. Steps

a. balance eqn.

b. use mole ratio to find mol gas made

c. multiply mol of gas (coefficient) by 22.4 L/mol

ex) What vol of H2 will be made if 1.0 mol of Zn is completely reacted with excess HCl?

Zn + HCl → ZnCl2 + H2

Mole Ratio 1:1, so 1.0 mol H2(g)

1.0 mol x 22.4 L / mol = 22 L of H2

B. Vol. to Vol. conversions under constant conditions

1. Steps

a. balance eqn.

b. multiply given vol by mol ratio

ex) What vol of CO2 will be made when 3.0 L of ethane (C2H6) is completely combusted?

2C2H6 + 7O2 → 4CO2 +6H2O

3.0 L C2 H6 x 4 mol CO2 / 2 mol C2H6 = 6.0 L CO2

C. Mass to vol conversions under any conditions

1. steps

a. balance eqn.

b. find mol gas produced

c. plug into ideal gas law

ex) p 443 # 60