Avogadro's Law

The Obvious Truth

- You blow up two balloons.
  - They are both the same size.
  - Why?

They both contain the same amount of air.

- You blow up two more balloons.
  - One is twice as big as the other.
  - Why?

The bigger one contains twice as much air.

The Law

- Under the same conditions of temperature and pressure, equal volumes of gases contain the same number of moles of particles.

$$V = k\,n$$

V = volume; k = constant; n = number of moles

The Consequences

- If, as Avogadro says, under the same conditions of temperature and pressure, equal volumes of gases contain the same number of moles of particles, then . . .

under the same conditions of temperature and pressure, 1 mole of different gases must always have equal volumes.

- The volume of 1 mole of gas at STP (Standard Temperature and Pressure) is always the same –

22.4L

Problem 1

Sample Problem 1: Moles to Volume

- **How many liters do 3.50 moles of oxygen occupy at STP?**

$$(3.50\ mol)\left(\frac{22.4\ L}{1\ mol}\right) = 78.4\ L$$

Problem 2

Sample Problem 2: Volume to Moles

- **How many moles of nitrogen occupy 186 *L* at STP?**

$$(186\ L)\left(\frac{1\ mol}{22.4\ L}\right) = 8.30\ mol$$

Problem 3

Sample Problem 3: Grams to Volume

- **What is the volume of 84.21 g of methane (CH_4) at STP?**

$$(84.21\ g)\left(\frac{1\ mol}{16.04\ g}\right)\left(\frac{22.4\ L}{1\ mol}\right) = 118\ L$$

Problem 4

Sample Problem 4: Volume to Grams

- **What is the mass of 25.0 *mL* of dinitrogen trioxide (N_2O_3) at STP?**

$$(25.0\ mL)\left(\frac{10^{-3}\ L}{1\ mL}\right)\left(\frac{1\ mol}{22.4\ L}\right)\left(\frac{76.02\ g}{1\ mol}\right) = 8.48 \times 10^{-2}\ g$$