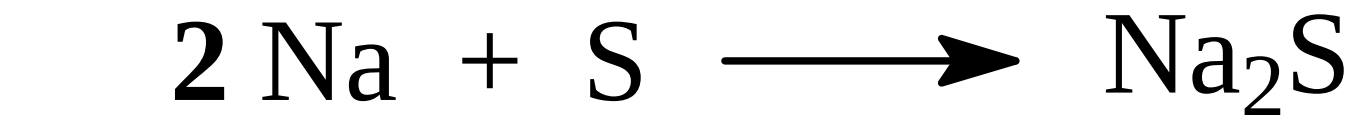
Equations and Reaction Stoichiometry

After correctly writing symbols, place numbers in front of correctly written symbols to have the same number of atoms on both sides of the arrow

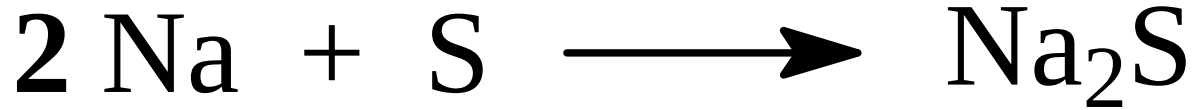
Meaning of a Balanced Equation



2 atoms 1 atom 1 "molecule"

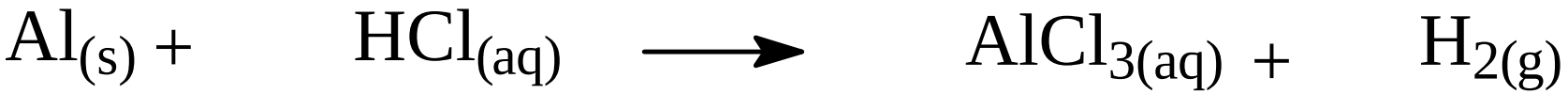
2 dozen 1 dozen 1 dozen

Identities Can Be Written



Try These
Q1

Balance the following:



Q2

Write all identities for the following:

$$2\ C_2H_{6(g)} + 7\ O_{2(g)} \longrightarrow 4\ CO_{2(g)}) + 6\ H_2O_{(l)}$$

Problem Q3

How many grams of CO_2 are produced by the combustion of 185 g of C_2H_6?

$$2\ C_2H_{6(g)} + 7\ O_{2(g)} \longrightarrow 4\ CO_{2(g)} + 6\ H_2O_{(l)}$$

% Yield

The problem just done calculates the theoretical maximum amount that could be produced, called the **theoretical yield**

In the lab, when you run a reaction and weigh your product, that is the **actual yield**

Problem Q4

A student in a lab reacts 12.95 g of zinc according to the following equation:

$$Zn_{(s)} + 2\,HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

At the end of the experiment, the student weighed 24.44g of $ZnCl_2$.

What was her % yield?

Limiting Reagent

1 cup butter + 2 cups sugar + 3 eggs ⟶ 24 cookies

if you have 4 cups butter, 5 cups sugar and 3 eggs, how many cookies can you make?

Which ingredients and how much would be left over?

Problem Q5

What mass of CO_2 can be made from reaction of 14.0g of CH_4 and 53.7g of O_2?

$$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$$

Use Limiting Reagent for Calculations!

How many grams of the excess reagent would be left at reaction's end?

Molarity

$$M = \frac{\text{mols solute}}{\text{liters solution}}$$

mols solute ◄------ reaction coefficients based on mols

liters solution ◄------ easy to measure volumes of a liquid

Q6

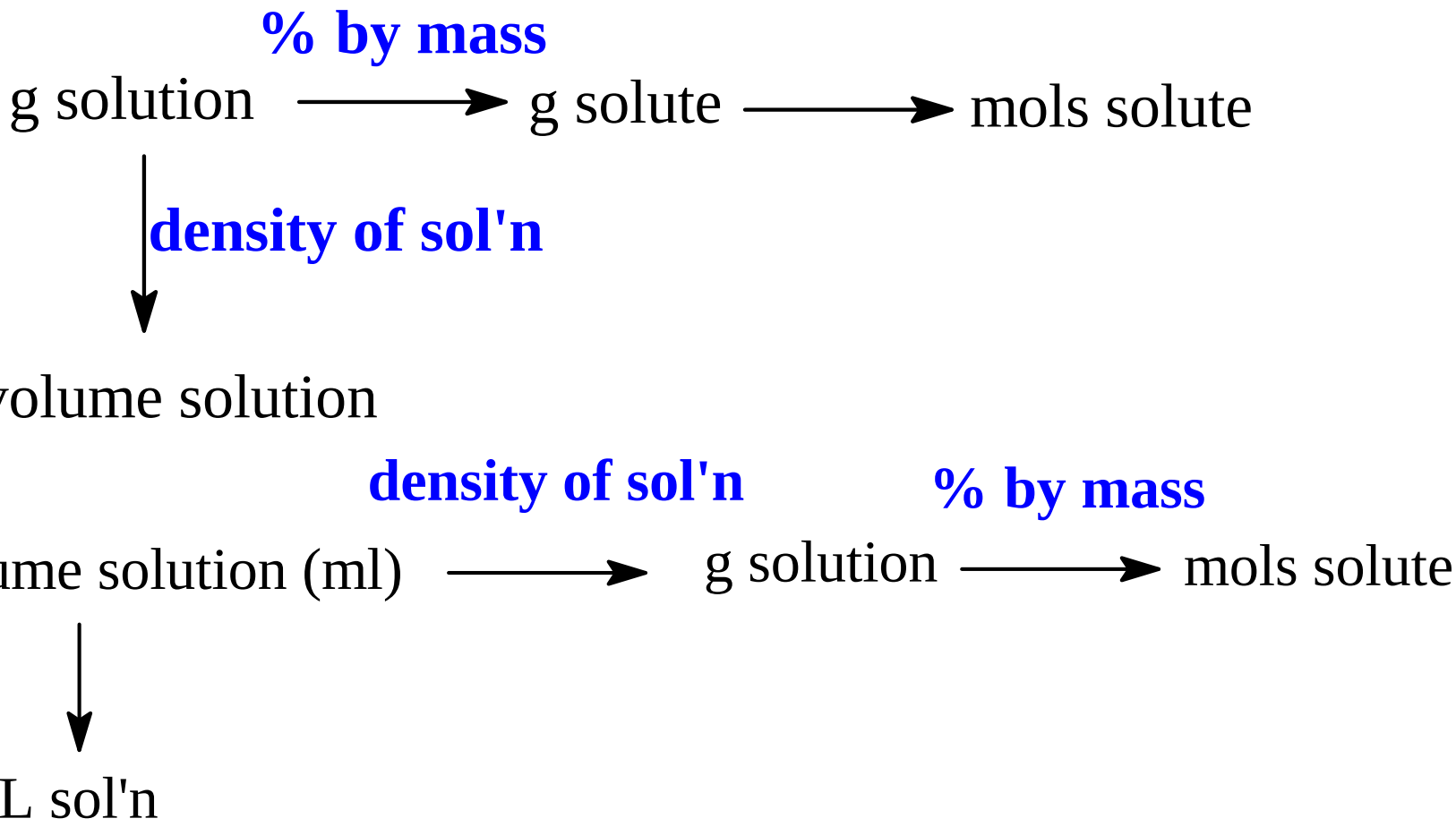
Calculate the molarity of a solution made from 8.00g of calcium nitrate dissolved into 435mL of solution.

$$\text{Molarity} = \frac{\text{mols } Ca(NO_3)_2}{\text{\# L sol'n}}$$

Q7

Calculate the molarity of a concentrated H_2SO_4 solution that is 96.4% pure H_2SO_4 by mass and has a density of 1.84 g/mL.

Since molarity needs mols solute and volume of solution, assume an amount of solution- 100.0 g or 100.0 mL



Solution 1

Calculate the molarity of a concentrated H_2SO_4 solution that is 96.4% pure H_2SO_4 by mass and has a density of 1.84 g/mL.

assume 100.0 g sol'n

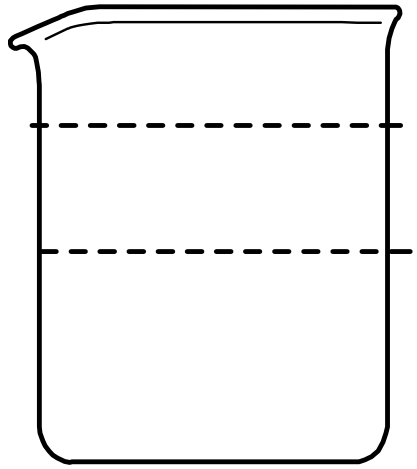
Solution 2

assume 100.0 mL sol'n

Dilution

$$M_C V_C = M_D V_D$$

Water Added



How much water was added to $\mathbf{V_C}$?

Problem Q8

How many mL of 18.0 mol/L HCl solution must be measured to make 275 mL of a 0.900 mol/L HCl solution?
How much water must be added to make the diluted solution?

Q9 Stoichiometry & Sol'ns

$$Zn_{(s)} + 2\ HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

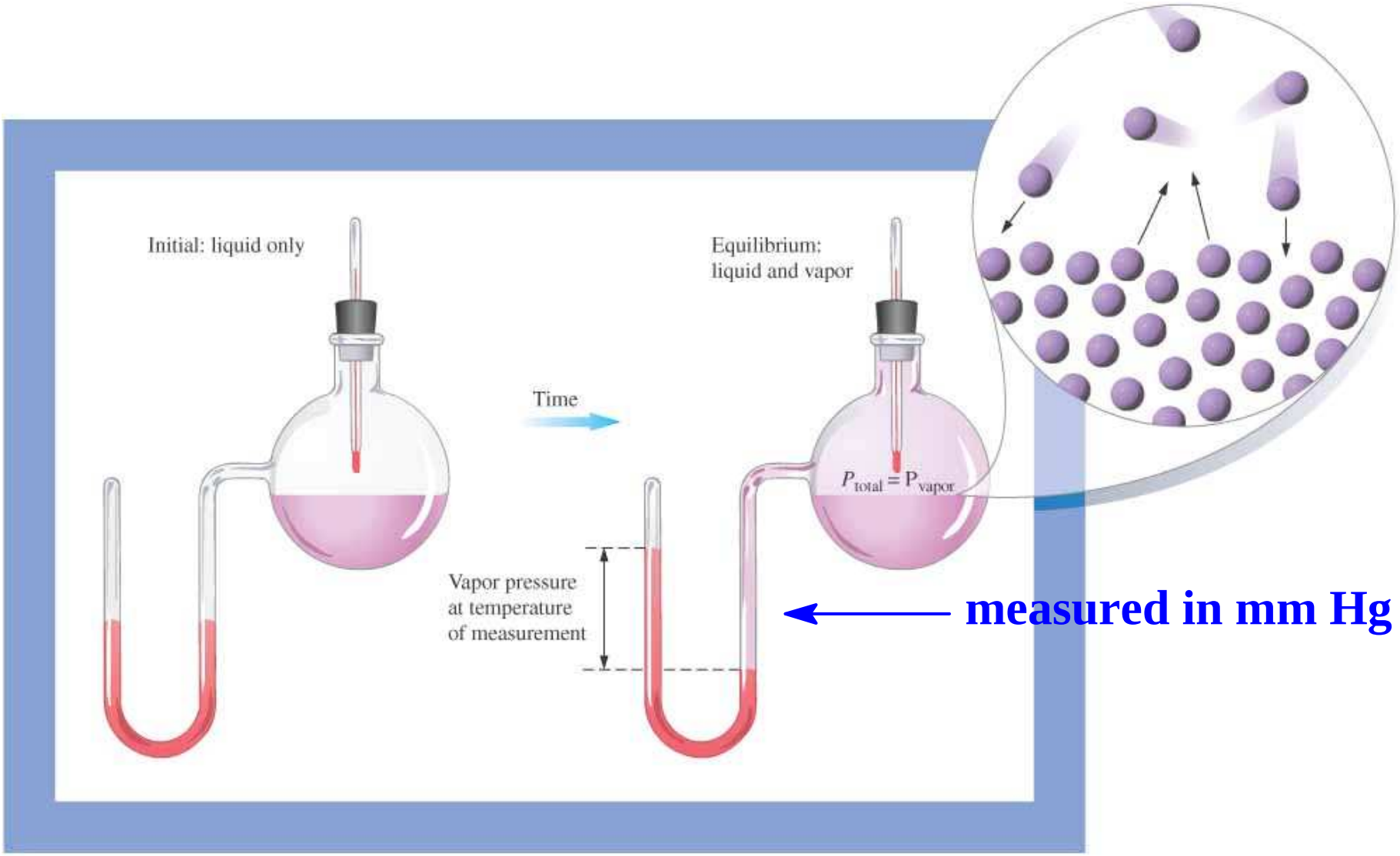
How many mL of 0.755 mol/L HCl solution will react with 6.85g of zinc?

Use molarity as an identity (0.755 mol HCl = 1 L sol'n)

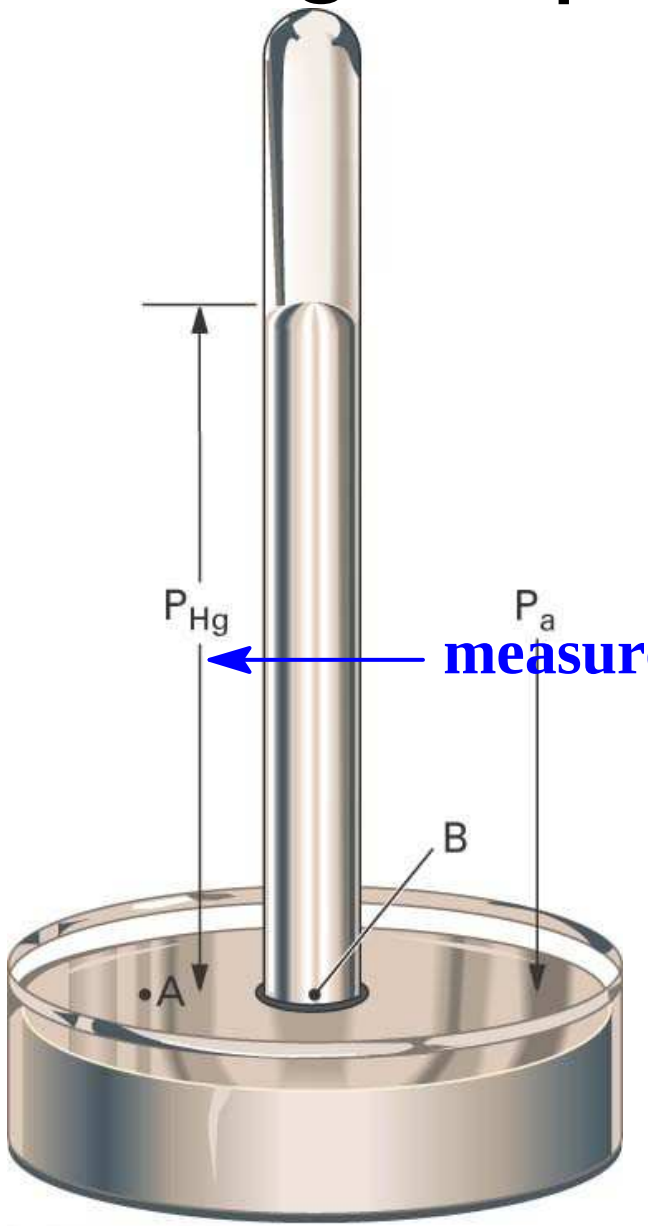
6.85 g Zn ⟶ mL HCl sol'n

Gases and gas stoichiometry

Measuring gas pressure



Measuring air pressure



invented by Torricelli

measured in mm Hg

Units of gas pressure

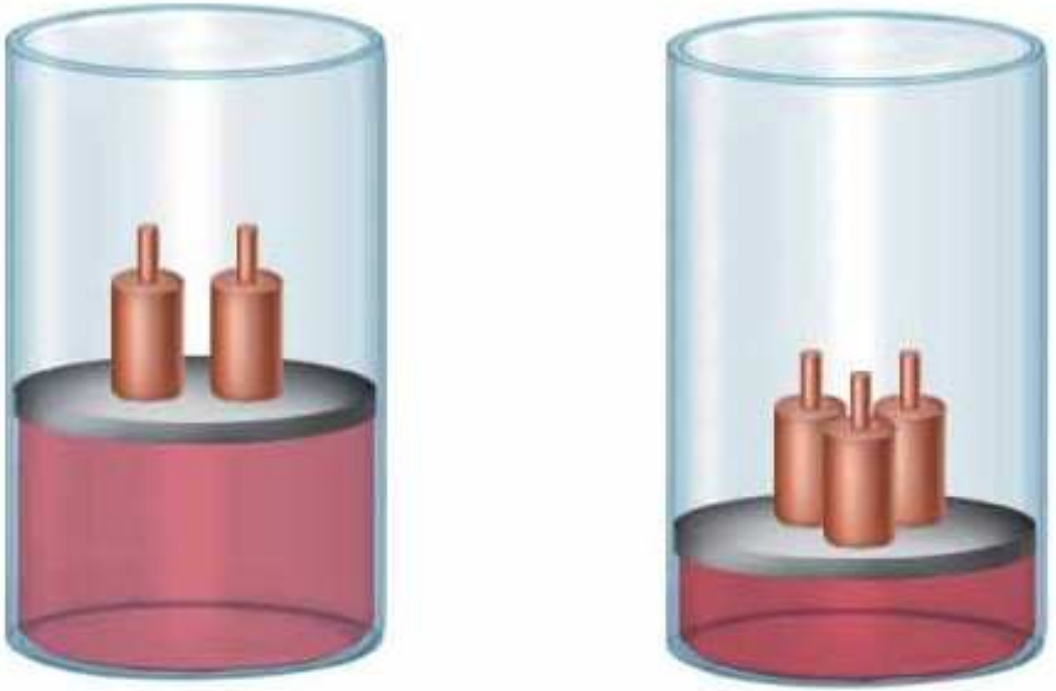
1 atm = 760 mm Hg

1 mm Hg = 1 torr (by definition)

therefore

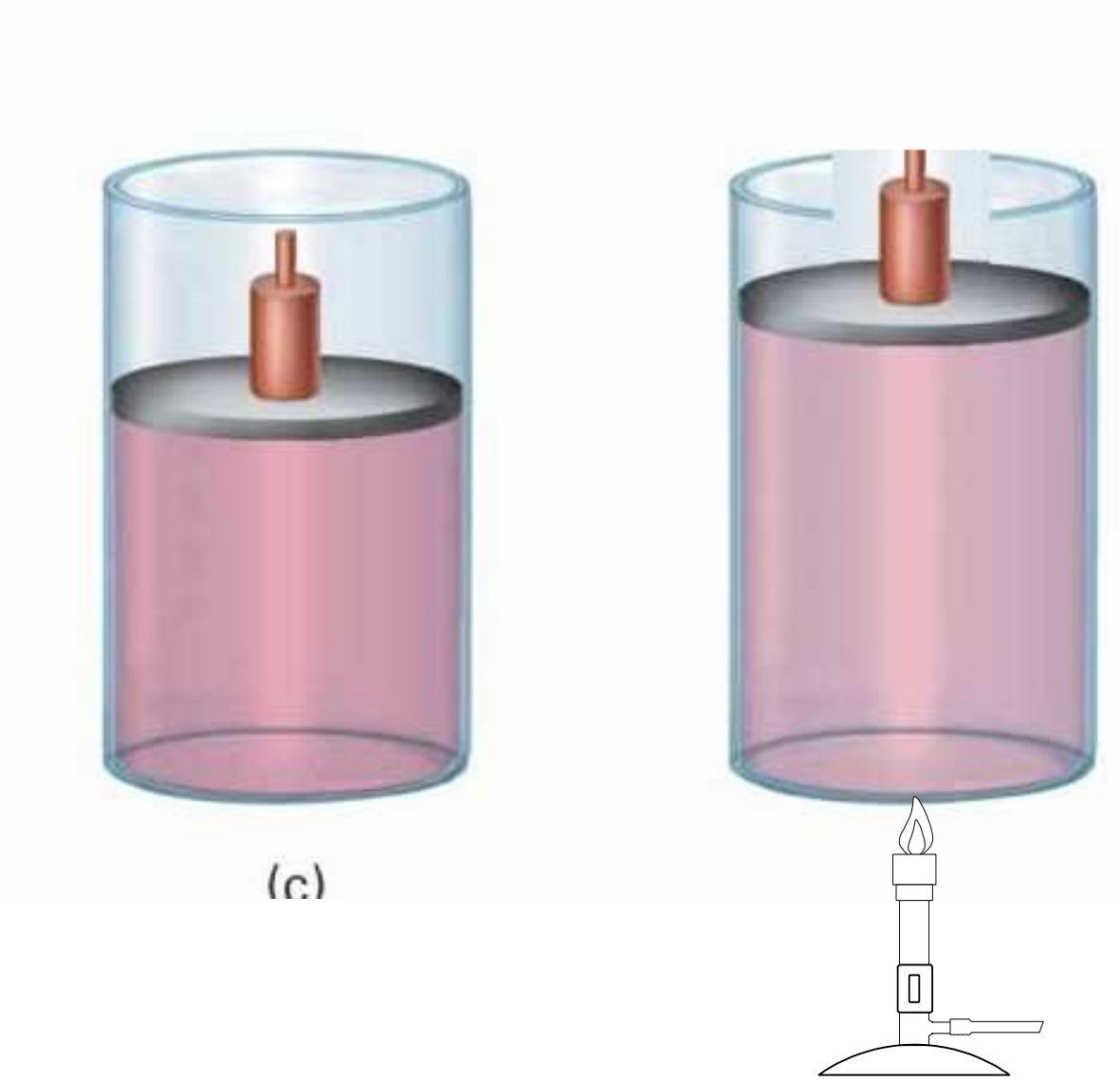
1 atm = 760 torr

The Gas Laws



(a) (b)

Volume / Temperature relationship

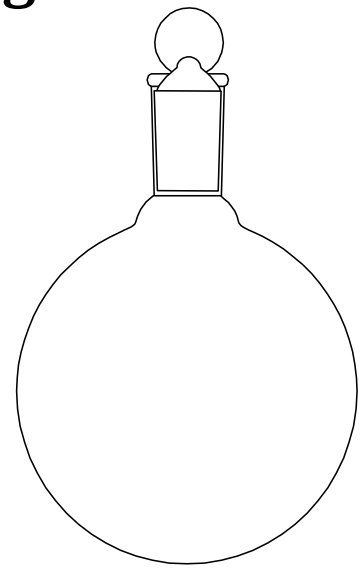


Pressure / Temperature relationship

$$P \propto T$$

Last One!

How could you increase the pressure inside the flask without heating it or changing the volume of the flask?



Ideal Gas Equation

$$\frac{PV}{nT} = k$$

$$PV = nRT$$

the gas constant
(formerly "k")

make sure:

P in atmospheres
V in liters
n is mols of gas
T in Kelvins

$$\mathbf{R = 0.0821 \frac{L\ atm}{mol\ K}}$$

Gas Stoichiometry

PV=nRT → mols gas (n) → do stoichiometry problem based on the equation

OR

do stoichiometry problem based on the equation → mols gas (n) → PV=nRT

Problem Q10

What volume of O_2 can be produced at 717 torr and 215^{o}C from decomposition of 112g of $KClO_3$, according to the following equation?

$$2\ KClO_{3(s)} \longrightarrow 2\ KCl_{(s)} + O_{2(g)}$$

Solution