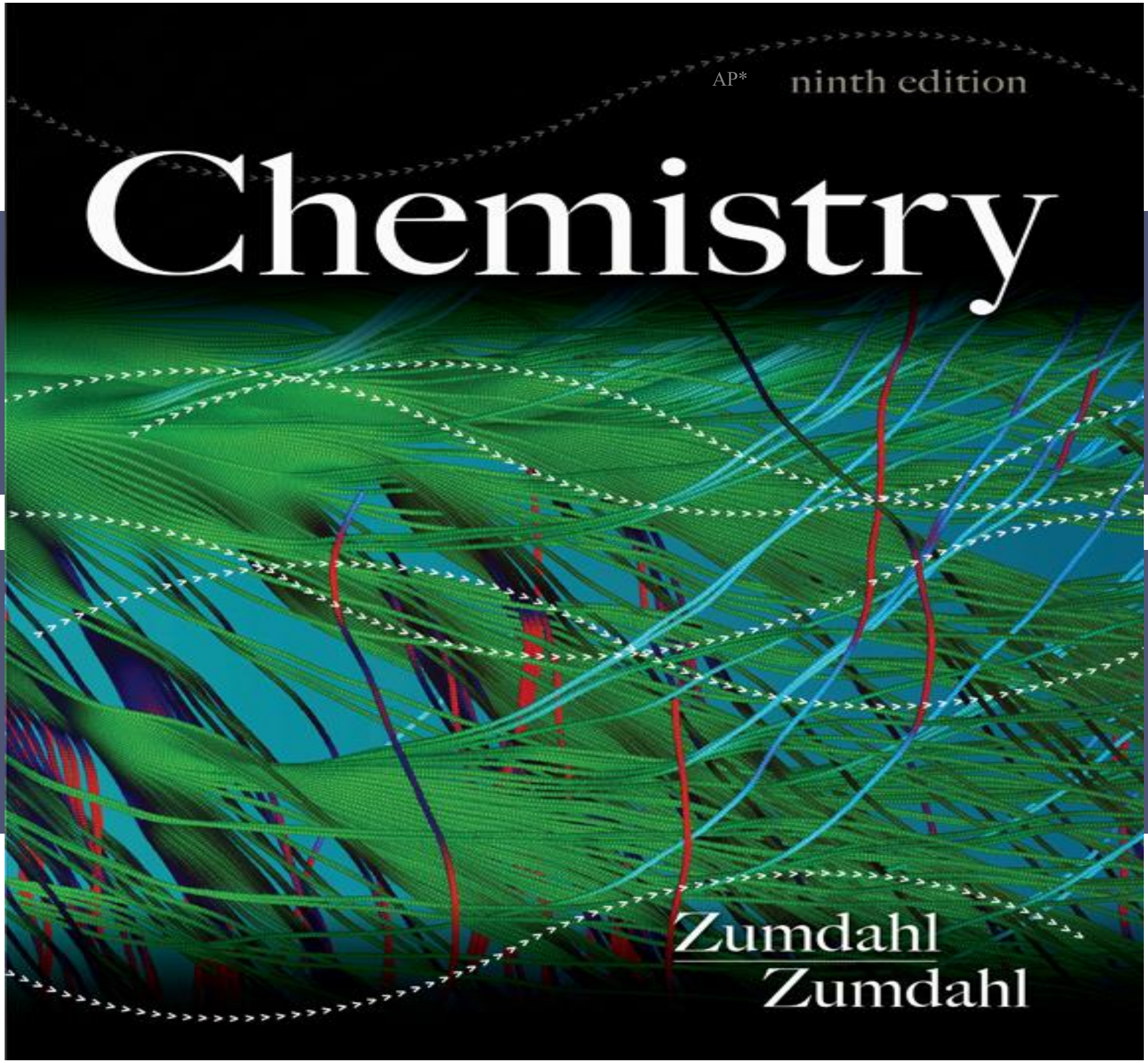


Chapter 5

Gases

Physical state of matter

Solid

-Particles are very close.

-Rigid movement.

-High intermolecular force.

- They don't take the shape or the volume of the container

Liquid

-Intermediate properties to solids

-Take the shape of the container only

Gas

-Particles are very far away and in continuous movements.

-intermolecular forces

Weak(real gas) or zero(ideal gas)

-Take the volume and the shape of the container

A Gas

- *Uniformly fills any container.*
- *Easily compressed.*
- *Mixes completely with any other gas(homogeneous mixture).*
- *Apply pressure on its surroundings(more collisions more pressure).*

Atmospheric pressure:

- *The force exerted by the air molecules in Earths's atmosphere on surfaces within it.*

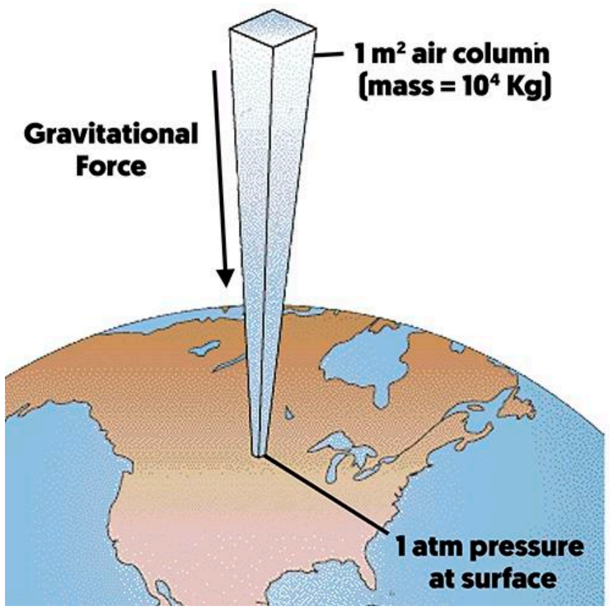
$$\text{Pressure} = \frac{\text{force}}{\text{area}}$$ Newton /m^2

Force=m.g

m= mass

g= gravity accelerating constant

Atmospheric Pressure is = 1atm at sea level.



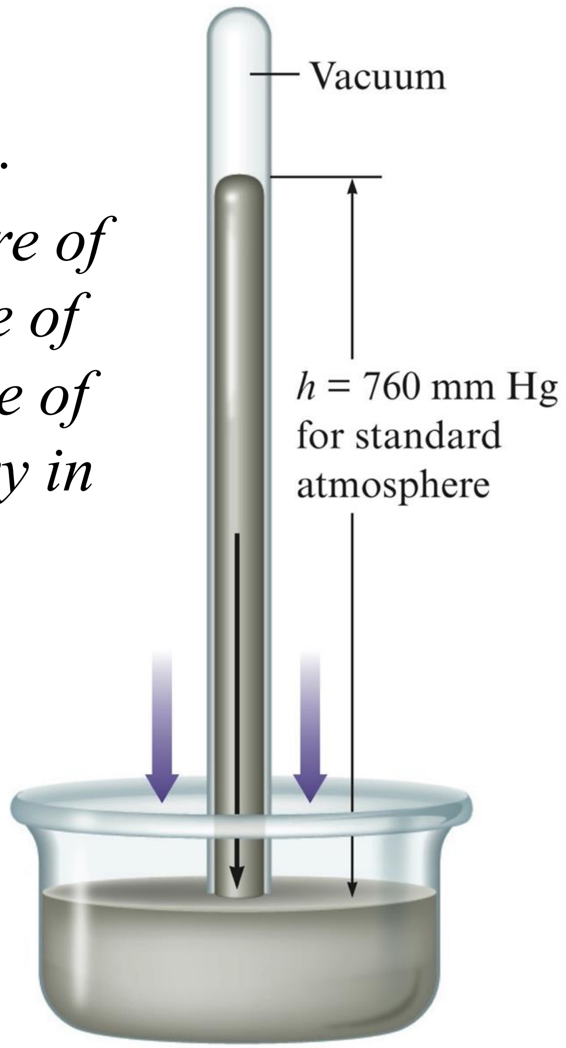
Barometer

- *Device used to measure atmospheric pressure.*
- *Mercury flows out of the tube until the pressure of the column of mercury standing on the surface of the mercury in the dish is equal to the pressure of the air on the rest of the surface of the mercury in the dish.*

760mmHg=1atm

Atmospheric Pressure > 1atm below sea level.

Atmospheric Pressure < 1atm above sea level.



760mmHg=1atm

Atmospheric Pressure > 1atm below sea level.

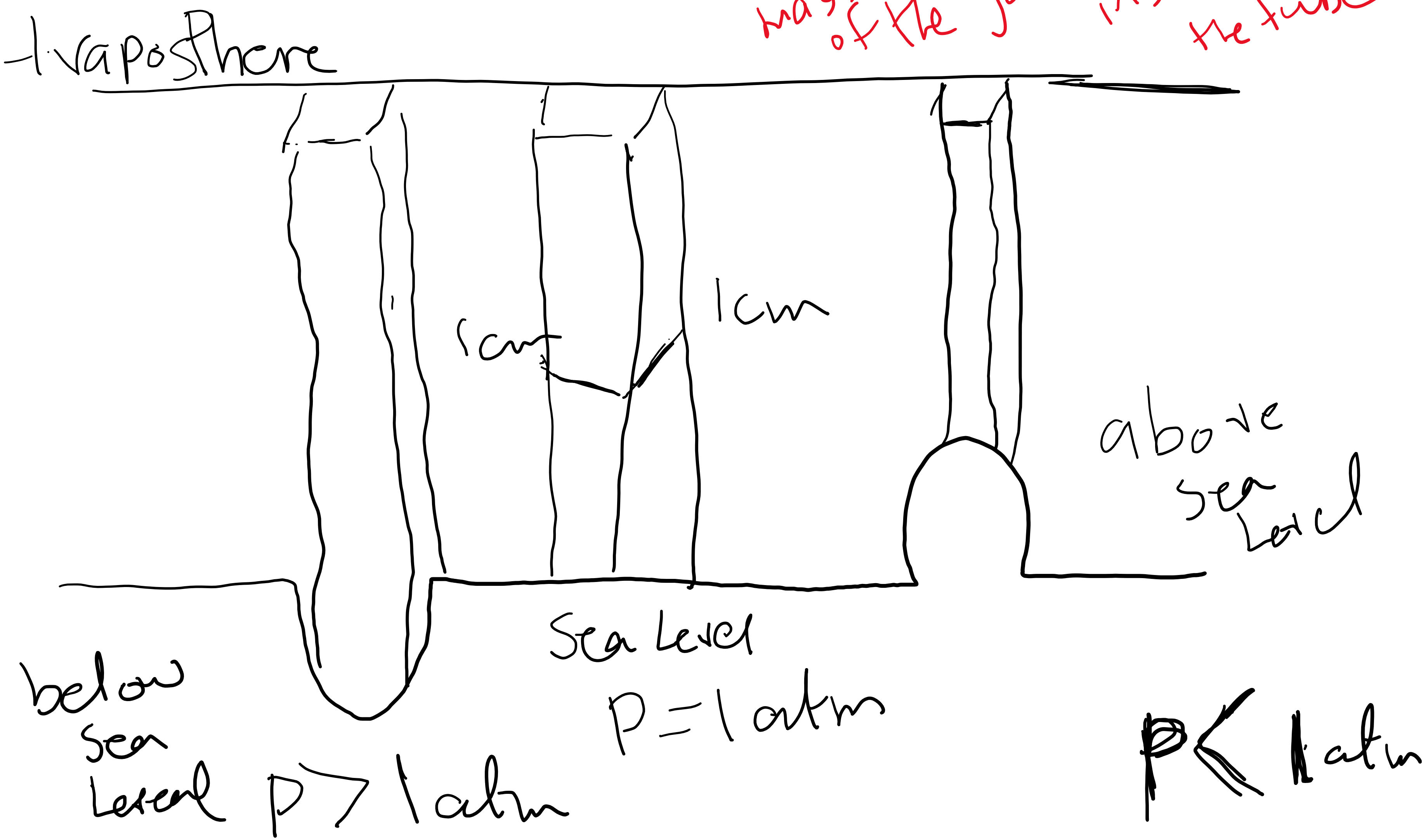
Atmospheric Pressure < 1atm above sea level.

Section 5.1
Pressure

$$P = \frac{F}{A} = \frac{m \cdot g}{A}$$

m → mass of the gass inside the tube

g → gravity acceleration constant



Pressure

$$\text{Pressure} = \frac{\text{force}}{\text{area}}$$

- *SI units = Newton/meter2 = 1 Pascal (Pa)*
- *1 standard atmosphere = 101,325 Pa*
- *1 standard atmosphere = 1 atm = 760 mm Hg = 760 torr*

Pressure Conversions: An Example

The pressure of a gas is measured as 2.5 atm. Represent this pressure in both torr and pascals.

$$(2.5\ \cancel{\text{atm}}) \times \left(\frac{760\ \text{torr}}{1\ \cancel{\text{atm}}}\right) = 1.9 \times 10^{3}\ \text{torr}$$

$$(2.5\ \cancel{\text{atm}}) \times \left(\frac{101{,}325\ \text{Pa}}{1\ \cancel{\text{atm}}}\right) = 2.5 \times 10^{5}\ \text{Pa}$$

Manometer

- *Device used for measuring the pressure of a gas in a container(collisions).*

Collapsing Can

- ***The can is filed with steam (vapor water) no air →air out.***
- ***Steam(vapor) begins to condense rapidly.***
- ***Less pressure inside pushing agents the atmosphere →the atmosphere pressure crash the can.***

Liquid Nitrogen and a Balloon

Liquid Nitrogen and a Balloon

- *What happened to the gas in the balloon?*
- *A decrease in temperature was followed by a decrease in the pressure and volume of the gas in the balloon.*

Liquid Nitrogen and a Balloon

- *This is an observation (a fact).*
- *It does NOT explain "why," but it does tell us "what happened."*

- *Gas laws can be deduced from observations like these.*
- *Mathematical relationships among the properties of a gas (Pressure, Volume, Temperature and Moles) can be discovered.*
- *Charles, Boyle and Avogadro produce 3 laws based on observations.*

- *We can bring all of these laws together into one comprehensive law:*
  - $V = bT$ (constant P and n) Charles's Law
  - $V = an$ (constant T and P) Avogadro's Law
  - $V = \frac{k}{P}$ (constant T and n) Boyle's Law

$$PV = nRT$$

(where R = 0.08206 L·atm/mol·K, the universal gas constant)

$K = {}^{o}C + 273$

EXERCISE!

An automobile tire at 23°C with an internal volume of 25.0 L is filled with air to a total pressure of 3.18 atm. Determine the number of moles of air in the tire.

3.27 mol

EXERCISE!

What is the pressure in a 304.0 L tank that contains 5.670 kg of helium at 25° C?

114 atm

Molar Volume of an Ideal Gas

- *For 1 mole of an ideal gas at 0° C and 1 atm, the volume of the gas is 22.42 L.*

$$V = \frac{nRT}{P} = \frac{(1.000\ \text{mol})(0.08206\ \text{L}\cdot\text{atm/K}\cdot\text{mol})(273.2\ \text{K})}{1.000\ \text{atm}} = 22.42\ \text{L}$$

- *STP = standard temperature and pressure*
  - *0° C and 1 atm*
  - *Therefore, the molar volume is 22.42 L at STP.*

EXERCISE!

A sample of oxygen gas has a volume of 2.50 L at STP. How many grams of O_2 are present?

3.57 g

EXERCISE!

Determine the volume of 1 mole of CO2 gas at STP.

PV=nRT

1XV =1X0.082X273

V=22.41 L

Molar Mass of a Gas

$$\text{Molar mass} = \frac{dRT}{P} = \frac{\left(\frac{\text{g}}{\text{L}}\right)\left(\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(\text{K})}{(\text{atm})} = \frac{\text{g}}{\text{mol}}$$

d = density of gas
T = temperature in Kelvin
P = pressure of gas
R = universal gas constant

- ***Note that:*** *Density is usually given in g/cm³ (or g/mL) but in such problems must be in g/L (R is in L)*

EXERCISE!

What is the density of F2 at STP (in g/L)?

1.70 g/L

EXERCISE!

A sample of helium gas occupies 12.4 L at 23° C and 0.956 atm. What volume will it occupy at 1.20 atm assuming that the temperature stays constant?

EXERCISE!

If 2.45 mol of argon gas occupies a volume of 89.0 L, what volume will 2.10 mol of argon occupy under the same conditions of temperature and pressure?

76.3 L

EXERCISE!

At what temperature (in °C) does 121 mL of CO_2 *at 27°C and 1.05 atm occupy a volume of 293 mL at a pressure of 1.40 atm?*

EXERCISE! HW

Suppose a balloon containing 1.30 L of air at 24.7° C is placed into a beaker containing liquid nitrogen at –78.5° C. What will the volume of the sample of air become (at constant pressure)?

0.849 L

EXERCISE!

Air bags in cars are inflate by nitrogen gas, $N_{2(g)}$, which is generated according to the following equation:

$6NaN_{3(s)} + Fe_2O_{3(s)} \rightarrow 9N_{2(g)} + 3Na_2O_{(s)} + 2Fe_{(s)}$

How many grams of sodiume azide, NaN3, would be required to provide 75.0L of nitrogen gas at 25° C and 748 mmHg:

a) 130.9 g b) 3.0 g c)292.0g d)14.3g

EXERCISE!

A 24.9 ml sample of HCL solution is reacted completely with Na_2CO_3 aqueous solution according to the following equation:

$$2HCl_{(aq)} + Na_2CO_{3(aq)} \rightarrow 3CO_{2(g)} + H_2O_{(l)}$$

The volume of the CO_2 gas formed is 141.0ml at 27° C and 727 torr. What is the molarity of HCL?

EXERCISE!

One way to isolate metals from their ores is to react the metal oxide with carbon as shown in the following reaction:

$2MO_{(S)} + C(s) \rightarrow 2M_{(s)} + CO_{2(g)}$

If 34.08 g of a metal oxide, MO, reacted with excess carbon, at 100° C and 1.50 atm, the volume of CO_2 formed was 4.37L. What is the identity of the metal.