GASES

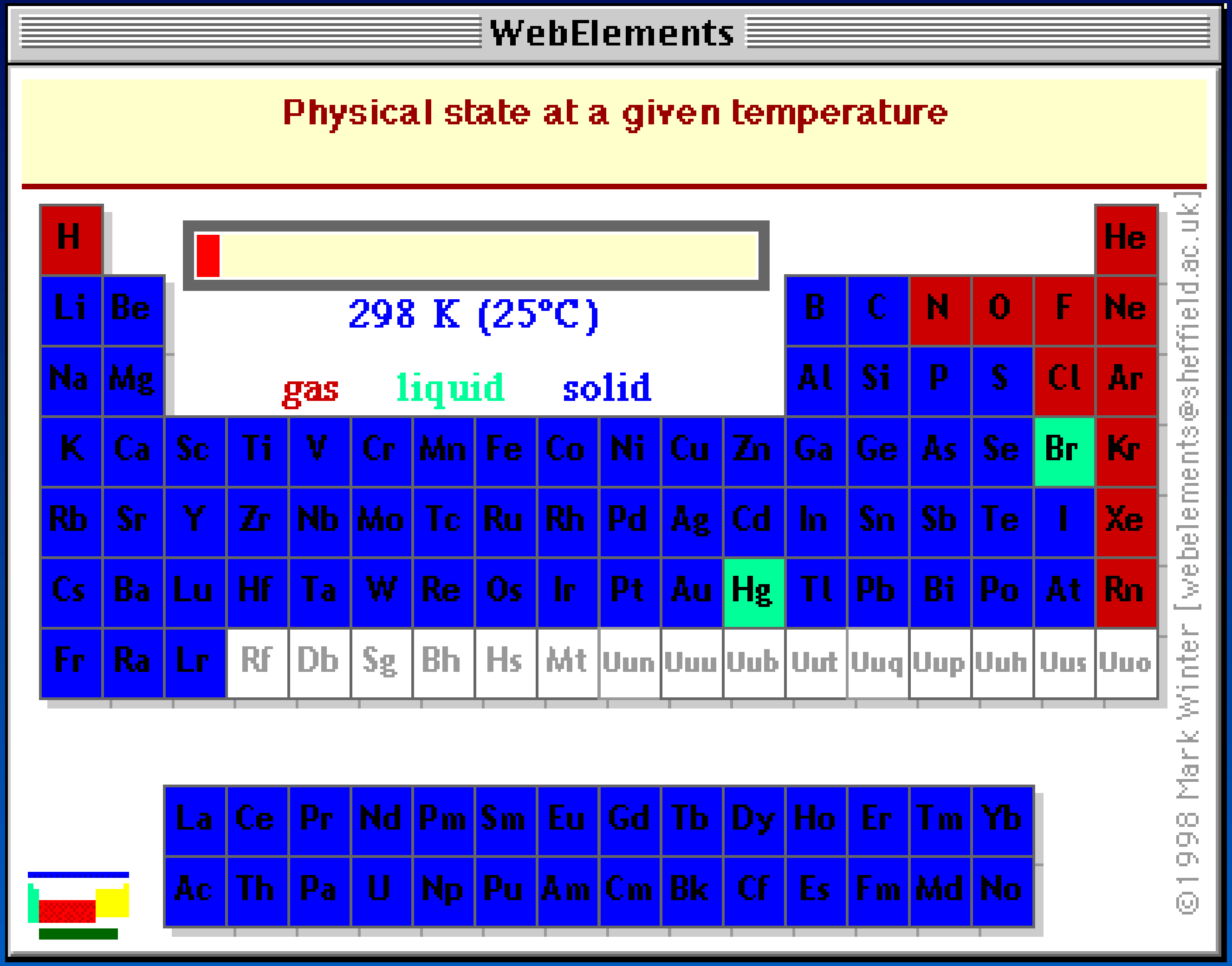
Name some common gases

H_2

O_2

N_2

O_3



Gas & vapor

Cl_2

NH_3

CH_4

CO_2

The Gaseous State

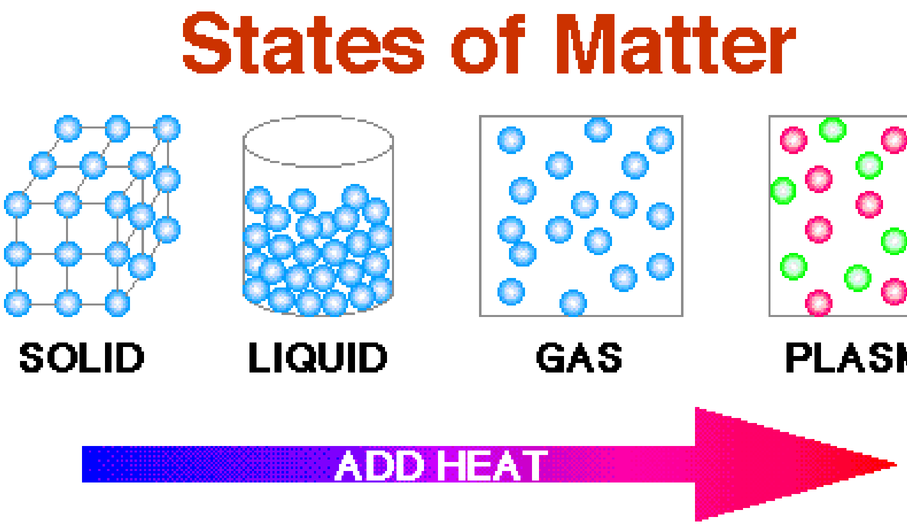
Particles have sufficient energy to overcome all forces of attraction

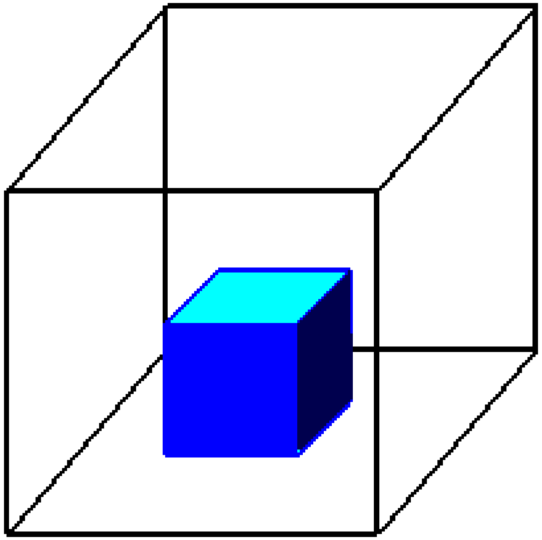
Particles completely separated from others

Results in low densities
Gases completely fill their containers

Observed Properties of Matter

Solids, liquids, & gases can be easily recognized by their different properties

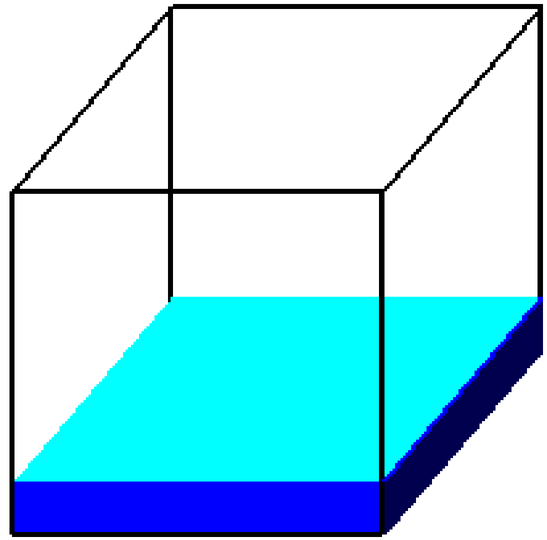




Solid

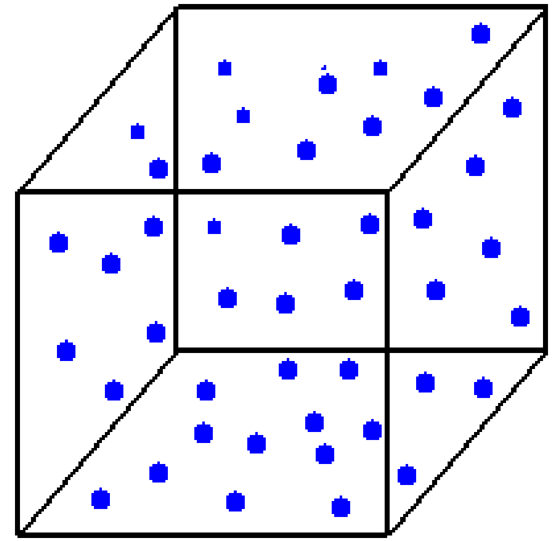
Holds Shape

Fixed Volume



Liquid

Shape of Container
Free Surface
Fixed Volume



Gas

Shape of Container

Volume of Container

Observed Properties of Matter

		State	
Property	**Solid**	**Liquid**	**Gas**
DENSITY	high	high	low
COMPRESSIBILITY	small	small	large
THERMAL EXPANSION	very small	small	moderate

The Gas Laws

The effect of T, P and V on gases has been extensively studied

The relationships between temperature, pressure, volume and moles are called the gas laws

Some definitions ....

Pressure

Gases exert pressure on their container

Pressure is defined as force per unit area

pressure = force/area

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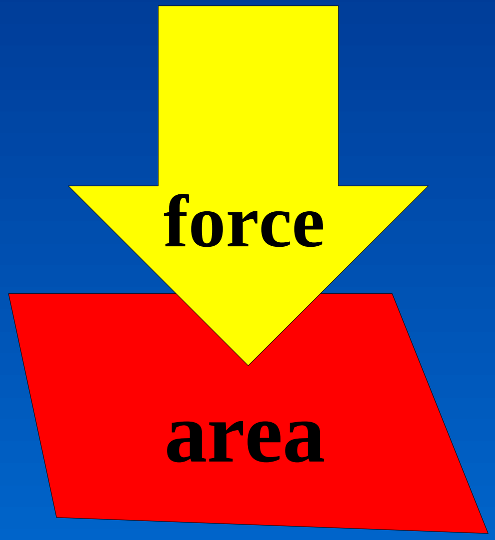
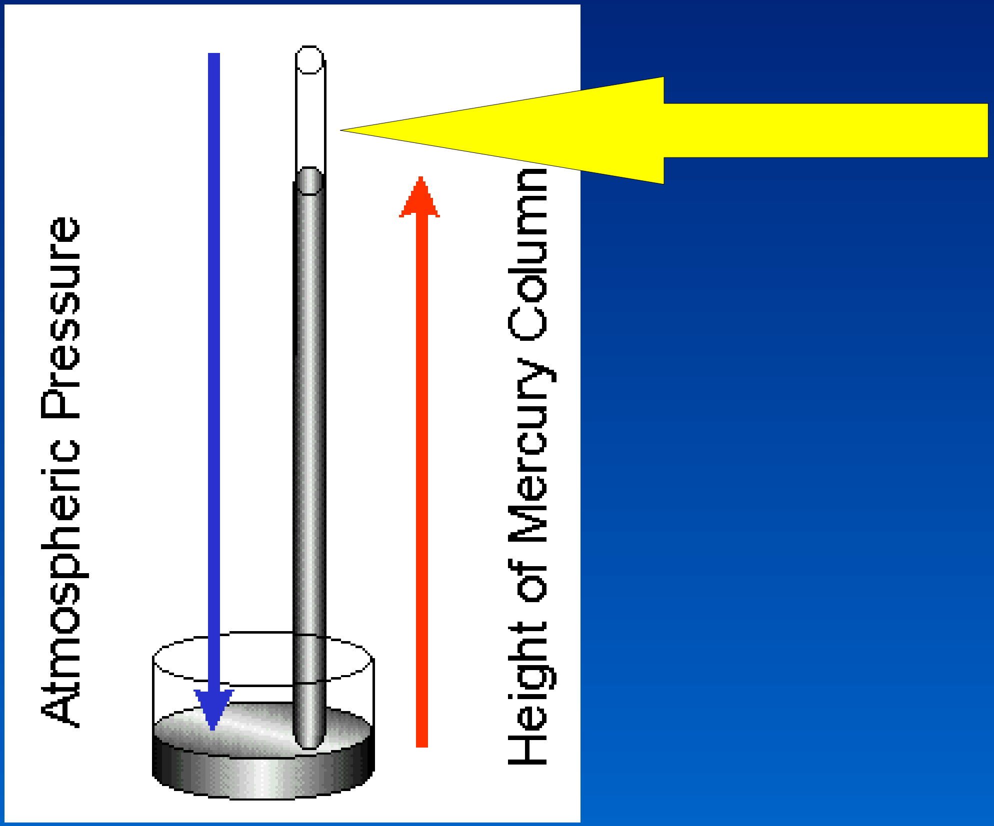


Barometer

Device used to measure atmospheric pressure



vacuum

Units of Pressure

1 atmosphere =	760 torr
	760 mm Hg
	29.9 in Hg
	15 lb/in^2
SI unit: Pascal →	101,325 Pa

Units for Other Properties

Volume	Temperature	Moles
↓	↓	↓
Liters	Kelvin no negative temperatures	Amounts in moles

The Gas Laws

Laws that show the relationship between volume and other properties of gases

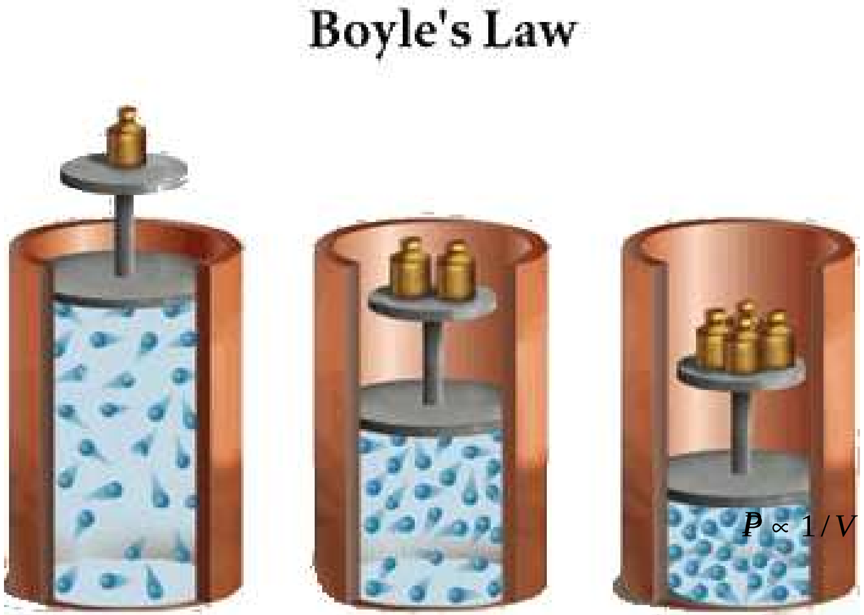
Boyle's law
Charles' law
Avodagro's law

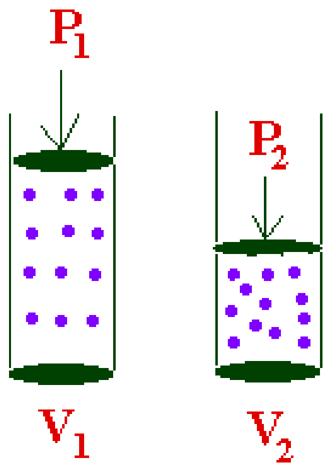
Ideal Gas law combines all into 1 law

Boyle's law

Increasing pressure º decreases volume

shows how P and V vary at constant temp





$$P \,\%\, \frac{1}{V} \qquad P = \frac{k}{V} \qquad PV = k \qquad P_1V_1 = P_2V_2$$

Charles' law

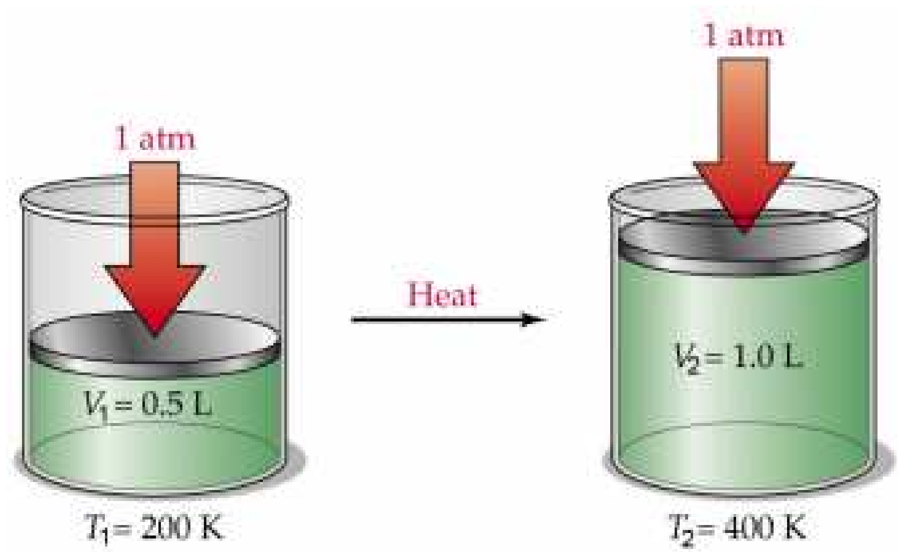
Increasing temperature º increases volume

V % T

$$V = k\,T$$

$$\frac{V}{T} = k$$

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



Avogadro's law

Increasing moles º increases volume

V % moles(n)

V = k n

In a chemical reaction:
mole ratio = volume ratio

$2\ H_2\ (g)\ +\ O_2\ (g)$ 6 $2\ H_2O\ (g)$

The Ideal Gas Law

A combination of Boyle's, Charles' and Avogadro's laws

V % 1/P × T x n

Y **V = R × 1/P × T × n**

Y **PV = nRT**

R called gas law constant

The Ideal Gas Law

Units: P = atm
V = liter
T = K
n = mol

R = 0.082 L.atm/mol.K

R = 8.31 L.kPa/mol.K when P = kPa

Example

What is the volume of 2.0 moles of gas, at 3.50 atm and 310 K?

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$= \frac{2.0 \times 0.082 \times 310}{3.50} = 14.5\ \text{L}$$

Using the Ideal gas Law

$$PV = nRT$$

$$\frac{PV}{T} = nR$$

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

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

Using the Ideal gas Law

$$PV = nRT$$

$$\frac{m}{M} = n$$

$$PV = \frac{mRT}{M}$$

$$M = \frac{mRT}{PV}$$

Using the Ideal gas Law

$$PM = \frac{mRT}{V} \quad \leftarrow \quad PV = \frac{mRT}{M}$$

$$D = \frac{m}{V} \qquad PM = DRT \qquad \boxed{\frac{PM}{RT} = D}$$

Dalton's Law of partial pressures

Total P = sum of individual pressures

$$P_{air} = P_N + P_o + P_{water} + P_{He}$$

Collect gases by water displacement

$$P_{total} = P_{gas} + P_{water}$$

Graham's Law of Effusion

Rate of gas movement r % $1/M^{1/2}$

Smaller molecules move faster

H_2 moves 4× faster than O_2

$$r_a/r_b = (M_b/M_a)^{1/2}$$

Kinetic Theory of Matter

A model used to explain the behavior of matter

It postulates that........

matter is composed of small particles

each particle is in constant motion......kinetic energy

Particles contain potential energy due to the attractions and repulsions between them

Particles move faster as temperature increases

Particles transfer energy when they collide