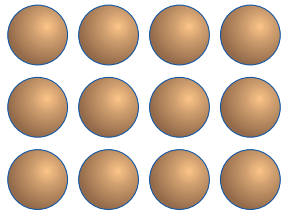
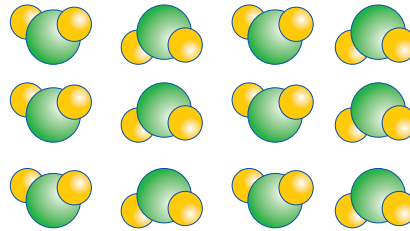


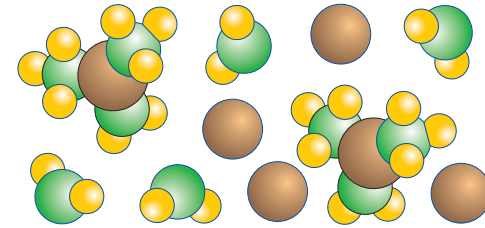
Types of Matter



Element



Compound



Mixture

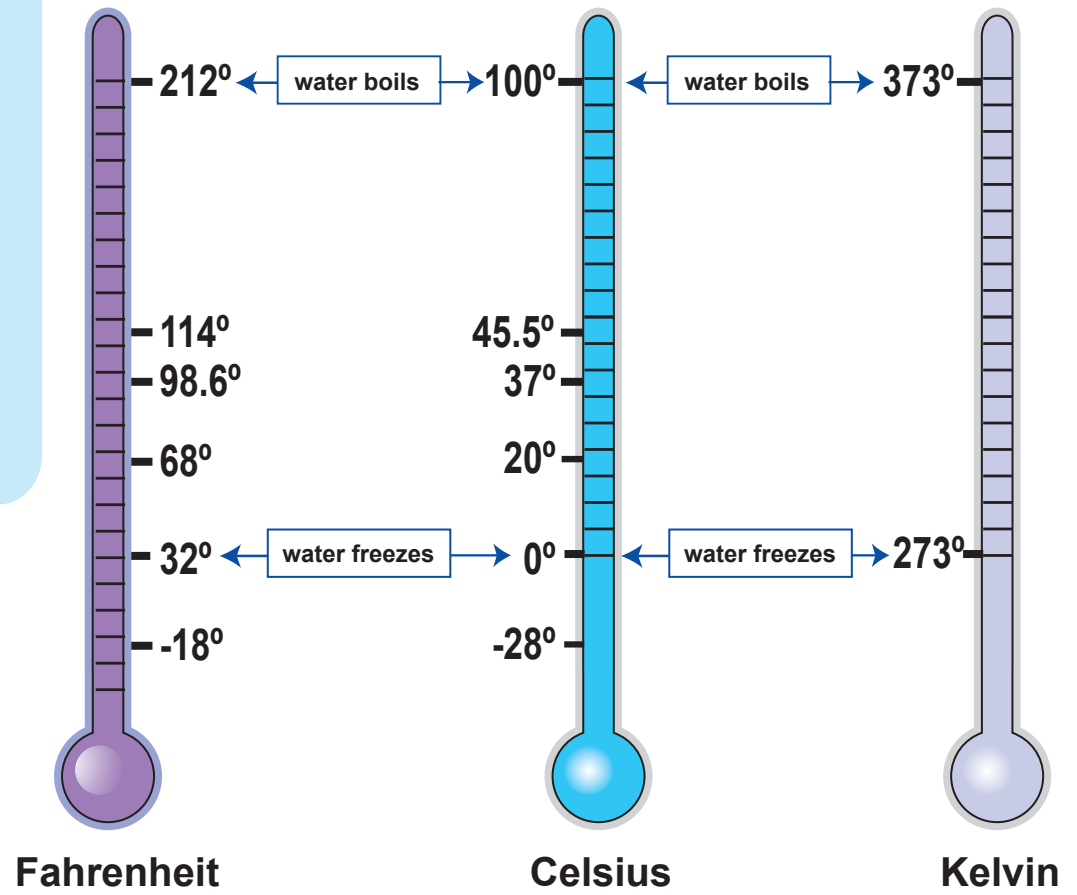
Type of matter	Definition	Examples
Element	One single kind of atom	copper, metal, oxygen gas, liquid nitrogen
Compound	One type of molecule	propane, water, table salt, rust (iron oxide), carbon dioxide gas
Mixture	Combination of different compounds and/or elements	Soda pop, air, chicken soup, soil, chocolate ice cream

Temperature Conversion

$$T_{\text{Fahrenheit}} = \frac{9}{5} T_{\text{Celsius}} + 32$$

$$T_{\text{Celsius}} = \frac{5}{9} (T_{\text{Fahrenheit}} - 32)$$

$$T_{\text{Kelvin}} = T_{\text{Celsius}} + 273$$



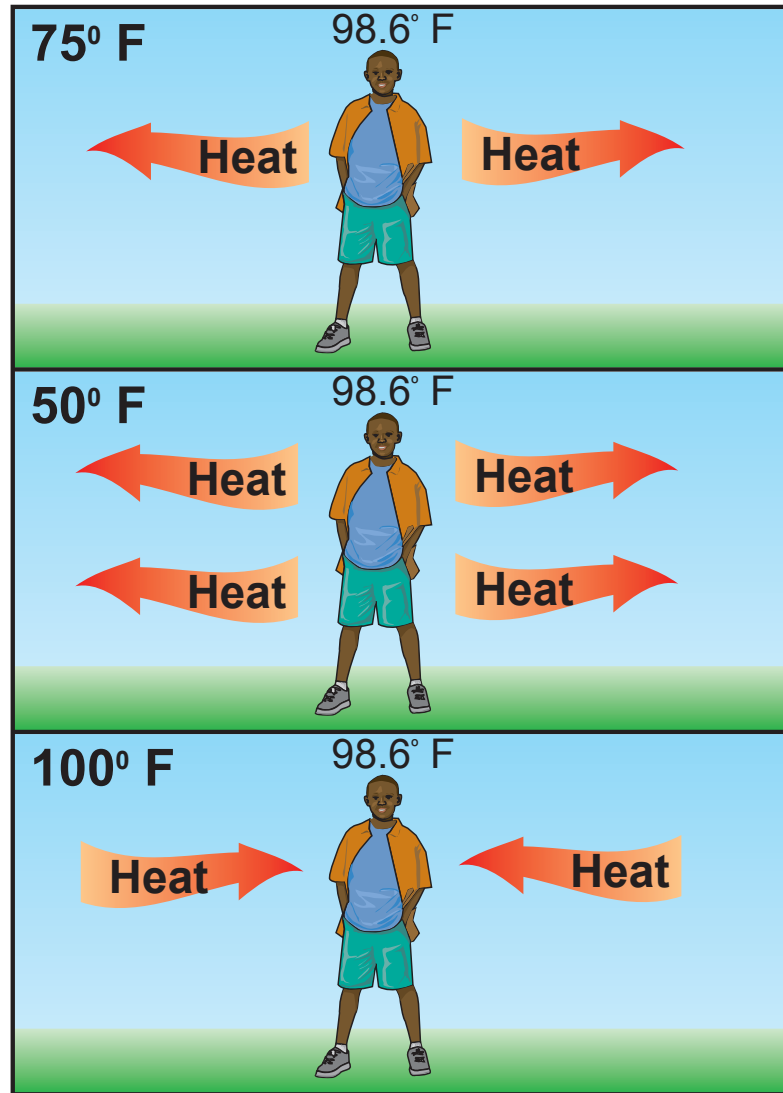
Heat Equation

$$\begin{array}{c} \text{Heat energy (joules)} \rightarrow E = m C_p (T_2 - T_1) \\ \text{Mass (kg)} \rightarrow m \\ \text{Specific heat (} \frac{\text{joule}}{\text{kg} \text{ } ^\circ\text{C}} \text{)} \rightarrow C_p \\ \text{Change in temperature (} ^\circ\text{C} \text{)} \rightarrow (T_2 - T_1) \end{array}$$

Specific heat values of some common materials

Materials	Specific heat (J/kg °C)
Water	4,184
Wood	1,800
Aluminum	900
Glass	800
Gold	129

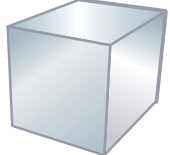
Heat Transfer



Heat flow depends on temperature differences.

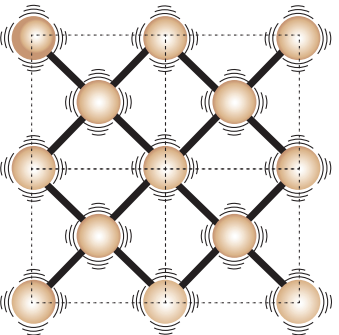
Specific Heat

Comparing Silver and Aluminum



1 kilogram

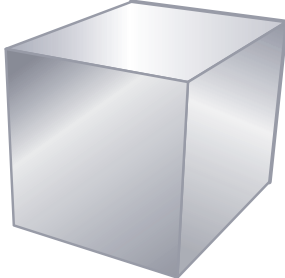
Silver
Specific heat: 235 J/kg°C
Heavier atoms mean fewer atoms per kilogram



Energy is spread over **fewer** atoms

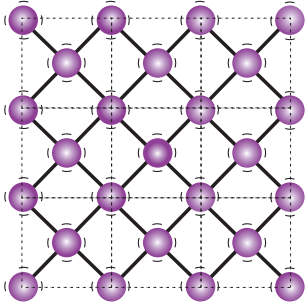
More energy per atom

Higher temperature gain per joule
(lower specific heat)



1 kilogram

Aluminum
Specific heat: 900 J/kg°C
Lighter atoms mean more atoms per kilogram



Energy is spread over **more** atoms

Less energy per atom

Lower temperature gain per joule
(higher specific heat)

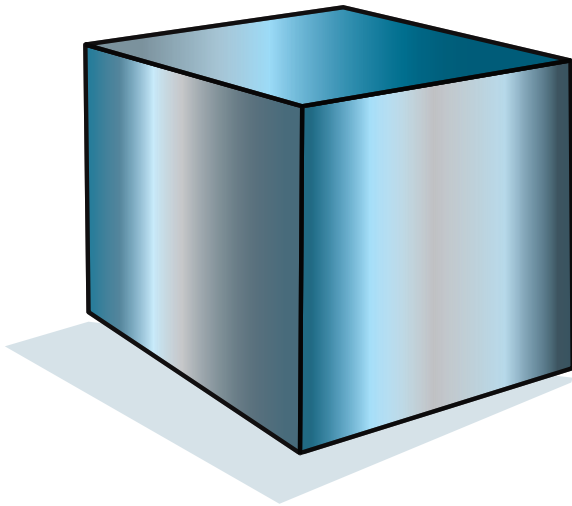
Density

$$\text{Density (kg/m}^3 \text{ or g/cm}^3\text{)} \longrightarrow D = \frac{m}{V}$$

m ← Mass (kg or g)
 V ← Volume (m³ or cm³)

Steel cube

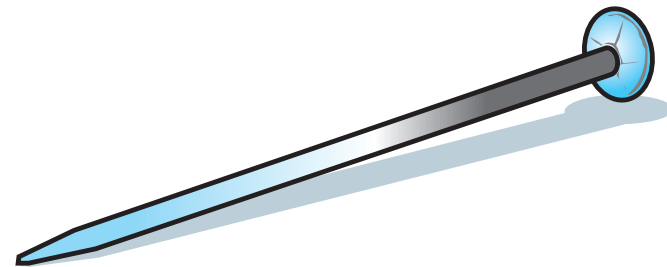
Volume: 1.0 cm³
Mass: 7.8 g
Density: 7.8 g/cm³



Steel Density

Nail

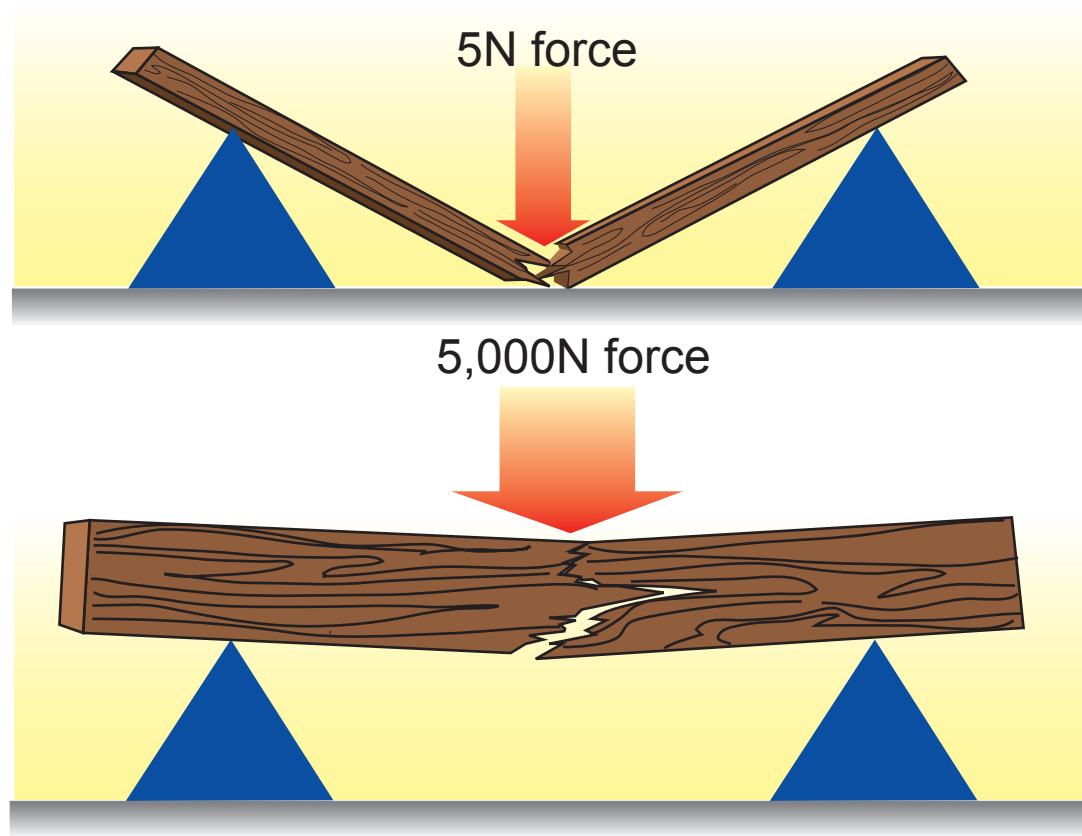
Volume: 1.6 cm³
Mass: 12.5 g
Density: 7.8 g/cm³



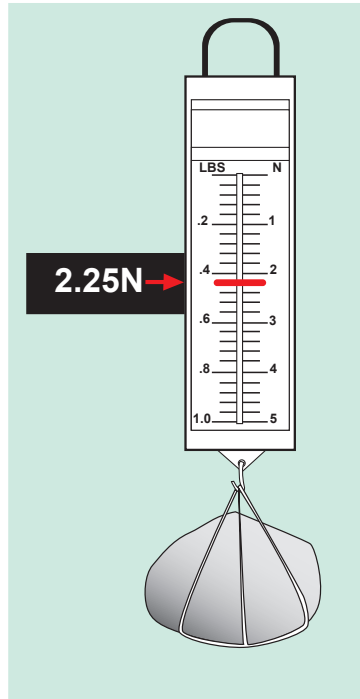
Stress

$$\text{Stress (N/m}^2\text{)} \rightarrow \sigma = \frac{\mathbf{F}}{\mathbf{A}}$$

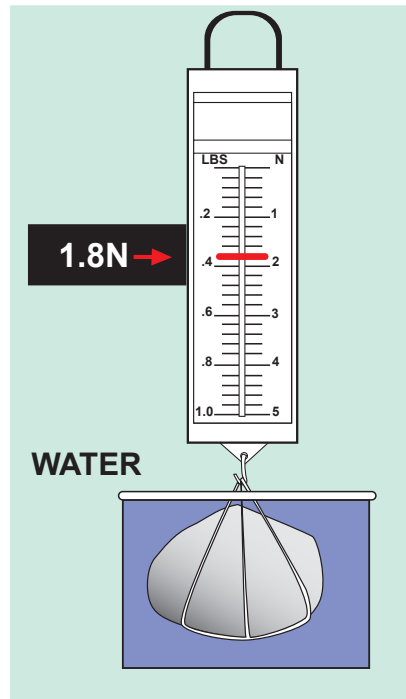
Force (N)
Area (m²)



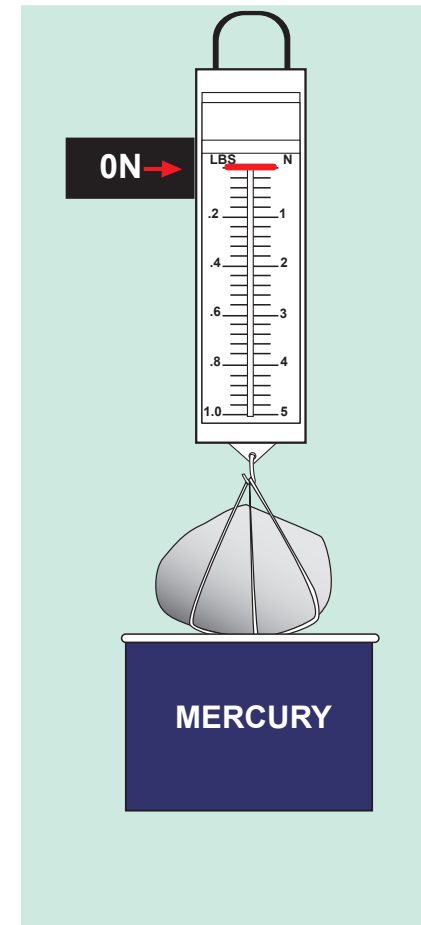
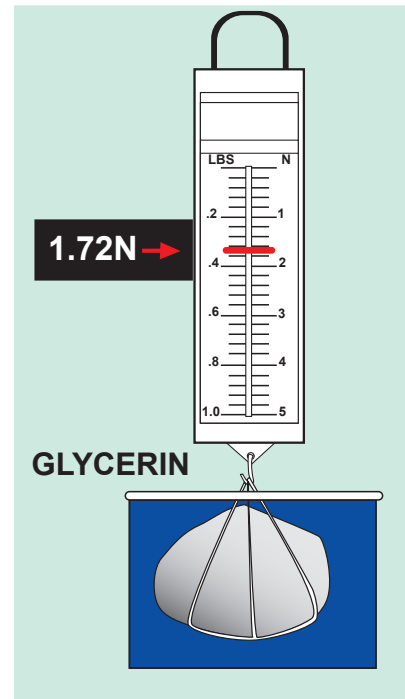
Buoyancy



The rock weighs 2.25N in air.



The rock weighs less in water and glycerin because these fluids exert an upward buoyant force on the rock. The rock weighs nothing in mercury. Why?

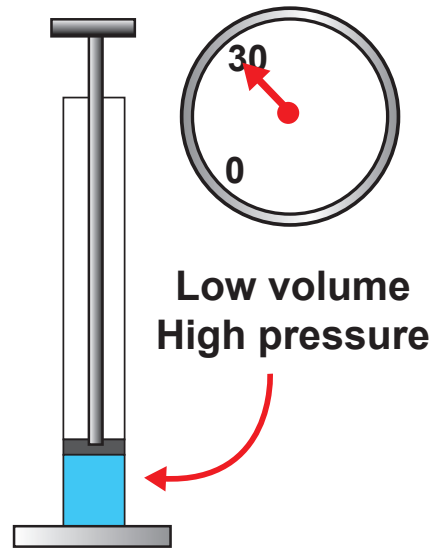
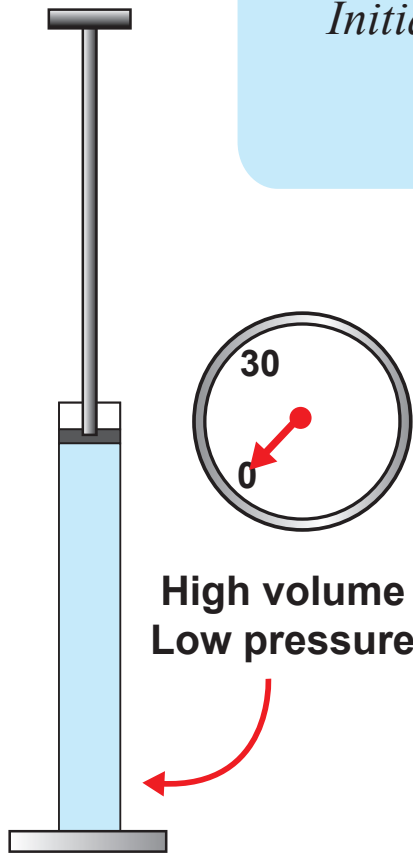


Which liquid exerts the most buoyant force on the rock?

Boyle's Law

Initial volume → $P_1 V_1 = P_2 V_2$ ← *New pressure*
Initial pressure → $P_1 V_1 = P_2 V_2$ ← *New volume*

Mass and temperature constant



Charles' Law

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

Initial volume (m³) *New volume (m³)*
Initial temperature (K) *New temperature (K)*

Pressure and mass constant

The air inside a hot-air balloon is less dense than the surrounding air.

The hot air in the balloon takes up more volume than a similar amount of cooler air outside the balloon.

Outside
15°C



Pressure-Temperature Relationship

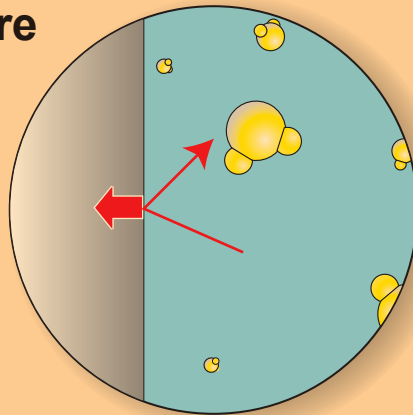
$$\begin{array}{l} \text{Initial pressure (N/m}^2\text{)} \rightarrow P_1 = P_2 \leftarrow \text{New pressure} \\ \text{Initial temperature (K)} \rightarrow T_1 = T_2 \leftarrow \text{New temperature} \end{array}$$

Volume and mass constant

Low Temperature

↓
Slower molecules

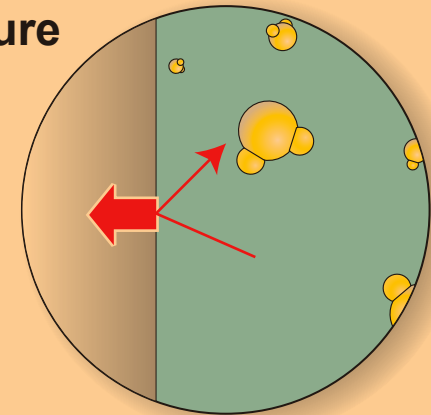
↓
Lower pressure



High Temperature




↓
Faster molecules

↓
Higher pressure

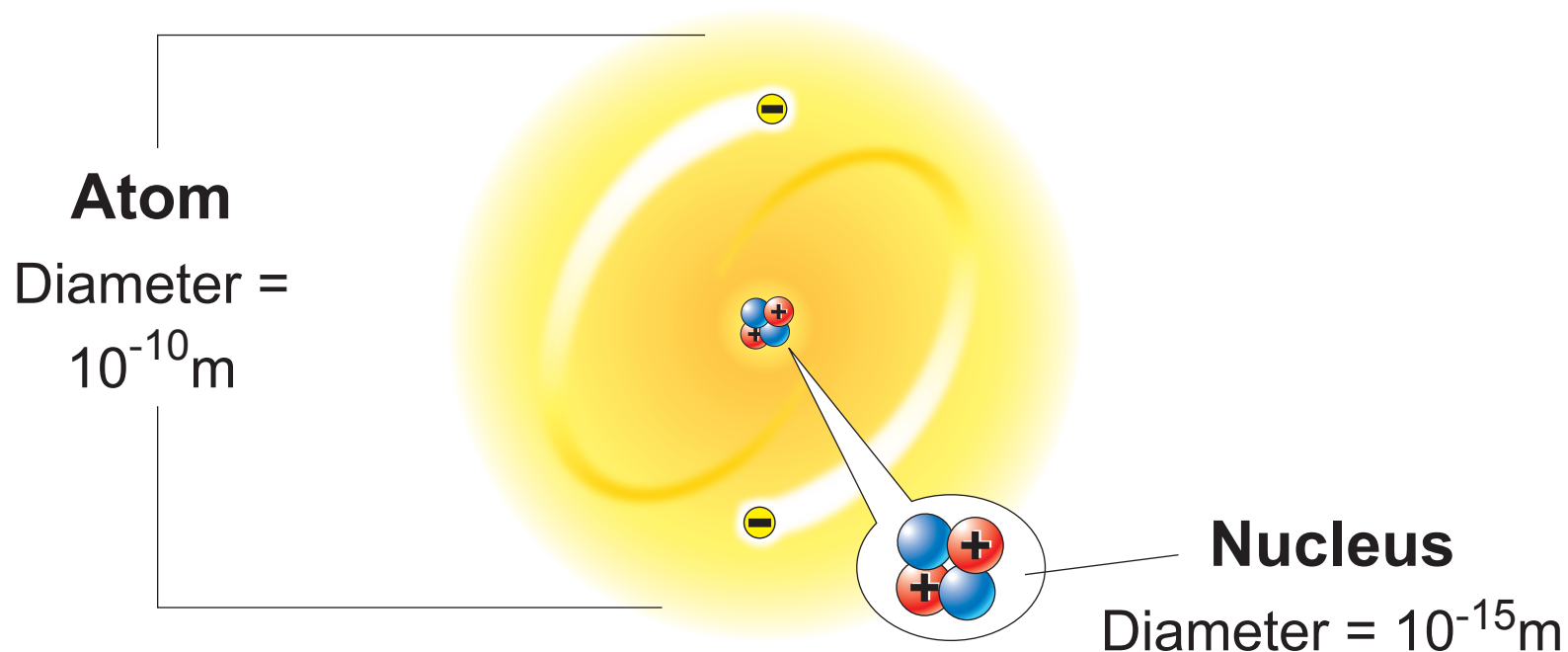


Faster molecules create higher pressure because they exert larger forces as they collide with the sides of the container holding them.

Three Subatomic Particles

Subatomic particle	Occurrence	Charge	Mass (g)	Relative Mass
 Electron	found outside of nucleus	-1	9.109×10^{-28}	1
 Proton	found in all nuclei	+1	1.673×10^{-24}	1,837
 Neutron	found in almost all nuclei (exception: most H nuclei)	0	1.675×10^{-24}	1,839

Size and Structure of the Atom



Periodic Table of the Elements

Li	← Element symbol
3	← Atomic number
lithium	← Element name

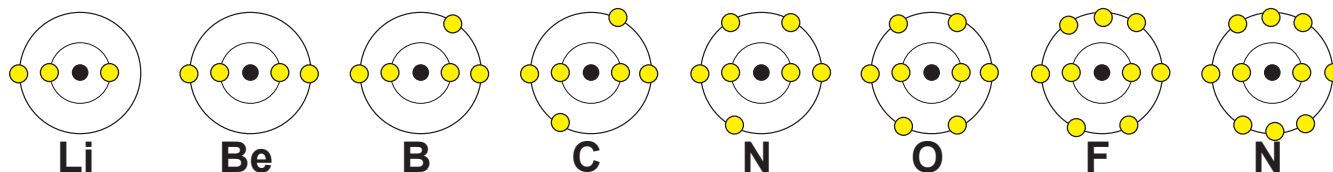
	Main Group Elements		Non metals
	Transition Elements		Metals



ROWS = PERIODS COLUMNS = GROUPS

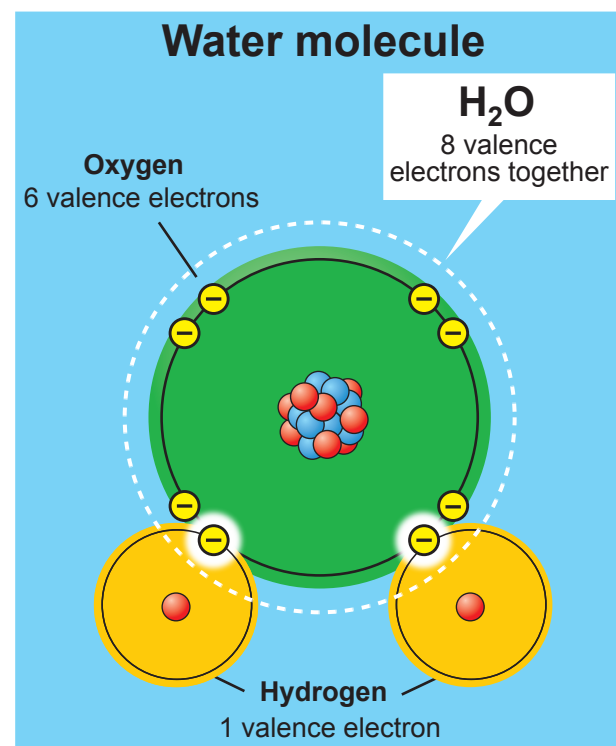
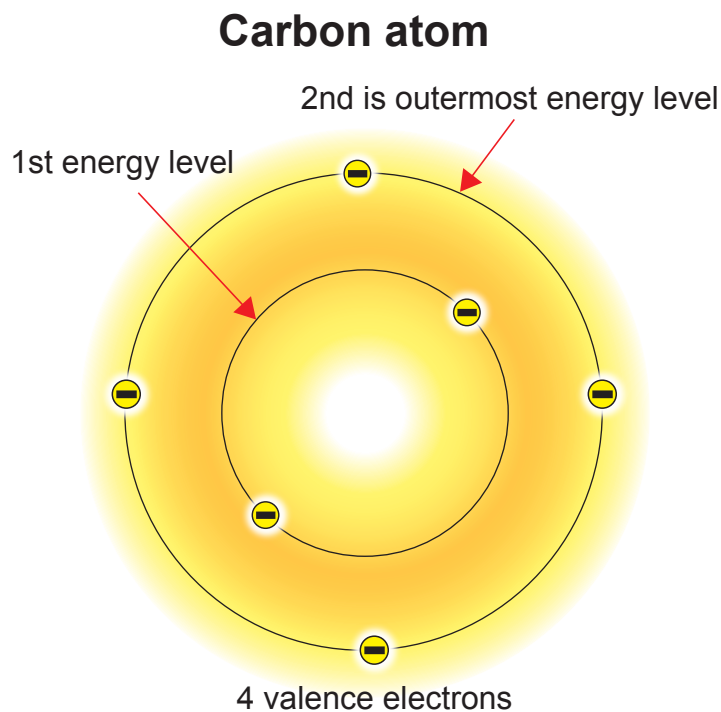
1																	18
H 1 hydrogen																	He 2 helium
Li 3 lithium	Be 4 beryllium											B 5 boron	C 6 carbon	N 7 nitrogen	O 8 oxygen	F 9 fluorine	Ne 10 neon
Na 11 sodium	Mg 12 magnesium	3	4	5	6	7	8	9	10	11	12	Al 13 aluminum	Si 14 silicon	P 15 phosphorus	S 16 sulfur	Cl 17 chlorine	Ar 18 argon
K 19 potassium	Ca 20 calcium	Sc 21 scandium	Ti 22 titanium	V 23 vanadium	Cr 24 chromium	Mn 25 manganese	Fe 26 iron	Co 27 cobalt	Ni 28 nickel	Cu 29 copper	Zn 30 zinc	Ga 31 gallium	Ge 32 germanium	As 33 arsenic	Se 34 selenium	Br 35 bromine	Kr 36 krypton
Rb 37 rubidium	Sr 38 strontium	Y 39 yttrium	Zr 40 zirconium	Nb 41 niobium	Mo 42 molybdenum	Tc 43 technetium	Ru 44 ruthenium	Rh 45 rhodium	Pd 46 palladium	Ag 47 silver	Cd 48 cadmium	In 49 indium	Sn 50 tin	Sb 51 antimony	Te 52 tellurium	I 53 iodine	Xe 54 xenon
Cs 55 cesium	Ba 56 barium	Hf 72 hafnium		Ta 73 tantalum	W 74 tungsten	Re 75 rhenium	Os 76 osmium	Ir 77 iridium	Pt 78 platinum	Au 79 gold	Hg 80 mercury	Tl 81 thallium	Pb 82 lead	Bi 83 bismuth	Po 84 polonium	At 85 astatine	Rn 86 radon
Fr 87 francium	Ra 88 radium	Rf 104 rutherfordium		Db 105 dubnium	Sg 106 seaborgium	Bh 107 bohrium	Hs 108 hassium	Mt 109 meitnerium	Uun 110 ununilium	Uuu 111 unununium	Uub 112 ununbium	113	Uuq 114 ununquadium	115	Uuh 116 ununhexium	117	Uuh 118 ununoctium

La 57 lanthanum	Ce 58 cerium	Pr 59 praseodymium	Nd 60 neodymium	Pm 61 promethium	Sm 62 samarium	Eu 63 europium	Gd 64 gadolinium	Tb 65 terbium	Dy 66 dysprosium	Ho 67 holmium	Er 68 erbium	Tm 69 thulium	Yb 70 ytterbium	Lu 71 lutetium
Ac 89 actinium	Th 90 thorium	Pa 91 protactinium	U 92 uranium	Np 93 neptunium	Pu 94 plutonium	Am 95 americium	Cm 96 curium	Bk 97 berkelium	Cf 98 californium	Es 99 einsteinium	Fm 100 fermium	Md 101 mendelevium	No 102 nobelium	Lr 103 lawrencium

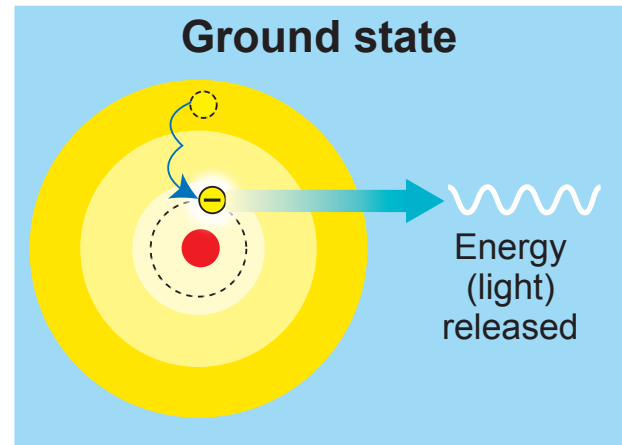
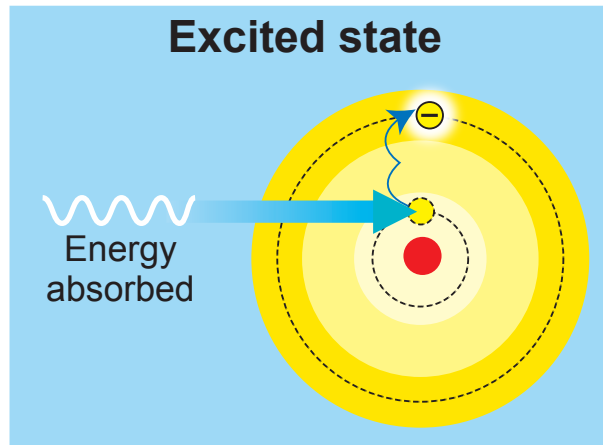
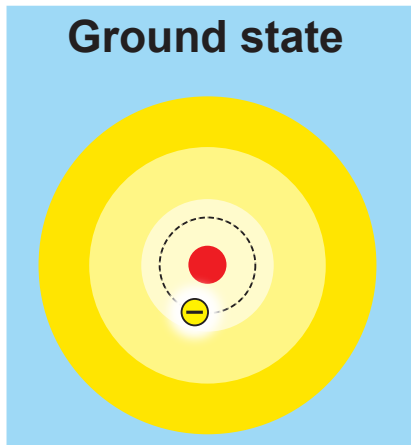
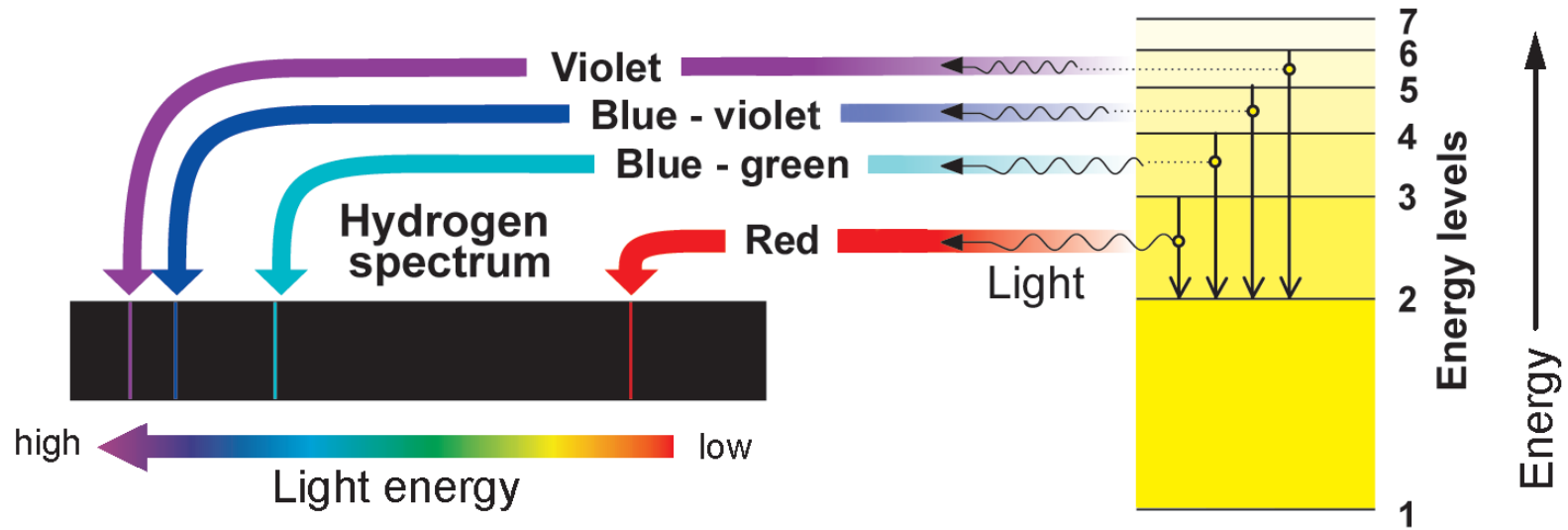
Electrons and Energy Levels



Total 	3	4	5	6	7	8	9	10
 In the outermost energy level	1	2	3	4	5	6	7	8



Quantum Theory



Spectral Lines



R **O** **Y** **G** **B** **V**



Hydrogen



Sodium



Helium



Neon



Mercury