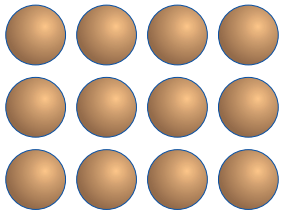
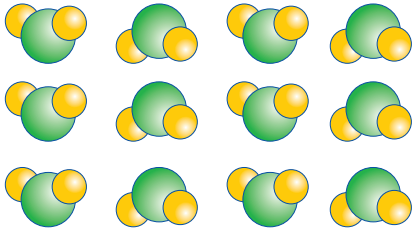
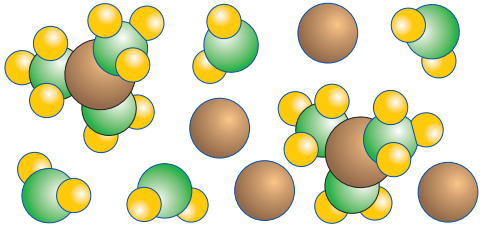
Types of Matter



Element



Compound



Mixture

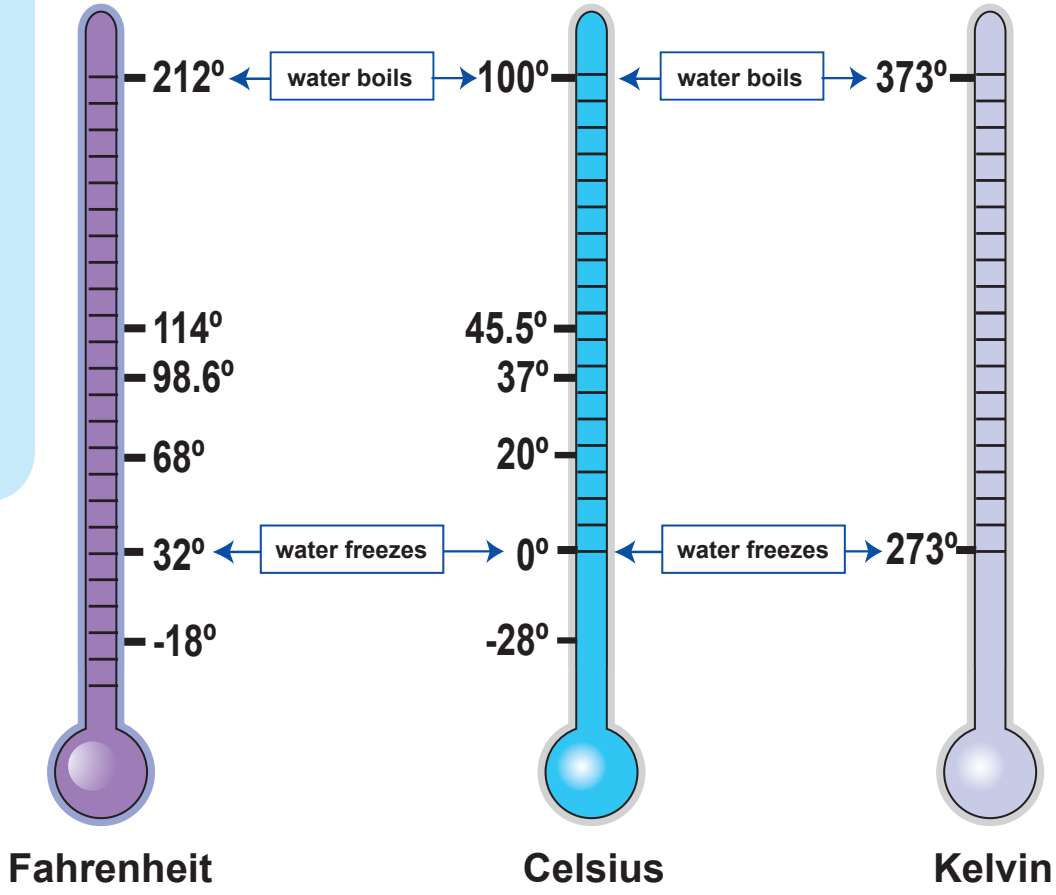
Type of matter	Definition	Examples
Element	One single kind of atom	copper, metal, oxygen gas, liquid nitrogen
Compound	One type of molecule	propane, water, table salt, rust (iron oxide), carbon dioxide gas
Mixture	Combination of different compounds and/or elements	Soda pop, air, chicken soup, soil, chocolate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

Temperature Conversion

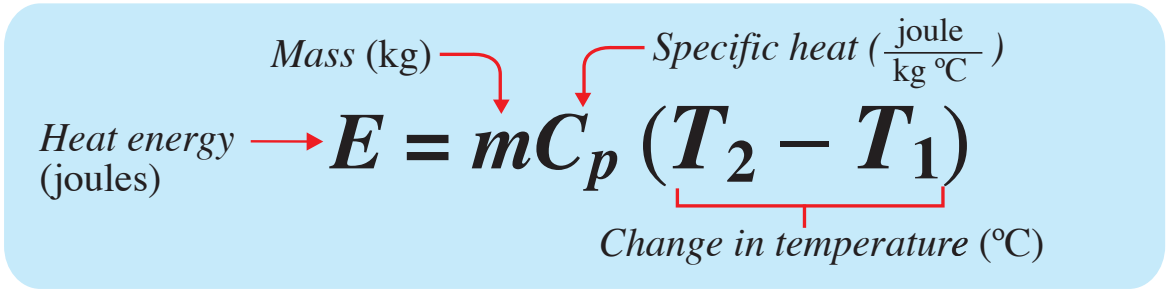
$$T_{Fahrenheit} = \frac{9}{5} T_{Celsius} + 32$$

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

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



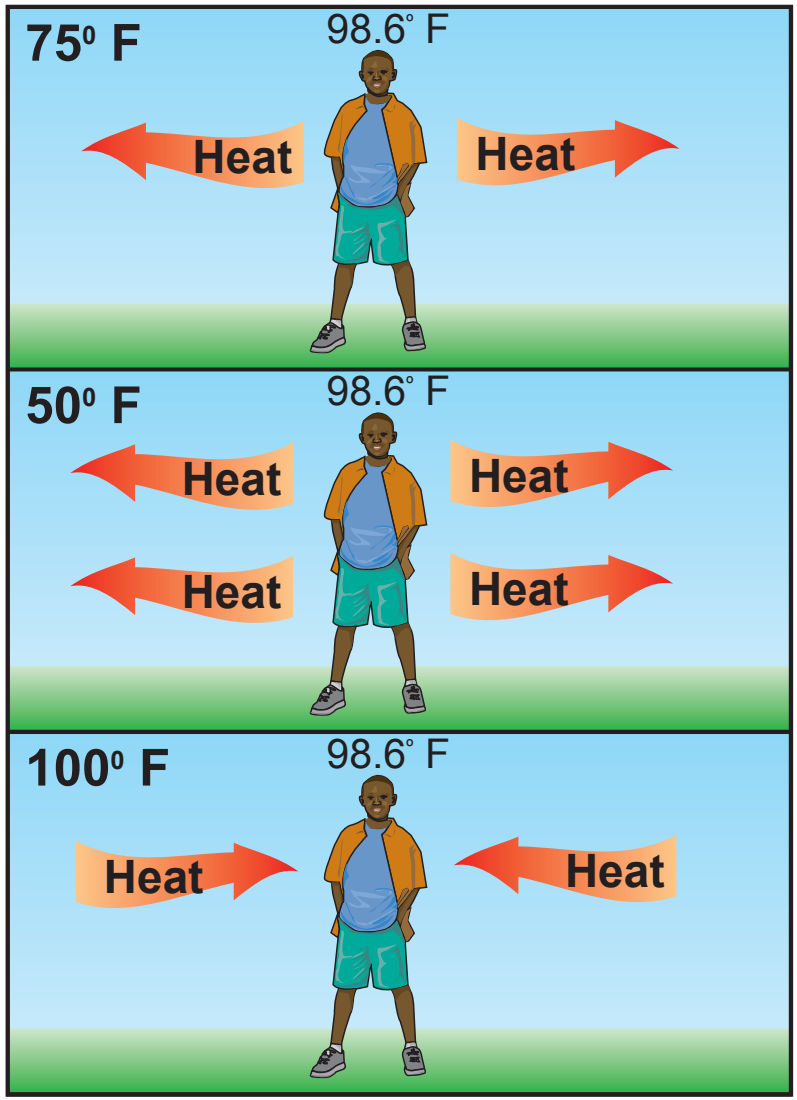
Heat Equation



Specific heat values of some common materials

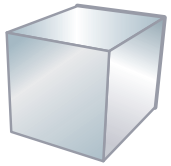
Materials	Specific heat (J/kg °C)
Water	4,184
Wood	1,800
Aluminum	900
Glass	800
Gold	129

Heat Transfer

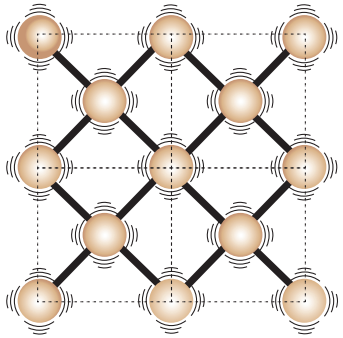


Heat flow depends on temperature differences.

Specific Heat
Comparing Silver and Aluminum



1 kilogram



Silver

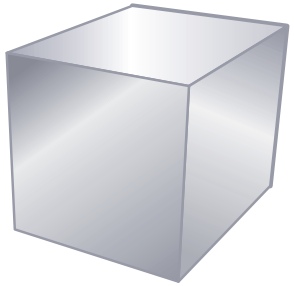
Specific heat: 235 J/kg°C

*Heavier atoms mean **fewer** atoms per kilogram*

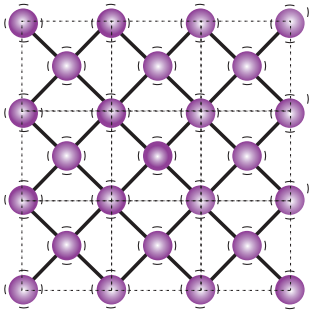
Energy is spread over **fewer** atoms

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

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

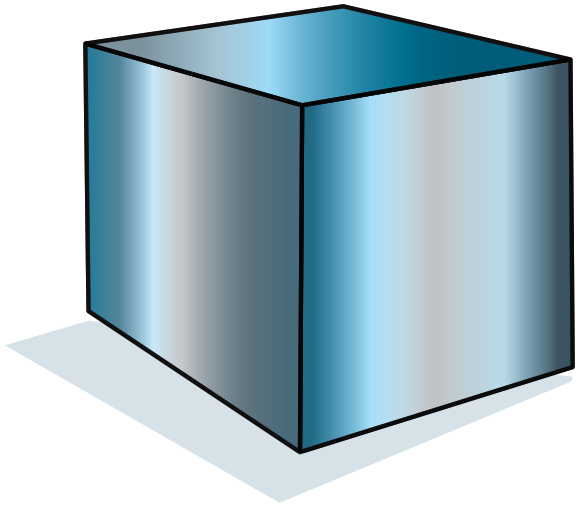
← *Mass* (kg **or** g)

← *Volume* (m^3 **or** cm^3)

Steel Density

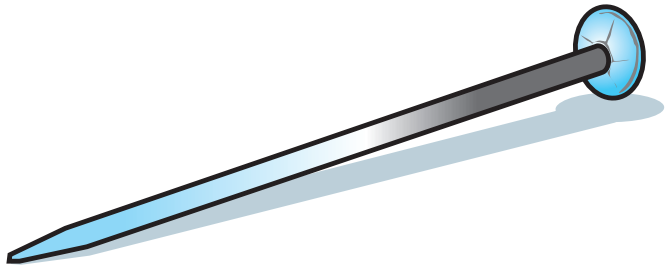
Steel cube

Volume: 1.0 cm^3
Mass: 7.8 g
Density: 7.8 g/cm^3



Nail

Volume: 1.6 cm^3
Mass: 12.5 g
Density: 7.8 g/cm^3

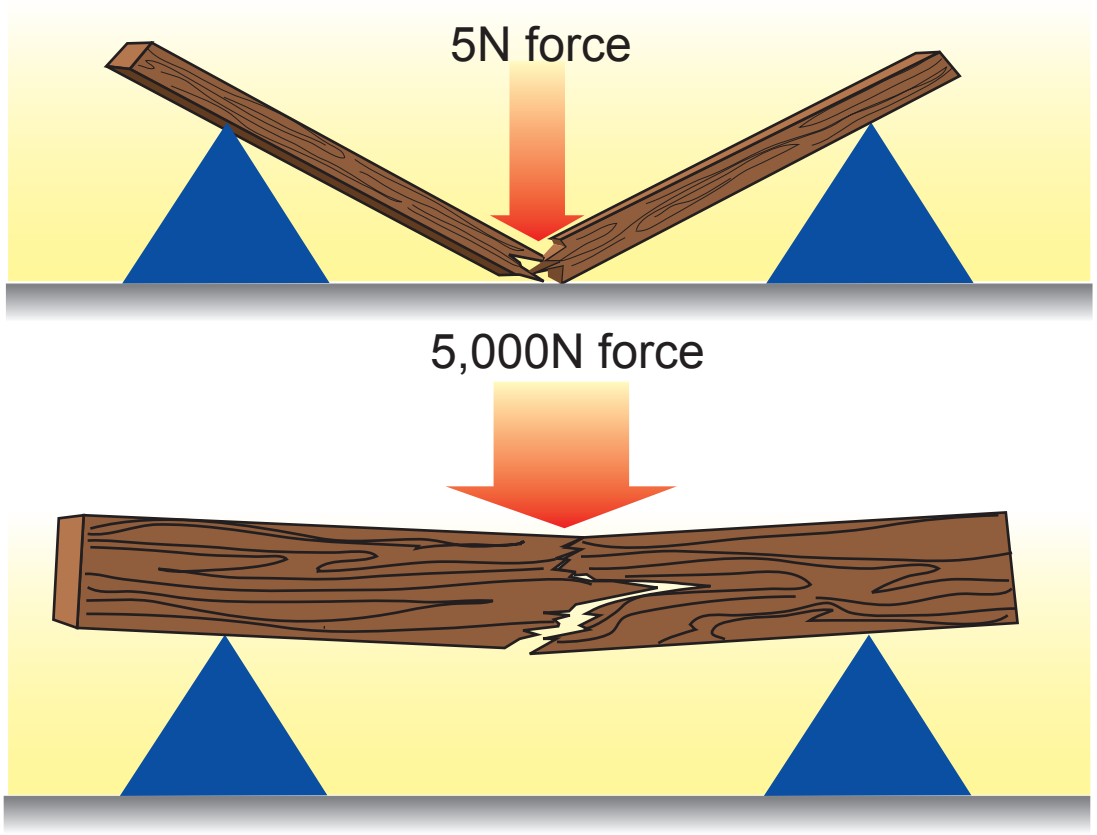


Stress

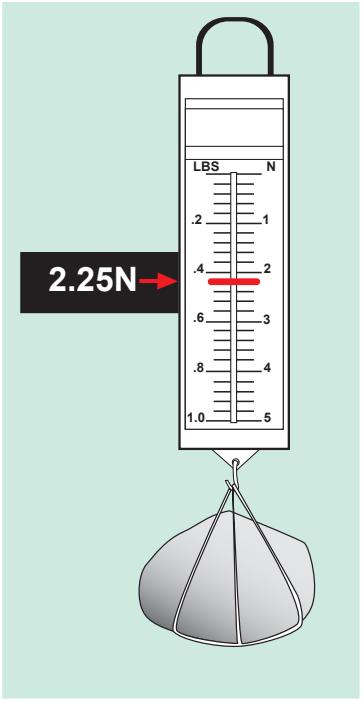
$$\text{Stress } (N/m^2) \rightarrow \sigma = \frac{F}{A}$$

F ← *Force (N)*

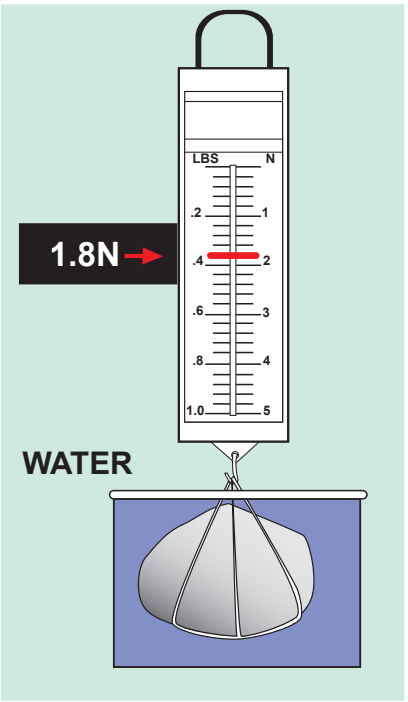
A ← *Area (m^2)*

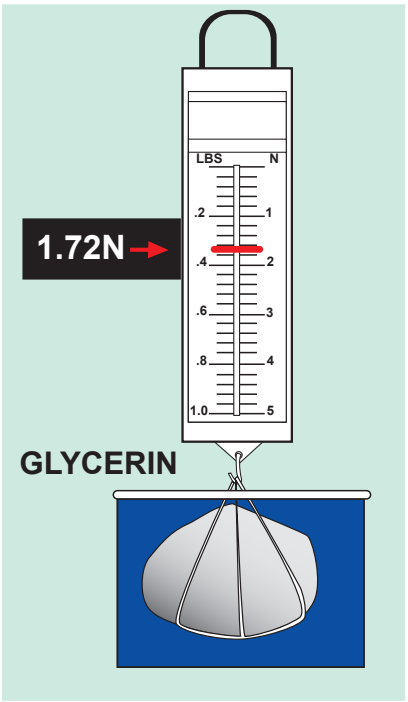


Buoyancy

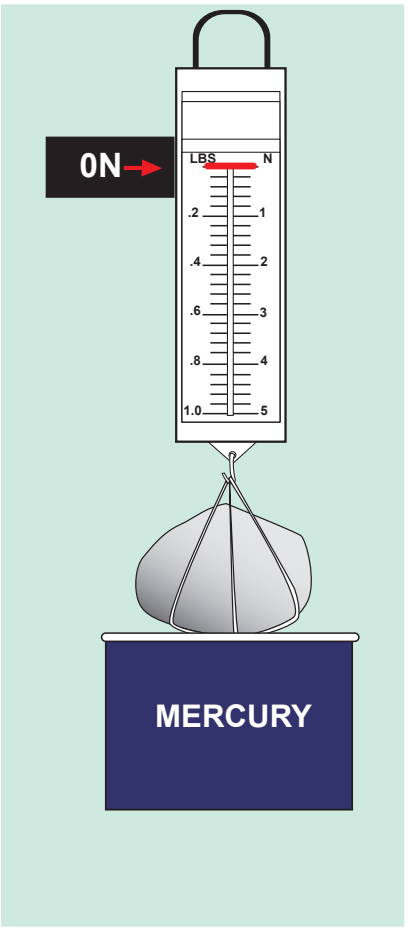


The rock weighs 2.25N in air.





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?



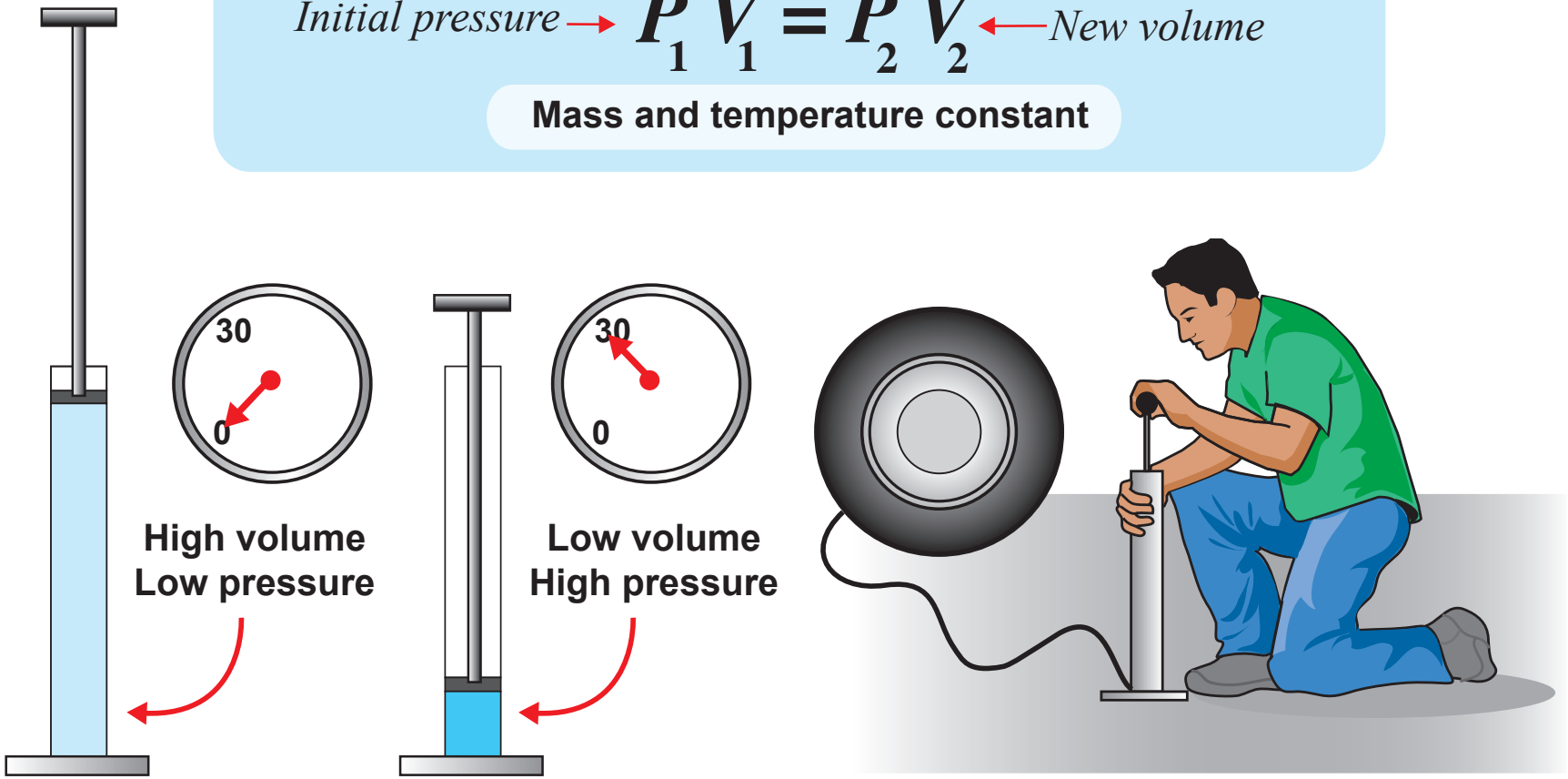
Which liquid exerts the most buoyant force on the rock?

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

Initial volume (m^3) *New volume* (m^3)

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

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.

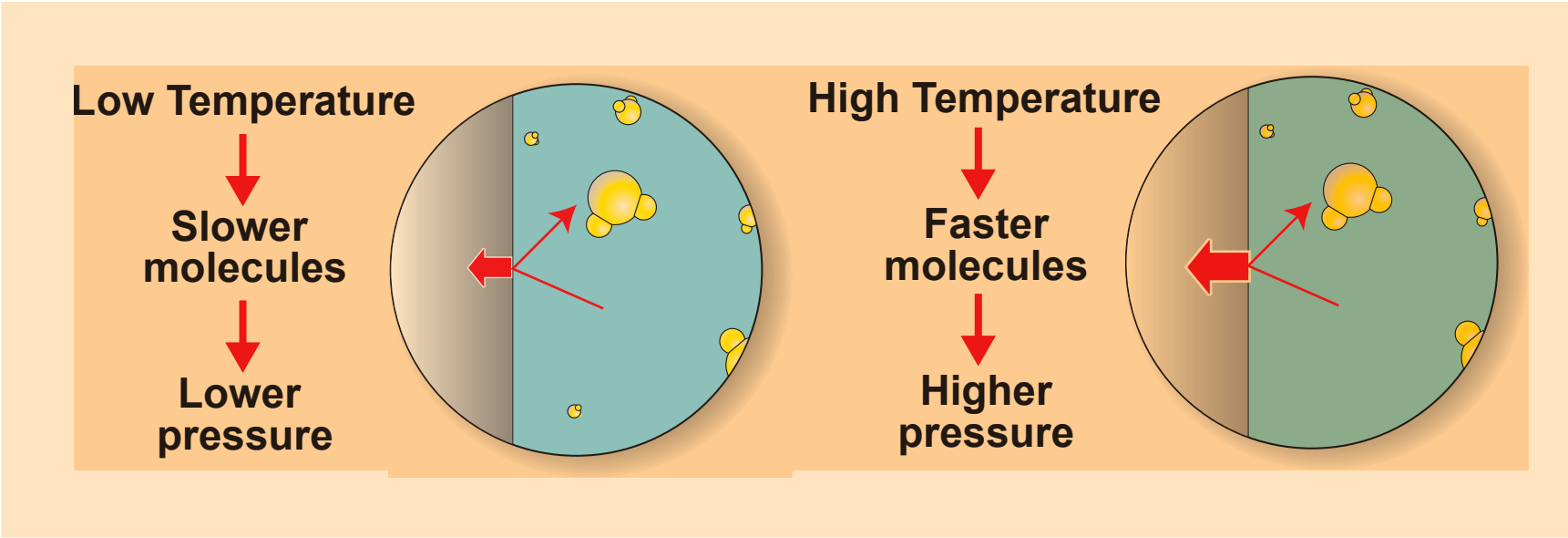
Pressure-Temperature Relationship

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

Initial pressure (N/m^2) → P_1 ← *New pressure*

Initial temperature (K) → T_1 ← *New temperature*

Volume and mass constant

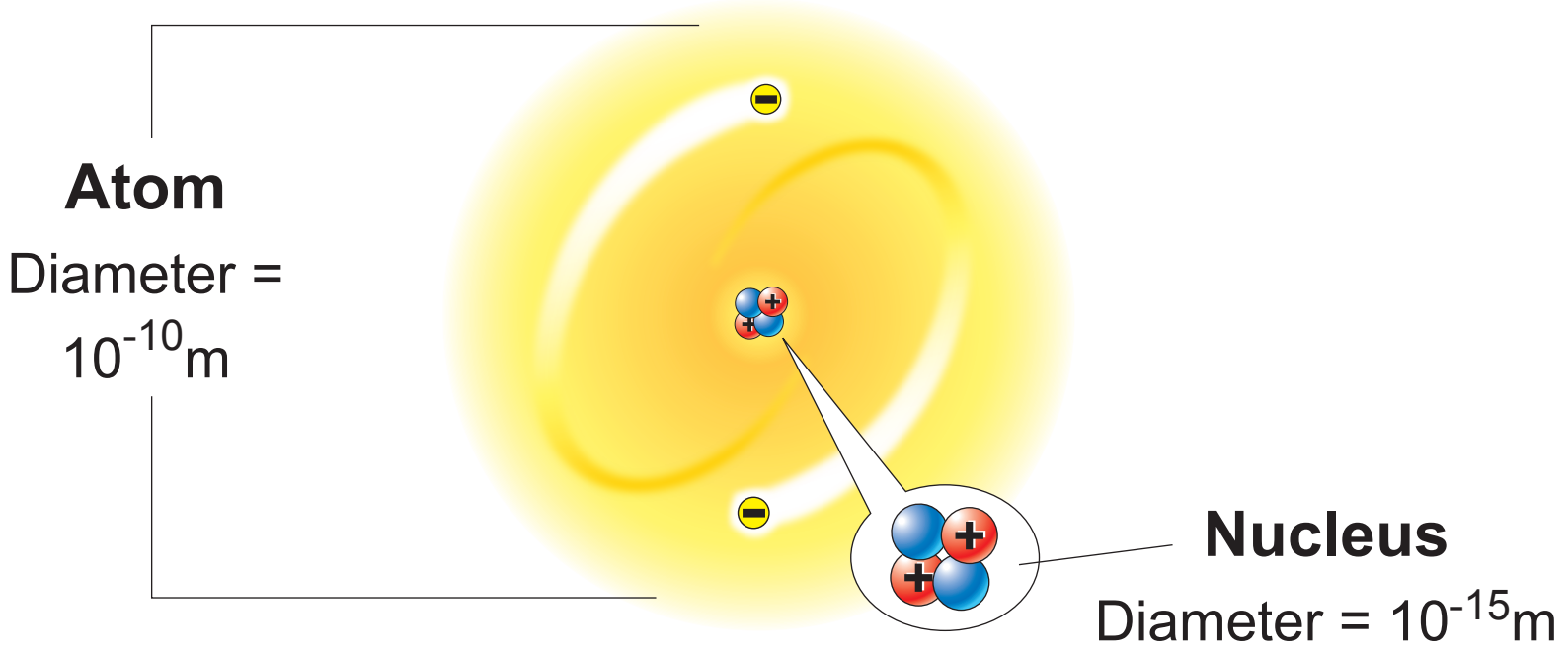


Faster molecules create higher pressure because they exert larger forces as they collide with the sides of the container holding them.

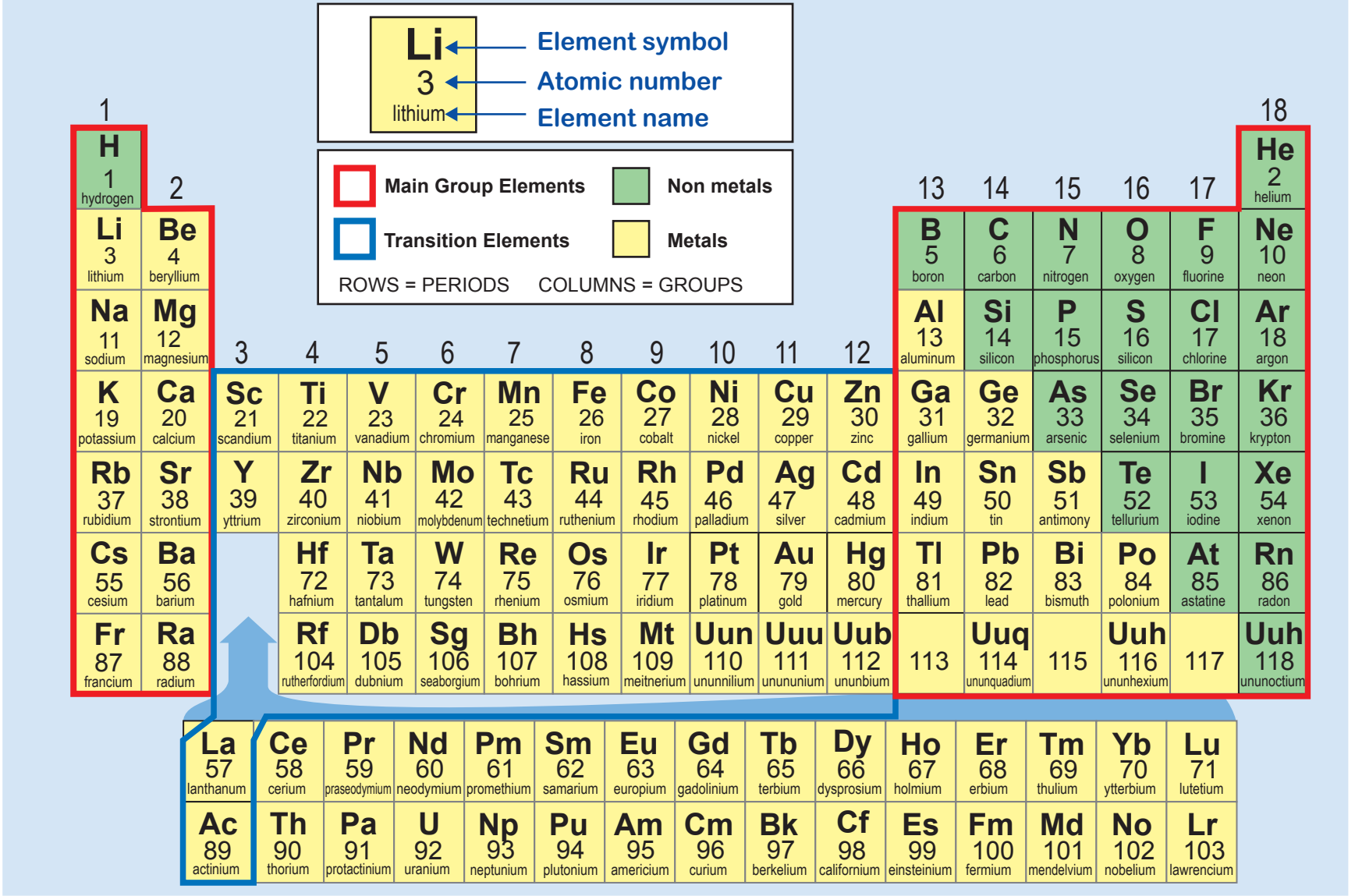
Three Subatomic Particles

Subatomic partial	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

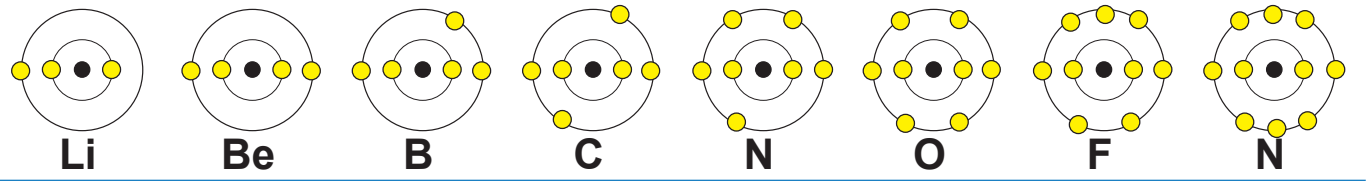
Size and Structure of the Atom



Periodic Table of the Elements

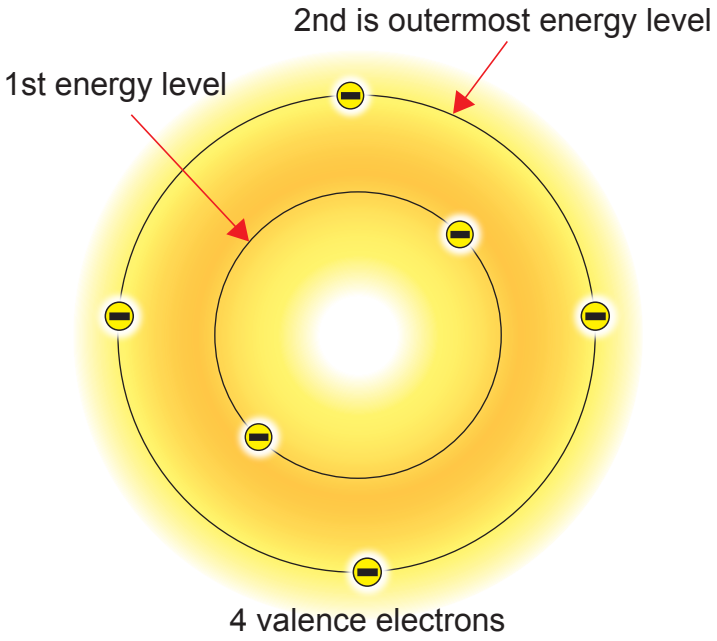


Electrons and Energy Levels

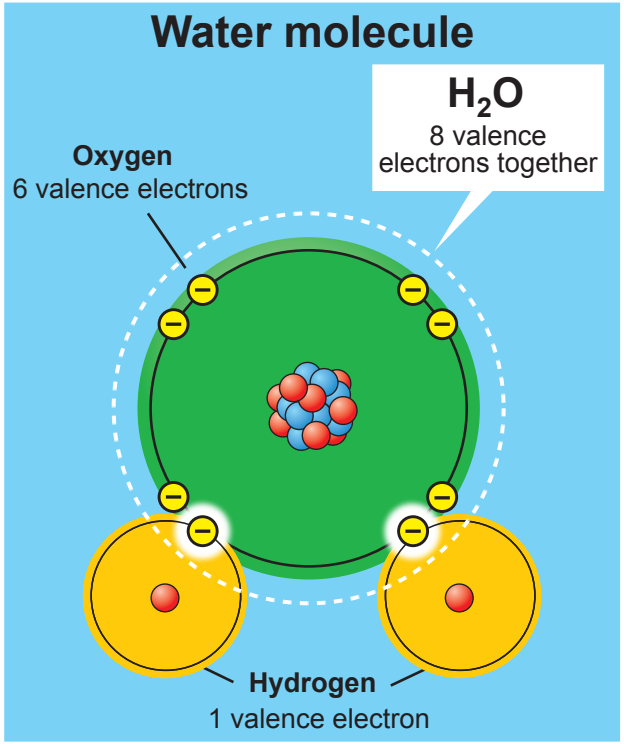


	Li	Be	B	C	N	O	F	N
Total ⊖	3	4	5	6	7	8	9	10
⊖ In the outermost energy level	1	2	3	4	5	6	7	8

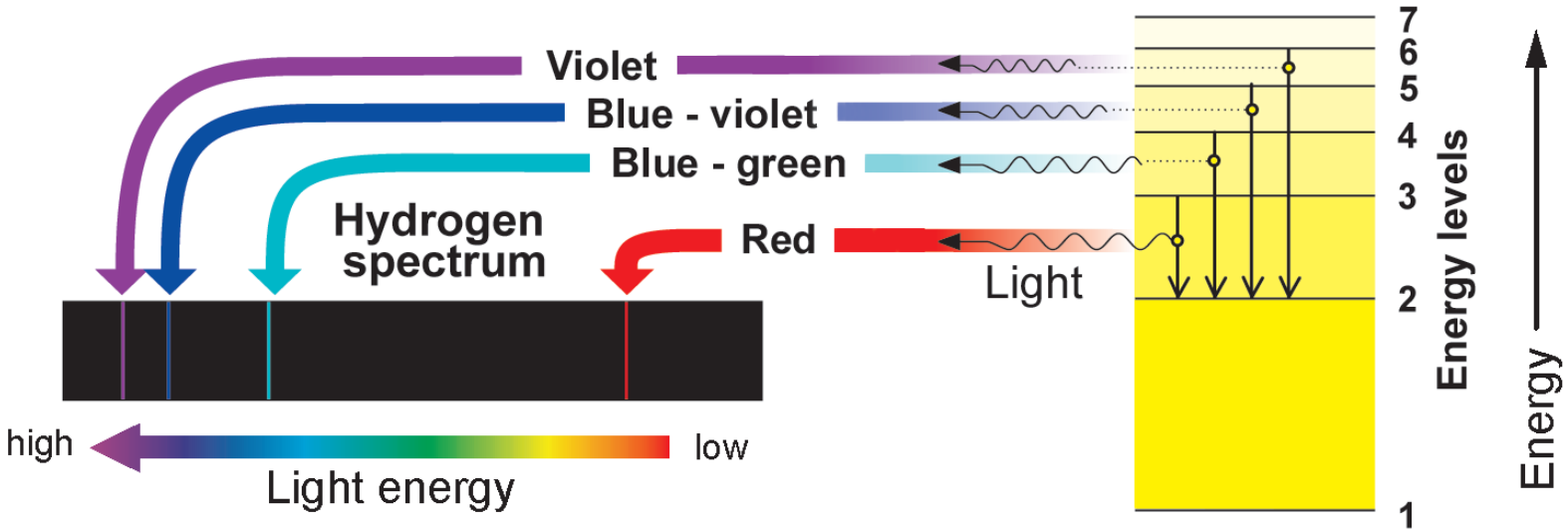
Carbon atom

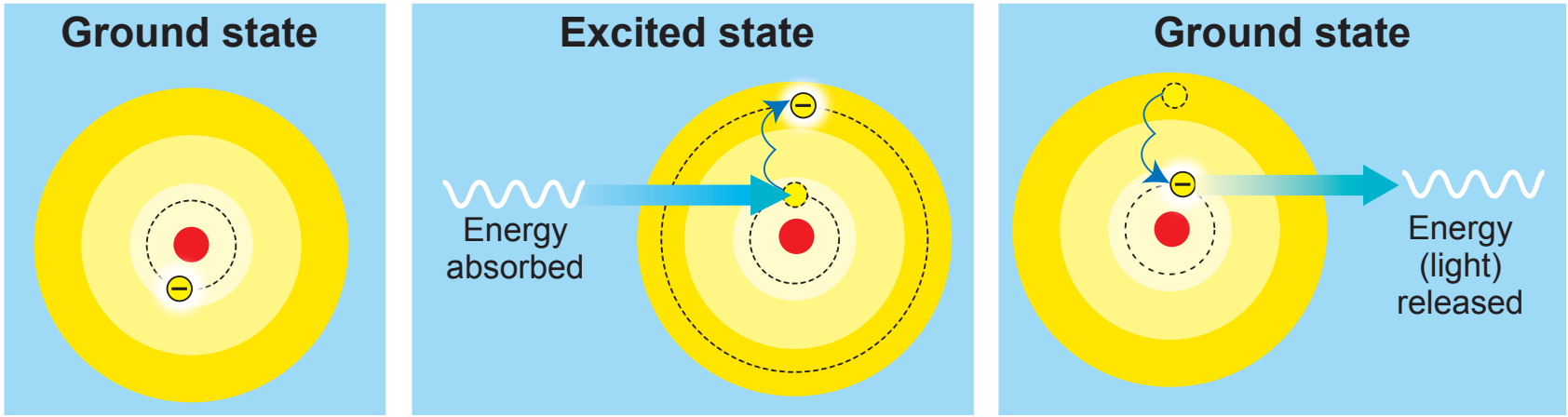


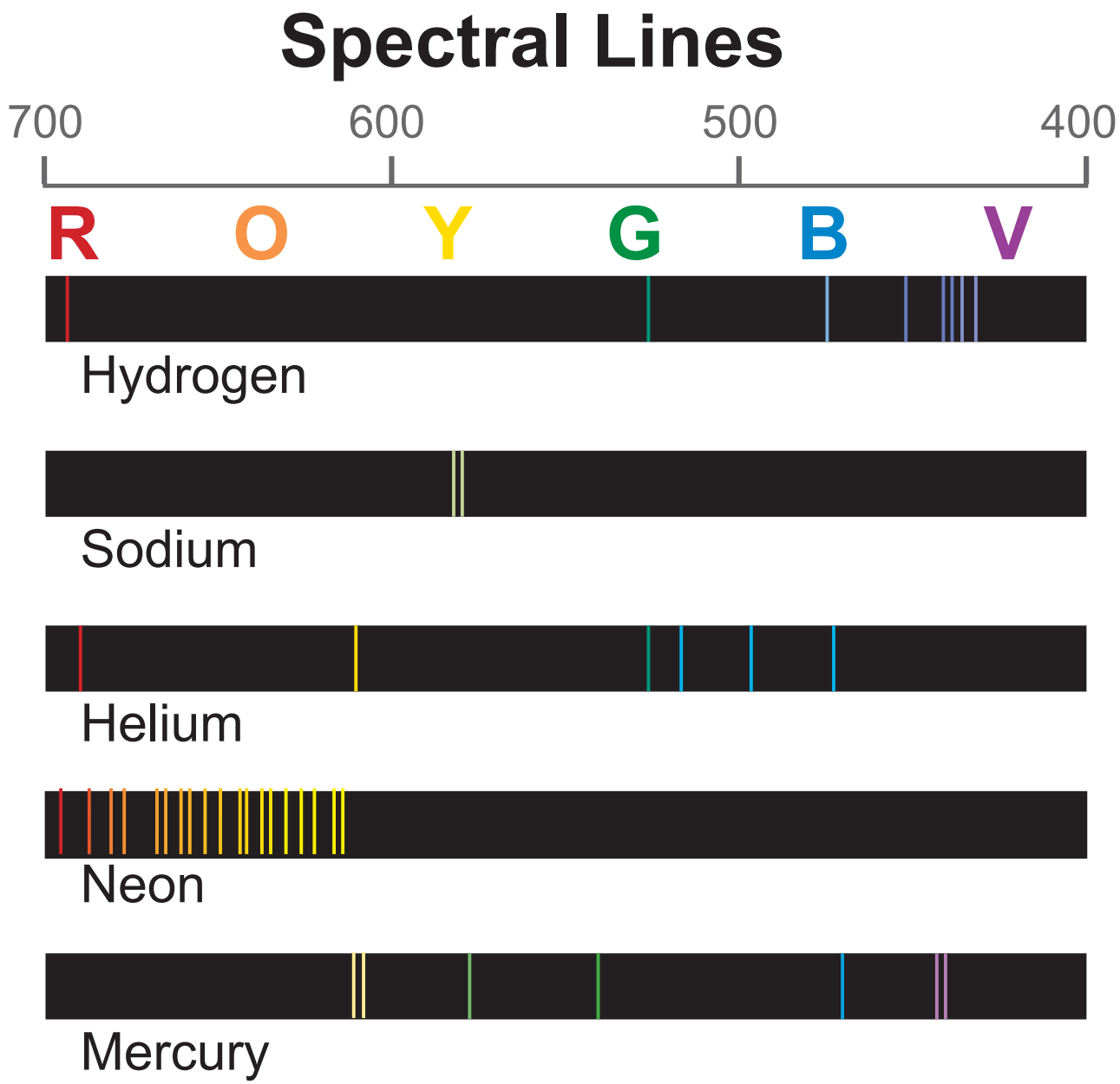
Water molecule



Quantum Theory






Spectral Lines
700
600
500
400
R
O
Y
G
B
V
Hydrogen
Sodium
Helium
Neon
Mercury