# Modern Atomic Theory

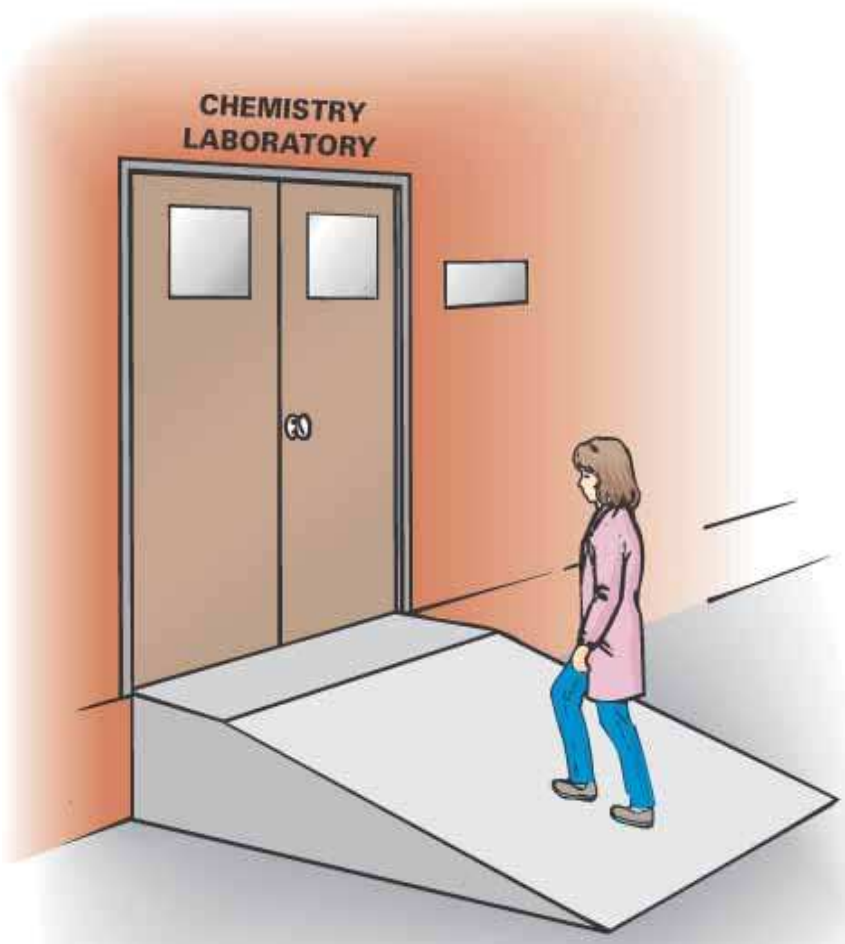
**Problems with the atomic model?**

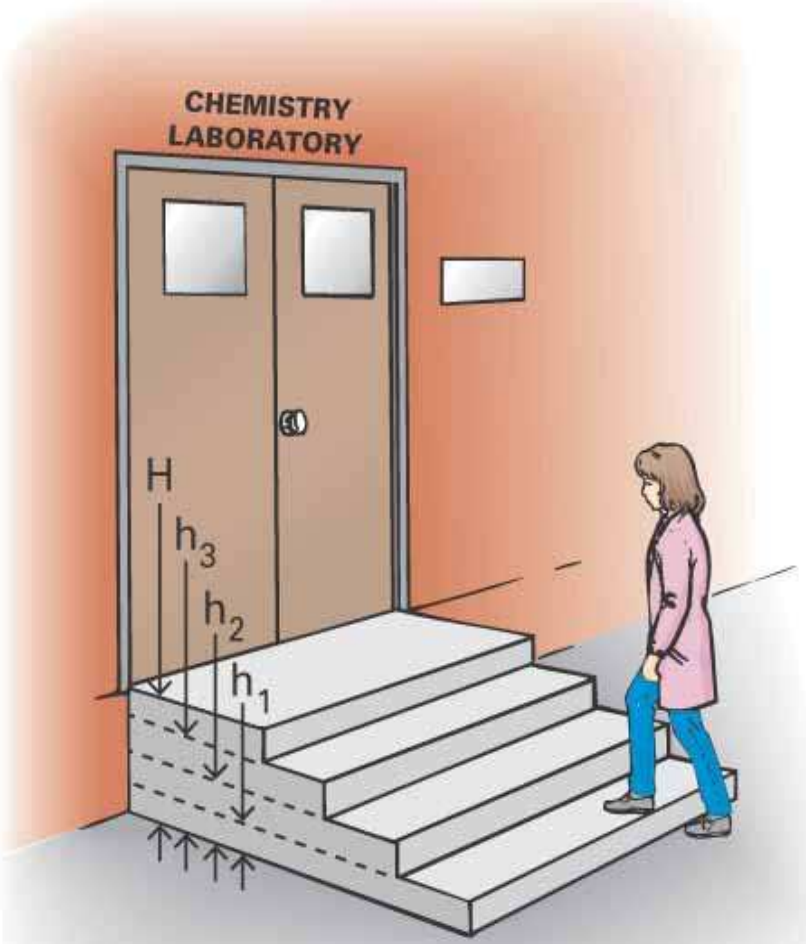
Where would you expect to find (-) electrons?

# First a little about energy:

Max Planck determines that energy transferred is **quantized**

# Quantized vs Continuous



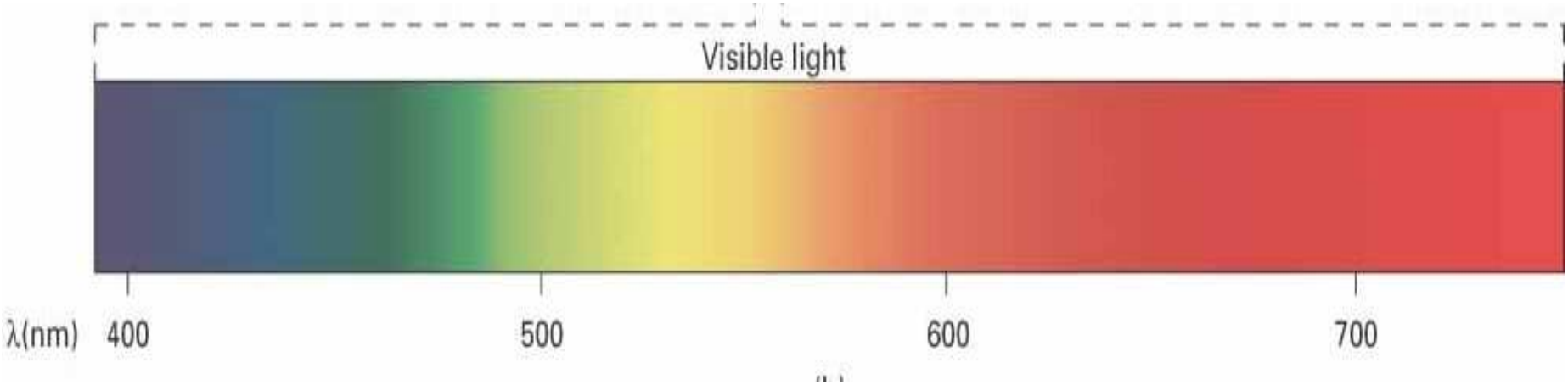
# Question Q1-
# quantized or continuous?

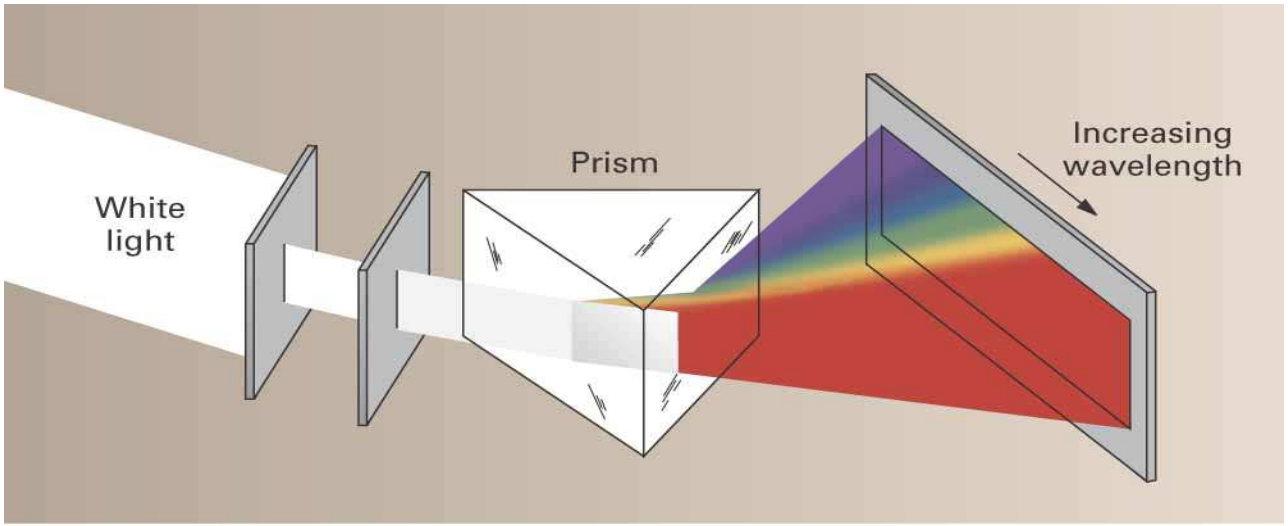
money?

shoe sizes?

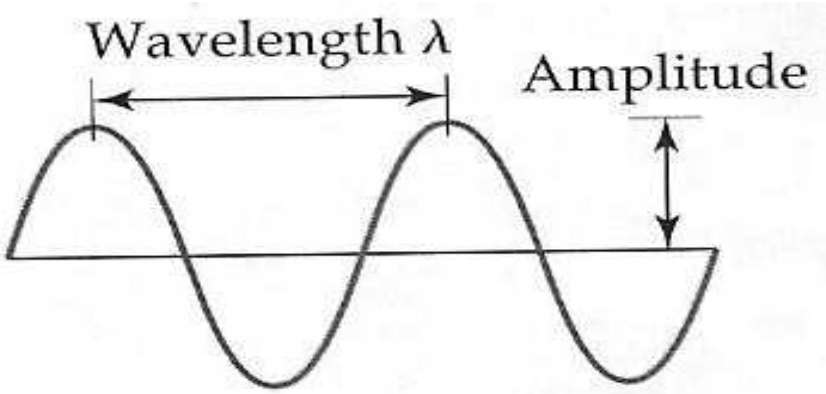
water from a faucet?

# Light

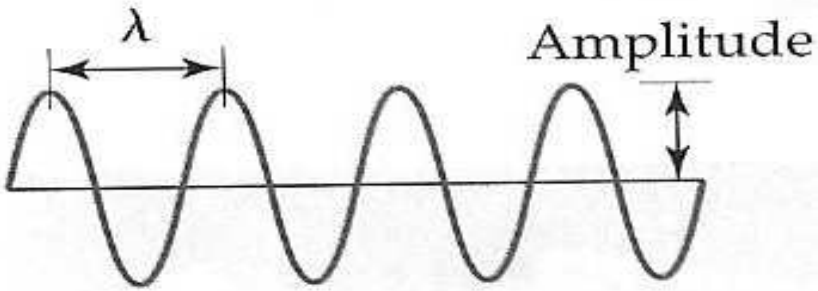


# Properties of Light

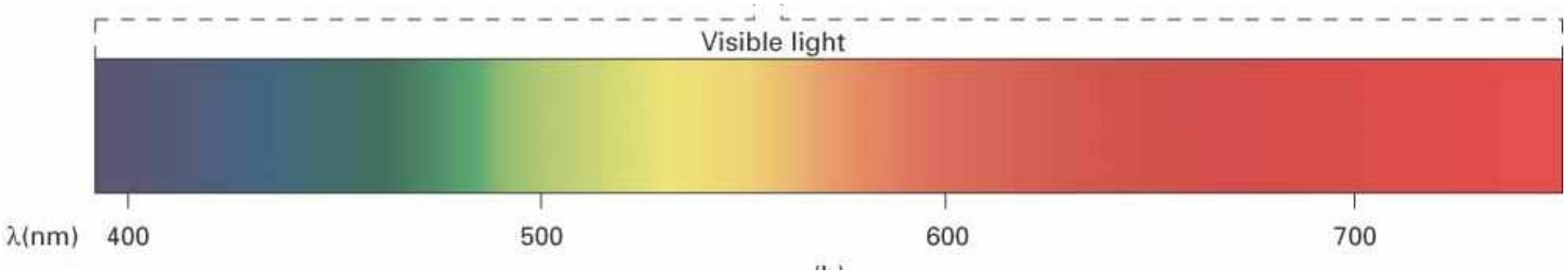



(a) Two complete cycles of wavelength λ




(b) Wavelength half of that in (a); frequency twice as great as in (a)

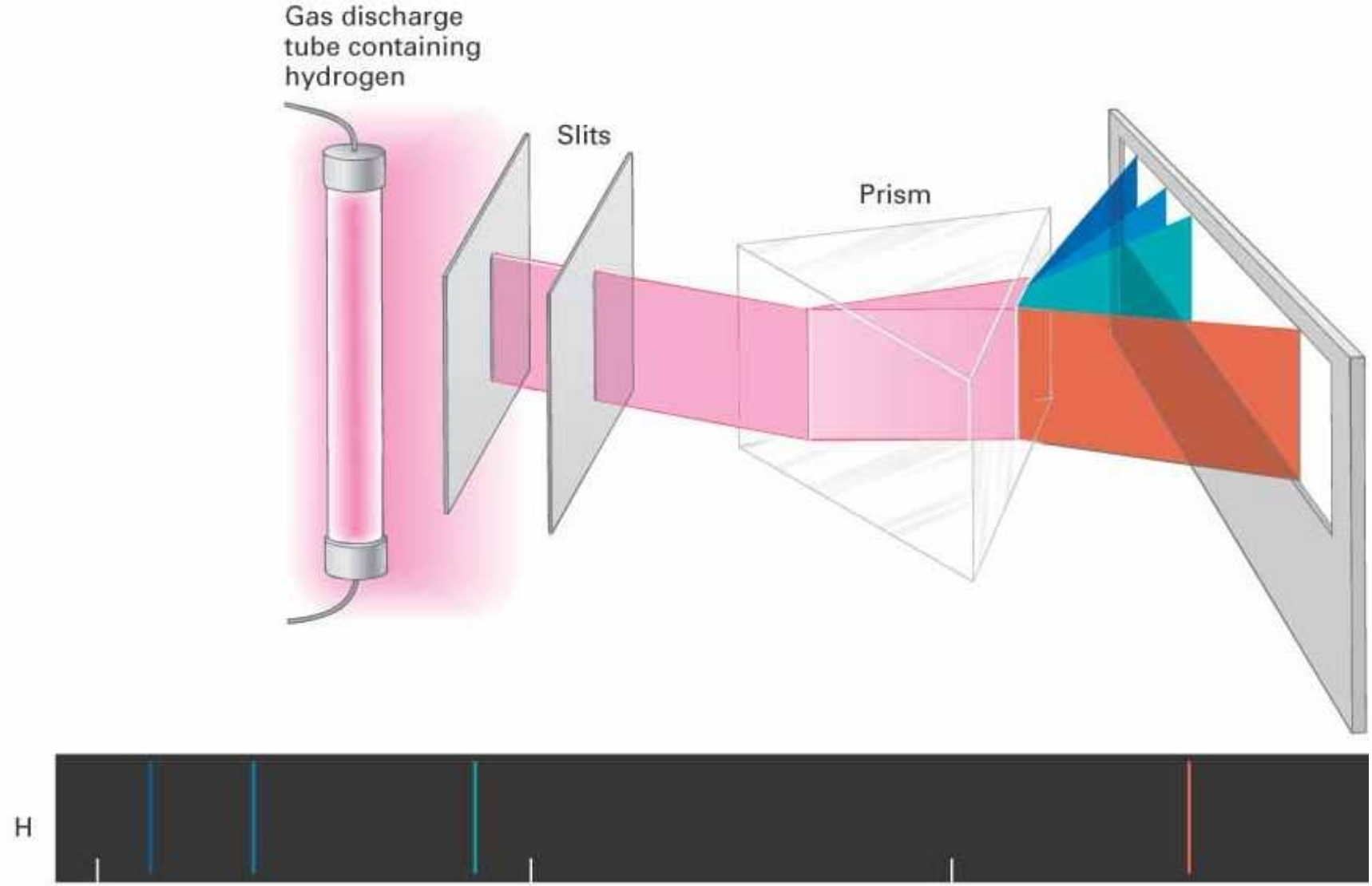
# More about light- color




$\lambda \nu = c$ *(speed of light)*

$E = h \nu$

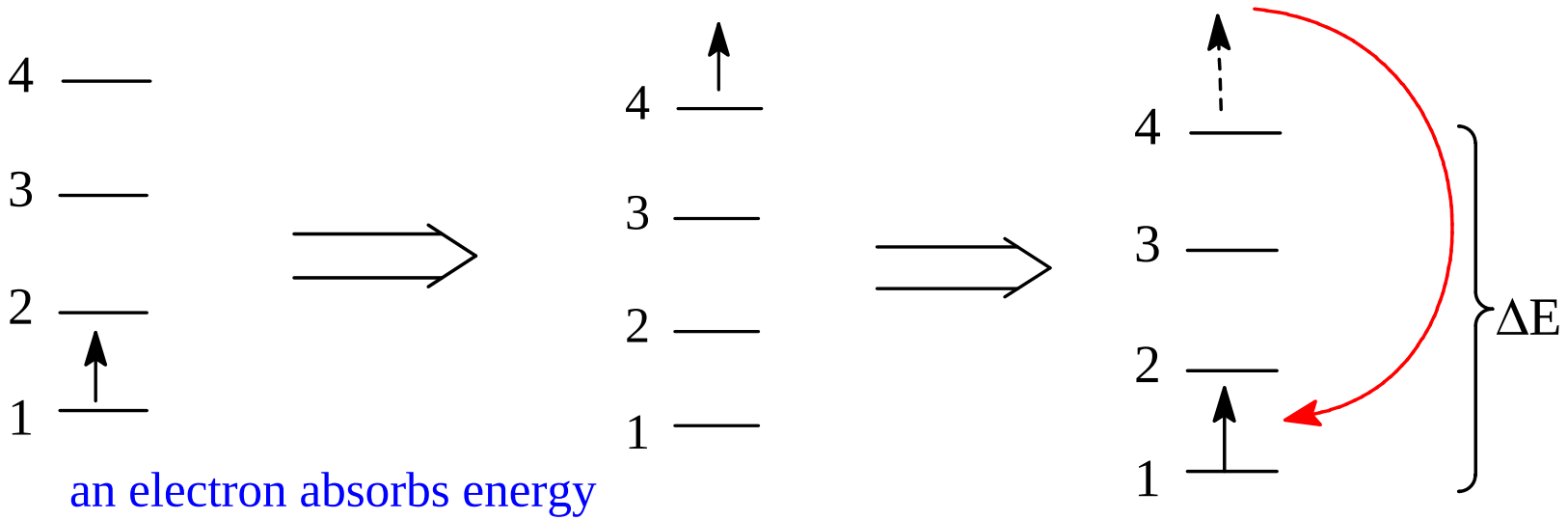
# Light from Excited Atoms' Electrons are Quantized-the Bohr model



# Every atom has its own, unique spectrum (fingerprint)

# The Bohr Model

**Niels Bohr interprets the lines as *quantized* energy emitted by electrons between allowed energy levels**




an electron absorbs energy
and is promoted to
a higher energy level

the excited electron returns to a
lower energy level and emits
a specific amount of energy
seen as a sharp line of light

# Other Important Ideas

**Heisenberg**

Proves that the exact position and energy
of an electron is impossible to know

(the Heisenberg Uncertainty Principle)

**DeBroglie**

Assigns wave properties to particles

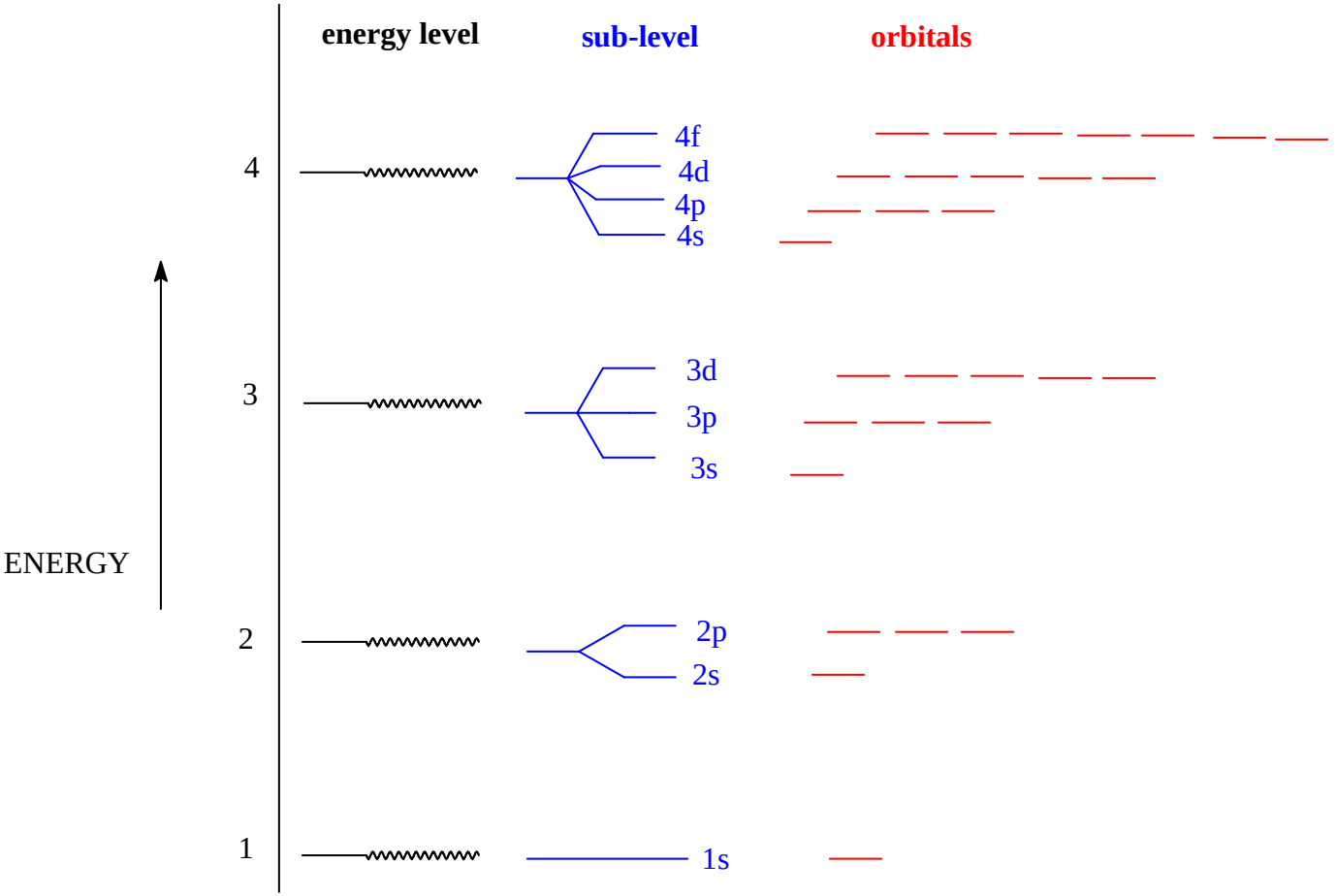
(the wavelength of an electron was measured in 1928)

**Schroedinger**

Applies the mathematics of waves and probability to electrons

(creates wave functions that describe electrons in atoms)

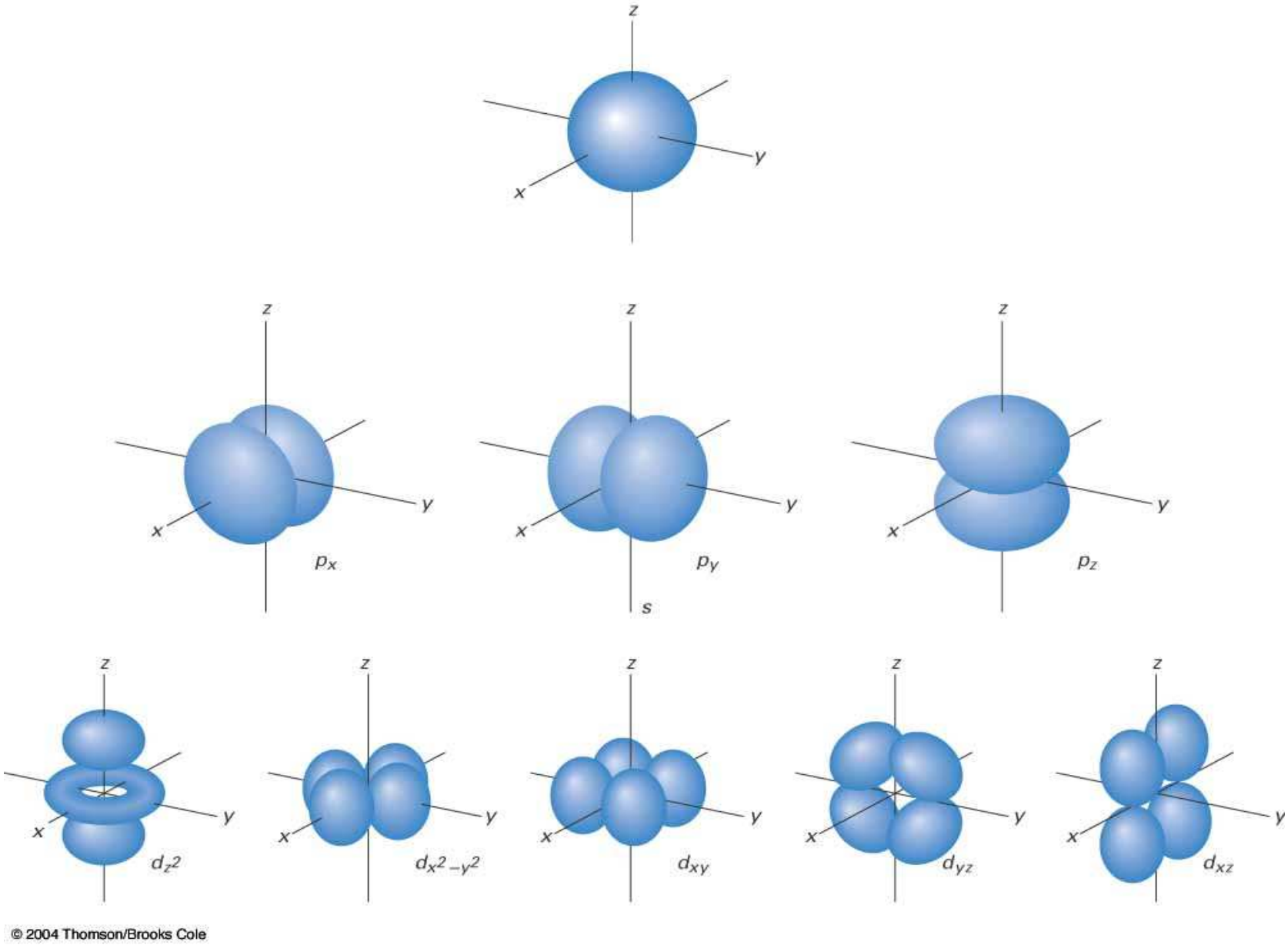
# The Rules


energy level
sub-level
orbitals
4
3
2
1
4f
4d
4p
4s
3d
3p
3s
2p
2s
1s
ENERGY

# Orbitals

**regions of space where the probability of finding electrons is good**

# Shapes of Orbitals



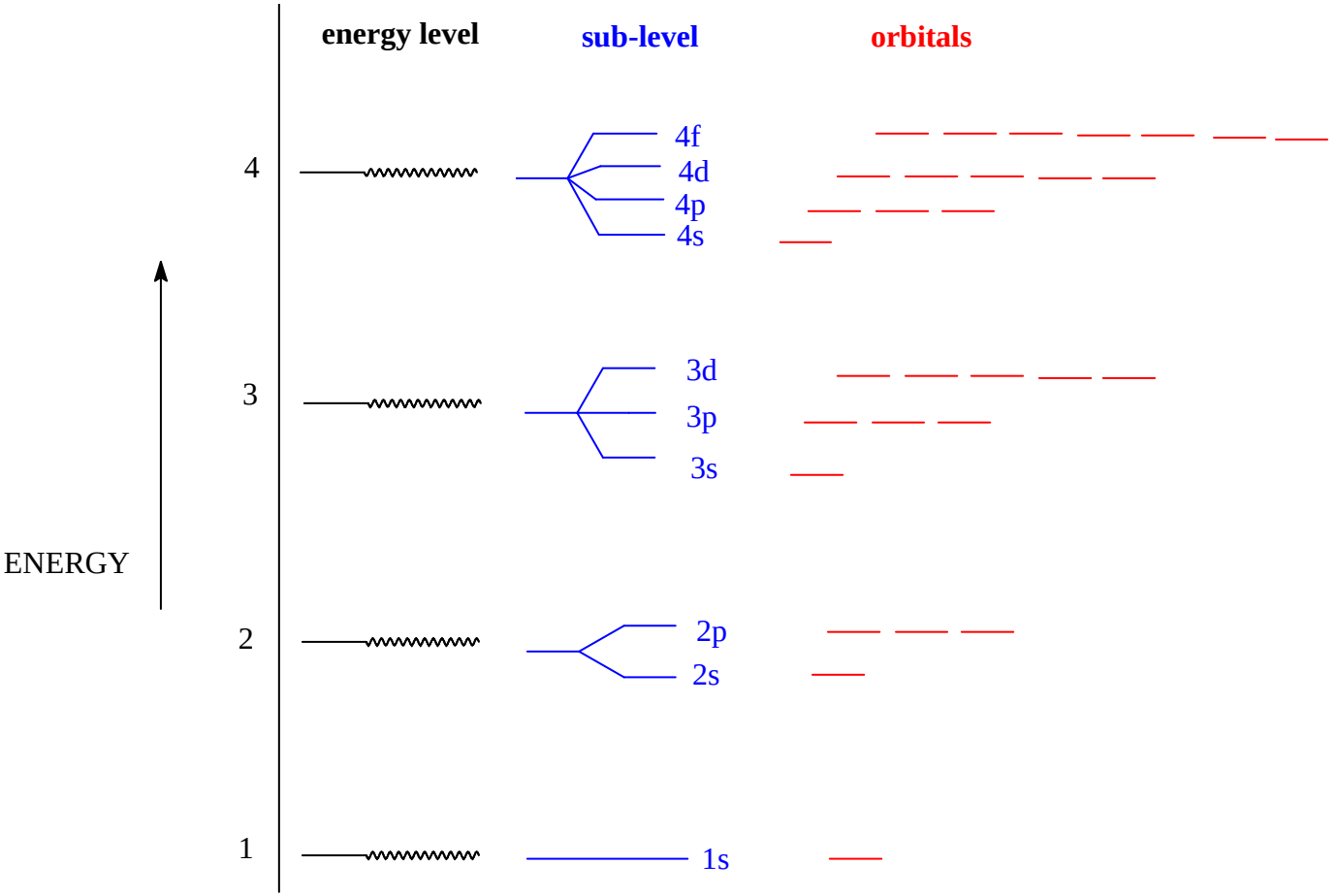
# More Rules

**1. fill lowest energy level before proceeding to the next higher level**

**2. fill the lowest sub-level before proceeding to the next higher sub-level**

**3. a maximum of 2 electrons can occupy any one orbital**

# Numbers of Electrons



# Electron Configurations- putting it all together

$_{8}O$

start with the lowest energy level 1
s sublevel is only one in 1st energy level
the one orbital can hold 2 electrons

*this fills the first energy level*

next electrons goes in the 2nd energy level
the s sub-level is lower than p
two electrons fill the s sublevel

*there is a p sublevel in the 2nd energy level*

the remaining electrons can go into
the p sub-level of the 2nd energy level

# Order of electron filling-
# first 36 elements (through krypton)

**1 s 2 s 2 p 3 s 3 p 4 s 3 d 4 p**

Maximum number of electrons:

**1 s 2 s 2 p 3 s 3 p 4 s 3 d 4 p**

# Try These (Q2)

**fluorine**

**phosphorous**

# Simplifying Electron Configurations

**"inert gas core" notation**

$_{19}K$

$$\mathbf{1s^2 2s^2 2p^6 3s^2 3p^6} 4s^1$$

# Try These (Q3)

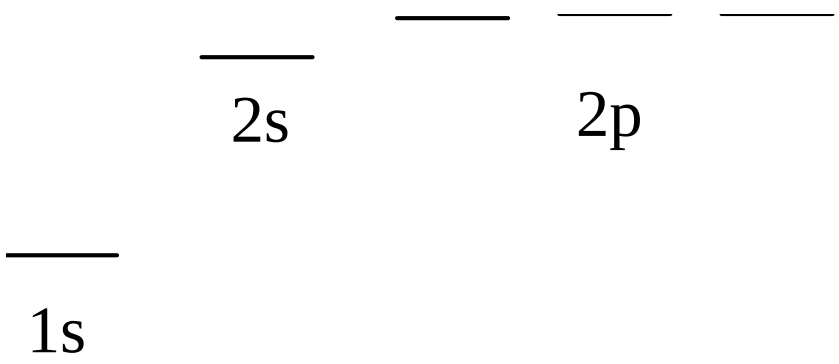
Write electron configurations for the following, using "inert gas core notation"

phosphorous

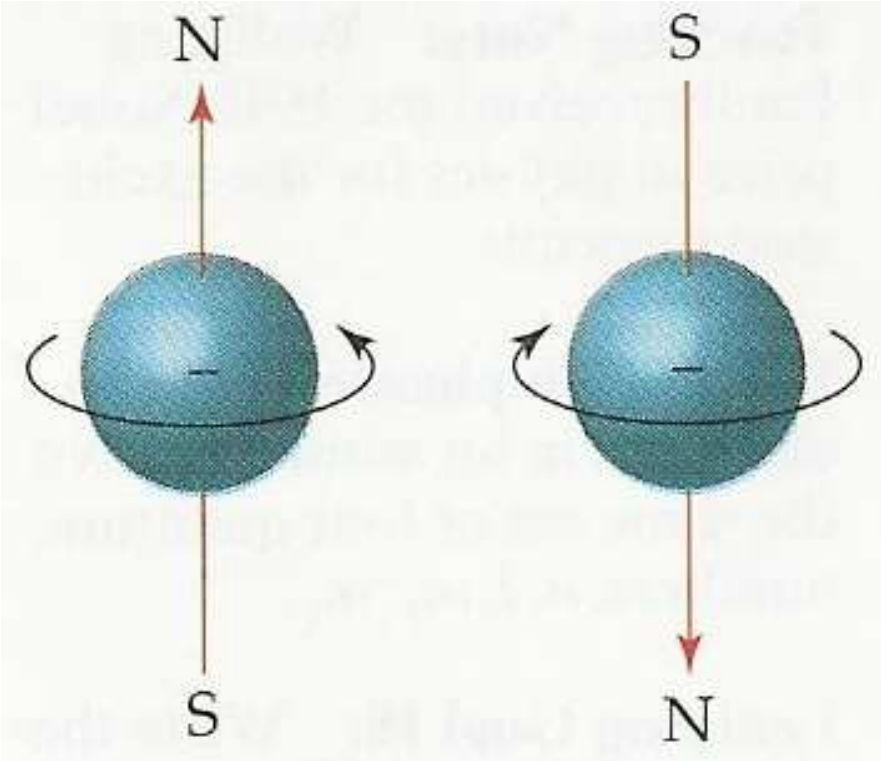
calcium

# Energy Diagrams- visualizing electron configurations

1s 2s 2p



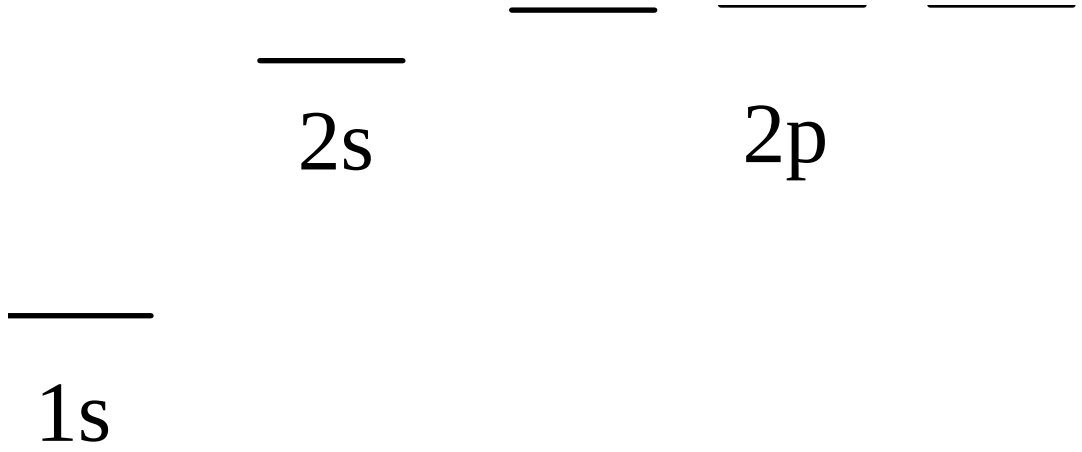
# Electron Spin Pairing




***representing paired electrons in an energy diagram***

# Example- carbon

$_{6}C$ $1s^2\ 2s^2\ 2p^2$

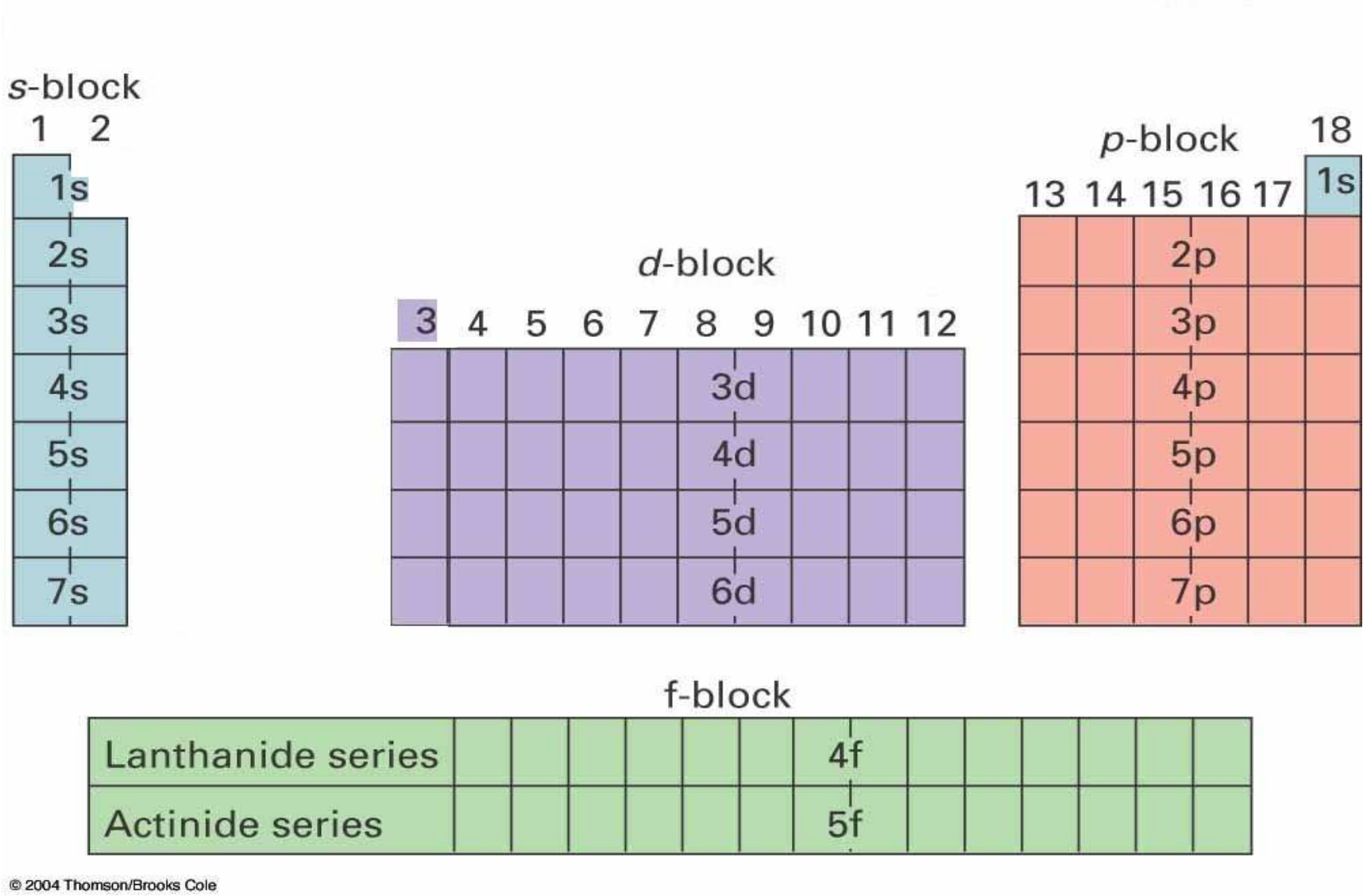


# Try These (Q4)

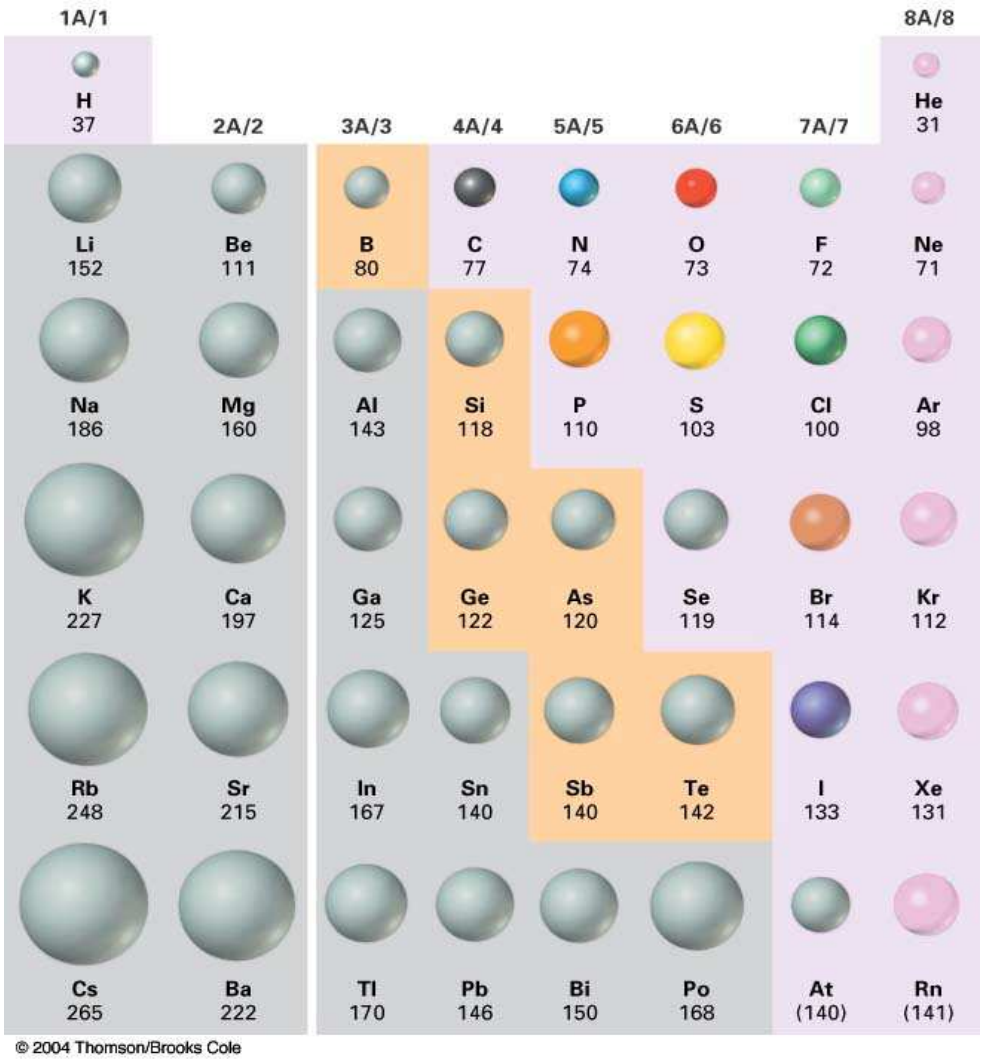
nitrogen $_{7}N$

chlorine $_{17}Cl$

# Electronic Structure and the Periodic Table



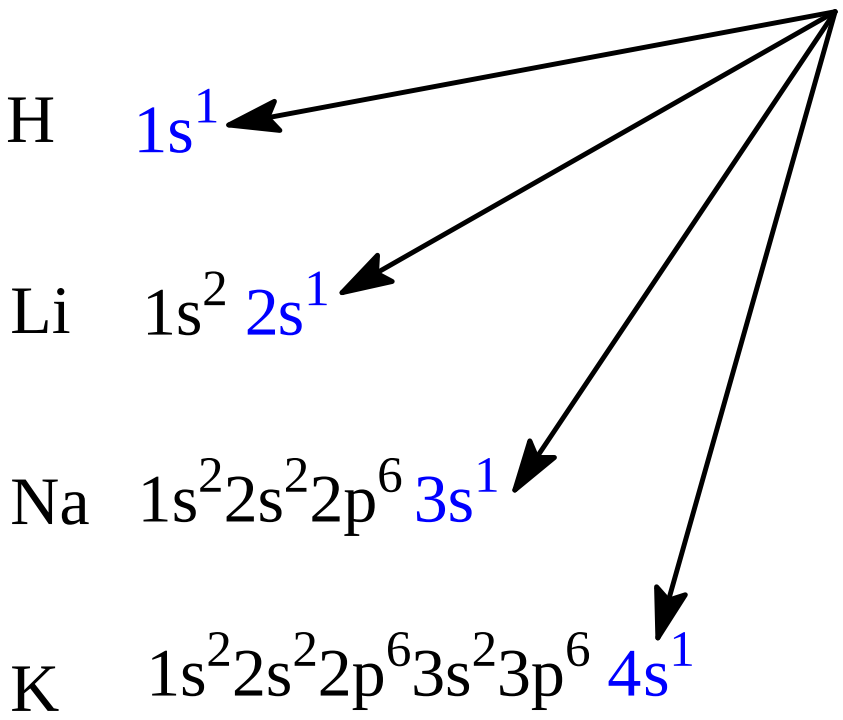
# Periodicity-
# The Representative Elements



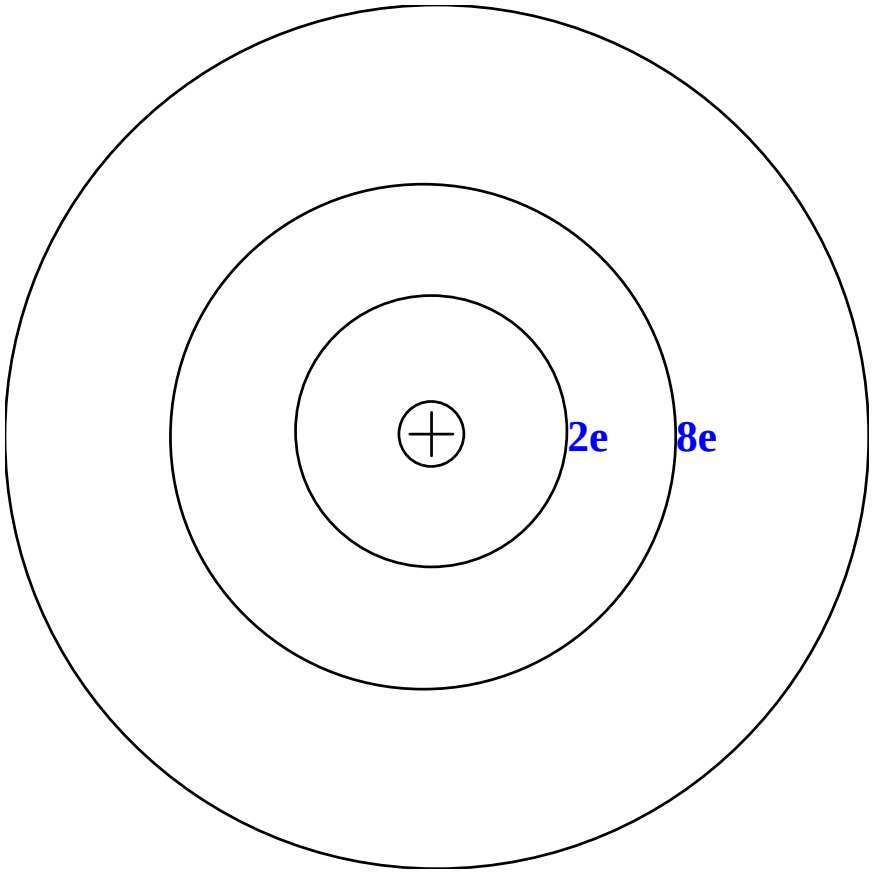
# Valence Electrons

**electrons in the outer (highest) energy level**

# Down a Group



# Shielding- the nucleus is shielded from valence electrons by inner energy level electrons

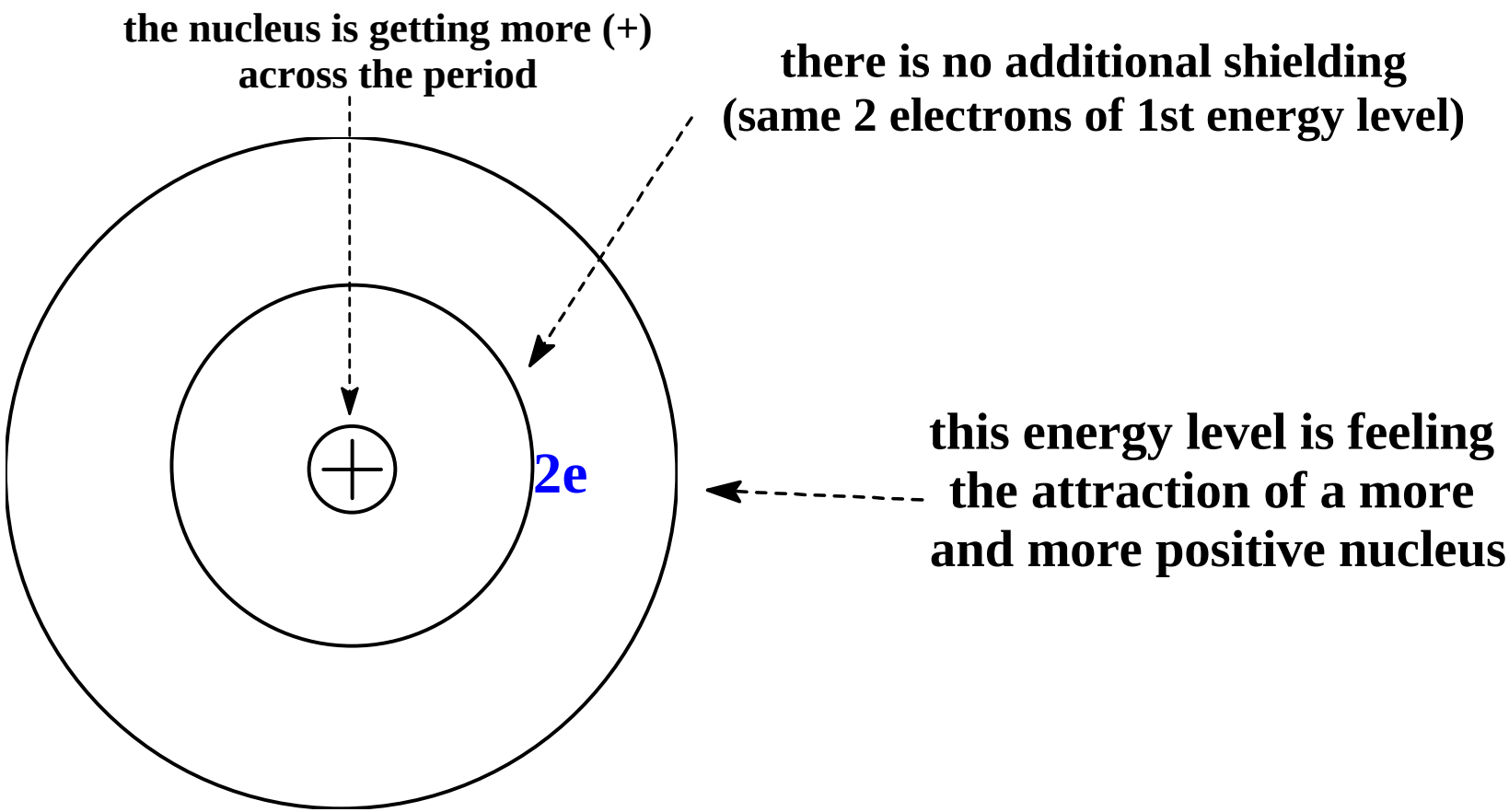



**The more shielding of the nucleus, the less atttraction for the valence electrons by the nucleus**

# Across a Period
# (the second period)

| | Li | Be | B | C | N | O | F | Ne |
|---|---|---|---|---|---|---|---|---|
| $1s^2$ | $2s^1$ | $2s^2$ | $2s^2 2p^1$ | $2s^2 2p^2$ | $2s^2 2p^3$ | $2s^2 2p^4$ | $2s^2 2p^5$ | $2s^2 2p^6$ |

# Therefore


the nucleus is getting more (+)
across the period
there is no additional shielding
(same 2 electrons of 1st energy level)
2e
this energy level is feeling
the attraction of a more
and more positive nucleus

# Ionization Energy

The amount of energy **required** to remove an electron from the valence shell (highest energy level).

# Trends in Ionization Energy