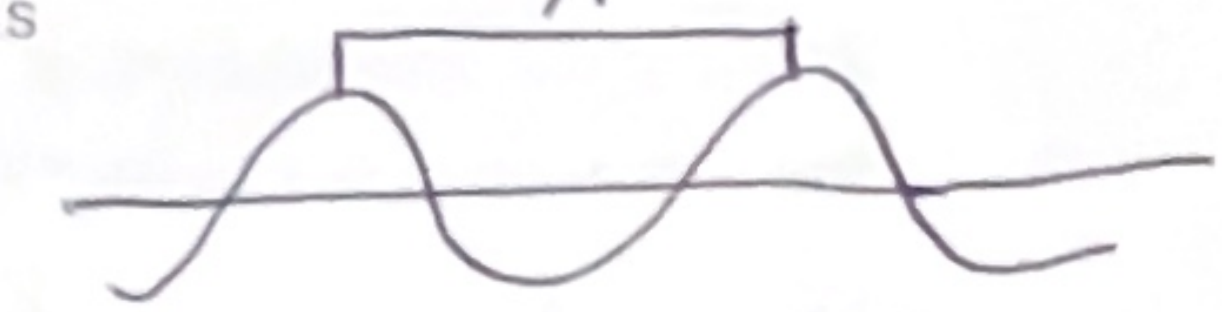
Key!

Chapter 6 – Electronic Structure of Atoms



C = Speed of light 3.00×10^8 m/s

λ = wave-length (m) (nm)

How do you find wavelength?

$$C = \lambda V \qquad V = \frac{C}{\lambda} \qquad \lambda = \frac{C}{V}$$

V = Frequency (s^{-1}) (hz)

Does red light or blue light have a longer wavelength?

Red

Increase → λ

Blue   Red

← frequency

A laser used in communication systems emits radiation with a wavelength of 550.0 nm. Calculate the frequency of this radiation.

$$\frac{550.0\ \cancel{nm}}{} \left| \frac{1 \times 10^{-9}\ m}{1\ \cancel{nm}} \right. = 5.5 \times 10^{-7}\ m$$

$$V = \frac{C}{\lambda}$$

$$= \frac{3.00 \times 10^8\ \cancel{m}/s}{5.5 \times 10^{-7}\ \cancel{m}}$$

$$= \boxed{5.5 \times 10^{14}\ s^{-1}}$$

What is Planck's constant?

6.626×10^{-34} J·s

$E = hV$

E: energy, h: Planck's constant, V: frequency

Calculate the energy of one photon of blue light that has a wavelength of 450 nm.

$$450\ \cancel{nm} \cdot \frac{1 \times 10^{-9}\ m}{1\ \cancel{nm}} =$$

$$E = hV$$

$$= (6.626 \times 10^{-34}\ J \cdot s)(6.6 \times 10^{14}\ s^{-1})$$

$$= \boxed{4.4 \times 10^{-19}\ J}$$

$$V = \frac{C}{\lambda}$$

$$= \frac{3.00 \times 10^8\ \cancel{m}/s}{4.5 \times 10^{-7}\ \cancel{m}}$$

$$= 6.6 \times 10^{14}\ s^{-1}$$

$E = mc^2$ $E = h\nu$ $\lambda = \frac{h}{m \cdot v}$ de Broglie equation

$mc^2 = h\nu$

What is the wavelength of an electron moving with a speed of 2.50×10^6 m/s? The mass of the electron is 9.11×10^{-31} kg.

These are SI units, in base units $kg \cdot \frac{m}{s^{-1}}$

$$\lambda = \frac{h}{m \cdot v} = \frac{6.626 \times 10^{-34}\ J \cdot s}{(9.11 \times 10^{-31}\ kg)(2.50 \times 10^{6}\ m/s)}$$

$$= \boxed{2.91 \times 10^{-10}\ m}$$

$$\frac{2.91 \times 10^{-10}\ m}{} \bigg| \frac{1 \times 10^{9}\ nm}{1\ m} = 0.291\ nm$$

A positive ΔE means energy is Absorbed

A negative ΔE means energy is Released.

Quantum Numbers:

Group 1A – 2A: s block

Group 3A – 8A: p block

Transition Metals: d block

Inner Transition Metals: f block

n = principal quantum number

m_l = magnetic quantum number

l = angular momentum number

m_s = spin quantum number

Pauli Exclusion Principle: No two electrons can have the same energy

Aufbau Principle: Electrons will fill atomic orbitals of lower energy before filling higher energy orbitals.

Hunds Rule: Orbitals with the same sublevel will be half-filled before electron pairing occurs.

Practice Problems: Electronic Configuration

Ca: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

S: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Mn: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$

$Cl = 17$
$\underline{+1}$
18

Anion
Cl^-: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

$Cs = 55$
$\underline{-1}$
54

Cation
Cs^+: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6$

Write the $\boxed{\text{condensed}}$ electron configuration for copper = 29 electrons

[Ar] $4s^1\ 3d^{10}$

Remember copper is an exception!
Wants to have outershell stable

Exceptions:

Ag: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1\ 4d^{10}$

condensed →
Au: [Xe] $4f^{14}\ 5d^{10}\ 6s^1$

[↑↓|↑↓|↑↓|↑↓|↑↓|↑↓|↑↓] [↑↓|↑↓|↑↓|↑↓|↑↓] [↑]
4f 5d 6s

Half filled [↑|↑|↑|↑|↑] or completely filled d orbitals are more stable than those with one e^- less.

Block	l
s	0
p	1
d	2
f	3

MEMORIZE

What would be the quantum numbers (n, l, m_l, m_s) for selenium's last electron?

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ \underbrace{4p^4}_{\text{valence } e^-}$

$n = 4$

$l = 1$

$m_l = \overbrace{-1, 0, 1}^{\text{range}} \Rightarrow -1$

$m_s = -\frac{1}{2}$

[↑↓|↑|↑]
-1 0 1
*