

# AP Worksheet 1c (Electron Structure)

## Part 1:

- This problem is about breaking covalent bonds.
  - The bond energies of the single bonds between two chlorine atoms within a chlorine molecule,  $\text{Cl}_2$ , and two fluorine atoms within a fluorine molecule,  $\text{F}_2$ , are calculated to be  $4.02 \times 10^{-19} \text{ J}$  and  $2.64 \times 10^{-19}$ , respectively. For each bond, calculate the following:
    - The frequency of a photon that could be used to break the bond  
 $6.06 \times 10^{14} \text{ Hz}$  for Cl;  $3.98 \times 10^{14} \text{ Hz}$  for F
    - The wavelength of each photon in (i) above.  
 $495 \text{ nm}$  ( $4.95 \times 10^{-7} \text{ m}$ ) for Cl;  $754 \text{ nm}$  ( $7.54 \times 10^{-7} \text{ m}$ ) for F
  - When an excited electron falls back to its ground state, what can be said of the energy change that occurs when compared to the energy change of the original promotion process? Explain.  
When an electron transitions from an excited state to ground state, it releases energy. When it is promoted from its ground state to an excited state, it absorbs energy

- Lithium ions give a distinctive red flame test. In one such experiment the energy of this red light was found to be  $3.06 \times 10^{-19} \text{ J}$ . Calculate the wavelength of the lithium ion, in nm.  
 $650. \text{ nm}$  ( $6.50 \times 10^{-7} \text{ m}$ )

- Which of the following processes will release the greatest amount of energy? Explain.

Promoting an electron from  $n = 1$  to  $n = 6$

Promoting an electron from  $n = 1$  to  $n = 4$

An electron falling from  $n = 6$  to  $n = 2$

An electron falling from  $n = 6$  to  $n = 5$

Promoting electrons requires an absorption of energy while electrons falling from higher energy to lower energy releases energy

- ~~When an electron falls from  $n = 5$  to its lowest possible state in the Lyman series, the energy that is released is greater than the energy that is released when an electron falls from  $n = 5$  to its lowest possible state in the Balmer series. Explain.~~

- Electron transitions are expected to absorb or emit *greater* magnitudes of energy in the  $\text{He}^+$  ion than in the hydrogen atom? Why?  
The nucleus on a He atom has more protons, so an electron has a stronger attraction to  $2+$  vs just  $1+$  in the nucleus of H.

## Part 2

The rules that you apply in order to determine the electron configuration of an atom are summarized below.

- Lowest energy orbitals are filled first. **AUFBAU PRINCIPLE.**
- Orbitals can only contain a maximum of two electrons and when two electrons enter the same orbital they must have opposite spins ( $+\frac{1}{2}$  or  $-\frac{1}{2}$ ) so that each electron has a unique set of quantum numbers. (In the electrons in boxes diagram they must be drawn  $\uparrow\downarrow$  not  $\uparrow\uparrow$  or  $\downarrow\downarrow$ ). **PAULI EXCLUSION PRINCIPLE.**
- When orbitals of identical energy (degenerate) are available, electrons enter these orbitals singly before any spin pairing takes place. **HUND'S RULE.**

Consider each of the elements listed and the INCORRECT electron configuration associated with each one. In each case, identify which of the above rules or principles (A, B or C) is violated and insert the correct configuration (in a similar format to that of the incorrect configuration).

ELEMENT	INCORRECT CONFIGURATION	VIOLATION	CORRECT CONFIGURATION
N	$1s^2 2s^2 2p_x^2 2p_y^1$	C (Hund's)	$1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$
Al	$1s^2 2s^2 sp^6 3p^3$	A (aufbau)	
B	$1s^2 2s^3$	B (Pauli)	
P	$1s^2 2s^2 2p^6 3p^5$	A	
Mg	[Ne] $\uparrow\uparrow$	B	
C	$1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$	A	
C	$1s^2 2s^2 2p_x^2$	C	
Mn	[Ar] $4s^1 3d^6$	A	
Cl	[Ne] $\downarrow\downarrow \uparrow\uparrow \downarrow\downarrow \uparrow$	B	
Sc	[Ar] $3d^3$	A	
B	$1s^2 2s^1 2p_x^1 2p_y^1$	A	
Na	$1s^1 2s^2 2p^6 3s^2$	A	
S	[Ne] $3s^2 3p_x^2 3p_y^2$	C	
V	[Ar] $3d^5$	A	
P	[Ne] $3s^2 3p_x^2 3p_y^1$	C	
Kr	[Ar] $4s^2 3d^{16}$	B	

