Unit 2

Atomic Structure and Properties
&
Chemical Bonding

Blueprint question

http://www.spectro-oil.com/laboratory-services-aviation.html

http://news.commercialaircraft.bombardier.com/wp-content/gallery/engine-run/right_engine.jpg

Learning Objectives

After mastering this unit you will be able to:

- Define the terms valence and core electrons
- Determine the number of valence electrons and core electrons based on electron configuration for atoms and ions
- Define, in words or using equations, effective nuclear charge (Z_{eff}), atomic and ionic radius, ionization energy, and electron affinity.
- Rank elements and ions according to their Z_{eff}, atomic size, ionization energy, and electron affinity.
- Rationalize the periodic trends of radii, relative ionization energies and electron affinities of atoms and ions based on nuclear charge and/or electron configurations.

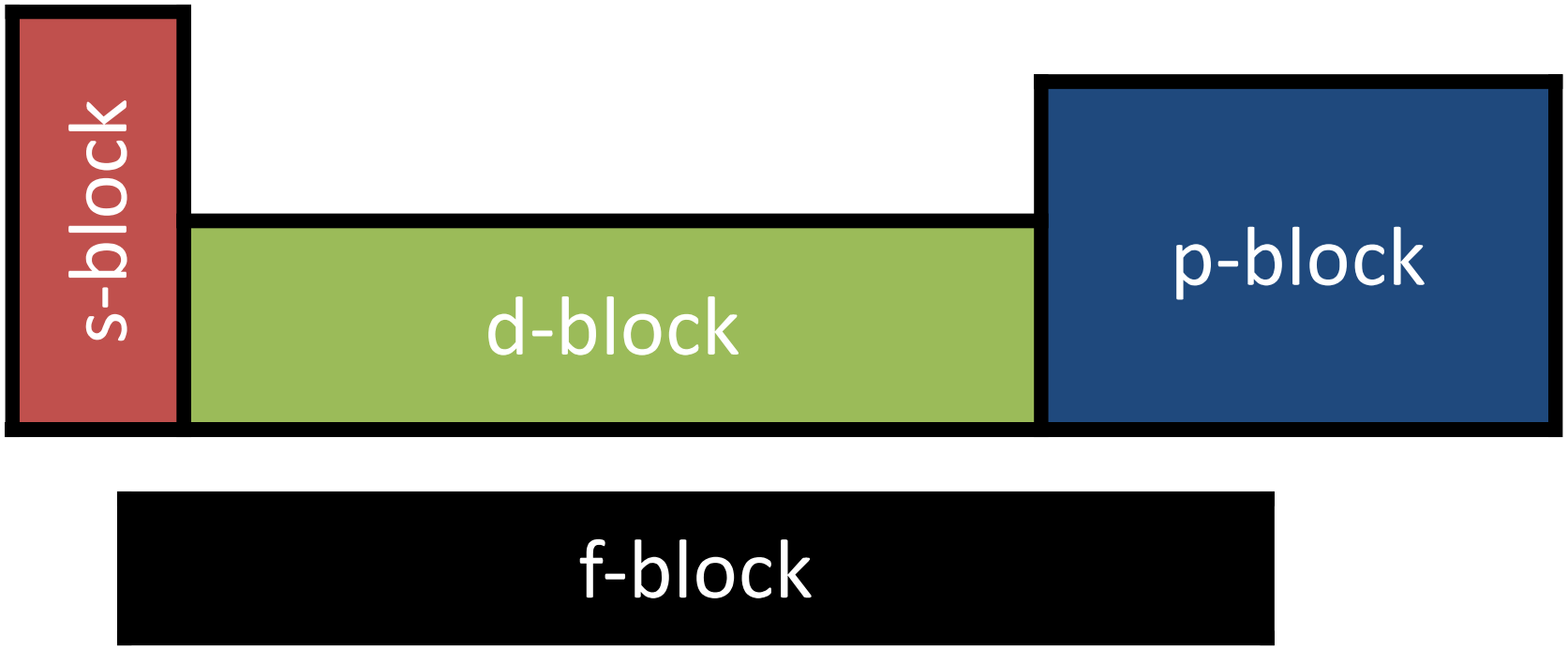
Learning Objectives (continued)

- Describe the nature of ionic and covalent bonds.
- Define electronegativity and describe how electro-negativity varies with position in the periodic table.
- Predict the nature of a chemical bond (ionic/covalent, polar/nonpolar) and justify your prediction by comparing the relative electronegativities of the atoms involved.
- Predict lattice energy trends in ionic solids & justify your predictions.

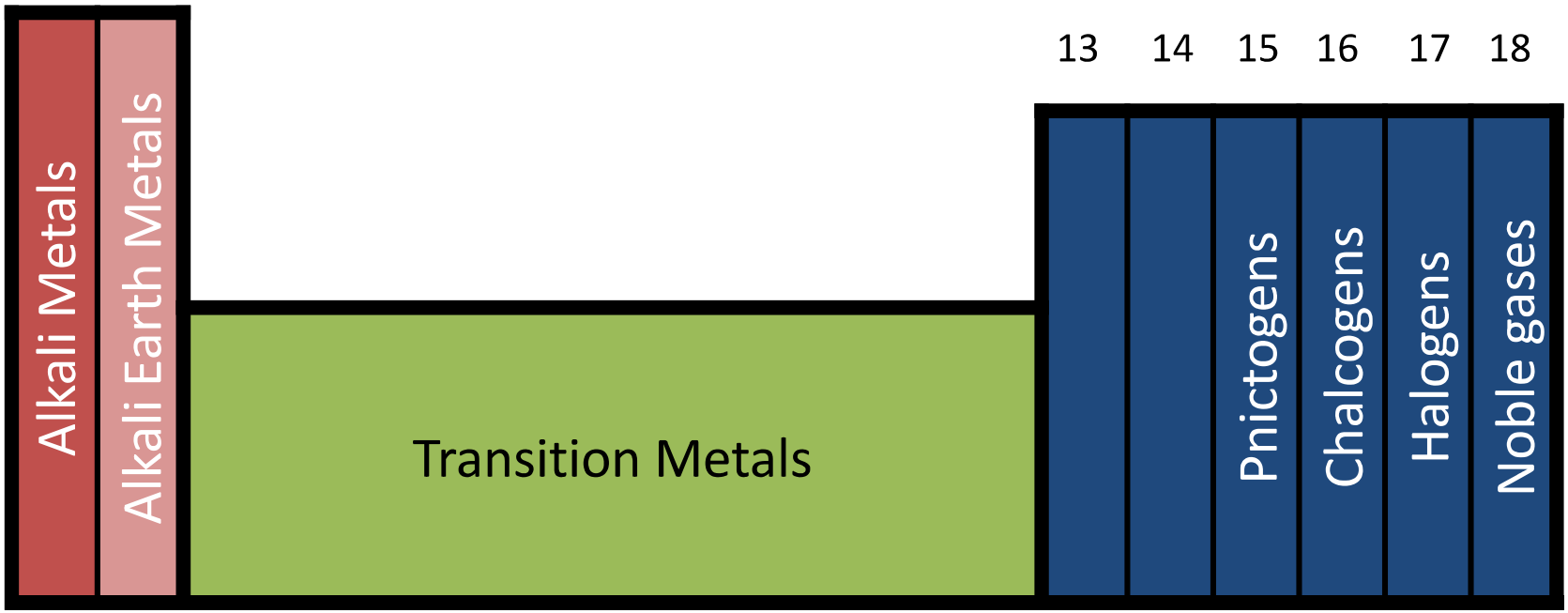
The Periodic Table

Columns in the periodic table are called groups.

Rows in the periodic table are called periods.



The Periodic Table



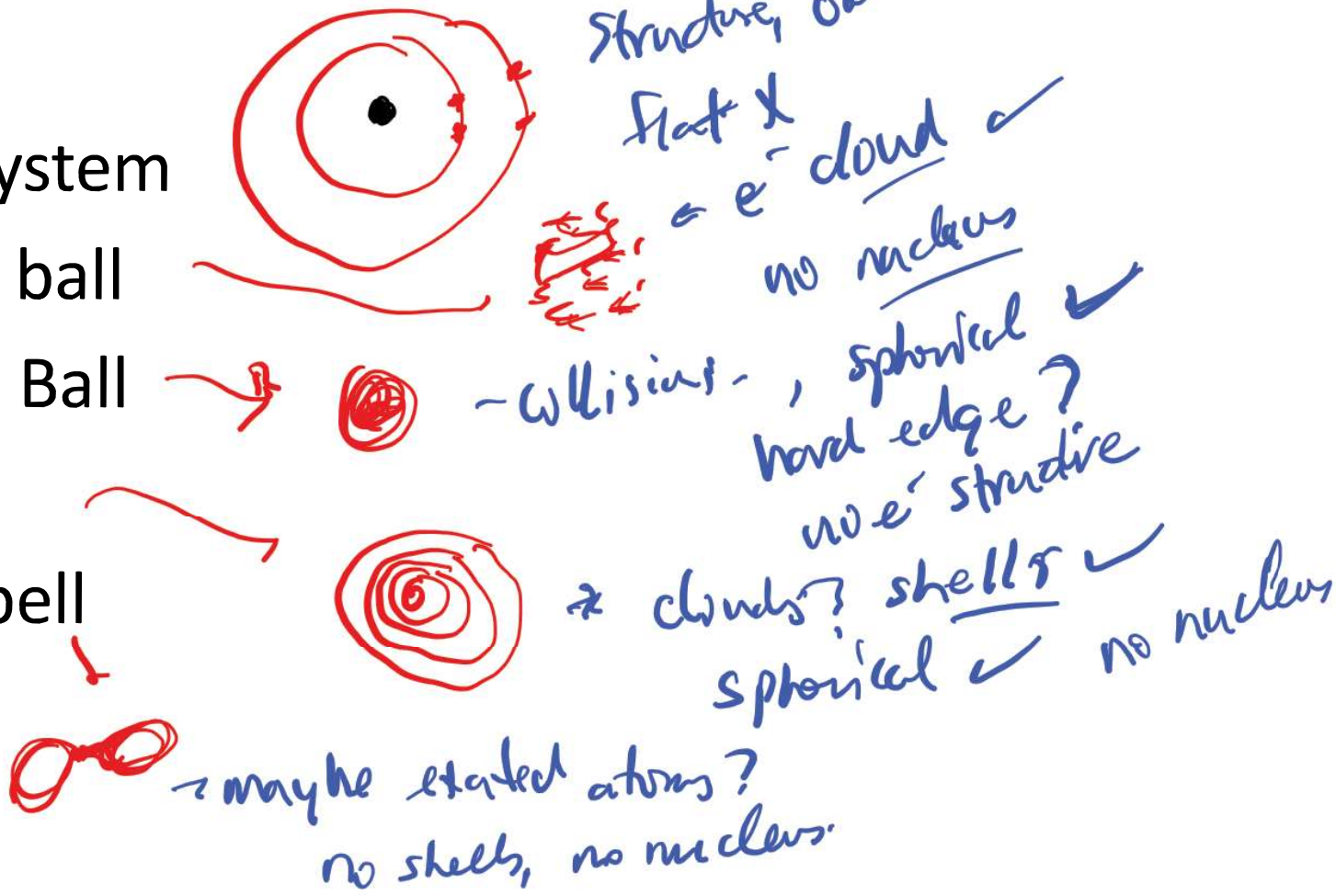
Lanthanides

Actinides

Clicker Question

Which of the following represents the best analogy for the structure of an atom?

a) Solar system
b) Cotton ball
c) Billiard Ball
d) Onion
e) Dumbbell

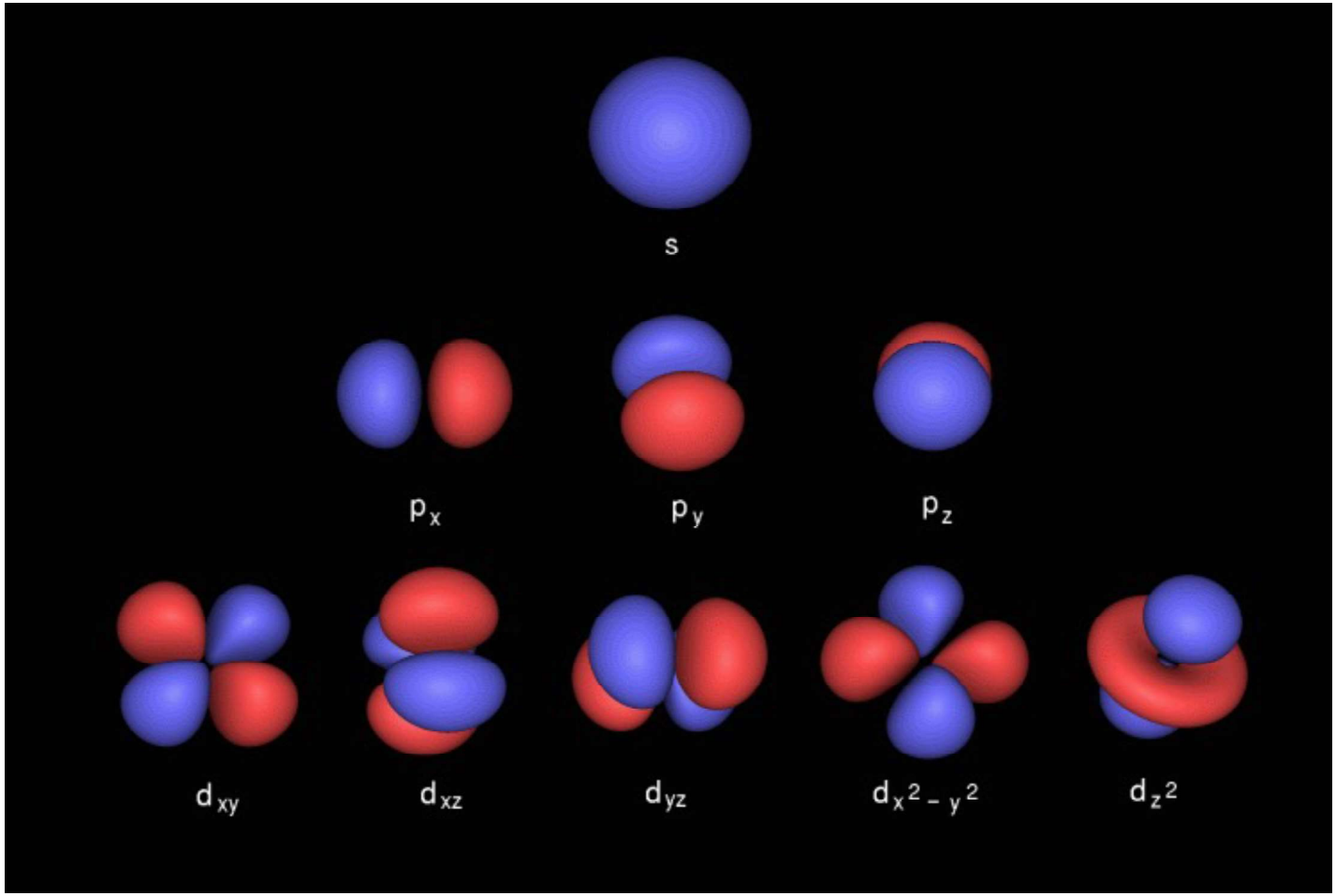


Salient Features of Quantum Mechanics

Small objects, like electrons, behave as both particles and waves which means they can interfere, diffract and spread. Orbitals give the probability for finding electrons at particular points in space.

Quantum mechanics is the theory explaining why energies and angular momenta of atoms and molecules are quantized, that is only have certain discrete values.

Hydrogenic Orbitals



Electronic Structure

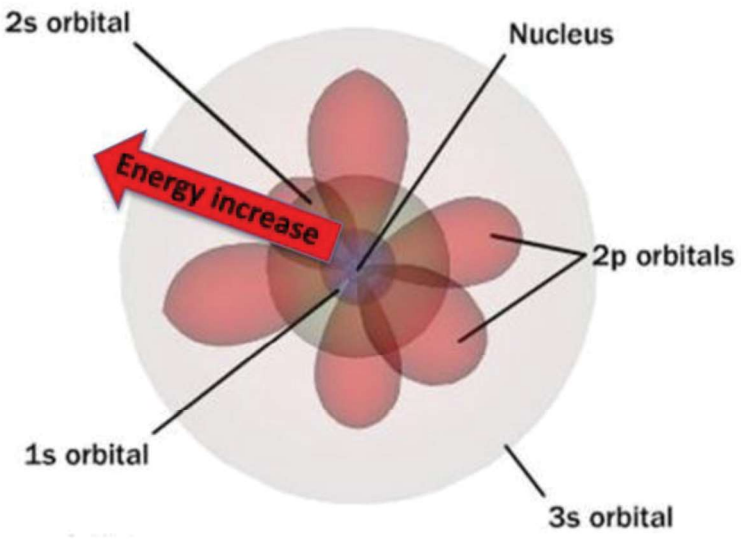
Electrons have negative charge but are also tiny magnets. Spin is our way of describing the orientation of the poles of these magnets ("spin up ↑" or "spin down ↓").

The Pauli Principle states a maximum of 2 electrons can be assigned to any one orbital, and the electrons must have opposite spins (↑↓).

Orbitals are arranged in shells, labelled by n, and sub-shells. Each shell contains only certain orbitals. Starting with the lowest shell, n=1, electrons are assigned to s, p, d orbitals until they are all accounted for. Note: orbitals get bigger as n increases (a 2s orbital is bigger than a 1s orbital) thus forming the shell structure of atoms.

Shell Structure of Atoms

Orbitals become larger as the energy level increases



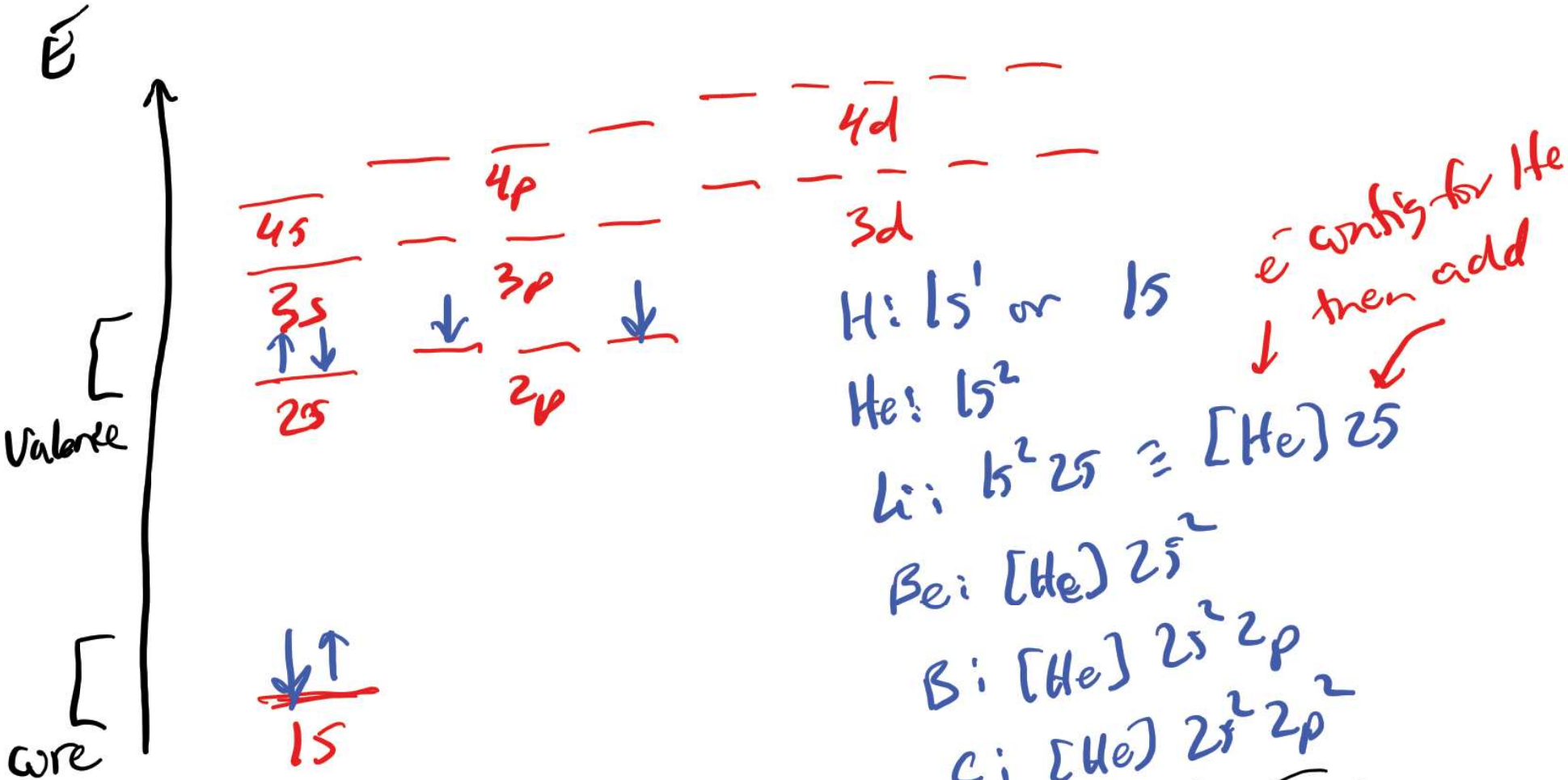
n=1 1st shell
1 subshell 1s
n=2 2nd shell
2 subshell 2s 2p
n=3 .... 3s 3p 3d

- **Electrons filling order : 1s, 2s 2p, 3s**
- **Orbitals** arranged in order of **increasing energy: 1s, 2s 2p, 3s**
- **Orbitals** arranged in **increasing size: (smallest) 1s <2s <2p < 3s (largest)**

Shells and subshells

Shell (n)	Sub-shells	Max. # e^- in subshells	
1	s	2	$2(1)^2 = 2$
2	s, p	2 + 6 = 8	$2(2)^2 = 8$
3	s, p, d	2 + 6 + 10 = 18	$2(3)^2 = 18$
4	s, p, d, f	2 + 6 + 10 + 14 = 32	$2(4)^2 = 32$

Electron Configuration: Idea - put e^- in orbitals to give the lowest energy → ground state



H: $1s^1$ or $1s$

He: $1s^2$

Li: $1s^2 2s \equiv [He]\,2s$

Be: $[He]\,2s^2$

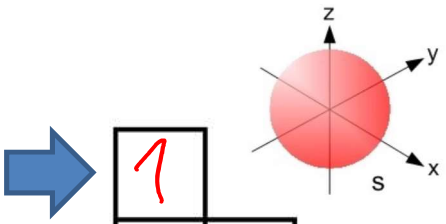
B: $[He]\,2s^2 2p$

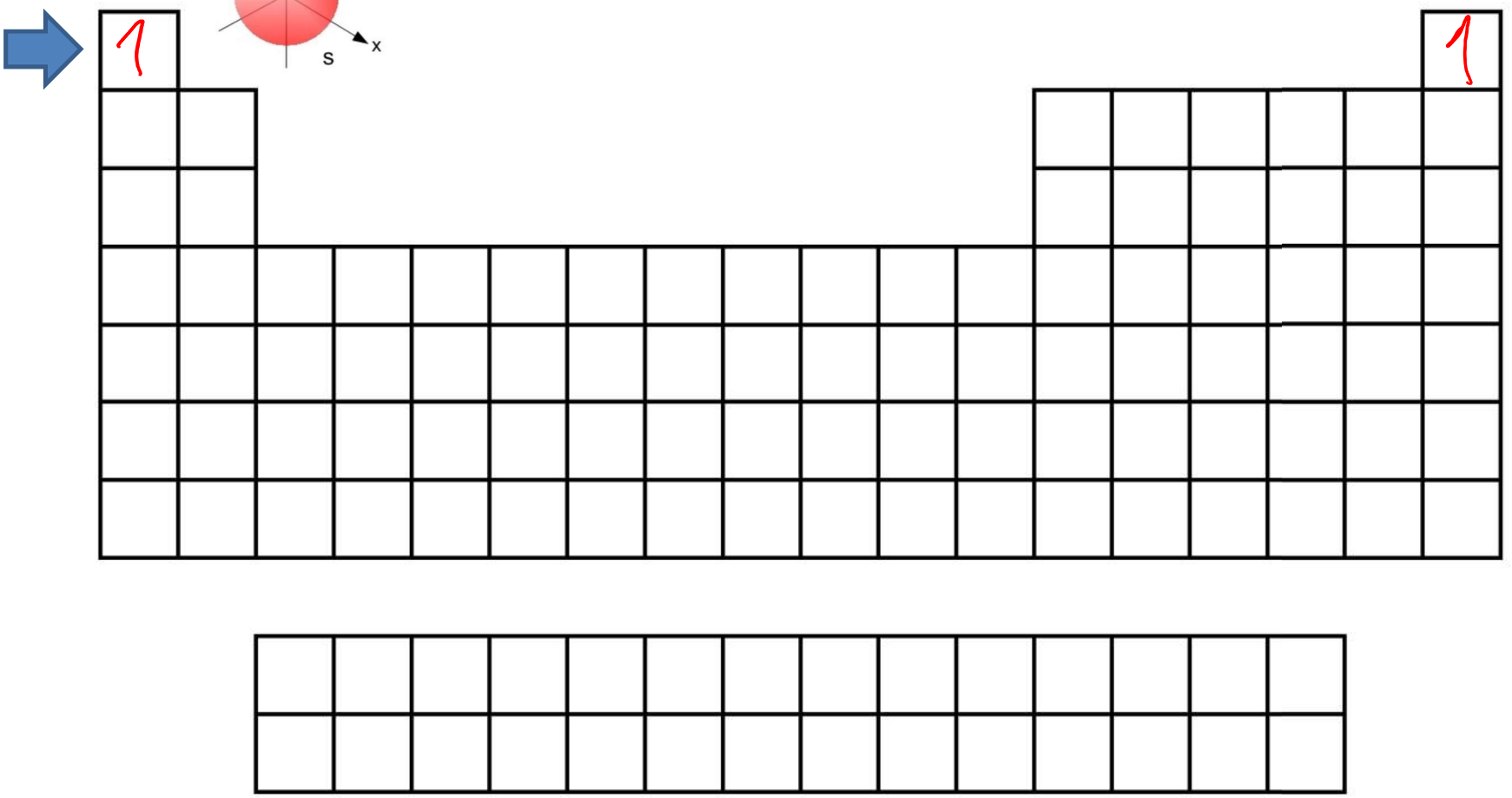
C: $[He]\,2s^2 2p^2$

e^- configs for He then add

[He] = core; $2s^2 2p^2$ = valence

Fill in electrons





Fill in electrons