1. Metallic bonding occurs best when the atoms have _____ electrons in their outer shell.

(A) 4 or more
(B) 1, 2, or 7
(C) Less than 4
(D) 2 to 5

Hint: Atoms with less than four electrons in their outer shell can still fill their outer shells by dumping their valence electrons into a sea of electrons, leaving behind metal ions with filled inner shells.

2. Metallic bonding entails atoms _____.

(A) taking electrons from a sea of electrons
(B) sharing electrons with a sea of electrons
(C) releasing electrons into a sea of electrons
(D) surrounding a sea of electrons

Hint: Releasing their outer electrons into a sea of electrons creates a metallic bond in which the now positive metal ions are attracted to the sea of electrons swarming around them.

3. Metal atoms are arranged as _____.

(A) metal ions in rows and columns
(B) pairs of metal ions arranged in alternating directions
(C) individual groups of metal ions arranged in a circular pattern
(D) sheets of metal ions intersecting other sheets perpendicularly

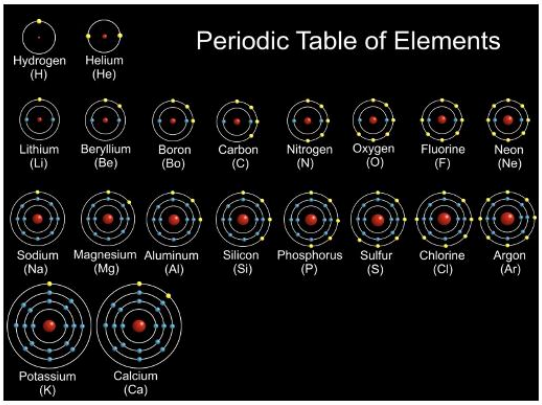
Hint: Having released their outer electrons, the metal atoms become metal ions.

Since every metal ion is the same, they arrange themselves in straight rows and columns equidistant from each other.

4. The reason boron is not considered a metal is that _____.

(A) boron has only three valence electrons
(B) boron will not release its electrons into a sea of electrons
(C) boron's electronegativity value is only 2.0
(D) boron's nucleus does not have enough protons to sufficiently attract any released electrons

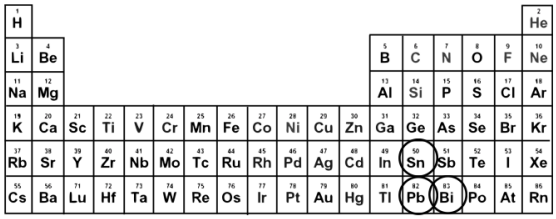
Hint: Boron has only five electrons total. It cannot release its three outer electrons because that would mean releasing 3/5's of its electrons. Moreover, the three electrons in Shell 2 are still very close to the positive nucleus and being held very tightly by the nucleus.



5. The reasons tin, lead, and bismuth form metallic bonds includes all of the following except:

(A) Tin, lead, and bismuth have fewer protons to hold the electron in their orbits.
(B) The outer electrons for tin, lead, and bismuth are far from the nucleus.
(C) The outer electrons are repelled by electrons in the inner shells.
(D) The outer electrons represent a small fraction of the total number of electrons.

Hint: You wouldn't expect tin, lead, and bismuth, with four or five electrons in their outer shell, to release so many electrons at one time, but because those electrons are so far from the nucleus, and shielded from the nucleus by inner electrons, and such a small percentage of the total number of electrons, tin, lead, and bismuth do release their electrons and form metallic bonds with each other.



6. Shell 3 can handle more than eight electrons, ten more electrons to be exact. These ten elements are the _____.

(A) softer metals
(B) extended metals
(C) harder metals
(D) transition metals

Hint: Each larger shell adds a subshell. The added subshell is at a slightly higher energy level than the other subshells already in that shell.

The extra 3d subshell added to Shell 3 has room for ten electrons. The ten elements in the 3d subshell are the transition metals.

7. Which of these statements about electron shells is untrue?

(A) Each larger shell requires more energy for an electron to orbit there.
(B) Each shell has subshells.
(C) The number of the shell indicates how many subshells that orbit has.
(D) The order of the subshells is s, p, d, f, g, h, and each subshell is filled highest energy first.

Hint: Each larger shell is at a higher energy level than the previous shell.

Each larger shell adds another subshell. Shell 1 has one subshell, Shell 2 two subshells, Shell 3 three subshells, and so on.

Subshells have letter names beginning with s, then p, d, f, and g. Each additional subshell is at a slightly higher energy level.

Each new element adds a proton to the nucleus and an electron to the lowest energy subshell available.

8. Which of these statements about subshells is untrue?

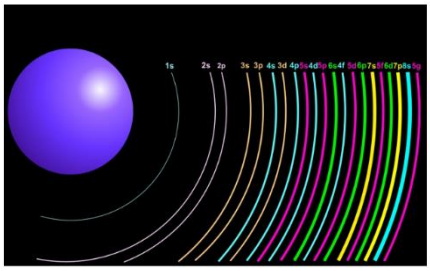
(A) The s subshell can hold four electrons.
(B) The p subshell can hold six electrons.
(C) The d subshell can hold ten electrons.
(D) The f subshell can hold 14 electrons.

Hint: Each slot in the s, p, d, and f subshells can hold two electrons. The s subshell has one slot, so it can hold two electrons. The p subshell three slots, so it can hold six electrons. The d subshell five slots, so it can hold ten electrons. The f subshell seven slots, so it can hold 14 electrons.

9. Shell 4 begins to receive electrons before Shell 3 has completely filled up because _____.

(A) of Shell 4's peculiar shaped orbit
(B) some of Shell 3's electrons repel other Shell 3 electrons into Shell 4
(C) the electrons in Shell 4 have too much energy to fit into Shell 3
(D) some of Shell 4's subshells have a lower energy than some of Shell 3's subshells

Hint: There are a few exceptions to the rule that every new subshell lies at a higher energy level than the previous subshell. The 3d subshell is actually at a higher energy level than the 4s subshell and will thus be filled before the 4s subshell.



10. Which statement is true?

(A) An electron needs the same energy to orbit in Shell 3 of magnesium as it does to orbit in Shell 3 of sulfur.
(B) In a shell completely filled with electrons, the electrons orbit in pairs, one electron spinning in one direction and the other spinning in the opposite direction.
C) An electron in Shell 1 needs to absorb less energy to jump up to Shell 2 than an electron in Shell 5 does to jump up to Shell 6.
(D) In order to hold onto the outermost electrons, the nucleus must exert a greater attractive force on them.

Hint: The energy difference between subshells narrows the further from the nucleus. That's why subshells further from the nucleus begin to overlap each other. It's also why an electron in Shell 1 needs more energy to jump to Shell 2 than an electron in Shell 5 needs to jump to Shell 6.

Because different elements have different numbers of protons pulling the electrons toward them, a 3d subshell in two different elements is at a different energy level.

11. Electrons can jump from a lower energy level to a higher energy level, but _____.

(A) they can only jump to the next higher energy level; they cannot skip energy levels
(B) they cannot jump back down to the same energy level they started from
(C) they must jump to the lowest open energy level
(D) they must have the exact amount of energy needed to reach the higher energy level

Hint: Electrons can jump from any subshell up to any other subshell but they need to have the exact amount of energy to do this, no more, no less.

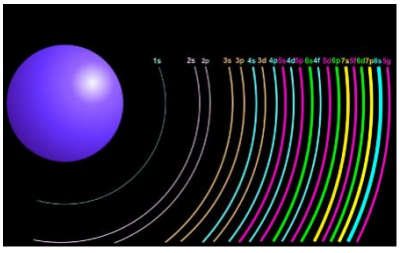
Jumping back down allows electrons to shed the exact amount of energy separating the two subshells. Electrons can jump back down to any open subshell.

12. An atom with the electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ _____.

(A) has ten electrons in its 3d subshell
(B) has completely filled its Shell 4
(C) needs two more electrons to fill its 4p subshell
(D) will add the next electron to its 4d subshell

Hint: The subshells in Shell 4 are 4s, 4p, 4d, and 4f. After the 4p subshell is filled, the next higher energy is the 5s subshell, not the 4d subshell.

The p subshell can hold six electrons and the d subshell can hold ten electrons.



13. Which rule governing electrons is untrue?

(A) Electrons must enter an empty slot before a half-filled slot
(B) Electrons must fill the highest energy slot first
(C) Electrons in half-filled slots must spin in the same direction
(D) Electrons in the same slot must spin in opposite directions

Hint: Atoms want to be at the lowest energy state possible.

When entering subshell slots, electrons want to remain as far away from each other as possible. In order to travel together, two electrons need to be surrounded by opposite magnetic fields.

14. Which statement is untrue? Atoms with low electron affinities and high ionization energies:

(A) are electrically unstable
(B) resist adding an electron
(C) resist the removal of an electron
(D) have half-filled subshells

Hint: Ionization enegy is the energy needed to remove an electron.
Electron affinity is the energy shed when an atom accepts an electron and becomes more stable, because it is filling its outer shell.