1. Which statement is true?

(A) The atomic number indicates the number of protons and neutrons in the nucleus.
(B) The atomic number indicates the number of electrons in an ion.
(C) Changing the number of ions changes the element.
(D) The valence electrons are the electrons in the outermost ring (or shell).

Hint: The atomic number is the number of protons in the nucleus, which in turn determines the element.

When the number of electrons does not equal the number of protons, the atom is an ion -- positive if there are more protons than electrons, negative if there are more electrons than protons.

The electrons in the outer shell are known as the valence electrons.

2. Changing the number of protons in the nucleus changes _____. (Choose the best answer.)

(A) the element
(B) the atomic weight
(C) the atomic number
(D) all the above

Hint: The atomic number is the number of protons in the nucleus, which determines the element. Adding protons also increases the atomic weight of the atom.

3. The atomic number _____.

(A) refers to the number of protons and neutrons in the nucleus
(B) refers to the number of protons in the nucleus
(C) refers to the number of neutrons in the nucleus
(D) refers to the molecular weight of an atom

Hint: The atomic number is the number of protons in the nucleus.

The isotope number is the number of protons and neutrons in the nucleus.

The atomic weight is the combined weight (or mass) of all the protons and neutrons in the nucleus.

4. Which statement about Ionic bonds is untrue?

(A) Ionic bonds involve one atom giving one or more electrons from an inner ring to another atom.
(B) Ionic bonds are how sodium combines with chlorine.
(C) An ionic bond between two atoms makes each atom ionic.
(D) Ionic bonds keep atoms together because one atom becomes electrically positive and the other electrically negative.

Hint: Ionic bonds form when one atom gives an electron from its outer shell to another atom's outer shell.

What binds the two atoms together is that in giving away an electron, the giving atom becomes electrically positive and the taking atom electrically negative, and their opposite charges attract each other.

Ionic bonds commonly form when an atom like sodium has only one valence electron to give away and the other atom, chlorine for example, needs only one electron to fill up its outer ring.

5. The reason sodium and chlorine form crystals is that _____.

(A) they immediately shed energy when bonding into sodium chloride molecules
(B) they lose ionization energy when forming crystals
(C) they shed lattice energy when forming crystals
(D) they gain polarity when bonding into sodium chloride molecules

Hint: It takes energy to remove sodium's outer valence electron and add the electron to chlorine's outer shell. However, more energy than this is shed in the form of lattice energy as more and more sodium and chloride ions join the growing lattice of sodium and chloride ions.

Polarity simply means that one side of an atom is positive and the other side negative.

6. Which statement is untrue?
Sodium chloride molecules form crystals _____.

(A) because of their polarity
(B) and change from molecules to formula units
(C) with properties similar to the properties of sodium and chloride atoms
(D) that easily crack when struck

Hint: Sodium chloride molecules are quite polar, which attracts other sodium chloride molecules to join a growing crystal of sodium chloride molecules.

Once in the crystal, the sodium chloride molecules lose their identity and are simply called "formula units."

Typically, when two atoms bond, the properties of the resulting molecule are much different from the properties of the individual atoms before they bonded.

7. Crystals crack easily because _____.

(A) vibrations in the crystal lattice shatter the crystal
(B) of their high lattice energy
(C) electrons around sodium ions repel electrons around chloride ions
(D) sodium ions are brought next to sodium ions and chloride ions next to chloride ions

Hint: Ionic crystals crack easily because what started out as alternating rows of positive ions lying next to negative ions, when struck, become positive ions lying next to other positive ions and negative ions next to negative ions.

The electrical repulsion between atoms, now situated positive against positive and negative against negative, splits the crystal.

8. Ionic bonding can be predicted using _____.

(A) the periodic table
(B) Pauling's ionic force chart
(C) Pauling's electronegativity chart
(D) Pauling's valence chart

Hint: Pauling's electronegativity chart indicates how much pull each atom in a molecule has on the electrons forming the intramolecular bond.

If one atom is able to pull much more than the other, it suggests that a highly polar ionic bond will be formed.

9. The easiest way to change an atom of one element into an atom of another element is to _____.

(A) change the number of protons in the nucleus
(B) change the number of neutrons in the nucleus
(C) change the number of electrons in the nucleus
(D) change the number of valence electrons

Hint: Elements are identified by the number of protons in their nucleus.

Isotopes are determined by the number of protons and neutrons in their nucleus.

Molecular weight is determined by the mass of the protons and neutrons in a nucleus.

Ions are determined by the difference in protons and electrons in an atom.

10. Which statement is untrue?

(A) Each column of the periodic table refers to the number of valence electrons.
(B) Each row of the periodic table refers to the ring around the nucleus.
(C) Atoms at the end of each row in the periodic table have 8 electrons in their outer ring.
(D) In each row of the periodic table, atomic diameter increases as protons are added.

Hint: The periodic table is organized in columns and rows. Each row refers to the ring surrounding the nucleus. There are only two elements in the first row because it takes only two electrons to fill up Ring 1. There are eight elements in rows 2 and 3 because there are eight slots for eight electrons to fill those rings.

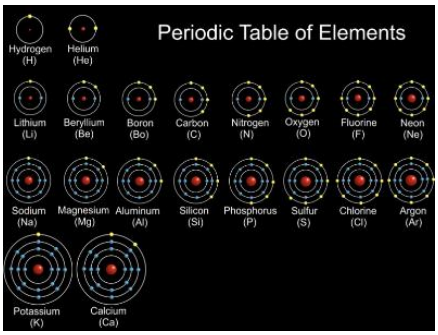
Because all the atoms in a particular column (or group) have the same number of valence electrons, all the atoms in a column tend to have similar properties.

In any one row of the periodic table, adding an electron could theoretically enlarge the atom's diameter, but because a proton is also being added with each electron, the nucleus is becoming more positive and attracting electrons to the nucleus with greater and greater force. The result is a decrease in atomic size as electrons are added to each ring.

11. How many electrons does chlorine have in its outer shell?

(A) 5
(B) 6
(C) 7
(D) 8

Hint:

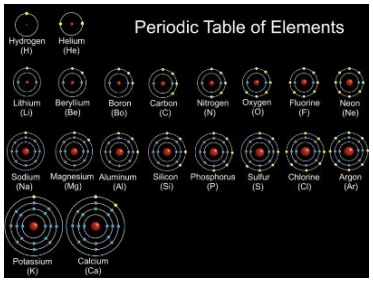


12. Ionic bonds tend to form _____.

(A) crystals with low melting points that crack easily
(B) crystals with high melting points that crack easily
(C) crystals with low melting points that resist mechanical force
(D) crystals with high melting points that resist mechanical force

Hint: Even though ionic crystals crack easily when hammered, the positive and negative ions stick tightly to each other, despite the energy being added by heat. Eventually, heat will pull the ions apart into a liquid consisting of sodium and chloride ions, known as molten salt.

13. Which element does not have a filled outer ring?



(A) Be^{2+} (beryllium)
(B) Na (sodium)
(C) Cl^- (chlorine)
(D) Ne (neon)

Hint: Removing two electrons from beryllium completely empties its outer Ring 2, leaving a filled Ring 1.

Adding an electron to chlorine fills up its Ring 3.

14. When Na and Cl ions join a growing crystal of sodium chloride, _____.

(A) both atoms shed ionization energy
(B) both atoms shed lattice energy
(C) both atoms shed electron affinity energy
(D) both atoms shed electronegativity

Hint: Ionization energy is the energy needed to pull an electron from an atom.

Lattice energy is the energy given off when ionic molecules form a crystal lattice.

Electron affinity energy is the energy shed, or on occasion absorbed, when a valence electron is added to an atom. When energy is shed, the number is negative; when energy is absorbed, the number is positive.

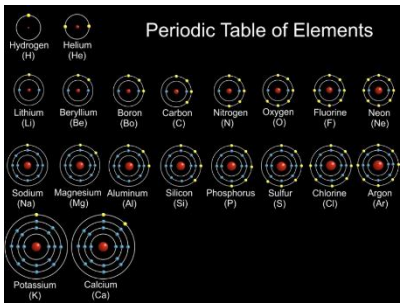
Electronegativity is a number indicating how strongly each atom in a molecule attracts electrons.

15. A negative chlorine ion has the same number of electrons as an argon atom and a positive potassium ion. The chlorine atom is the largest atom because _____.

(A) chlorine has the fewest protons.
(B) the potassium ion has most protons.
(C) the argon atom, being electrically neutral, is able to maintain its size.
(D) chlorine's nucleus has the fewest neutrons.

Hint: All three atoms have three filled rings, but chlorine has the fewest number of protons in its nucleus, and therefore the weakest attraction for its electrons.

16. Which element has the highest ionization energy?



(A) Cl (chlorine)
(B) Br (bromine)
(C) Na (sodium)
(D) K (potassium)

Hint: Ionization energy is the energy needed to pluck a valence electron from a gaseous atom and form a positive ion. Sodium and potassium with only a single electron in their outer shell are only too happy to be rid of their outer electron, so their ionization energies should be fairly low.

Bromine and chlorine want to hang on to their valence electrons because they only need one more electron to fill up their outer ring. Bromine's outer electron is further from its nucleus than chlorine's outer electron is to its nucleus, so bromine should have a lower ionization energy than chlorine. Moreover, bromine has more inner electrons repelling its outer electrons away from the nucleus. So even though bromine has more protons in its nucleus than chlorine and should be exerting a tighter grip on its outer electron, chlorine has a higher ionization energy than bromine, because its electrons are so much closer to the nucleus and there are fewer inner electrons repelling the valence electrons.

17. Which element has the lowest ionization energy?

(A) Li (lithium)
(B) K (potassium)
(C) Cl (chlorine)
(D) Br (bromine)

Hint: Lithium and potassium are both willing to rid themselves of their single outer electron, so they should have much lower ionization energies than chlorine and bromine needing only one more electron to fill their outer ring.

Lithium's valence electron is in Ring 2 while potassium's valence electron is in Ring 3. With so many interior electrons shielding potassium's valence electron from its nucleus, it's easier to remove potassium's valence electron than lithium's.

18. Electron affinity is the energy shed when an atom _____.

(A) bonds ionically with another atom
(B) gains an electron to become an ion
(C) loses an electron to become an ion
(D) passes through a positive electrical field

Hint: The attraction of a nucleus for an extra electron results in energy being shed when an extra electron is added to an atom. The larger the nucleus, and the closer the electron is to completely filling the outer ring, the greater the attraction for that extra electron.

19. Which element has a high ionization energy and a high negative electron affinity?

(A) Li (lithium)
(B) K (potassium)
(C) Cl (chlorine)
(D) Ne (neon)

Hint: Ionization energy measures how easy or hard it is to remove a valence electron. Electron affinity (affinity means liking) measures how easy it is to add a valence electron.

The halogens (fluorine, chlorine, and bromine) have a high ionization energy, because, needing only one electron to fill their outer shell, they are reluctant to remove a valence electron. They also have a high electron affinity because they only one electron short of a filled outer ring.

20. In Row 2 of the periodic table (Li, Be, B, C, N, O, F, Ne), lithium and beryllium have a larger _____ than nitrogen, oxygen, fluorine, and neon.

(A) atomic number
(B) ionization energy
(C) electron affinity
(D) atomic radius

Hint: While adding electrons should increase the size of an electron cloud around an atom's nucleus, for every electron added, a proton is also added in the nucleus.

Each added proton is able to pull the electron in toward the nucleus with greater force, so in the first three rows of the periodic table, each larger element has a smaller atomic diameter.

21. Which atom is the smaller atom in a crystal of sodium chloride (NaCl)?

(A) neutral sodium atom
(B) positive sodium ion
(C) neutral chlorine atom
(D) negative chloride ion

Hint: When sodium gives its electron to chlorine, it loses its outer ring. When chlorine takes sodium's electron, all the outer electrons repel each other, and the chlorine atom enlarges.