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Radius	

# Electronegativity, Ionization Energy and Atomic Radius Chart

Use Reference Table S to find the electronegativity, ionization energy and atomic radius of each of the elements here, and fill in the chart. Answer the questions on the back based on this table.

1	2		13	14	15	16	17	18
H								He
Li	Be		B	C	N	O	F	Ne
Na	Mg		Al	Si	P	S	Cl	Ar
K	Ca		Ga	Ge	As	Se	Br	Kr
Rb	Sr		In	Sn	Sb	Te	I	Xe
Cs	Ba		Tl	Pb	Bi	Po	At	Rn

Questions:

- 1) Define ELECTRONEGATIVITY: \_\_\_\_\_
  - 2) Define IONIZATION ENERGY: \_\_\_\_\_
  - 3) Define ATOMIC RADIUS: \_\_\_\_\_
  - 4) As the elements in Group 1 are considered from TOP to BOTTOM, what happens to the  
a) Electronegativity? \_\_\_\_\_ b) Ionization Energy? \_\_\_\_\_ c) Atomic Radius? \_\_\_\_\_
  - 5) As the elements in Period 3 are considered from LEFT to RIGHT, what happens to the  
a) Electronegativity? \_\_\_\_\_ b) Ionization Energy? \_\_\_\_\_ c) Atomic Radius? \_\_\_\_\_
  - 6) What kind of relationship exists between electronegativity and ionization energy? \_\_\_\_\_
  - 7) Do metals or nonmetals in period 3 have the **higher** electronegativity? \_\_\_\_\_
  - 8) Do metals or nonmetals in period 3 have the **higher** ionization energy? \_\_\_\_\_
  - 9) Does a metal or a nonmetal in period 3 have the **smaller** radius? \_\_\_\_\_
  - 10) What is the relationship between atomic radius, electronegativity and ionization energy? \_\_\_\_\_
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## Electronegativity, Ionization Energy and Atomic Radius

**Electronegativity:** An atom's attraction to electrons when involved in a chemical bond. The higher the electronegativity is, the more strongly attracted an atom will be for another atom's electrons.

An arbitrary scale designed by Linus Pauling, based on **fluorine** (F) having the strongest attraction, given a value of **4.0** and all others compared to it.

Electronegativity values can be found on Reference Table S.

**Ionization Energy:** The amount of energy that must be absorbed by an atom to remove the most loosely bound valence electron from an atom.

It is measured in KJ/mole of atoms. A mole is the number of atoms needed for an element to weigh its atomic mass in grams. More on that later.

Ionization Energy values can be found on Reference Table S.

**Electronegativity and Ionization energy trends:** As elements consider from top to bottom in a group, electronegativity and ionization energy will decrease down a group, because number of PEL increases, valence electrons become less attracted to the nucleus, so the for it is easier to lose them rather than gain.

As elements consider from left to right across a period, electronegativity and ionization energy will increase. This is due to the increasing number of valence electrons. And again it is easier to lose electrons if element has a fewer valence electrons. It is easier to gain electrons if an element has many valence electrons.

**Atomic Radius:** The size of an atom, from the center of the nucleus to the outer edge of the electron cloud.

Atomic radius **INCREASES** as the elements on the Periodic Table are considered from top to bottom down a group. This is due to the increasing numbers of principal energy levels, putting the valence electrons further from the nucleus.

Atomic radius **DECREASES** as the elements on the Periodic Table are considered from left to right across a period. The elements in a period all have the same number of energy levels, but as their atomic numbers increase, their nuclear charge increases. This extra nuclear charge attracts the electrons closer to the nucleus, making the atom smaller than one with less nuclear charge.

**So, the general trend is:**

**Closer to Fr = larger atomic radius,**

**AND making Fr the most REACTIVE METAL**

**Closer to F = smaller atomic radius**

**AND making F the most REACTIVE NONMETAL**

### **IONIC RADIUS**

**1) NEGATIVE** ions are larger than the original atom, because the gained electrons repel each other.

When Cl (2-8-7) gains an electron to form  $\text{Cl}^{-1}$  (2-8-8), the extra valence electron repels the others, making the ion larger than the original atom was.

**2) POSITIVE** ions are smaller than the original atom because all of the outermost electrons have been lost. When Mg (2-8-2) loses two electrons to form  $\text{Mg}^{+2}$  (2-8), the third energy level is lost, making the ion smaller than the original atom was.

## What was the pattern for electron dot diagrams?

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### Properties Of The Elements In Each Group

#### Group

1

6.941	+1
<b>Li</b>	
3	
2-1	
22.98977	+1
<b>Na</b>	
11	
2-8-1	
39.0983	+1
<b>K</b>	
19	
2-8-8-1	
85.4678	+1
<b>Rb</b>	
37	
2-8-18-8-1	
132.905	+1
<b>Cs</b>	
55	
2-8-18-18-8-1	
(223)	+1
<b>Fr</b>	
87	
-18-32-18-8-1	

#### Group 1: The Alkali Metals

- Alkali metals all have 1 valence electron
- They all lose that valence electron when forming ions.
- Alkali metals form ions with a +1 charge.
- Alkali metals have the lowest ionization energy and electronegativity on the Periodic Table
- They lose electrons (oxidize) more readily than any other group.
- They are extremely reactive.
- When exposed to air they quickly corrode, forming a thick layer of oxide.
- The further down in the group you look, the more reactive the elements are.
- They are only found bonded to other elements in compounds in their natural state.
- They can be separated from those compounds using electricity (electrolytic decomposition).
- They react violently with water, forming explosive hydrogen gas and strong bases.

- The term alkali means "basic".

Due to the high reactivity with air and water, pure samples of alkali metals should be stored in mineral oil or kerosene so that water cannot reach the metal to corrode it.

## Group 2

9.01218	+2
<b>Be</b>	
4	2-2
24.305	+2
<b>Mg</b>	
12	2-8-2
40.08	+2
<b>Ca</b>	
20	2-8-8-2
87.62	+2
<b>Sr</b>	
38	2-8-18-8-2
137.33	+2
<b>Ba</b>	
56	2-8-18-18-8-2
226.025	+2
<b>Ra</b>	
88	18-32-18-8-2

### Group 2: The Alkaline Earth Metals

- Alkaline Earth metals all have 2 valence electrons.
- They all lose those two valence electrons when forming ions.
- Alkaline Earth metals form ions with a +2 charge.
- Alkaline Earth metals have low ionization energy and electronegativity, but higher than Group 1.
- They lose electrons (oxidize) more readily than any group other than Group 1.
- They are very reactive.
- When exposed to air they quickly corrode, forming a thin layer of oxide.
- The further down in the group you look, the more reactive the elements are.
- They are only found bonded to other elements in compounds in their natural state.
- They can be separated from those compounds using electricity (electrolytic decomposition).
- They react quickly with water, forming explosive hydrogen gas and medium-strength bases.

- The term alkaline means "basic".

Since alkaline earth metals are not as reactive as alkali metals, you do not have to store them under oil. They do have a limited shelf-life, however, and you should close the container tightly when you are done.

## Groups 3-12: The Transition Metals

Group											
3	4	5	6	7	8	9	10	11	12		
<b>Sc</b> 21 44.956 2-8-9-2	<b>Ti</b> 22 47.88 2-8-10-2	<b>V</b> 23 50.9415 2-8-11-2	<b>Cr</b> 24 51.996 2-8-13-1	<b>Mn</b> 25 54.9380 2-8-13-2	<b>Fe</b> 26 55.847 2-8-14-2	<b>Co</b> 27 58.9332 2-8-15-2	<b>Ni</b> 28 58.69 2-8-16-2	<b>Cu</b> 29 63.546 2-8-18-1	<b>Zn</b> 30 65.39 2-8-18-2		
<b>Y</b> 39 88.905 2-8-18-9-2	<b>Zr</b> 40 91.224 2-8-18-10-2	<b>Nb</b> 41 92.9064 2-8-18-12-1	<b>Mo</b> 42 95.94 2-8-18-13-1	<b>Tc</b> 43 (98) 2-8-18-14-1	<b>Ru</b> 44 101.07 2-8-18-15-1	<b>Rh</b> 45 102.905 2-8-18-16-1	<b>Pd</b> 46 106.42 2-8-18-18	<b>Ag</b> 47 107.868 2-8-18-18-1	<b>Cd</b> 48 112.41 2-8-18-18-2		
<b>La</b> 57 138.906 2-8-18-18-9-2	<b>Hf</b> 72 178.49 2-8-18-32-10-2	<b>Ta</b> 73 180.948 2-8-18-32-11-2	<b>W</b> 74 183.85 2-8-18-32-12-2	<b>Re</b> 75 186.207 2-8-18-32-13-2	<b>Os</b> 76 191.2 2-8-18-32-14-2	<b>Ir</b> 77 192.22 2-8-18-32-15-2	<b>Pt</b> 78 195.08 2-8-18-32-17-1	<b>Au</b> 79 196.967 2-8-18-32-18-1	<b>Hg</b> 80 200.59 2-8-18-32-18-2		
<b>Ac</b> 89 227.028 2-8-18-32-18-9-2	<b>Rf</b> 104 (261) 2-8-18-32-10-2	<b>Db</b> 105 (262) 2-8-18-32-11-2	<b>Sg</b> 106 (263) 2-8-18-32-12-2	<b>Bh</b> 107 (264) 2-8-18-32-13-2	<b>Hs</b> 108 (265) 2-8-18-32-14-2	<b>Mt</b> 109 (266) 2-8-18-32-15-2	<b>Uun</b> 111 (271) 2-8-18-32-17-1	<b>Uuu</b> 112 (272) 2-8-18-32-18-1	<b>Uub</b> 112 (273) 2-8-18-32-18-2		

- Transition metals can be very reactive (like Zn) or slightly reactive (like Au).
- Transition metals lose electrons from their valence shell and the shell beneath it.
- Transition metals can form more than one ion charge (Cr can form a charge of +2, +3 or +6)
- Transition metal compounds tend to be colored (copper compounds are blue or green, iron compounds are red, brown or orange, manganese compounds are purple, chromium compounds are yellow or orange, cobalt compounds are blue or pink)

## Group 17

<b>F</b> 9 18.998403 2-7	<b>Cl</b> 17 35.453 2-8-7	<b>Br</b> 35 79.904 2-8-18-7	<b>I</b> 53 126.905 2-8-18-18-7	<b>At</b> 85 (210) 2-8-18-32-18-7
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## Group 17: The Halogens: all 3 phases of matter

- Halogens all have 7 valence electrons.
- They all gain one electron when forming ions to make a stable octet of 8.
- Halogens form ions with a -1 charge.
- Halogens have the highest ionization energy and electronegativity on the Periodic Table.
- They gain electrons (reduce) more readily than any other group on the Periodic Table.
- They are violently reactive (corrosive).
- When exposed to metals, they quickly corrode the metals, forming metal halide compounds.
- The further up in the group you look, the more reactive the elements are.

### Group 17: Halogens

- They are only found bonded to other elements in compounds in their natural state.
- They can be separated from those compounds using electricity (electrolytic decomposition).
- They combine with hydrogen, to form strong acids (like hydrochloric acid, HCl).

Fluorine and chlorine are extremely corrosive gases, and should be stored in special sealed cylinders. Chlorine is very toxic, and is used in water treatment and in swimming pools to kill bacteria. Bromine is a corrosive liquid, but since it is less reactive than chlorine, it can be used to kill bacteria in indoor swimming pools. Iodine is a solid and can be safely stored in glass jars, tightly sealed. Astatine is radioactive, so has other safety issues.

### Group 18: The Noble Gases

Group  
18

4.00260	0
<b>He</b>	
2	2
20.179	0
<b>Ne</b>	
10	2-8
39.948	0
<b>Ar</b>	
18	2-8-8
83.80	0 +2
<b>Kr</b>	
36	2-8-18-8
131.29	0 +2 +4 +6
<b>Xe</b>	
54	2-8-18-18-8
(222)	0
<b>Rn</b>	
86	-18-32-18-8

- Noble Gases all have 8 valence electrons (except for He, which has 2, but that fills its valence shell)

- Noble gases, already having a stable octet, do not form ions or compounds.

- Kr and Xe have ion charges listed because they can be forced to react with F (the most reactive nonmetal) in the laboratory. These compounds do not exist in nature.

- Noble gases glow brightly when heated, which makes them safe gases to use for lighting sources such as advertising signs.

- Noble gases (also called inert gases) can be used to safely pressurize light bulbs. Krypton is found in high-brightness lighting, such as automotive headlamps, and xenon is found in flashbulbs.

- Since noble gas atoms do not bond with any other atoms, they are considered to be one-atom (monatomic) molecules.

- Radon is a radioactive gas that forms as a result of the natural radioactive decay of uranium. In areas with porous rock over uranium deposits in the ground, houses with basements can be invaded by this gas. Being radioactive, breathing it in can lead to lung cancer. Part of the process of moving into a new home is to do a radon test, using an inexpensive kit you can buy in most stores. If the basement contains radon, a ventilation system can be installed to circulate it out.