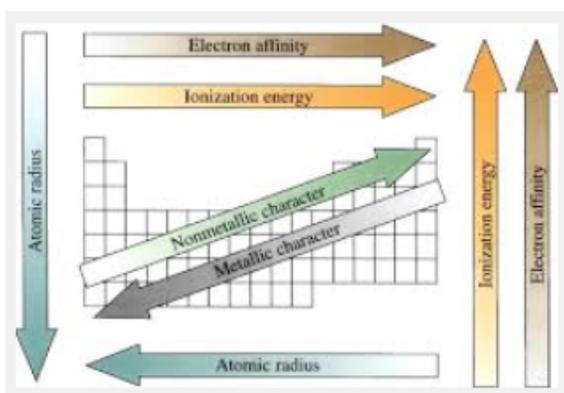


Better Understanding of Element Property Trends

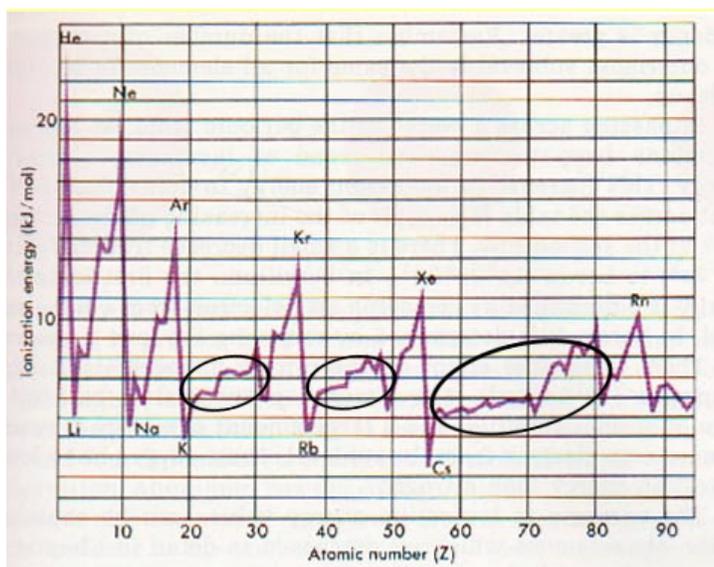
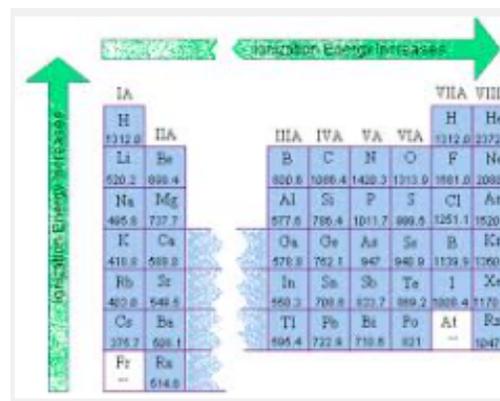
Description of the TrendsTube® Teaching Aid Rationale & Product

Property trend patterns - physical, electrical, or chemical aspects of adjacent



elements of the periodic table - increase or decrease in different directions, but often not strictly continuous. The main trends are: *ionization energy, electron affinity, metallic character, atomic radius, electronegativity, and melting point*. Chemists may use them to predict an element's properties by its position relative to others, a common application of the periodic table in general.

Charts (as left) that are intended to help students to learn the direction of these trends are commonly found in books and online. The trending among elements is most evident in the Main Group: blocks s & p (right). These blocks, in the common periodic table, are separated by the transition metals (circled in the chart below) which trend less among the elements there. The trends chart we have developed only uses the Main Group elements for those reasons.

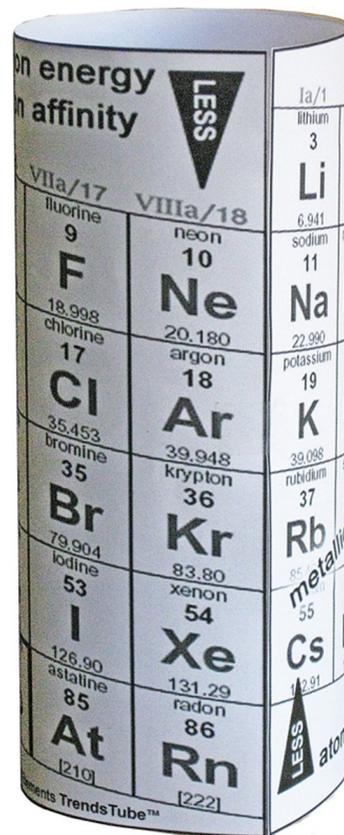


Currently approved (by IUPAC) column numbers are 1-18 across the periodic table. Older periodic tables often identified those of the Main Group with a Roman numeral and an 'a' suffix - Ia, IIa, IIIa, IVa, Va, VIa, VIIa, and VIIa. In addition to the 1-18, we use them, since they define the Main Group properly, and also provide the number of valence electrons, with the first, Ia, introducing a new shell, and the last, VIIa, being the filled shell of the Noble Gases.

Ionization energy, a very important trend, is the amount of energy needed to remove from the outer (valence) shell, the most loosely bound electron, the valence electron, of an isolated gaseous atom to form a cation (more protons than electrons).

Ionization energy decreases as one moves from periods 1 to 7 down any given column. The zero ionization energy column, the Noble Gases, are flanked: to the left, by a column of elements with all but one electron in the outer ring, and on the right, by elements with one.

When our chart is used, in the final part of a lesson the chart is wrapped and joined (right), like the Main Group on the 3D Forever AAE, hence the name TrendsTube®. This feature uniquely provides greater clarity to the inter-relationship of ionization energy of the elements before and after the Noble Gas elements. The most reactive, volatile elements (Alkali Metals) eager to discard the sole occupant of their valence shell and become stable, in the wrapped TrendsTube®, are neighbors to that goal, the lowest ionic energy Noble Gases (with the same goal) instead of at the opposite end of the flat periodic table.



Enhancing this factor is a slant of the databoxes, bringing contiguity to the element sequence, which, when joined, allows the end of one period to be directly adjacent to the beginning of the next, so each Noble Gas is to what those elements on either side specifically seek.

Different from most other trends charts, is that the trend identity (name) is named at the corner of maximum measure, and the adjacent

arrow points toward diminishment, rather than the other way around.

The TrendsTube® was initially intended for use with the 3D Forever Alexander Arrangement of Elements Model, as it matches the form and connected periods. Teachers, however have found it to have virtually universal application: in support of **any periodic table** in any trends lesson.

The Alexander Arrangement of Elements TrendsTube™ - for learning the property trends of elements in the periodic table

Ia/1	IIa/2	IIIa/13	IVa/14	Va/15	VIa/16	VIIa/17	VIIIa/18
lithium 3 6.941 Li	beryllium 4 9.0122 Be	boron 5 10.811 B	carbon 6 12.011 C	nitrogen 7 14.007 N	oxygen 8 15.999 O	fluorine 9 18.998 F	neon 10 20.180 Ne
sodium 11 22.990 Na	magnesium 12 24.305 Mg	aluminum 13 26.982 Al	silicon 14 28.086 Si	phosphorus 15 30.974 P	sulfur 16 32.065 S	chlorine 17 35.453 Cl	argon 18 39.948 Ar
potassium 19 39.098 K	calcium 20 40.078 Ca	gallium 31 69.723 Ga	germanium 32 72.64 Ge	arsenic 33 74.922 As	selenium 34 78.96 Se	bromine 35 79.904 Br	krypton 36 83.80 Kr
rubidium 37 85.468 Rb	strontium 38 87.62 Sr	indium 49 114.82 In	tin 50 118.71 Sn	antimony 51 121.76 Sb	tellurium 52 127.60 Te	iodine 53 126.90 I	xenon 54 131.29 Xe
cesium 55 132.91 Cs	barium 56 137.33 Ba	thallium 81 204.38 Tl	lead 82 207.2 Pb	bismuth 83 208.98 Bi	polonium 84 [209] Po	astatine 85 [210] At	radon 86 [222] Rn

ionization energy
electron affinity
LESS

metallic character
LESS

atomic radius
LESS

The Alexander Arrangement of Elements TrendsTube™

TRIM AT THE BORDER LINES - WRAP BACK TO ALIGN SIDES - APPLY CLEAR TAPE TO JOIN SIDES WITH ATOMIC NUMBERS IN NUMERIC ORDER

The graphic above is art for the TrendsTube® you may download, print, and use is at: <http://www.3dperiodictable.com/better/3D/TrendsChart.html>.

Teacher's Notes - excerpted and/or adapted from chemwiki/U.C.Davis

Atomic Radius Trends

Atomic radius is actually one-half the distance between the nuclei of two atoms, as not all atoms are normally bound together in the same way, and this reduces the probable error factor.

Atomic size gradually decreases from left to right across a period of elements, and from bottom to top. Within a period, electrons are being added to the same shell, but, at the same time, protons are being added to the nucleus, making it more strongly charged, pulling the atom's shell closer to the nucleus, accounting for the decrease.

The vertical decrease is the result of valence electrons being closer to the nucleus, thus shielding their outer electrons from nucleus attraction to the nucleus with the resulting larger atomic radius.

- Atomic radius decreases from left to right within a period.
- Atomic radius decreases from top to bottom within a group.

Electron Affinity Trends

The ability of an atom to accept an electron is a measure of the energy change that occurs when one is added to a neutral gas atom: the more negative the value, the more of an affinity to electrons that atom has.

Electron affinity generally decreases down a group of elements because each atom is larger than the one above on the chart, with any added electron further away from the nucleus compared to its distance in the smaller atom resulting in weaker attraction.

Moving from right to left across a period, atoms become larger, causing the electrons to move closer to the nucleus, thus decreasing the electron affinity progressively.

- Electron affinity decreases from right to left within a period.
- Electron affinity decreases from top to bottom within a group.

Metallic Character Trends

One definition of metallic character of an element is how readily an atom can lose an electron. As you move in a diagonal from the most (cesium) to the least (neon) metallic character, it decreases because the attraction between valence electron and the nucleus is stronger, thus enabling a more difficult loss of electrons, an effect enhanced by the reduction in the size of the atom (see above).

- Metallic characteristics decrease from left to right across a period.
- Metallic characteristics decrease up a group.

Ionization Energy Trends

Energy is required to move electrons from one atom to another. The lower this energy is, the more readily the atom loses an electron to become a cation, and the higher, the easier to gain an electron; be anionized. On our trends chart, Neon is highest in the latter category.

Our trends chart, when wrapped and joined end to end (following the teaching of the other trends), demonstrates this exchange extremely well: elements with a space in their outer shell for a single electron find themselves one column away from those with a single element in their outer shell. Between them is only one element, a Noble Gas - which already epitomizes both their goals, a full outer shell. The VIII_a elements have higher ionization energy because their valence shell is nearly filled and therefore unwilling to lose electrons, while elements in the 1_a column have little resistance in order to gain a full valence shell, an effect that decreases even more down a column in general.

Another factor is electron shielding (or screening) of a positively charged nucleus from its valence electrons. When moving to the left on a period of elements, the number of electrons decreases and the strength of shielding decreases resulting in easier ionizing, so ionization energy decreases when going down a group as well.

- The ionization energy of the elements within a period generally decreases from right to left.
- The ionization energy of the elements within a group generally decreases from top to bottom.

Electronegativity Trends

This chemical property is the measure of an atom's ability to attract and bind to electrons. Because it is a qualitative property, there is no standardized method for calculation. The numbers assigned (by the Pauling scale), while dimensionless due to electronegativity being largely qualitative, indicate a trend we plan to include on the

TrendsTube® due to popular demand, however: matching the trends of ionization energy and electron affinity.

- The electronegativity of the elements within a period generally decreases from right to left.
- The electronegativity of the elements within a group generally decreases from top to bottom.

Melting Point Trends

Melting points are the energy needed to change a solid substance to a liquid. High bond dissociation energy correlates to a high temperature. Melting points are varied and don't generally form a distinguishable trend across the periodic table and are therefore **not included on our trends chart**.

- Metals generally possess a high melting point.
- Most non-metals possess low melting points. *[end]*