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Key.

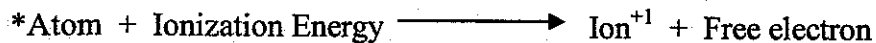
Atomic Theory

Trends in the Periodic Table Worksheet Package

Definitions and Discussion:

Ionization Energy (I.E.) – the MINIMUM energy required to remove an electron from a neutral atom. The electron removed is the outermost (most easily removed) and is always a valence electron unless the atom has a full outer shell).

*When an atom loses an electron this atom is said to be “ionized” because it forms a cation.



*An atom with a HIGH I.E. holds on to its electrons very tightly thus requiring a large amount of energy to remove an electron.

*ALL chemical reactions involve either gaining, losing, or sharing electrons; thus, the ease with which an atom loses electrons plays an important role in the REACTIVITY of the atom.

Electronegativity – the ability of an atom to ATTRACT an electron (ie. the “attractive strength” or “pulling power” of an atom for an electron).

*Any free electron which happens to be traveling near an atom may be “caught” by that atom (just as a meteorite may become caught by Earth’s gravitational pull).

*Some atoms attract electrons more than others.

*Highly electronegative atoms can also attract electrons from a neighbouring atom and may completely remove said electrons.

*Atoms with high electronegativity also attract their own valence electrons meaning that they possess a high I.E.

Atomic Radius – The radius of an atom is the distance from the nucleus to the outermost electron(s) in the atom.

*An atom’s size is related to the orbital that the valence electrons reside.

*The higher the energy level (Quantum # = n), the further from the nucleus those electrons will be.

GRAPHING ACTIVITY

Use the data provided to construct three graphs. Each graph will have the atomic number (1-20) plotted on the x-axis and an atomic property plotted on the y-axis.

Graph 1: Ionization Energy vs. Atomic Number

Graph 2: Electronegativity vs. Atomic Number

Graph 3: Atomic Radius vs. Atomic Number

* Each graph should provide clear titles, units, proper scales, and a legend.

* Each graph should be a scatter plot with a best-fit line (a disjointed line, see below).

* Do NOT connect He to Li, Ne to Na, or Ar to K with a line.

Data Table:

Element	Atomic Number	Ionization Energy (kJ/mol)	Electronegativity (no units)	Atomic Radius (pm)
H ₂	1	1312	2.1	37
He	2	2372	0	50
Li	3	519	1.0	152
Be	4	900	1.5	111
B	5	799	2.0	88
C	6	1088	2.5	77
N ₂	7	1406	3.0	75
O ₂	8	1314	3.5	73
F ₂	9	1682	4.0	71
Ne	10	2080	0	70
Na	11	498	0.9	186
Mg	12	736	1.2	160
Al	13	577	1.5	143
Si	14	787	1.8	117
P	15	1036	2.1	110
S	16	1000	2.5	104
Cl ₂	17	1255	3.0	99
Ar	18	1519	0	94
K	19	418	0.8	231
Ca	20	590	1.0	197

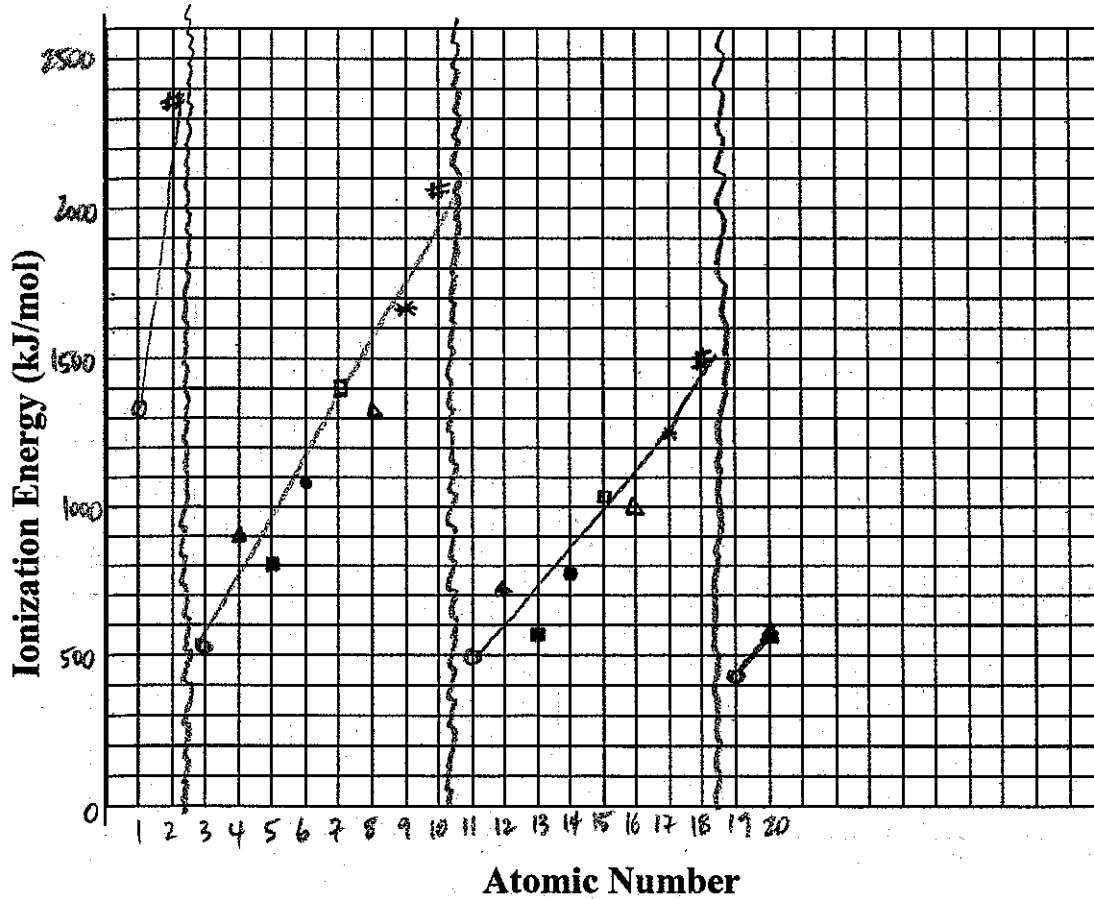
Analysis:

Using the following legend, label each element of each family as such, on each graph:

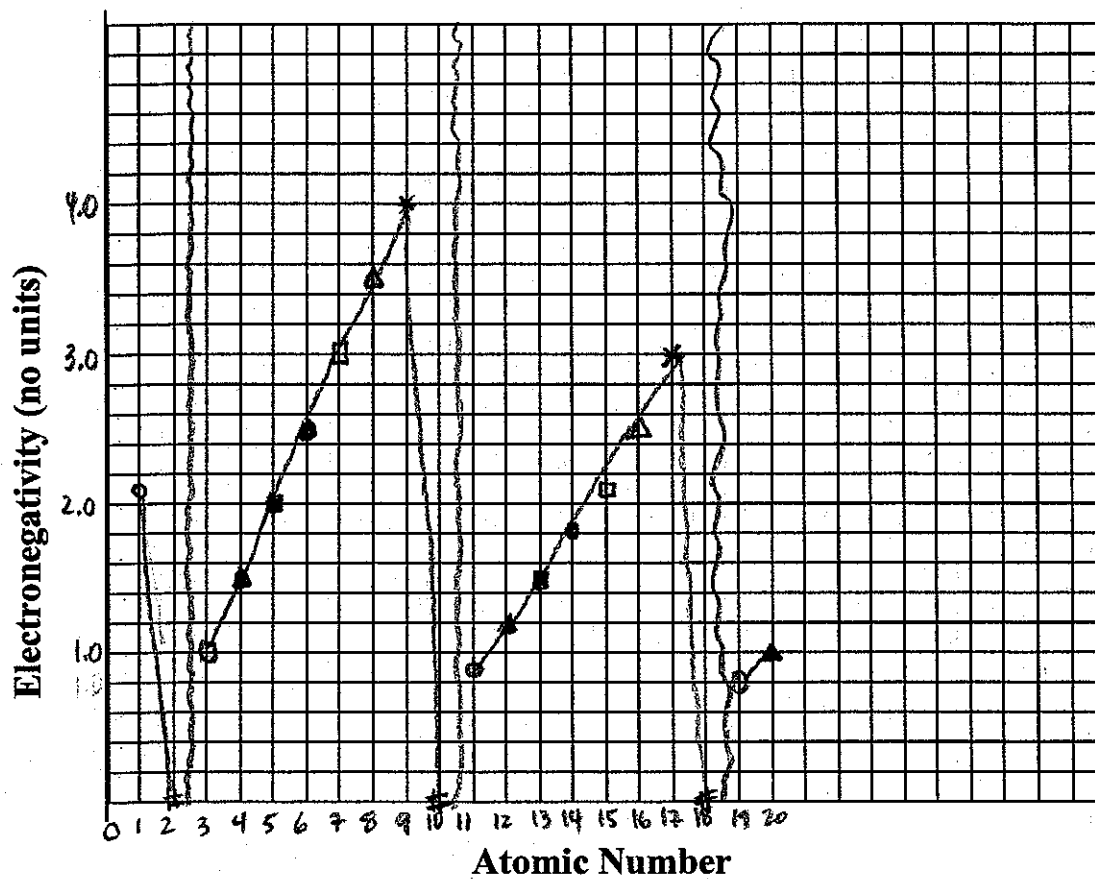
Legend:

Alkali Metals	○
Alkaline Earth Metals	▲
Boron Family elements	■
Carbon Family elements	●
Nitrogen Family elements	□
Oxygen Family elements	△
Halogens	*
Noble Gases	#

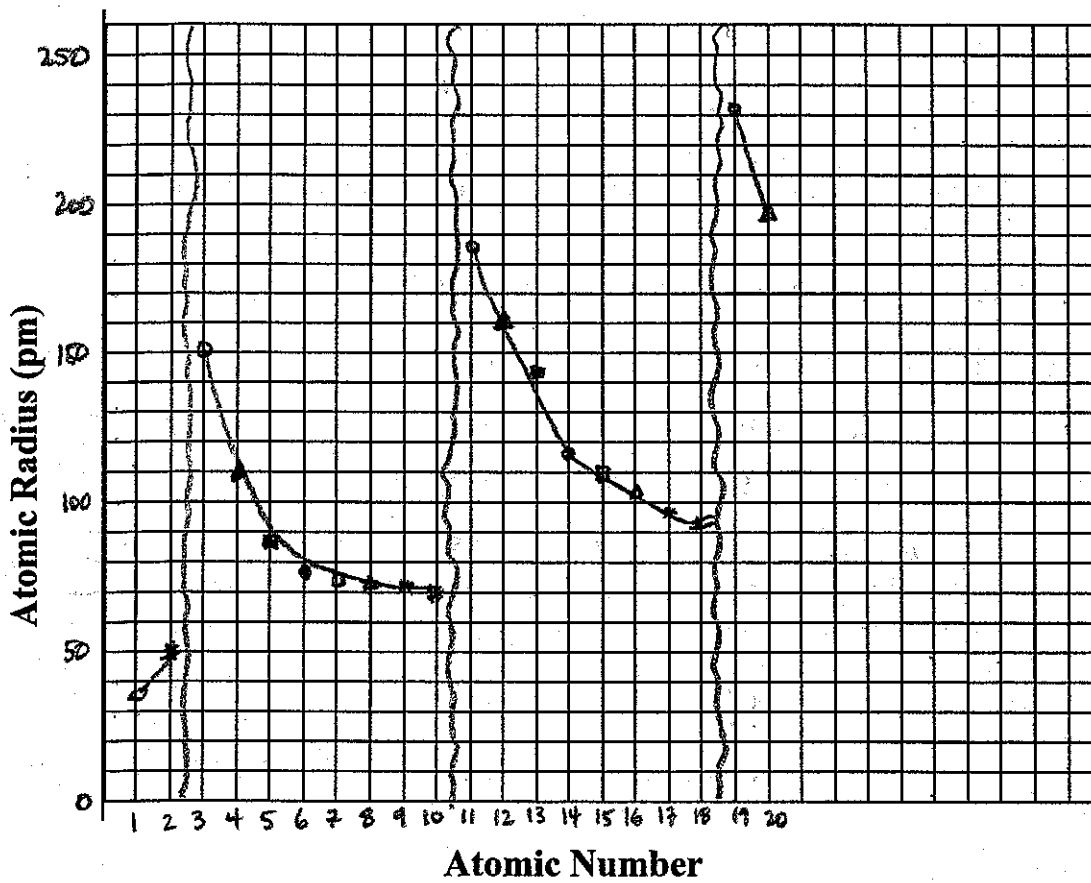
Graph 1: Ionization Energy



Graph 2: Electronegativity



Graph 3: Atomic Radii



Discussion Questions:

1. Explain the relationship between *ionization energy* and chemical reactivity. Based on your explanation, which family (group) should be the most reactive? Within this family, what element should be the most reactive?

The LOWER the ionization energy, the MORE REACTIVE an element is.
If it is easier to remove electrons, then an atom is more reactive.

The ALKALI METALS are the most reactive as they only possess one 'outer' electron. (in terms of LOSING electrons)

FRANCIUM is the most reactive as its electron is furthest from the nucleus

2. Explain the relationship between *electronegativity* and chemical reactivity. Based on your explanation, which family (group) should be the most reactive? Within this family, what element should be the most reactive?

The HIGHER the electronegativity, the more reactive an element is.
The greater the pull for electrons, the more reactive an atom is.
The HALOGENS are the most reactive in terms of GAINING electrons as they have more protons associated with its energy level.

FLUORINE is the most reactive as its outer energy level is CLOSEST to the nucleus.

3. It is known that noble gases are very unreactive. Explain why their 'unreactiveness' makes sense according to their *ionization energy* and *electronegativity* values.

Noble Gases have complete energy levels. \therefore strong hold on electrons by nucleus (high I.E.) and no need to gain more electrons (Low electroneg.).

4. Complete the following chart concerning the general trends of the indicated properties of the elements in the Periodic Table. Be general, don't be concerned with small deviations from the trends:

Property	Trend Across Period (Left to Right)	Trend Down Family (Group)
<i>Ionization Energy</i>	INCREASES	DECREASES
<i>Electronegativity</i>	INCREASES	DECREASES
<i>Atomic Radius</i>	DECREASES	INCREASES

5. Provide an explanation why ionization energies decrease as you go down a family's column (HINT: Consider the Atomic Radius and the strength of the force that the nucleus can exert on the valence electrons).

See explanation for Fr in Q.1.

6. Suggest an explanation for the surprising trend of Atomic Radii decreasing as you move across a period from left to right.

More protons for same energy level \therefore greater attraction and greater pull \therefore smaller ATOMIC RADII as you move (L) to (R).

Further Review Questions (not required to hand-in, but useful practice for TEST):

Textbook (Hebden): -- pages 146-147 #13-16, 19
-- page 168 #48-51
-- pages 170-171 #53-55
-- page 173 #58-61
-- pages 191-192 #106 a,d, 107, 111-112, 115, 125;

