Name:_____

Atomic Theory

Trends in the Periodic Table Worksheet Package

Definitions and Discusssion:

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.

*Atom + Ionization Energy $\longrightarrow$ Ion^{+1} + Free electron

*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

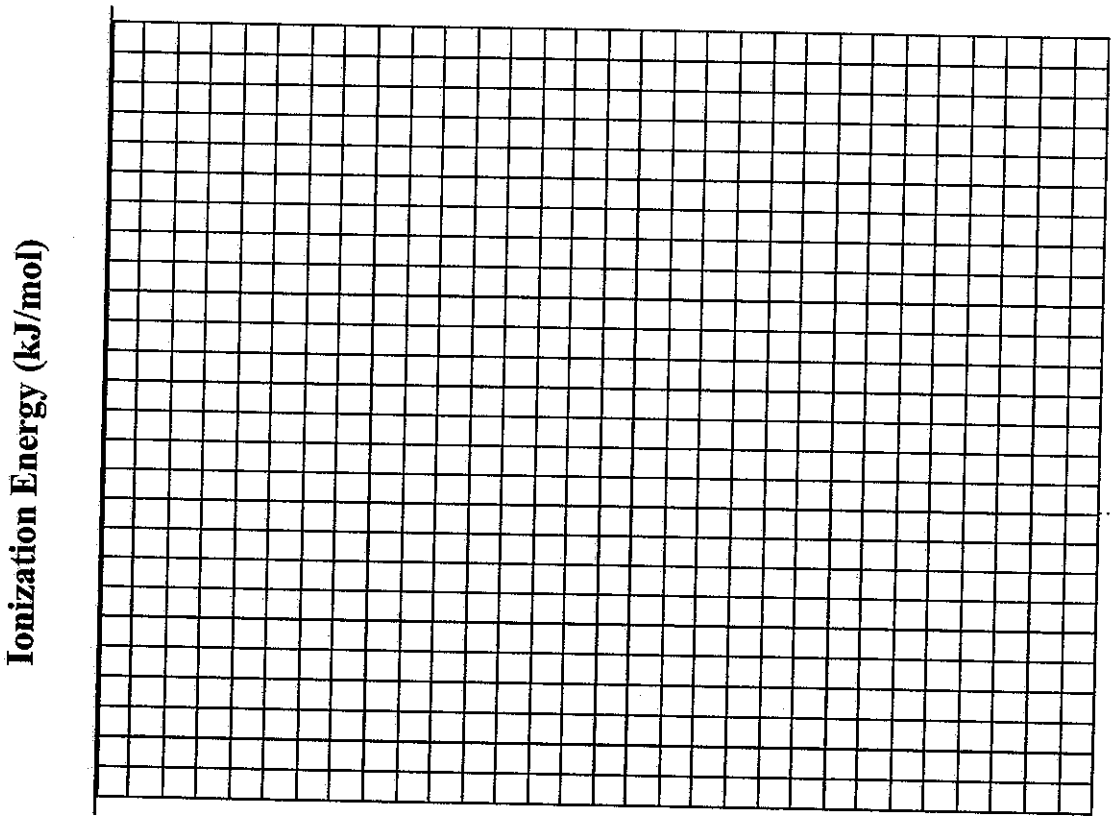
Analysis:

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

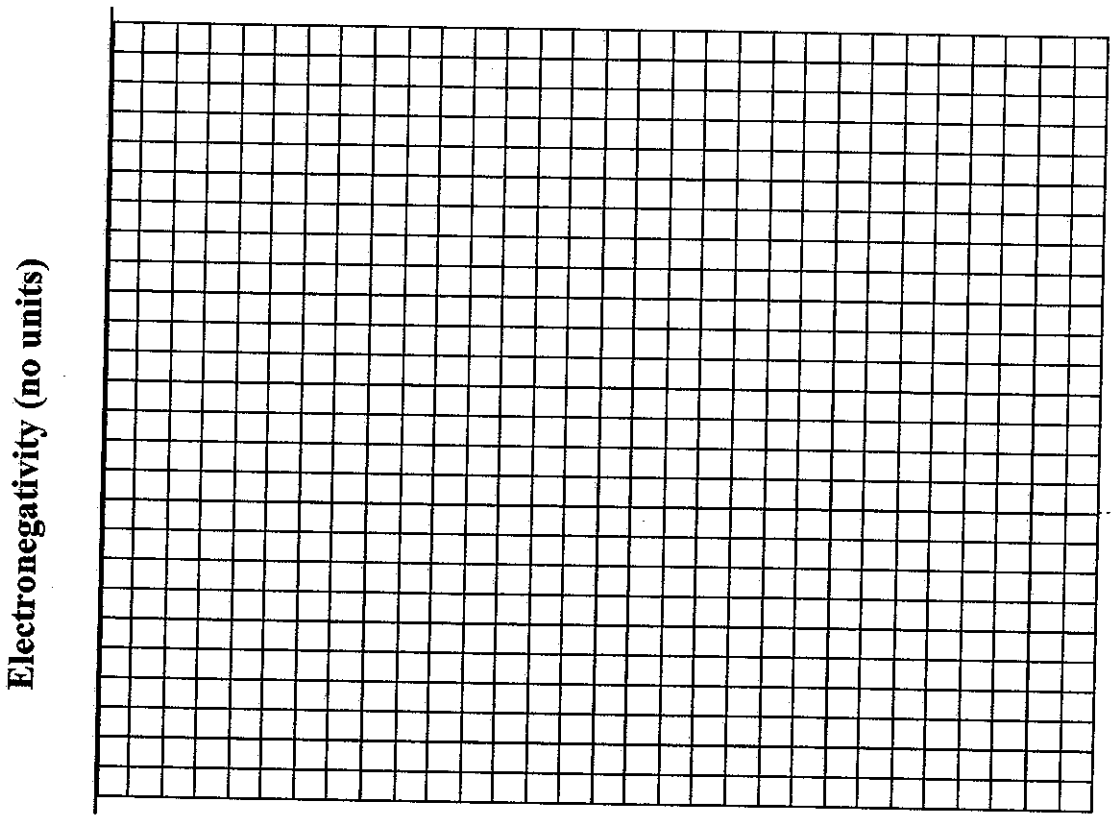
Legend:

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

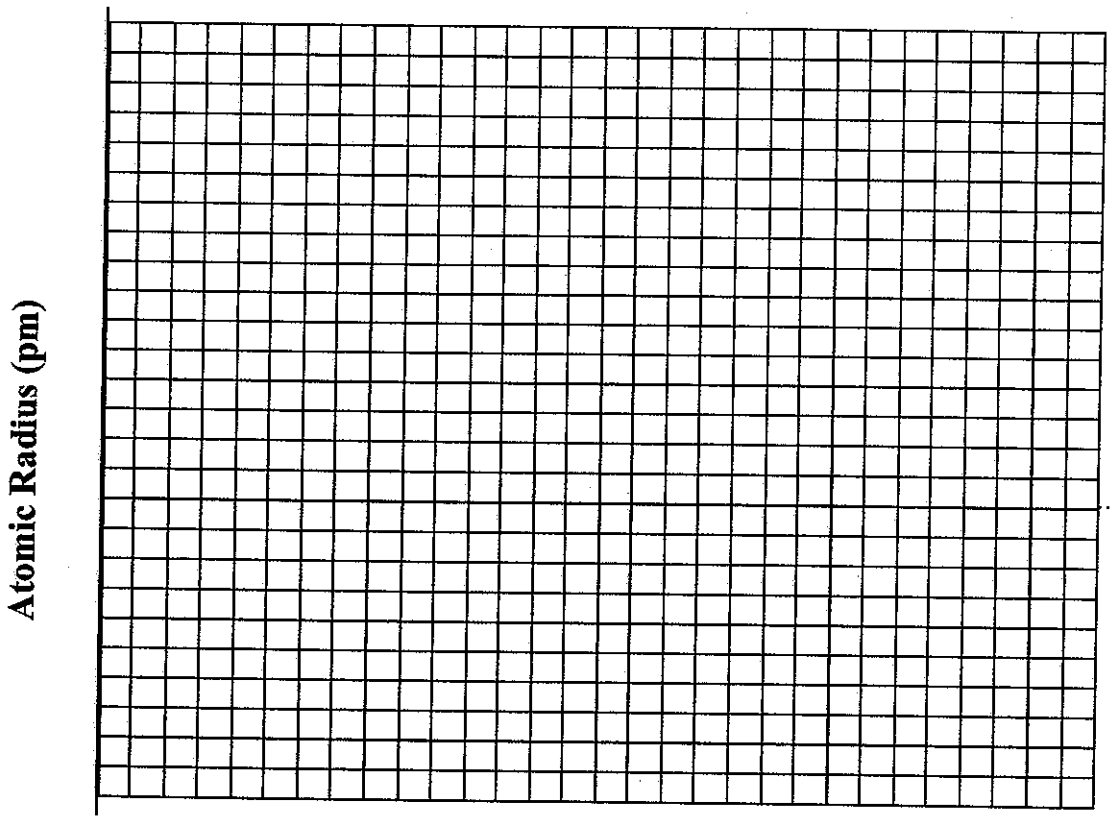
Graph 1:_____



Graph 2:_____



Graph 3:_____



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?

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?

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

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)**
Ionization Energy		
Electronegativity		
Atomic Radius		

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).

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

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;