Trends Handout **ANSWERS**

There are 7 trends on the periodic table that we will follow. Using your periodic table, answer all of the questions in the packet. Think hard.

The periodic table has **18** groups that go **UP and DOWN**.

The rows that go across left to right are called the **PERIODS**.

Similar elements are found in **GROUPS**.

Elements with the same number of electron orbitals are found in the **SAME PERIODS**.

The elements are arranged by increasing **ATOMIC NUMBER**

This is equal to the **NUMBER OF PROTONS (ALSO = TO THE NUMBER OF ELECTRONS)**

The atomic mass minus the atomic number equals the number of **NEUTRONS**.

Trend #1 atomic mass

What is the group trend for atomic mass? Why does this trend exist?
THE GROUP TREND FOR ATOMIC MASS IS INCREASING. ATOMS LITERALLY GET BIGGER - MORE PROTONS AND NEUTRONS (AND ELECTRONS TOO) AS THE ATOMIC NUMBER INCREASES.

What is the period trend for atomic mass? Why does this trend exist?
THE PERIOD TREND FOR ATOMIC MASS IS INCREASING. ATOMS GET MUCH BIGGER GOING DOWN ANY GROUP, THE ATOMIC NUMBER (AND NUMBER OF PROTONS + NEUTRONS) MAKES BIG JUMPS.

Explain what happens at the cobalt-nickel part of the table concerning mass and the period trend? Look also at the argon-potassium masses.
THERE ARE MORE THAN A COUPLE OF PLACES WHERE DUE TO DIFFERENT PROPORTIONS OF NATURALLY OCCURING ISOTOPES THAT THE AVERAGE WEIGHTED ATOMIC MASS BREAKS THE TREND, MAKES EXCEPTIONS TO WHAT WOULD BE EXPECTED (OR REGULAR). THAT'S JUST EXCEPTIONS, TRENDS SHOW PATTERNS, BUT CAN BE A LITTLE FLEXIBLE.

Trend #2 Atomic Size (the atomic radius measured in in pico-meters)
Fill in the tables for atomic size across period 2, then for groups 2 and 18 below.

atom	Li	Be	B	C	N	O	F	Ne
Radius in pm	**130 pm**	**99 pm**	**84 pm**	**75 pm**	**71 pm**	**64 pm**	**60 pm**	**62 pm**

The Period TREND for atomic size/atomic radius is
THE PERIOD TREND FOR ATOMIC SIZE IS DECREASING.

Why do atoms get smaller going across a period?
THE TREND FOR ATOM SIZE GETTING SMALLER MOVING ACROSS A PERIOD CAN BE EXPLAINED IF YOU UNDERSTAND THAT ALL OF THE ATOMS IN A PERIOD HAVE THE SAME NUMBER OF ELECTRON ORBITALS, BUT KEEP INCREASING THE NUMBER OF POSITIVE PROTONS JAMMED INTO THE NUCLEUS. THESE GET A LARGER INWARD ATTRACTION AS THE ATOMS GET BIGGER, PULLING THE OVERALL SIZE SMALLER AND SMALLER.

THE GROUP TREND FOR ATOMIC SIZE IS INCREASING. THERE IS NOT MUCH CHANCE FOR ANY EXCEPTION TO THIS, EACH STEP LOWER ON THE TABLE INDICATES THE ADDITION OF AN ADDITIONAL ELECTRON ORBITAL. THESE ORBITALS JUST KEEP GETTING LARGER.

GROUP 2 atom	radius in pm
Be	**99**
Mg	**140**
Ca	**174**
Sr	**190**
Ba	**206**
Ra	**211**

GROUP 17 atom	radius in pm
F	**60**
Cl	**100**
Br	**117**
I	**136**
At	**148**

Trend #3: Nuclear Charge or what is the charge of nucleus of each atom
List the net nuclear charge for Period 2 atoms below. Then do the same for any 2 groups that you choose. Label WHAT GROUP you use, then add symbols and their values.

atom	Li	Be	B	C	N	O	F	Ne
Net Nuclear Charge	**+3**	**+4**	**+5**	**+6**	**+7**	**+8**	**+9**	**+10**

Describe the TREND for Net Nuclear Charge going across a period.
THE PERIOD TREND FOR NET NUCLEAR CHARGE IS INCREASING (WITH NO EXCEPTIONS). INCREASING ATOMIC NUMBER MEANS ADDING PROTONS, WHICH IS THE ONLY SUBATOMIC PARTICLE IN THE NUCLUS TO HAVE CHARGE. ATOMS ARE NEUTRAL BECAUSE THE POSITIVE NUCLEUS IS BALANCED WITH THE SAME NUMBER OF ELECTRONS, WHICH ARE NOT IN THE NUCLEUS.

GROUP 1	Net Nuclear Charge
Li	**+3**
Na	**+11**
K	**+19**
Rb	**+37**
Cs	**+55**
Fr	**+87**

GROUP 15	Net Nuclear Charge
N	**+7**
P	**+15**
As	**+33**
Sb	**+51**
Bi	**+83**

Describe the TREND for Net Nuclear Charge going down any group.
THE GROUP TREND FOR NET NUCLEAR CHARGE IS INCREASING (ALSO WITH NO EXCEPTIONS).

Trend #4 Electronegativity

Define Electronegativity (EN): **ELECTRONEGATIVITY IS THE RELATIVE TENDENCY TO GAIN ELECTRONS WHEN SHARING ELECTRONS IN A MOLECULAR BOND - MEANING BETWEEN NON-METALS ONLY**.

Look at Table S, which element has the highest EN value? **F** What is it? **4.0**

Define RELATIVE SCALE: **A RELATIVE SCALE IS WHERE ALL MEMBERS OF THIS GROUP ARE COMPARED TO ONE STANDARD. ON THIS ELECTRONEGATIVITY SCALE, ATOMS ARE RANKED RELATIVE TO FLUORINE.**

Fill in this abbreviated Periodic Table, put the EN value for each listed element below its symbol. Fill in the GROUP NUMBERS ACROSS THE TOP SET OF EMPTY BOXES

GROUP **1**	GROUP **2**	GROUP **13**	GROUP **14**	GROUP **15**	GROUP **16**	GROUP **17**	GROUP **18**
H **2.2**	Leave empty						He **---**
Li **1.0**	Be **1.6**	B **2.0**	C **2.6**	N **3.0**	O **3.4**	F **4.0**	Ne **---**
Na **0.9**	Mg **1.3**	Al **1.6**	Si **1.9**	P **2.2**	S **2.6**	Cl **3.2**	Ar **---**
K **0.8**	Ca **1.0**	Ga **1.8**	Ge **2.0**	As **2.2**	Se **2.6**	Br **3.0**	Kr **---**
Rb **0.8**	Sr **1.0**	In **1.8**	Sn **2.0**	Sb **2.1**	Te **2.1**	I **2.7**	
Cs **0.8**	Ba **0.9**	Tl **1.8**	Pb **1.9**	Bi **1.8**			

What is the EN TREND going down a group? **THE GROUP TREND FOR ELECTRONEGATIVITY IS DECREASING.**

What is the EN TREND going across a period? **THE PERIOD TREND FOR ELECTRONEGATIVITY IS INCREASING.**

Why do most NOBLE GASES have no Electronegativity value?
NOBLE GASES TEND TO MAKE NO BONDS, THEY DON'T FORM IONS OR SHARE ELECTRONS (THEY DON'T BOND), SO THEY HAVE NO TENDENCY TO GAIN ELECTRONS IN BONDS. XENON IS AN EXCEPTION, IT CAN MAKE SOME BONDS UNDER SOME CONDITIONS. THIS IS AN EXCEPTION TO THE TREND THAT NOBLE GASES HAVE NO EN VALUES.

Which elements of each pair have the higher EN values? (circle higher EN value)

Cl **Ge** **Br**

What is the TREND FOR EN for the whole periodic table?
THE PERIOD TREND FOR ELECTRONEGATIVITY VALUE IS INCREASING.

Explain how Xenon and Radon can have an EN value even as noble gases.
THEY ARE EXCEPTIONS, THEY CAN MAKE SOME BONDS UNDER CERTAIN CONDITIONS, WHICH IS ODD FOR A NOBLE GAS.

Explain why group 1 atoms have lower electronegativity values than the group 17 atoms. Explain this difference.
GROUP 1 ATOMS TEND TO FORM ONLY +1 CATIONS WHEN THEY BOND, THEY DO NOT HAVE ANY TENDENCY TO GAIN ELECTRONS, THEY ONLY HAVE TENDENCY TO LOSE ELECTRONS. IN GROUP 17, THE HALOGENS HAVE A STRONG TENDENCY TO GAIN ELECTRONS WHEN THEY FORM INTO ANIONS. ATOMS CLOSER TO FLUORINE USUALLY HAVE A HIGHER ELECTRONEGATIVITY VALUE BY TREND RULE.

Trend #5: 1st Ionization Energy

Define 1st Ionization Energy: **THE AMOUNT OF ENERGY REQUIRED TO TURN A MOLE OF ATOMS IN TO A MOLE OF +1 CATIONS. NOT ALL ATOMS WANT TO TURN INTO +1 CATIONS, BUT THIS CAN BE FORCED, AND FOR SOME, ADDITIONAL ENERGY IS NEEDED TO FORM THEM INTO +2 CATIONS, OR EVEN +3 CATIONS.**

The unit is **Kj/mole KILO-JOULE PER MOLE**

Fill in this chart with the 1st Ionization Energy levels for each atom in this chart.

GROUP 1	GROUP 2	GROUP 13	GROUP 14	GROUP 15	GROUP 16	GROUP 17	GROUP 18
H **1312**	*Leave empty*						He **2372**
Li **520**	Be **900.**	B **801**	C **1086**	N **1402**	O **1314**	F **1681**	Ne **2081**
Na **496**	Mg **738**	Al **578**	Si **787**	P **1012**	S **1000.**	Cl **1251**	Ar **1521**
K **419**	Ca **590.**	Ga **579**	Ge **762**	As **944**	Se **941**	Br **1140.**	Kr **1351**
Rb **403**	Sr **549**	In **558**	Sn **709**	Sb **831**	Te **869**	I **1008**	Xe **1170**
Cs **376**	Ba **503**	Tl **589**	Pb **716**	Bi **703**	Po **812**	At ---	Rn **1037**

Describe the GROUP TREND for 1st Ionization Energy.
THE GROUP TREND FOR 1ST IONIZATION ENERGY IS DECREASING.

Define the PERIOD TREND for 1st Ionization Energy.
THE PERIOD TREND FOR 1ST IONIZATION ENERGY IS INCREASING.

Where are the highest and lowest 1st Ionization Energy values? Why?
LOWEST BOTTOM LEFT OF TABLE, HIGHEST AT HELIUM.
If you ever forget a TREND, how will you deal with this on the REGENTS?
JUST LOOK IT UP ON TABLE S.

Trend #6: Cation and anion size trends

It is clear that cations are smaller than their atoms from this chart.

THE GROUP TREND FOR CATION SIZE IS INCREASING. THE NUMBER OF ORBITALS KEEPS INCREASING. THE ATOMS ARE ALWAYS LARGER THAN THE CATIONS, BUT THEY BOTH KEEP GETTING BIGGER GOING DOWN A GROUP.

GROUP 2 atom	Atomic electron configuration	Cation electron configuration
Be	**2-2**	**2**
Mg	**2-8-2**	**2-8**
Ca	**2-8-8-2**	**2-8-8**
Sr	**2-8-18-8-2**	**2-8-18-8**
Ba	**2-8-18-18-8-2**	**2-8-18-18-8**
Ra	**2-8-18-32-18-8-2**	**2-8-18-32-18-8**

THE PERIOD TREND FOR CATION SIZE IS DECREASING. THE REASON FOR THIS IS THE SAME REASON THAT THE ATOM SIZE TREND ALSO DECREASES:

THEY HAVE THE SAME NUMBER OF ORBITALS, BUT MORE + MORE POSITIVE PROTONS IN THEIR NUCLUES PULL MORE STRONGLY INWARD AS THE NUMBER OF THEM INCREASES GOING ACROSS A PERIOD.

atom	Na	Mg	Al
Electron config	**2-8-1**	**2-8-2**	**2-8-3**
Cation config	**2-8**	**2-8**	**2-8**

atom	K	Ca	Sc	Ti
Electron config	**2-8-8-1**	**2-8-8-2**	**2-8-9-2**	**2-8-10-2**
Cation config	**2-8-8**	**2-8-8**	**2-8-8**	**2-8-8**

Anion Size

GROUP 17 atom	Atom electron configuration	Anion electron configuration
F	**2-7**	**2-8**
Cl	**2-8-7**	**2-8-8**
Br	**2-8-18-7**	**2-8-18-8**
I	**2-8-18-18-7**	**2-8-18-18-8**

THE GROUP TREND FOR ANION SIZE IS INCREASING. EACH STEP DOWN THE GROUP ADDS ORBITALS, SO THE ANIONS GET BIGGER. EACH ANION IS SLIGHTLY LARGER THAN IT'S ATOM. THE EXTRA ELECTRONS ARE CONTAINED IN THE SAME NUMBER OF ORBITALS, BUT THAT EXTRA NEGATIVE CHARGE CAUSES THE ORBITAL TO STRETCH A BIT TO ACCOMMODATE THAT EXTRA BIT OF NEGATIVITY.

atom	N	O	F
Electron config	**2-5**	**2-6**	**2-7**
Anion config	**2-8**	**2-8**	**2-8**
atom	P	S	Cl
Electron config	**2-8-5**	**2-8-6**	**2-8-7**
Anion config	**2-8-8**	**2-8-8**	**2-8-8**

THE PERIOD TREND FOR ANION SIZE IS DECREASING. EACH ELECTRON ADDED TO THE SAME NUMBER OF ORBITALS ALSO ADDS A PROTON. FOR THE SAME REASON THAT ATOMS GET SMALLER GOING ACROSS A PERIOD, SO DO THE ANIONS.

ANIONS ARE ALWAYS LARGER THAN THEIR ATOMS BECAUSE THE SAME NUMBER OF PROTONS ARE IN THE NUCLEUS, BUT WITH THAT EXTRA ELECTRON (OR 2 OR 3) THE OUTER MOST ORBITAL STRETCHES A BIT TO ACCOMMODATE FOR THE EXTRA NEGATIVE CHARGE.

Trend #7 Metallic Properties + Non-Metallic Properties of the Elements

The metals on the table are on the **LEFT** side. The non-metals are on the **RIGHT SIDE**.

Metals properties include: **MALLEABLE, DUCTILE, CONDUCT HEAT, CONDUCT ELECTRICITY, FORM CATIONS, LOW ELECTRONEGATIVITY VALUE, HIGHER 1ST IONIZATION ENERGY, HIGHER DENSITY, AND LOW SPECIFIC HEAT CAPACITY CONSTANTS.**

Nonmetal properties include: **MOSTLY OPPOSITE METAL PROPERTIES: NOT MALLEABLE, NOT DUCTILE, BRITTLE INSTEAD, CONDUCT HEAT AND ELECTRICITY VERY POORLY, FORM ANIONS, HIGHER ELECTRONEGATIVITY VALUES, LOWER 1ST IONIZATION VALUES, LOWER DENSITY, AND HIGHER SPECIFIC HEAT CAPACITIY CONSTANTS.**

The most metallic element of them all is **FRANCIUM**.

The most non-metallic element of them all is **HELIUM**.

When comparing, which is most metallic: silver, zirconium, or **CESIUM**

When comparing, which is most nonmetallic: **CHLORINE**, iodine, phosphorous

What are metalloids? **METALS WITH SOME NON-METALLIC PROPERTIES OR NON-METALS WITH SOME METALLIC PROPERTIES. ALSO CALLED "SEMI-METALS".**

List the symbols of all the metalloids: **B, Si, Ge, As, Sb, Te, At**

What are the 2 exceptions to the metalloids? **Al + Po touch the staircase but they are both metals. They are exceptions to the trend if an element touches the staircase then they are a metalloid.**