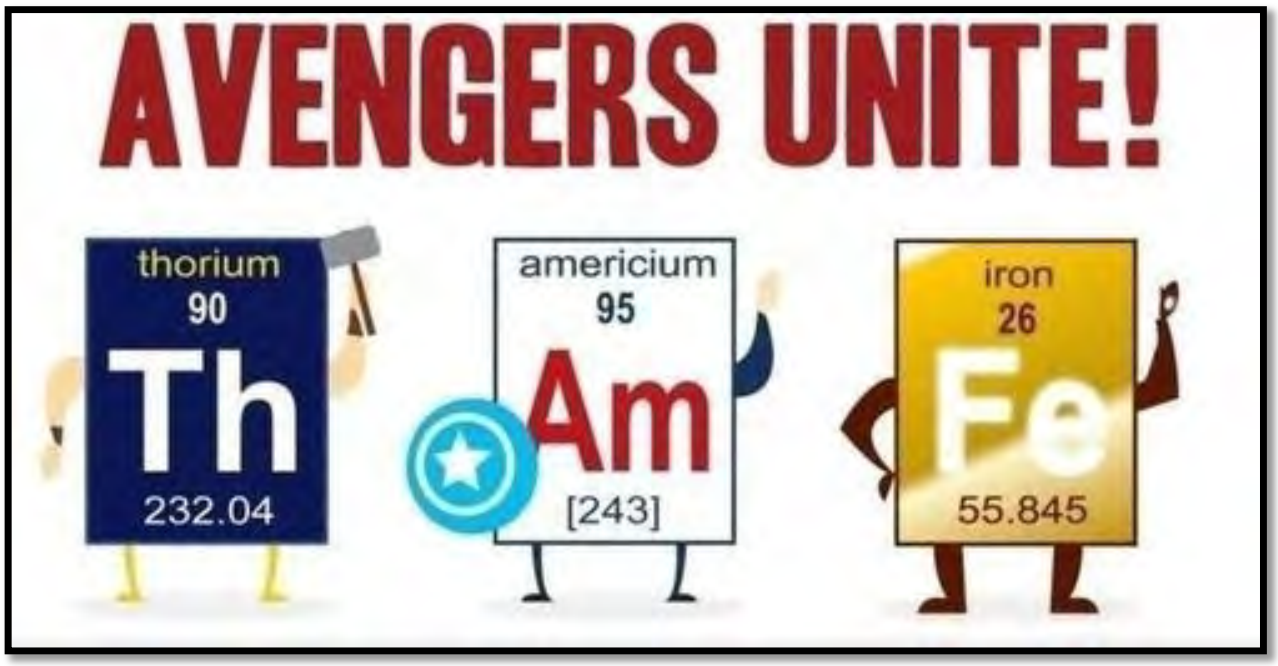
Regents Chemistry: Dr. Shanzer

Practice Packet

Chapter 6: Periodic Table



History of the Periodic Table

Video 6.1

Objectives

- By the end of the video you should be able to…
  - Define and explain periodicity (or the periodic law)
  - Identify and explain similarities within groups and periods.

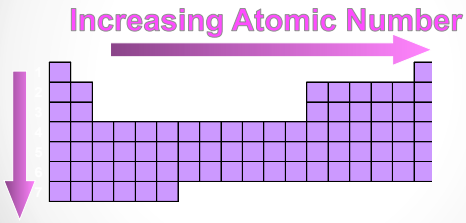
Periodic Law

"When elements are arranged in order of increasing atomic mass, periodic, or repeating, trends occur."

In 1869, Mendeleev arranged the elements in order of mass he and his students studied according to trends such as conductivity, ductility, malleability, etc.

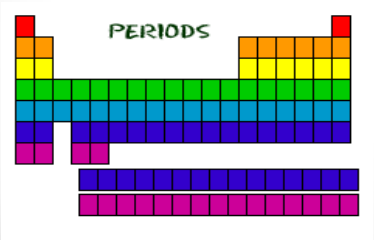
Now the table is in order of atomic number!

The Modern Periodic Table



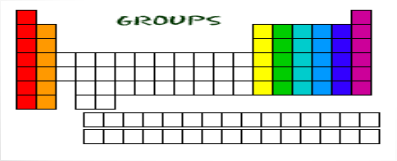
Periods

- Periods represent horizontal rows on the periodic table and are numbered 1-7. These numbers can also represent the number of energy levels.

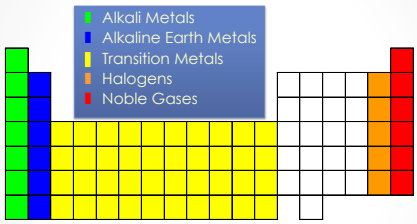


Groups

- Groups represent vertical columns on the table and are numbered 1-18 (different on some other tables). Elements in the same group have the same number of valence electrons and similar properties.



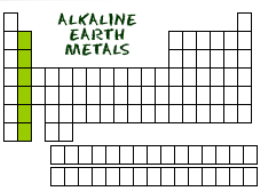
PERIODIC GROUPS



Alkali Metals Group 1

- Very reactive (not found in elemental form)
- One valence e^-: 1+ charge
- Metallic character increases down the group
- Strong exothermic reaction with water

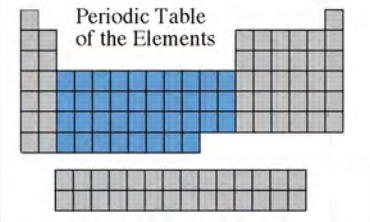
Alkaline Earth Metals



- Reactive (not as much as alkali metals)
- Two valence e^-
- 2+ charge
- Alkaline means base

Transition Metals – Groups 3-12

Form colored compounds and solutions with various charges

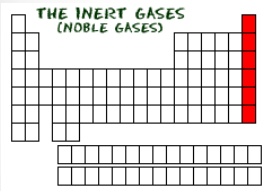


Halogens – Group 17

- Form diatomic molecules
- Mostly 1- charge, though others possible
- 7 valence e^-
- Very reactive

Fluorine	yellow gas
Chlorine	green gas
Bromine	volatile brown liquid
Iodine	volatile purple solid

Noble Gases – Group 18



- Also known as "inert gases" because they do not react (except Xe in rare cases)
- Zero charge
- 8 valence e^-
- Monatomic

Objectives

- Now you must be able to…
  - Define and explain periodicity (or the periodic law)
  - Identify and explain similarities within groups and periods.

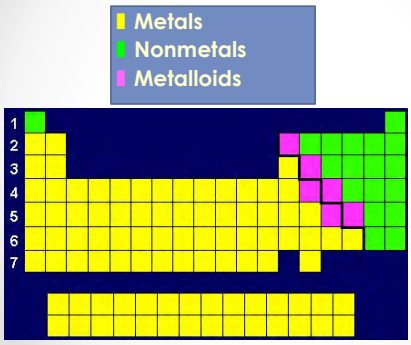
Metals, Nonmetals, and Metalloids

Video 6.2

Objectives

- By the end of the video you should be able to…
  - Identify and explain properties of metals, metalloids, and nonmetals.
  - Explain the octet rule.

Periodic Table & Properties of Elements



Know This!

Metals

•On the left side of the periodic table
•Great conductors of electricity and heat
•Ductile (wire)
•Malleable (moldable)
•Lusterous (shiny)
•Solids (except Hg)
•Lose e- when bonding

Non-metals

- On the right side of the periodic table
- Not conductors of electricity and heat
- Brittle
- Dull
- Mostly gases (Br is a liquid)
- Tend to gain e- when bonding

Metalloids

- Metalloids have properties of both metals and nonmetals such, as poor conductors, may be shiny, etc.
- Metalloids are in the middle of the periodic table and only include these elements on the staircase:

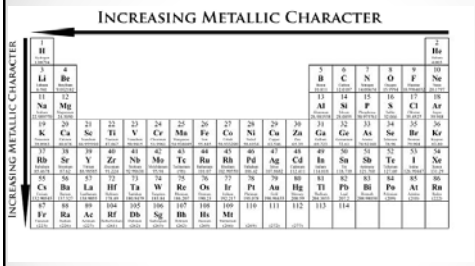
  B, Si, Ge, As, Sb & Te

  <u>Al Po At</u> are metals!!

Using the Periodic Table

- Which is the most metallic element?
- Which is the most nonmetallic element?
- Which is the most *reactive* nonmetallic element?

Metallic Trends

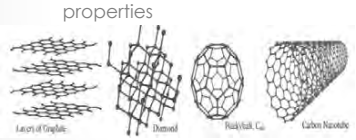


Octet Rule

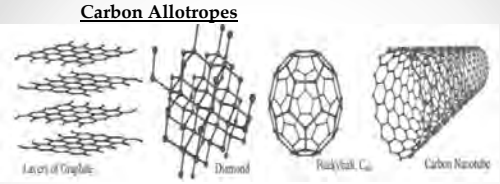
- Atoms will gain or lose electrons in order to form a stable noble gas configuration with 8 electrons in the valence shell
- Hydrogen, Lithium, Beryllium and boron can have 2 valence electrons like helium
- Metals tend to have 1-3 valence so metals will lose electrons to complete an octet.
- Nonmetals tend to have 5-7 valence so nonmetals will gain electrons to complete an octet.

Allotropes

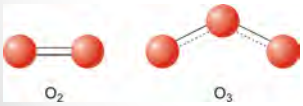
- One or more forms of an elementary substance
  - Graphite and Diamond are allotropes
    - Both made of carbon atoms
    - Arranged differently
    - Have different chemical and physical properties



Carbon Allotropes



Oxygen Allotropes



Phosphorus is also an allotrope as it can be found in a number of different colors

Objectives

- Now you must be able to…
  - Identify and explain properties of metals, metalloids, and nonmetals.
  - Explain the octet rule.

Atomic Radius

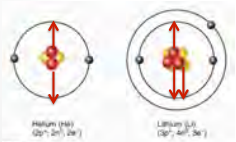
Video 6.3

Objectives

- By the end of the video you should be able to…
  - Explain the trends associated with atomic radius within groups and periods.
  - Compare atomic and ionic radii of atoms and ions.

Atomic Radius Groups

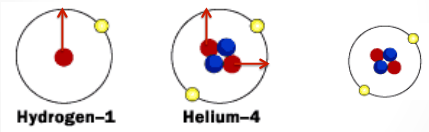
- The size of the atom in the ground state.
  - Down a group, the radius increases due to more energy levels. The protons cannot pull on the outer electrons as much as the kernel(inner) electrons.



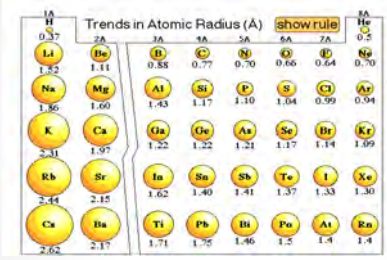
As you pack on layers, the drawing as well as the atom gets larger!

Atomic Radius - Periods

- Across a period, the radius decreases due to a higher nuclear charge pulling the electrons in tighter.



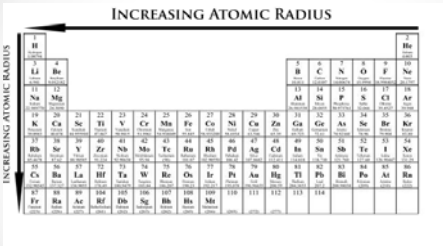
Atomic Radius



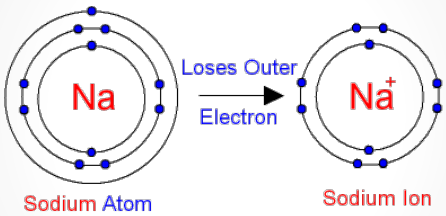
Atomic Radius – Using Table S

- Which element has the largest radius?
  - H
  - Fr
- Which element has the smallest radius?
  - Na
  - Ar

Atomic Radius

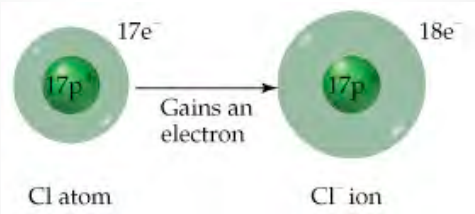


Ionic Radius



When losing an electron, sometimes a whole shell is lost, making the ion smaller than the atom.
CATIONS ARE ALWAYS SMALL!

Ionic Radius



When gaining an electron, electrons repel each other making the ion bigger than the atom.
ANIONS ARE ALWAYS BIG!

Ionic Radius

- When atoms gain electrons, the size increases.
- When the atom loses electrons, the size decreases.

Objectives

- Now you must be able to…
  - Explain the trends associated with atomic radius within groups and periods.
  - Compare atomic and ionic radii of atoms and ions.

Ionization Energy

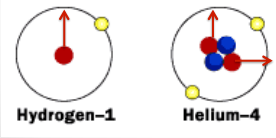
Video 6.4

Objectives

- By the end of the video you should be able to…
  - Explain the trends associated with ionization energy within groups and periods.
  - Compare ionization energies of atoms and ions.

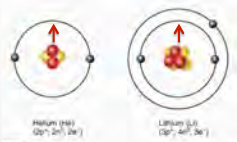
Ionization Energy

- The energy needed to remove an electron from the valence shell of an atom.
  - Across a period, IE increases because electrons are more tightly bound to a stronger nuclear charge (more protons pulling on the electrons so they can't escape).



Ionization Energy

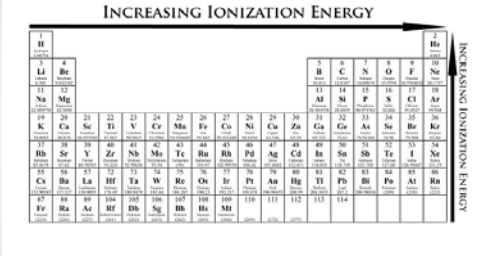
- Down a group, IE decreases because electrons are less bound due to more principle energy levels (protons can't pull as well since they are far away).
- SMALLER ATOMS WITH MANY PROTONS NEED MORE ENERGY TO LOSE AN ELECTRON!



Examples Using Table S

- Which element has the highest IE?
  - F
  - I
- Which element has the lowest IE?
  - K
  - Br
- What do you think the second and third IE means?

Ionization Energy



Objectives

- Now you must be able to…
  - Explain the trends associated with ionization energy within groups and periods.
  - Compare ionization energies of atoms and ions.

Electronegativity

Video 6.4

Objectives

- By the end of the video you should be able to…
  - Explain the trends associated with electronegativity within groups and periods.
  - Compare electronegativity values of atoms and ions.

Electronegativity

- Ability of an atom to attract electrons.
  - Across a period, electronegativity increases due to stronger nuclear charge (more protons pulling).

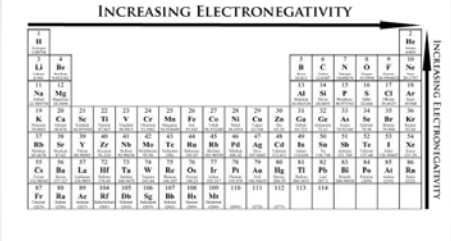
Electronegativity

- Down a group, electronegativity decreases due to more principle energy levels, it is harder for protons to pull on outer electrons.
- SMALLER ATOMS WITH MORE PROTONS PULL IN ELECTRONS THE BEST!
- These values range from 0-4 and are not energy values.
- Notice the trend and explanations are similar to IE.

Examples

- Which element has the highest e-negativity?
  - F
  - I
- Which element has the lowest e-negativity?
  - K
  - Br
- Do noble gases have e-negativity values? Why?

Electronegativity



This Unit is Awesome!

- Many answers are on Table S so just look them up!
- What do you need to study?
  - Names and properties of groups
  - Properties of periods
  - Properties of metals, nonmetals, and metalloids
  - What is nuclear charge and how it affects size, IE and electronegativity

Objectives

- Now you must be able to…
  - Explain the trends associated with electronegativity within groups and periods.
  - Compare electronegativity values of atoms and ions.

Sketch Notes

Sketch Notes

Periodic Table Coloring Activity

You have been given a black and white periodic table that needs some color according to the following directions.

You may use any colors you like unless specified. Like the diagrams in your book, make a color key so your periodic table may be accurately read. Some boxes may be shaded multiple colors – just make sure you can see them all! Have fun and make them pretty. You don't want to stare at an ugly periodic table ☺

1. **State of Matter at Room Temperature (solid, liquid, or gas)**
   - There are two elements that are liquid at room temperature: Hg and Br. Using a blue marker **outline** the symbols.
   - 11 elements exist as gases at room temperature. **Outline** their symbols using a red marker. H, He, N, O, F, Ne Cl, Ar, Kr, Xe, Rn
   - The remaining elements are solid at room temperature – leave those alone.

2. **Metalloids**
   - Choose any color of a color pencil or crayon and shade in the following elements: B, Si, Ge, As, Sb, and Te**.** These elements are called metalloids and exhibit both metallic and nonmetallic properties.

3. **Metals vs. Nonmetals**
   - With a dark marker add the "stair step" pattern that starts under Boron and extends down to Po and At (Al & Po are metals!). This is the division line between metals and nonmetals.
   - Choose a colored pencil of any color and shade the area where nonmetals are found (don't forget about Hydrogen!) to the right of the staircase.
   - Choose a different colored pencil and shade the area in the periodic table where the metals are found, to the left of the staircase (dont forget the bottom two rows).

The Periodic Table

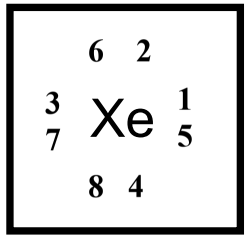
Color Key

1 **H** Hydrogen 1.00794																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

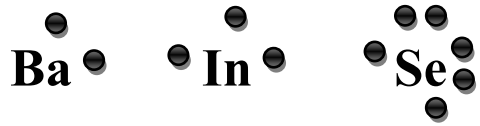
58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

Lewis Structures Name:

- Lewis structures, or dot diagrams, are a simplified way to show how the valence electrons are arranged in the outer shell. This is where the chemical reactions take place. Atoms will either share or give away these electrons to form bonds.
- Using your periodic table, determine the number of valence electrons for each element.
- Draw a dot to represent each valence electron around the element symbol.
- Follow the pattern below starting with position number 1.



Examples:



H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca						

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Activity: Color Coding the Periodic Table

The Periodic Table is a list of all the known elements. It is organized by increasing atomic number. There are two main groups on the periodic table: metals and nonmetals. The left side of the table contains elements with the greatest metallic properties. As you move from the left to the right, the elements become less metallic with the far right side of the table consisting of nonmetals. A small group of elements, whose members touch the zigzag line, are called metalloids because they have both metallic and nonmetallic properties. Identify the zig zag line and make it more bold using a black crayon.

The table is also arranged in vertical columns called "groups" or "families" and horizontal rows called "periods." Each arrangement is significant. The elements in each vertical column or group have similar properties. There are a number of major groups with similar properties. They are as follows:

Hydrogen: This element does not match the properties of any other group so it stands alone. It is placed above group 1 but it is not part of that group. It is a very reactive, colorless, odorless gas at room temperature. (1 outer level electron) Outline Hydrogen in red.

Group 1: Alkali Metals – These metals are extremely reactive and are never found in nature in their pure form. They are silver colored and shiny. Their density is extremely low so that they are soft enough to be cut with a knife. (1 outer level electron) Color the alkali metals in red.

Group 2: Alkaline-earth Metals – Slightly less reactive than alkali metals. They are silver colored and more dense than alkali metals. (2 outer level electrons) Color the alkaline earth metals in orange.

Groups 3 – 12: Transition Metals – These metals have a moderate range of reactivity and a wide range of properties. In general, they are shiny and good conductors of heat and electricity. They also have higher densities and melting points than groups 1 & 2. (1 or 2 outer level electrons) Color the transition metals in pink.

Lanthanides and Actinides: These are also transition metals that were taken out and placed at the bottom of the table so the table wouldn't be so wide. The elements in each of these two periods share many properties. The lanthanides are shiny and reactive. The actinides are all radioactive and are therefore unstable. Elements 95 through 103 do not exist in nature but have been manufactured in the lab. Color the lanthanides and actinides brown.

Group 13: Boron Group – Contains one metalloid and 4 metals. Reactive. Aluminum is in this group. It is also the most abundant metal in the earth's crust. (3 outer level electrons) Color group 13 yellow.

Group 14: Carbon Group – Contains on nonmetal, two metalloids, and two metals. Varied reactivity. (4 outer level electrons) Color group 14 light green.

Group 15: Nitrogen Group – Contains two nonmetals, two metalloids, and one metal. Varied reactivity. (5 outer level electrons) Color group 15 dark green.

Group 16: Oxygen Group – Contains three nonmetals, one metalloid, and one metal. Reactive group. (6 outer level electrons) Color group 16 light blue.

Group 17: Halogens – All nonmetals. Very reactive. Poor conductors of heat and electricity. Tend to form salts with metals. Ex. NaCl: sodium chloride also known as "table salt". (7 outer level electrons) Color group 17 dark blue.

Group 18: Noble Gases – Unreactive nonmetals. All are colorless, odorless gases at room temperature. All found in earth's atmosphere in small amounts. (8 outer level electrons) Color group 18 Purple.

Analysis:

1. The vertical columns on the periodic table are called _____.
2. The horizontal rows on the periodic table are called _____.
3. Most of the elements in the periodic table are classified as _____.
4. The elements that touch the zigzag line are classified as _____.
5. The elements in the far upper right corner are classified as_____.
6. Elements in the first group have one outer shell electron and are extremely reactive. They are called

7. Elements in the second group have 2 outer shell electrons and are also very reactive. They are called

8. Elements in groups 3 through 12 have many useful properties and are called _____.
9. Elements in group 17 are known as "salt formers". They are called _____.
10. Elements in group 18 are very unreactive. They are said to be "inert". We call these the _____.
11. The elements at the bottom of the table were pulled out to keep the table from becoming too long. The first period at the bottom called the _____.
12. The second period at the bottom of the table is called the _____.

Periodic Table of the Elements

KEY

Atomic Mass → 12.011
Symbol → C
Atomic Number → 6
Electron Configuration → 2-4
← Selected Oxidation States: –4, +2, +4

Relative atomic masses are based on $^{12}C = 12$ (exact)

Note: Numbers in parentheses are mass numbers of the most stable or common isotope.

Period	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	1.00794 +1 −1 **H** 1 1																	4.00260 0 **He** 2 2
2	6.941 +1 **Li** 3 2-1	9.01218 +2 **Be** 4 2-2											10.81 +3 **B** 5 2-3	12.011 −4 +2 +4 **C** 6 2-4	14.0067 −3 −2 −1 +1 +2 +3 +4 +5 **N** 7 2-5	15.9994 −2 **O** 8 2-6	18.9984 −1 **F** 9 2-7	20.180 0 **Ne** 10 2-8
3	22.98977 +1 **Na** 11 2-8-1	24.305 +2 **Mg** 12 2-8-2											26.98154 +3 **Al** 13 2-8-3	28.0855 −4 +2 +4 **Si** 14 2-8-4	30.97376 −3 +3 +5 **P** 15 2-8-5	32.065 −2 +4 +6 **S** 16 2-8-6	35.453 −1 +1 +5 +7 **Cl** 17 2-8-7	39.948 0 **Ar** 18 2-8-8
4	39.0983 +1 **K** 19 2-8-8-1	40.08 +2 **Ca** 20 2-8-8-2	44.9559 +3 **Sc** 21 2-8-9-2	47.867 +2 +3 +4 **Ti** 22 2-8-10-2	50.9415 +2 +3 +4 +5 **V** 23 2-8-11-2	51.996 +2 +3 +6 **Cr** 24 2-8-13-1	54.9380 +2 +3 +4 +7 **Mn** 25 2-8-13-2	55.845 +2 +3 **Fe** 26 2-8-14-2	58.9332 +2 +3 **Co** 27 2-8-15-2	58.693 +2 +3 **Ni** 28 2-8-16-2	63.546 +1 +2 **Cu** 29 2-8-18-1	65.409 +2 **Zn** 30 2-8-18-2	69.723 +3 **Ga** 31 2-8-18-3	72.64 +2 +4 **Ge** 32 2-8-18-4	74.9216 −3 +3 +5 **As** 33 2-8-18-5	78.96 −2 +4 +6 **Se** 34 2-8-18-6	79.904 −1 +1 +5 **Br** 35 2-8-18-7	83.798 0 +2 **Kr** 36 2-8-18-8
5	85.4678 +1 **Rb** 37 2-8-18-8-1	87.62 +2 **Sr** 38 2-8-18-8-2	88.9059 +3 **Y** 39 2-8-18-9-2	91.224 +4 **Zr** 40 2-8-18-10-2	92.9064 +3 +5 **Nb** 41 2-8-18-12-1	95.94 +6 **Mo** 42 2-8-18-13-1	(98) +4 +6 +7 **Tc** 43 2-8-18-13-2	101.07 +3 **Ru** 44 2-8-18-15-1	102.906 +3 **Rh** 45 2-8-18-16-1	106.42 +2 +4 **Pd** 46 2-8-18-18	107.868 +1 **Ag** 47 2-8-18-18-1	112.41 +2 **Cd** 48 2-8-18-18-2	114.818 +3 **In** 49 2-8-18-18-3	118.71 +2 +4 **Sn** 50 2-8-18-18-4	121.760 −3 +3 +5 **Sb** 51 2-8-18-18-5	127.60 −2 +4 +6 **Te** 52 2-8-18-18-6	126.904 −1 +1 +5 +7 **I** 53 2-8-18-18-7	131.29 0 +2 +4 +6 **Xe** 54 2-8-18-18-8
6	132.905 +1 **Cs** 55 2-8-18-18-8-1	137.33 +2 **Ba** 56 2-8-18-18-8-2	138.9055 +3 **La** 57 2-8-18-18-9-2	178.49 +4 **Hf** 72 *18-32-10-2	180.948 +5 **Ta** 73 -18-32-11-2	183.84 +6 **W** 74 -18-32-12-2	186.207 +4 +6 +7 **Re** 75 -18-32-13-2	190.23 +3 +4 **Os** 76 -18-32-14-2	192.217 +3 +4 **Ir** 77 -18-32-15-2	195.08 +2 +4 **Pt** 78 -18-32-17-1	196.967 +1 +3 **Au** 79 -18-32-18-1	200.59 +1 +2 **Hg** 80 -18-32-18-2	204.383 +1 +3 **Tl** 81 -18-32-18-3	207.2 +2 +4 **Pb** 82 -18-32-18-4	208.980 +3 +5 **Bi** 83 -18-32-18-5	(209) +2 +4 **Po** 84 -18-32-18-6	(210) **At** 85 -18-32-18-7	(222) 0 **Rn** 86 -18-32-18-8
7	(223) +1 **Fr** 87 -18-32-18-8-1	(226) +2 **Ra** 88 -18-32-18-8-2	(227) +3 **Ac** 89 -18-32-18-9-2	(261) +4 **Rf** 104	(262) **Db** 105	(266) **Sg** 106	(272) **Bh** 107	(277) **Hs** 108	(276) **Mt** 109	(281) **Ds** 110	(280) **Rg** 111	(285) **Cn** 112	(284) **Uut** 113**	(289) **Uuq** 114	(288) **Uup** 115	(292) **Uuh** 116	(?) **Uus** 117	(294) **Uuo** 118

140.116 +3 +4 **Ce** 58	140.908 +3 **Pr** 59	144.24 +3 **Nd** 60	(145) +3 **Pm** 61	150.36 +2 +3 **Sm** 62	151.964 +2 +3 **Eu** 63	157.25 +3 **Gd** 64	158.925 +3 **Tb** 65	162.500 +3 **Dy** 66	164.930 +3 **Ho** 67	167.259 +3 **Er** 68	168.934 +3 **Tm** 69	173.04 +2 +3 **Yb** 70	174.9668 +3 **Lu** 71
232.038 +4 **Th** 90	231.036 +4 +5 **Pa** 91	238.029 +3 +4 +5 +6 **U** 92	(237) +3 +4 +5 +6 **Np** 93	(244) +3 +4 +5 +6 **Pu** 94	(243) +3 +4 +5 +6 **Am** 95	(247) +3 **Cm** 96	(247) +3 +4 **Bk** 97	(251) +3 **Cf** 98	(252) +3 **Es** 99	(257) +3 **Fm** 100	(258) +2 +3 **Md** 101	(259) +2 +3 **No** 102	(262) +3 **Lr** 103

*denotes the presence of (2-8-) for elements 72 and above

**The systematic names and symbols for elements of atomic numbers 113 and above will be used until the approval of trivial names by IUPAC.

Source: *CRC Handbook of Chemistry and Physics*, 91st ed., 2010–2011, CRC Press

Periods and Groups Introduction

Look at the periodic table of elements.

1. Periods represent the (vertical/horizontal) rows on the table.
2. Draw Bohr diagrams for Carbon-12, Boron-11 and Oxygen-16, all in period 2.

3. Elements in the same period have the same number of _____.
4. Groups represent the (vertical/horizontal) columns on the table.
5. Draw Bohr diagrams for Lithium-7, Sodium-23, and Potassium-39, all in group 1.

6. Elements in the same group have the same number of _____.

RULES: Group 1 are known as Alkali Metals. Group 2 are Alkaline earth metals. Groups 3-12 are Transition metals. Group 17 are Halogens. Group 18 are Noble gases. All other groups do not have names.

Name	Symbol	Period	# Energy Levels	Group	# Valence Electrons	Group Name	Lewis Diagram
Sodium							
	S						
	Ne						
		1				Noble Gases	
		2		2			
		2				Alkali Metals	
			4	1			
			4		7		
			4			Alkaline Earth Metals	
		2				Halogens	
			3		8		

Periods and Groups Summary

Look at the periodic table of elements.

1. How many periods are on the periodic table of elements?
2. Write out electron configurations for any three elements in period 3.
3. What do elements in the same period have in common?
4. How many groups are on the periodic table of elements?
5. Write out Lewis dot diagrams for any three elements in group 18.
6. Write out the most probable charges of elements in group:
   a. One___ b. Two___ c. Seventeen____ d. Eighteen___
7. What do elements in the same group have in common?
8. Do elements in the same period have more or less in common than elements in the same group?

Metals, Nonmetals, and Metalloids Introduction

1. Draw the Bohr diagrams for Neon-20 and Helium-4 and explain why they do not bond:

_____
_____
_____
_____
_____
_____

2. Draw the Bohr diagrams for Sodium-23 and Calcium-40 and explain why **metals lose electrons**:

_____
_____
_____
_____
_____
_____

3. Draw the Bohr diagrams for Fluorine-19 and Sulfur-32 and explain why **nonmetals gain electrons**:

_____
_____
_____
_____
_____
_____

4. Draw the Bohr diagrams for Silicon-28 and germanium-73 and explain why they are **metalloids**:

_____
_____
_____
_____
_____
_____

1. Put a check in each box that correctly describes the element given.

	Metal	Metalloid	Nonmetal	Alkali Metal	Alkaline Earth Metal	Transition metal	Halogen	Noble gas	Monatomic	Diatomic
Sb										
Sr										
Rn										
P										
Pt										
Cs										
S										
Fe										
Br										
Ar										
H										
Si										
B										
F										
He										
Se										
Zn										
Ra										

2. Write in the space, “alkali metals”, “alkaline earth metals”, “transition metals”, “halogens”, or “noble gases” to indicate which group each statement is describing.

a.		Colored solutions
b.		Full valence shell
c.		Most active metals
d.		Most active nonmetals
e.		Monatomic gases
f.		Diatomic elements
g.		Stable and unreactive
h.		7 valence electrons
i.		2 valence electrons
j.		Form ions with a +1 charge

Name:

D	R	.		S	H	A	N	Z	Er
Dilithium	Reardon			Sulphur	Hydrogen	Adamantium	Nitrogen	Zanium	Erbium

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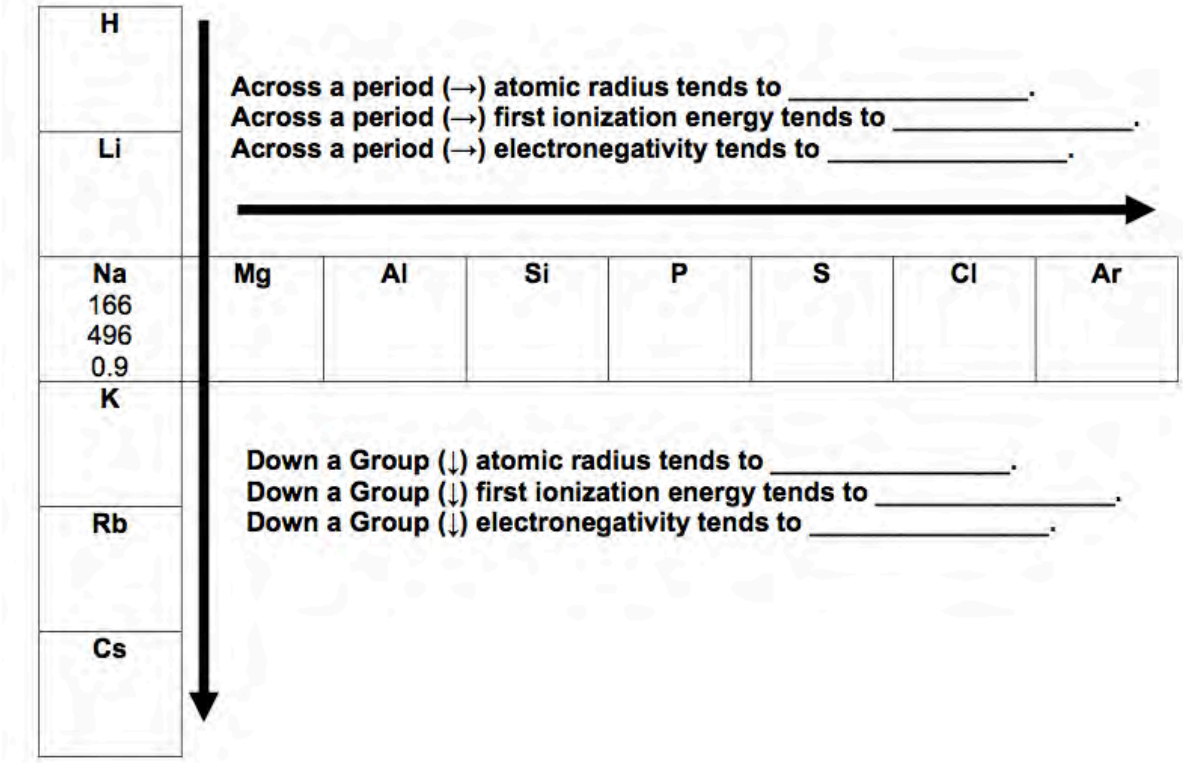
Periodic Trends Summary

Directions: Write "increases" or "decreases" on the line.



Periodic Table –Summary Sheet

1. Elements originally arranged horizontally according to increasing **atomic mass** (Dmitri Mendeleev), however there were some inconsistencies.

2. Moseley performed experiments on elements using x-rays and found a consistent pattern when observing protons. This resulted in organizing the periodic table based on increasing **atomic number**, the current periodic table**.**

3. **Period** (rows) – period number indicates how many energy levels for all elements in that period.

4. **Group** (columns) – last number of group number indicates how many valence electrons all elements in that group have. All elements in the same group have similar chemical properties because they have the same number of valence electrons → ***FOR GROUPS 1,2, 13-18.***

5. **Metalloids** – B, Si, Ge, As, Sb, Te. Properties of metals & nonmetals, known as semimetals or semiconductors. Located on the STAIRCASE.

6. **Metals** – All elements to the left of the staircase, *EXCEPT HYDROGEN*. ***Properties*** Good conductors of heat and electricity, malleable and have luster.
   a. **Transition metals** – groups 3-12, form colored solutions (aq)

7. **Nonmetals** – All elements to the right of the staircase, *INCLUDING HYDROGEN*. ***Properties*** Poor conductors of heat and electricity, brittle, lack luster (dull).

8. **Trends**
   a. ACROSS THE PERIOD L→R
      i. **Atomic Radius** (decreases)– distance from the center of the nucleus to the edge of outermost shell

      ii. **Ionic Radius** (decreases) – distance from the center of the nucleus to the edge of outermost shell
         1. **Metals** – form + ions, lose electron(s) therefore the ionic radius for a metal is smaller than it's atom
         2. **Nonmetals** – form – ions, gain electron(s) therefore the ionic radius for a nonmetal is larger than it's atom

      iii. **Electronegativity** (increases) – an atom's attraction for another atom's bonding electrons. Measured on a scale of 0–4, where 4 is the strongest. Fluorine most electronegative element on the periodic table.

      iv. **Ionization Energy** (increases) – the energy required to remove the outermost electron(s) from an atom.
   b. DOWN THE GROUP TOP→BOTTOM
      Opposite what happens across the periods.
9. **Phases**
   a. *Liquids* – Br,Hg
   b. *Gases* – H, N, O, F, Cl and Noble Gases (group 18)
   c. *Solids* – EVERYTHING ELSE

Grp 1 Alkali Metals
Grp 2 Alkali Earth Metals
Grp 17 Halogens
Grp 18 Noble Gases

Br I N Cl H O F
7 up to hydrogen } All the diatomic elements

Trends Review

1. Write in the space, “metals”, “metalloids”, or “nonmetals” to indicate which type of element.

a.		Located on the left side of the P.T.
b.		Located on the right side of the P.T.
c.		Solids are brittle
d.		Majority of the elements
e.		Gain electrons to form negative ions
f.		Located along the “staircase”
g.		Have luster
h.		Malleable
i.		Lose electrons to form positive ions
j.		Ductile
k.		Excellent conductors of heat & electricity
l.		Poor electrical & heat conductors
m.		Low electronegativity values
n.		Low ionization energy
o.		High ionization energy
p.		High electronegativity values
q.		Ions are larger than their atoms
r.		Ions are smaller than their atoms

2. Use Table S to fill in the names and states of each element below. Check all the boxes which describe the element.

	Name	Physical Properties					Chemical Properties					
		State at STP (s, l, or g)	Brittle	Malleable /ductile	Conductor		Ionization energy		Electro-negativity		Electrons	
					Good	Poor	Low	High	Low	High	Lose	Gain
C												
Ag												
Mg												
I												
S												
Au												
Fe												
Br												
Ar											X	X
H												
Hg												

Unit 4 Periodic Trends: Chemistry Review

THE PERIODIC LAW

The **Periodic Law** states that when elements are arranged in order of increasing atomic number, repetitious trends can be seen. **Mendeleev's** periodic table was arranged in order of increasing atomic mass. He then arranged columns in order to have elements with similar properties align in columns. The **modern** table is arranged by atomic number.

a. What subatomic particle decides the order of the modern periodic table? _____

b. Explain how Mendeleev's table is only slightly different than the modern table. _____

_____

METALS, NONMETALS, AND METALLOIDS

Metals are elements on the left side of the staircase on the periodic table. They have 1-2 valence electrons, which they tend to lose to form cations. Metals are **lustrous**, **malleable**, **ductile**, and good conductors of heat and electricity.

a. Define lustrous. _____

b. Define malleable. _____

c. Define ductile. _____

d. Circle the metal: H P Cu S

Nonmetals are elements on the right side of the staircase on the periodic table. They have 4-8 valence electrons, which they tend to gain to form anions and fill their octet. Nonmetals are dull, brittle, and poor conductors of heat and electricity.

a. Circle the nonmetal: C Mg Na Au

b. Why is hydrogen considered to be a nonmetal? _____

Metalloids are elements that touch the staircase on the periodic table. They have properties of both metals and nonmetals.

a. Most elements on the periodic table can be classified as metal, nonmetal, or metalloid?

b. Circle the metalloid: S Si Se Sr

c. Circle the element that is lustrous: Na N Rn Ne

d. Circle the element that is malleable: Mg C Ar H

e. Circle the element that is dull: S Sc Sr Sn

f. Circle the best conductor: C Cl Cu He

g. Circle the element that has properties of both metals and nonmetals: Ge Ga

GROUPS AND PERIODS

Periods are the horizontal rows on the periodic table. Elements in the same period have the same number of electron levels in the Bohr diagram.

a. Draw Bohr diagrams of Na, Si, Li and C and show how you can tell which are in the same period.

b. How many energy levels will an atom in the second period have? _____ Third period? _____

Groups (or families) are the vertical columns on the periodic table. Elements in the same group have the same number of valence electrons and often have similar properties.

a. How many valence electrons do the following atoms have?

Na: ___ Mg: ___ Al: ___ Si: ___ P: ___ S: ___ Cl: ___

b. Which two have the same number of valence electrons? Ca S Mg

Group 1 elements are the **Alkali Metals**, which have 1 valence electron and are very reactive (explode in water). Group 2 elements are the **Alkaline Earth Metals**, which have 2 valence electrons and are still very reactive (not as much as alkali). Groups 3-12 are the **Transition Metals**, which form colored compounds and solutions. Group 17 elements are the **Halogens**, which have 7 valence electrons and are the most reactive nonmetals. Group 18 are the **Noble Gases**, which have 8 valence electrons and are not reactive.

a. Why are the noble gases not reactive? _____

b. Which element may be blue in solutions? C Cu Ca Cl

c. Which element is a halogen? C Cu Ca Cl

d. Which element is an alkaline earth metal? C Cu Ca Cl

e. Which element is a noble gas? H F Cs Rn

f. Which element is the most reactive metal? H F Cs Rn

g. Which element is the most reactive nonmetal? H F Cs Rn

ATOMIC RADIUS

The **atomic radius** is the size of an atom. You can look up the atomic radius on Table S of the reference tables.

a. Record the atomic radius of: Li _____ Be _____ B _____ C _____

N _____ O _____ F _____ Ne _____

b. As you go across a period the atomic radius _____ because _____

_____

c. Record the atomic radius of: Li _____ Na _____ K _____ Rb _____ Cs _____

d. As you go down a group the atomic radius _____ because _____

_____

e. Which element is the largest? _____ The smallest? _____

ELECTRONEGATIVITY

The **electronegativity** of an atom is its ability to gain an electron. You can look up the electronegativity on Table S of the reference tables.

a. Record the electronegativity of: Li _____ Be _____ B _____ C _____

N _____ O _____ F _____ Ne _____

b. As you go across a period the electronegativity _____ because _____

_____

c. Record the electronegativity of: Li _____ Na _____ K _____ Rb _____ Cs _____

d. As you go down a group the electronegativity _____ because _____

_____

e. Why don't noble gases have electronegativity values? _____

_____

f. Which element has the highest electronegativity? _____

IONIZATION ENERGY

The last level contains **valence** electrons that can be lost or gained to form ions involved in bonding. **Cations** are positive ions that have lost electrons, therefore having more positive protons than negative electrons. **Anions** are negative ions that have gained electrons and then have fewer protons than electrons.

a. How many valence electrons does Sodium have? _____

b. How many valence electrons does fluorine have? _____

c. If an atom has 8 protons and 10 electrons, what is the charge? _____ What type of ion is it? _____

d. If an atom has 12 protons and 10 electrons, what is the charge? _____ What type of ion is it? _____

The **ionization energy** of an atom is how much energy is required to remove an electron from the valence. You can look up the ionization energies on Table S of the reference tables.

a. Record the ionization energies of: Li _____ Be _____ B _____ C _____

N _____ O _____ F _____ Ne _____

b. As you go across a period the ionization energies _____ because _____

_____

c. Record the ionization energies of: Na _____ Li _____ K _____ Rb _____ Cs _____

d. As you go down a group the ionization energies _____ because _____

_____

e. Which element has the highest ionization energy? _____ The lowest? _____

Periodic Table Review

1. Which list of elements consists of a metal, a metalloid, and a nonmetal?

   1) Li, Na, Rb 3) Sn, Si, C
   2) Cr, Mo, W 4) O, S, Te

2. The elements on the Periodic Table are arranged in order of increasing

   1) atomic mass 3) molar mass
   2) atomic number 4) oxidation number

3. Which list includes elements with the most similar chemical properties?

   1) Br, Ga, Hg 3) O, S, Se
   2) Cr, Pb, Xe 4) N, O, F

4. Compared to the atoms of nonmetals in Period 3, the atoms of metals in Period 3 have

   1) fewer valence electrons
   2) more valence electrons
   3) fewer electron shells
   4) more electron shells

5. Which element has chemical properties that are most similar to the chemical properties of sodium?

   1) beryllium 3) lithium
   2) calcium 4) magnesium

6. Which statement identifies the element arsenic?

   1) Arsenic has an atomic number of 33.
   2) Arsenic has a melting point of 84 K.
   3) An atom of arsenic in the ground state has eight valence electrons.
   4) An atom of arsenic in the ground state has a radius of 146 pm.

7. Which quantity identifies an element?

   1) atomic number
   2) mass number
   3) total number of neutrons in an atom of the element
   4) total number of valence electrons in an atom of the element

8. At STP, which element is a good conductor of electricity?

   1) chlorine 3) silver
   2) iodine 4) sulfur

9. A solid element that is malleable, a good conductor of electricity, and reacts with oxygen is classified as a

   1) metal 3) noble gas
   2) metalloid 4) nonmetal

10. Which element is a liquid at 305 K and 1.0 atmosphere?

    1) magnesium 3) gallium
    2) fluorine 4) iodine

11. Which Group 14 element is classified as a metal?

    1) carbon 3) silicon
    2) germanium 4) tin

12. An element that has a low first ionization energy and good conductivity of heat and electricity is classified as a

    1) metal 3) nonmetal
    2) metalloid 4) noble gas

13. Which two characteristics are associated with metals?

    1) low first ionization energy and low electronegativity
    2) low first ionization energy and high electronegativity
    3) high first ionization energy and low electronegativity
    4) high first ionization energy and high electronegativity

14. Which elements have the most similar chemical properties?

    1) boron and carbon
    2) oxygen and sulfur
    3) aluminum and bromine
    4) argon and silicon

15. The element sulfur is classified as a

    1) metal 3) nonmetal
    2) metalloid 4) noble gas

16. At STP, which element is solid, brittle, and a poor conductor of electricity?

    1) Al 2) K 3) Ne 4) S

17. Which element is classified as a nonmetal?

    1) Be 2) Al 3) Si 4) Cl

18. Which atom in the ground state has a stable electron configuration?

    1) carbon 3) neon
    2) magnesium 4) oxygen

19. Which element is a noble gas?

    1) krypton 3) antimony
    2) chlorine 4) manganese

20. Which Group 14 element is a metalloid?

1) tin 3) lead
2) silicon 4) carbon

21. Which element is a liquid at STP?

1) bromine 3) francium
2) cesium 4) iodine

22. Which Group 15 element exists as diatomic molecules at STP?

1) phosphorus 3) bismuth
2) nitrogen 4) arsenic

23. Which element has the greatest density at STP?

1) scandium 3) silicon
2) selenium 4) sodium

24. Which Lewis electron-dot diagram represents a nitrogen atom in the ground state?

1) 
3) 
2) 
4) 

25. Which Lewis electron-dot diagram represents an atom in the ground state for a Group 13 element?

1) 
3) 
2) 
4) 

26. Which Lewis electron-dot diagram represents a boron atom in the ground state?

1)  2)  3)  4) 

27. The elements in Group 2 have similar chemical properties because each atom of these elements has the same

1) atomic number
2) mass number
3) number of electron shells
4) number of valence electrons

28. Which set of properties is most characteristic of transition elements?

1) colorless ions in solution, multiple positive oxidation states
2) colorless ions in solution, multiple negative oxidation states
3) colored ions in solution, multiple positive oxidation states
4) colored ions in solution, multiple negative oxidation states

29. Which atom has the largest atomic radius?

1) potassium 3) francium
2) rubidium 4) cesium

30. Which ion has the *smallest* radius?

1) O^{2-} 3) Se^{2-}
2) S^{2-} 4) Te^{2-}

31. As the elements is Period 3 are considered in order of increasing atomic number, there is a general *decrease* in

1) atomic mass
2) atomic radius
3) electronegativity
4) first ionization energy

32. Which characteristics both generally *decrease* when the elements in Period 3 on the Periodic Table are considered in order from left to right?

1) nonmetallic properties and atomic radius
2) nonmetallic properties and ionization energy
3) metallic properties and atomic radius
4) metallic properties and ionization energy

33. An ion of which element has a larger radius than an atom of the same element?

1) aluminum 3) magnesium
2) chlorine 4) sodium

34. Which of the following ions has the *smallest* radius?

1) F^- 2) Cl^- 3) K^+ 4) Ca^{2+}

35. Which general trends in first ionization energy and electronegativity values are demonstrated by Group 15 elements as they are considered in order from top to bottom?

1) The first ionization energy decreases and the electronegativity decreases.
2) The first ionization energy increases and the electronegativity increases.
3) The first ionization energy decreases and the electronegativity increases.
4) The first ionization energy increases and the electronegativity decreases.

36. Which element has atoms with the strongest attraction for electrons in a chemical bond?

1) chlorine 3) fluorine
2) nitrogen 4) oxygen

37. Which atom has the *weakest* attraction for electrons in a chemical bond?

1) a boron atom 3) a fluorine atom
2) a calcium atom 4) a nitrogen atom

38. Which general trend is demonstrated by the Group 17 elements as they are considered in order from top to bottom on the Periodic Table?

1) a decrease in atomic radius
2) a decrease in electronegativity
3) an increase in first ionization energy
4) an increase in nonmetallic behavior

39. Which atom in the ground state requires the *least amount of energy to remove its valence electron?*

1) lithium atom
2) potassium atom
3) rubidium atom
4) sodium atom

40. In the ground state, each atom of an element has two valence electrons. This element has a lower first ionization energy than calcium. Where is this element located on the Periodic Table?

1) Group 1, Period 4
2) Group 2, Period 5
3) Group 2, Period 3
4) Group 3, Period4

41. Sodium atoms, potassium atoms, and cesium atoms have the same

1) atomic radius
2) first ionization energy
3) total number of protons
4) oxidation state

Base your answers to questions **42** through **44** on the information below and on your knowledge of chemistry.

There are six elements in Group 14 on the Periodic Table. One of these elements has the symbol Uuq, which is a temporary, systematic symbol. This element is now known as flerovium.

42. State the expected number of valence electrons in an atom of the element flerovium in the ground state.

43. Explain, in terms of electron shells, why each successive element in Group 14 has a larger atomic radius, as the elements are considered in order of increasing atomic number.

44. Identify an element in Group 14 that is classified as a metalloid.

Base your answers to questions **45** through **48** on the information below and on your knowledge of chemistry.

Before atomic numbers were known, Mendeleev developed a classification system for the 63 elements known in 1872, using oxide formulas and atomic masses. He used an R in the oxide formulas to represent any element in each group. The atomic mass was listed in parentheses after the symbol of each element. A modified version of Mendeleev's classification system is shown in the table below.

Modified Version of Mendeleev's Table

Group →		I	II	III	IV	V	VI	VII
Oxide formulas		R_2O	RO	R_2O_3	RO_2	R_2O_5	RO_3	R_2O_7
Series	1	H(1)						
	2	Li(7)	Be(9.4)	B(11)	C(12)	N(14)	O(16)	F(19)
	3	Na(23)	Mg(24)	Al(27.3)	Si(28)	P(31)	S(32)	Cl(35.5)
	4	K(39)	Ca(40)		Ti(48)	V(51)	Cr(52)	Mn(55)
	5	Cu(63)	Zn(65)			As(75)	Se(78)	Br(80)
	6	Rb(85)	Sr(87)	Yt(88)	Zr(90)	Nb(94)	Mo(96)	
	7	Ag(108)	Cd(112)	In(113)	Sn(118)	Sb(122)	Te(125)	I(127)
	8	Cs(133)	Ba(137)	Di(138)	Ce(140)			

45. Explain , in terms of chemical reactivity, why the elements in Group 18 on the modern Periodic Table were *not* identified by Mendeleev at that time.

46. Based on Table *J*, identify the *least* active metal listed in Group I on Mendeleev's table.

47. Based on Mendeleev's oxide formula, what is the number of electrons lost by each atom of the elements in Group III?

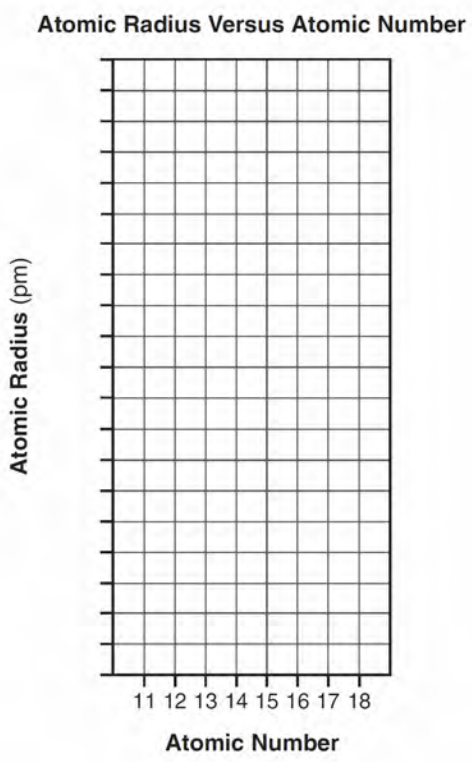
48. Identify *one* characteristic used by Mendeleev to develop his classification system of the elements.

Base your answers to questions **49** and **50** on the information below.

The atomic number and corresponding atomic radius of the Period 3 elements are shown in the data table below.

Data Table

Atomic Number	Atomic Radius (pm)
11	160.
12	140.
13	124
14	114
15	109
16	104
17	100.
18	101



49. Explain, in terms of electrons, the change in radius when a sodium atom becomes a sodium ion.

50. State the general relationship between the atomic number and the atomic radius for the Period 3 elements.

51. Draw a Lewis electron-dot diagram for an atom of silicon.

Base your answers to questions **52** through **54** on the information below.

The atomic radius and the ionic radius for some Group 1 and some Group 17 elements are given in the tables below.

Atomic and Ionic Radii of Some Elements

Group 1

Particle	Radius (pm)
Li atom	130.
Li^+ ion	78
Na atom	160.
Na^+ ion	98
K atom	200.
K^+ ion	133
Rb atom	215
Rb^+ ion	148

Group 17

Particle	Radius (pm)
F atom	60.
F^- ion	133
Cl atom	100.
Cl^- ion	181
Br atom	117
Br^- ion	?
I atom	136
I^- ion	220.

52. State the relationship between atomic number and first ionization energy as the elements in Group 1 are considered in order of increasing atomic number.

53. Explain, in terms of electron shells, why the radius of a K^+ ion is greater than the radius of an Na^+ ion.

54. Estimate the radius of a Br^- ion.

Base your answers to questions **55** through **59** on the information below.
The ionic radii of some Group 2 elements are given in the table below.

Ionic Radii of Some Group 2 Elements

Symbol	**Atomic Number**	**Ionic Radius** (pm)
Be	4	44
Mg	12	66
Ca	20	99
Ba	56	134

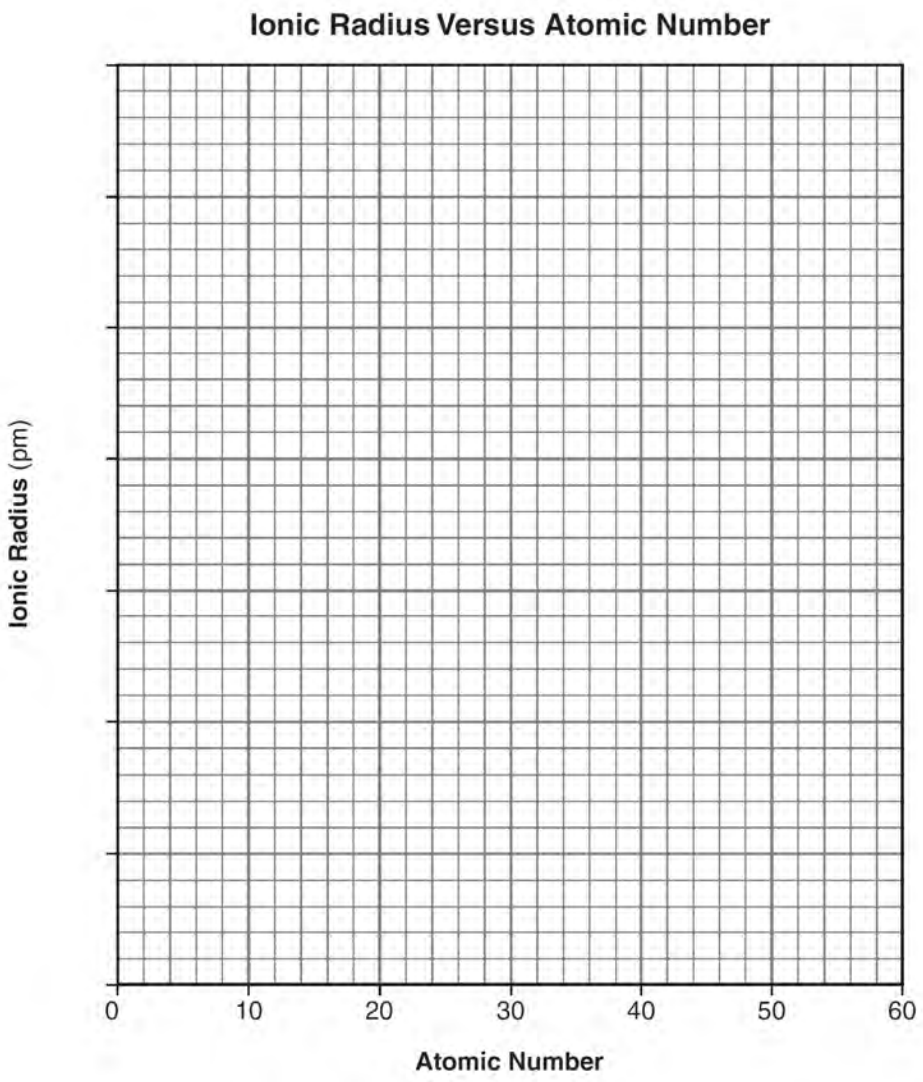
____ 55. Explain, in terms of electrons, why the ionic radius of a Group 2 element is smaller than its atomic radius.

____ 56. State the trend in ionic radius as the elements in Group 2 are considered in order of increasing atomic number.

____ 57. Estimate the ionic radius of strontium.

____ 58. On the same grid, plot the data from the data table. Circle and connect the points.

59. On the grid, mark an appropriate scale on the axis labeled "Ionic Radius (pm)."



____ 60. Base your answer to the following question on the information below.

Naturally Occurring Isotopes of Sulfur

Isotope	**Atomic Mass** (atomic mass units, u)	**Natural Abundance** (%)
^{32}S	31.97	94.93
^{33}S	32.97	0.76
^{34}S	33.97	4.29
^{36}S	35.97	0.02

In the space below, draw a Lewis electron-dot diagram for an atom of sulfur-33.