

Name: \_\_\_\_\_

## Chemistry Department Midterm Review

### A. Unit 1 Matter & Measurement

#### 1. Vocabulary Practice:

Chemical change	Gas	Physical change
Coefficient	Heterogeneous	Pure substances
Compound	Homogeneous	Qualitative
Diatomic element	Matter	Quantitative
Element	Mixtures	STP
Endothermic	Percent composition	Subscript
Exothermic	Percent error	

**MATTER**\_1. Anything that has mass and volume

**% COMP**\_2. The composition of a compound of each element compared with the total mass of the compound

**COMPOUND** 3. Substance in which the atoms exist in a fixed ratio

**CHEMICAL**4. A reaction in which the composition of a substance is changed

**DIATOMIC** 5. An element containing two identical atoms

**PHYSICAL**\_6. A change that does not alter the chemical properties of a substance

**PURE SUBSTANCE**\_7. Type of matter that includes compounds and elements only

**MIXTURE**8. Type of matter that includes homogeneous or heterogeneous substances

**QUANTITATIVE**\_9. Description of numerical information

**QUALITATIVE**10. Description of non-numerical information

**% ERROR**\_11. Actual error divided by the accepted value and multiplied by a factor of one hundred

**SUBSCRIPT**12. The number that indicates the number of atoms present

**COEFFICIENT**13. The number that indicates the number of units or molecules of that substance

**ENDOTHERMIC**14. Process in which energy is absorbed

**EXOTHERMIC**15. Process in which energy is released

**HETEROGENEOUS**16. Mixture in which the substances are not uniformly distributed

**HOMOGENEOUS**\_17. Mixture in which the substances are uniformly distributed

**STP**\_18. 1°C, 273K, 1 atm, 101.3 kPa

**ELEMENT**\_19. Form of matter which cannot be simplified or broken down any further by chemical means

**GAS**\_20. Phase of matter without definite shape or volume

2. The particles of a substance are arranged in a definite geometric pattern and are constantly vibrating. This substance can be in

- (1) **the solid phase, only**
- (2) the liquid phase, only
- (3) either the solid or the liquid phase
- (4) neither the liquid nor the solid phase

3. Use Table S to determine if these elements are in the solid, liquid, or gas state at STP. If the name is given, give the symbol, or vice versa.

Symbol	Name	State
S	<b>SULFUR</b>	<b>SOLID</b>
Na	<b>SODIUM</b>	<b>SOLID</b>
<b>Ne</b>	Neon	<b>GAS</b>
N	<b>NITROGEN</b>	<b>GAS</b>
<b>Mg</b>	Magnesium	<b>SOLID</b>

4. Iron is heated up to 2900 degrees Kelvin. Using the data on Table S, determine whether the iron is in the solid, liquid or gas state at this temperature. Explain how you know.

Iron is a liquid at 2900K because it has already surpassed (gone above) the melting point of 1808 K, which means it has gone from a solid to a liquid, but it has not yet reached the boiling point of 3023K, so it has not turned into a gas.

5. What is the difference between accuracy and precision?

Accuracy is correctness (being close to true/accepted value), while precision is consistency (getting same value each time)

6. Do the following conversions:

- a. 109.77 mL = **0.10977 L**
- b. 52.6 kg = **52600 g**
- c. 93.9 g = **93900 mg**

Use the information in the table to answer the following question:

Element	Density at STP (g/cm <sup>3</sup> )
C	3.51
Si	2.33
Ge	5.32
Sn	7.31
Pb	11.35

7. Calculate the volume of a tin block that has a mass of 95.04 grams at STP. Your response must include *both* a numerical setup, the calculated result, and proper significant figures.

$$D = \frac{m}{V} \quad 7.31 = \frac{95.04}{V} \quad 7.31V = 95.04 \quad \frac{7.31V}{7.31} = \frac{95.04}{7.31}$$

95.04 = 4 sig figs } Answer should have 3 sig figs  
 7.31 = 3 sig figs }

$$V = 13.0 \text{ cm}^3$$

8. Density is a key property because it is so useful in identifying a substance. You determine the mass of a piece of aluminum to be 55.9 grams.

- a.) Calculate the *volume* of the piece of metal that you massed. Show all work and round to the appropriate decimal value.

appropriate decimal value.

$$D = \frac{m}{V} \quad 2.698 = \frac{55.9}{V} \quad 2.698V = 55.9 \quad V = 20.7 \text{ cm}^3$$

2.698 = 4 sig figs } Answer = 3 sig figs  
 55.9 = 3 sig figs }

Look in Table S for aluminum's density

- b.) If the accepted mass value of your piece of aluminum is 56.2 grams, what is your percent error in massing? Show all work.

Table T

$$\% \text{ error} = \frac{mV - aV}{aV} \times 100 = \frac{55.9 - 56.2}{56.2} \times 100 = -0.53\%$$

\*Neg. % error is ok, it just means you were below the accepted value.

- c.) If you had 83.1 grams of aluminum, would the density increase, decrease, or remain the same. Explain.

Density would stay the same as long as it was the same substance. Density is a ratio of mass/volume and it is a direct relationship; as mass increases the volume also increases, so density is constant.

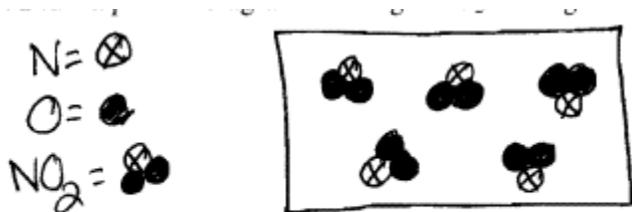
9. Is an atom the same thing as an element? Why or why not?

An atom is one single piece of matter. An element is always the same type of atoms, but it can be made by more than one of them, so no they are not the same.

10. What are the chemical symbols of the following elements?

- a. bromine **Br**                      c. potassium **K**  
b. sodium **Na**                        d. hydrogen **H**

11. Draw a particle diagram showing 5 NO<sub>2</sub> in the gas state. Include a key.



12. Which statement describes the composition of potassium chlorate, KClO<sub>3</sub>?

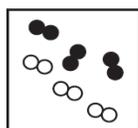
- (1) **The proportion by mass of elements combined in potassium chlorate is fixed.**  
(2) The proportion by mass of elements combined in potassium chlorate varies.  
(3) Potassium chlorate is composed of four elements.  
(4) Potassium chlorate is composed of five elements.

13. Every water molecule has two hydrogen atoms bonded to one oxygen atom. This fact supports the concept that elements in a compound are

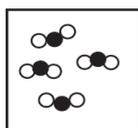
- (1) **chemically combined in a fixed proportion**  
(2) chemically combined in proportions that vary  
(3) physically mixed in a fixed proportion  
(4) physically mixed in proportions that vary

14. Which particle model diagram represents only one compound composed of elements X and Z?

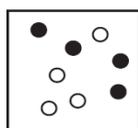
Key	
●	= atom of element X
○	= atom of element Z



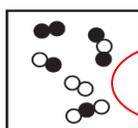
(1)



(3)



(2)



(4)

An unidentified sample is tested in a chemical laboratory. It is shown to contain the elements copper and iodine. Bart thinks the sample is a mixture of copper (Cu) and iodine (I<sub>2</sub>). Lisa thinks the sample contains the compound "copper iodide" (CuI).

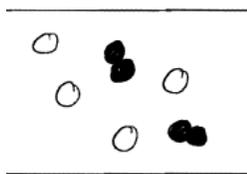
15. Draw particle diagrams of at least 6 particles in each diagram, to represent both ideas.

Use these symbols to construct the particles in your diagrams:

Iodine =  Copper = 



Lisa's idea  
(the compound CuI)



Bart's idea  
(mixture of Cu and I<sub>2</sub>)

16 How many of each type of atom are given in the following compounds? (Draw them if it helps.)

a.) Ba<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>      3 \_\_\_\_\_ Ba atoms      2 \_\_\_\_\_ P atoms      8 \_\_\_\_\_ O atoms

b.) 3 Ba<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>      9 \_\_\_\_\_ Ba atoms      6 \_\_\_\_\_ P atoms      24 \_\_\_\_\_ O atoms

17. What is the difference between CO<sub>2</sub> and 2 CO?

CO<sub>2</sub> is one molecule containing one atom of C and 2 atoms of O.  
()

2 CO is two molecules, each containing one atom of C and one atom of O.  
()

18. A compound differs from a mixture in that a compound always has a

- (1) **homogeneous composition**
- (2) maximum of two components
- (3) minimum of three components
- (4) heterogeneous composition

19. Which of these terms refers to matter that could be heterogeneous?

- (1) element
- (2) **mixture**
- (3) compound
- (4) solution

20. When sugar is dissolved in water and mixed well, the resulting solution is classified as a

- (1) **homogeneous mixture**
- (2) heterogeneous mixture
- (3) homogeneous compound
- (4) heterogeneous compound

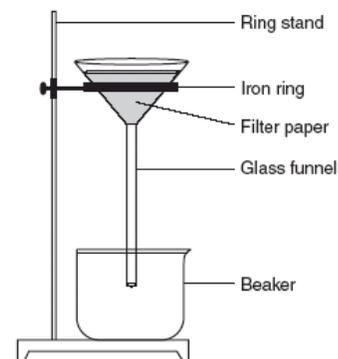
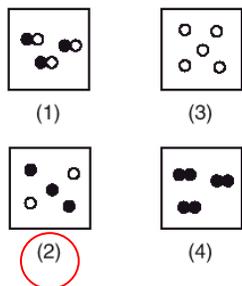
21. Which is a characteristic of all mixtures?

- (1) They are homogeneous.
- (2) They are heterogeneous.
- (3) Their composition is a definite ratio.
- (4) **Their composition can be varied.**

22. Which is true of *all* mixtures?

- (1) They are homogeneous
- (2) They are heterogeneous
- (3) They are able to be separated into their components by physical change**
- (4) They are able to be separated into their components by chemical change

23. Given: ● = particle X  
○ = particle Y Which diagram represents a mixture?



24. Which formula represents a mixture?

- (1)  $C_6H_{12}O_6(l)$
- (3)  $LiCl(aq)$**
- (2)  $C_6H_{12}O_6(s)$
- (4)  $LiCl(s)$

a. Explain how you chose your answer.

*(aq) indicates an aqueous solution, which means LiCl was dissolved in water, which is a physical change, so it forms a mixture, not a compound*

b. How would this mixture be classified?

**homogeneous**

c. How would you separate this mixture back into its components?

**Evaporation/distillation**

25. The apparatus to the right was used in lab.

a. Which type of mixture can be separated using the apparatus shown?

- 1. salt and water
- 2. oil and water
- 3. sand and water**
- 4. carbon dioxide gas and water

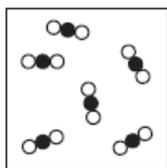
b. Describe the procedure you would use to separate the mixture you chose in part a.

*Put the sand and water mixture into the filter paper. The sand will stay on top and the water will drain through. You would have to then let the sand sit and the water evaporate to separate them completely.*

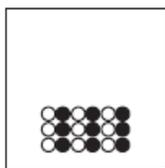
26. Which pair can be classified as pure chemical substances?

- (1) mixtures and solutions
- (2) elements and mixtures
- (3) compounds and solutions
- (4) compounds and elements**

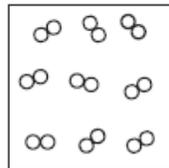
Use the diagrams below to answer questions 27 – 30:



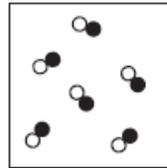
(1)



(2)



(3)



(4)

27. Which particle diagram is showing a sample where the particles are considered to be “fixed in place, vibrating”? **2= solid**

28. Why is Sample #1 considered a pure substance, even though there are two types of atoms involved?

*They are chemically combined to form just one compound.  
(Compounds are pure substances.)*

29. Which sample contains a “diatomic” element? **3** How do you know? **2 atoms same type**

30. Which sample contains a “diatomic” compound? **4** How do you know? **2 atoms different type**

31. Indicate whether the following is a **chemical change**, **physical change**, or **neither**.

     **CHEM** a) a hydrogen balloon explodes      **PHYS** c) a puddle of water evaporates  
     **PHYS** b) snow melts      **PHYS** d) sand and salt mixture are separated

32. Which substance can *not* be decomposed by a chemical change?

- (1) ammonia (3) propanol  
**(2) copper** (4) water

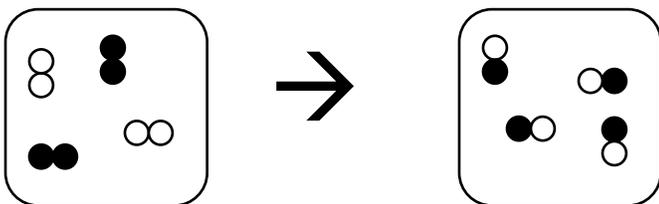
33. Which substance can be decomposed by chemical means?

- (1) aluminum (3) silicon  
 (2) octane (4) Xenon

34. Which equation represents a physical change?

- (1)  $\text{H}_2\text{O}(\text{s}) + \text{heat} \rightarrow \text{H}_2\text{O}(\text{l})$**  (3)  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) + \text{heat} \rightarrow 2\text{HI}(\text{g})$   
 (2)  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + \text{heat}$  (4)  $\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) + \text{heat} \rightarrow 2\text{NO}_2(\text{g})$

Use the diagram below to answer questions



35. Words for the change that is shown should read

- Two molecules of the element  $H_2$  and two molecules of the element  $Cl_2$  interacted physically and formed into four molecules of the compound  $HCl$ .
- Two atoms of the element  $H_2$  and two atoms of the element  $Cl_2$  interacted chemically and formed into four atoms of the compound  $HCl$ .**
- Two molecules of the compound  $H_2$  and two molecules of the compound  $Cl_2$  interacted chemically and formed into four molecules of the compound  $HCl$ .
- Two molecules of the element  $H_2$  and two molecules of the element  $Cl_2$  interacted chemically and formed into four molecules of the compound  $HCl$ .

## **B. Unit 2 Atomic Theory**

### **Vocabulary Practice:**

Alkali Metal	Electron	Metalloid	Rutherford
Alkaline Earth Metal	Group	Neutron	Thomson
Atom	Halogen	Noble Gas	Transition Metals
Atomic Mass	Ion	Nonmetal	Valence Electrons
Atomic Mass Unit (amu)	Isotope	Orbit (Shell)	Wave-Mechanical Model
Atomic Number	Mass Number	Period	
Bohr	Metal	Proton	

- alkaline earth metal** 1. An element of Group 2.
- mass number** 2. The total number of protons and neutrons in the nucleus of an atom.
- group** 3. A vertical column on the periodic table.
- atomic number** 4. The number of protons in the nucleus of an atom.
- nonmetal** 5. Element whose atoms will gain or share electrons in chemical reactions.
- isotope** 6. Atom of an element that has a specific number of protons and neutrons.
- Bohr** 7. Scientist who discovered that electrons must reside in fixed energy levels around the nucleus.
- metalloid** 8. An element that has both metallic and nonmetallic properties.
- atomic mass** 9. The weighted average mass of all naturally-occurring isotopes in a sample of an element.
- electron** 10. These negatively-charged subatomic particles can be found in a “cloud” surrounding the positive nucleus of an atom.
- period** 11. A horizontal row on the periodic table.

- alkali metal** 12. An element of Group 1.
- noble gas** 13. A non-reactive element that can be found in Group 18 on the periodic table.
- ion** 14. An atom that has either lost or gained electron(s).
- neutron** 15. A subatomic particle with no charge, that can be found in the nucleus of an atom.
- valence electron** 16. The outer electrons of an atom that can be exchanged or shared with other atoms.
- halogen** 17. An element of Group 17.
- Thomson** 18. Scientist whose use of cathode ray tubes led to the discovery of the electron.
- proton** 19. A subatomic particle with positive charge that tells the identity of an atom.
- metal** 20. Element whose atoms lose electrons in chemical reactions to become positive ions.
- transition metal** 21. Groups 3-12 on the periodic table.
- Rutherford** 22. Scientist who performed the gold foil experiment, and concluded that an atom must be composed of mostly empty space with a small, dense, positively-charged nucleus.
- orbit (shell)** 23. An electron configuration tells how many electrons belong in each \_\_\_\_\_.
- atom** 24. The smallest part of an element.
- wave-mechanical model** 25. The most current model of the atom states that electrons are found in “orbitals” – regions of most probable location.
- atomic mass unit (amu)** 26. Atoms are so small that we cannot measure their mass in grams. We must use \_\_\_\_.

1. Describe Dalton’s Atomic Model-

**Dalton theorized that the smallest piece of matter was solid, indivisible (couldn’t be broken down any further), and a sphere**

2. In the modern model of the atom, each atom is composed of three major subatomic particles.

a) Name the subatomic particles contained in the nucleus of the atom.

**Protons and Neutrons**

b) State the charge associated with each type of subatomic particle contained in the nucleus of the atom.

**Proton= +1 Neutron=0**

c) What is the net charge of the nucleus? **POSITIVE**

3 . Fill in the following table:

<b>Particle</b>	<b>Charge</b>	<b>Mass</b>	<b>Location</b>
neutron	0	1	Inside the nucleus
proton	+1	1	Inside the nucleus
electron	-1	0	Outside the nucleus

4. Give the names and chemical symbols for the elements that correspond to these atomic numbers:

a. 10

**Neon-Ne**

b. 18

**Argon-Ar**

c. 36

**Krypton-Kr**

d. 51

**Antimony-Sb**

5. What is the charge on the nucleus of...

a) a Cr atom? +24      b) a Ni atom? +28      c) a sodium atom? +11

6. The number of neutrons in the nucleus of an atom can be determined by

(1) adding the atomic number to the mass number

**(2) subtracting the atomic number from the mass number**

(3) adding the mass number to the atomic mass

(4) subtracting the mass number from the atomic number

7. Which statement best describes electrons?

(1) They are positive subatomic particles and are found in the nucleus.

(2) They are positive subatomic particles and are found surrounding the nucleus.

(3) They are negative subatomic particles and are found in the nucleus.

**(4) They are negative subatomic particles and are found surrounding the nucleus.**

8. The atomic number of an atom is always equal to the number of its

**(1) protons, only**      (2) neutrons, only      (3) protons plus neutrons      (4) protons plus electrons

9. The nucleus of an atom of K-42 contains

**(1) 19 protons and 23 neutrons**      (3) 19 protons and 42 neutrons

(2) 20 protons and 19 neutrons      (4) 23 protons and 19 neutrons

10. Which particles are found in the nucleus of an atom?

(1) electrons, only

(3) neutrons, only

(2) protons and electrons

**(4) protons and neutrons**

11. What is the total number of neutrons in an atom of an element that has a mass number of 19 and an atomic number of 9?

(1) 9

(2) 19

**(3) 10**

(4) 28

12. A neutral atom contains 12 neutrons and 11 electrons. The number of protons in this atom is

(1) 1

(2) 11

(3) 12

(4) 23

13. Which statement is true about the charges assigned to an electron and a proton?

(1) Both an electron and a proton are positive.

**(2) An electron is negative and a proton is positive.**

(3) An electron is positive and a proton is negative.

(4) Both an electron and a proton are negative.

14. What is the charge of the nucleus in an atom of oxygen-17?

(1) 0

(2) -2

**(3) +8**

(4) +17

15. Describe Rutherford's experiment (his observations) and his conclusions.

**Rutherford shot positively charged alpha particles through a piece of gold foil and found that most of the particles went straight through, so he concluded that the atom was mostly empty space. Some of the particles were deflected, so he concluded that there must be a positively charged core that they were bouncing off of.**

16. How do isotopes of the same element differ from each other?

**They have the same number of protons, which cause them to have the same atomic number, but they have different numbers of neutrons, which cause them to have a different mass.**

17. Which two notations represent different isotopes of the same element?

- (1)  ${}^6_4\text{Be}$  and  ${}^9_4\text{Be}$       (3)  ${}^{14}_7\text{N}$  and  ${}^{14}_6\text{C}$   
 (2)  ${}^7_3\text{Li}$  and  ${}^7_3\text{Li}$       (4)  ${}^{32}_{15}\text{P}$  and  ${}^{32}_{16}\text{S}$

18. State the number of valence electrons in an atom of:

a. sulfur

b. calcium

c. chlorine

d. arsenic

6

2

7

5

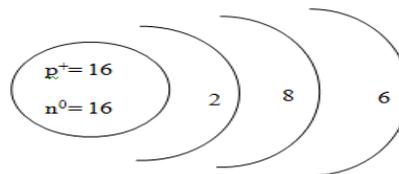
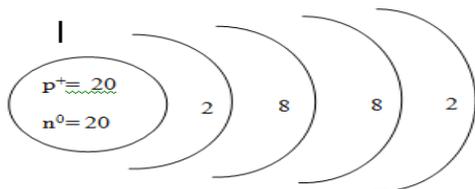
19. Draw Lewis dot structures for each of the structures in #20.



20. Draw Bohr diagrams for the following (include protons and neutrons in nucleus):

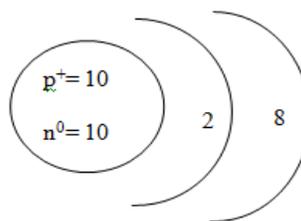
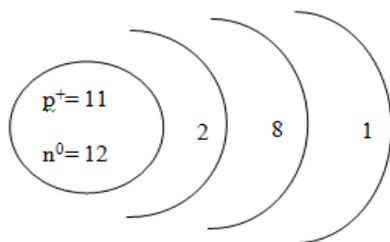
a.  ${}^{40}\text{Ca}$

b.  ${}^{32}\text{S}$

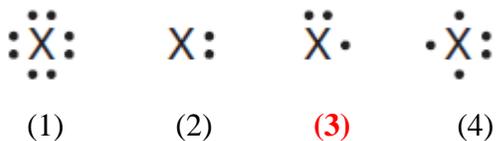


c.  ${}^{23}\text{Na}$

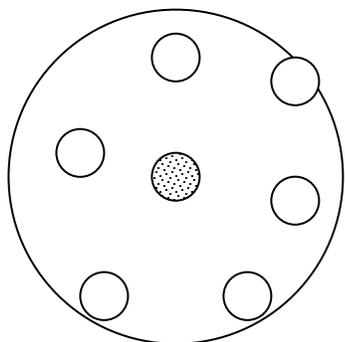
d.  ${}^{20}\text{Ne}$



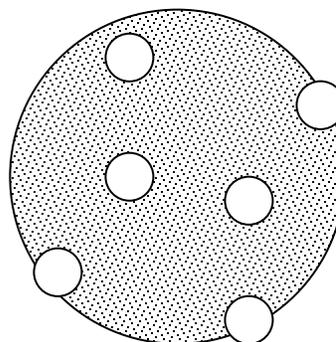
21. Which of the above in Question #22 has a stable octet? **Ne**
22. According to the wave-mechanical model of the atom, electrons in an atom
- (1) travel in defined circles
  - (2) are most likely found in an excited state
  - (3) have a positive charge
  - (4) are located in orbitals outside the nucleus**
23. An atom has seven valence electrons. This atom could be an atom of which element?
- (1) calcium
  - (2) fluorine**
  - (3) oxygen
  - (4) sodium
24. What is the total number of electrons in an atom of potassium?
- (1) 18
  - (2) 19**
  - (3) 20
  - (4) 39
- 25 Which Lewis electron-dot diagram represents an atom for a Group 13 element?



Base your answers to #26 and 27 on the diagram below.



**Rutherford**



**Thomson**

Shaded areas  represent the (+) charged area of the atom. “  “ represent electrons.

26. Label each drawing as either representing the Thomson model of the atom or the Rutherford model.

27. Match observation with conclusion. Use an arrow to connect observation with the matching conclusion.

Observation	Conclusion
CRT (cathode ray tube) device produces a stream of charged particles.	(+) charge exists in very small inner part of the atom.
The path of most alpha particles shot at gold foil was not changed	An atom has some (-) charged particles in it.
The path of a very few alpha particles were deflected (bent) as they passed thru the gold foil.	Most of the atom is made up of empty space.

### **C. Unit 3 Periodic Table of Elements- Unit 7 Vocabulary Practice:**

Alkali Metal	Electron	Isotope	Rutherford
Alkaline Earth Metal	Electronegativity	Mass Number	Thomson
Allotropes	Excited State	Metalloid	Valence Electrons
Atomic Mass	Ground State	Neutron	Wave-Mechanical Model
Atomic Number	Halogen	Noble Gas	
Bohr	Ion	Proton	
Bright-Line Spectrum	Ionization Energy	Reactivity	

alkaline earth metal. An element of Group 2.

Mass number 2. The total number of protons and neutrons in the nucleus of an atom.

Electronegativity 3. A scale ranking the desire for electrons, with nonmetals having the highest values.

Atomic Number 4. The number of protons in the nucleus of an atom.

Isotope 5. Atom of an element that has a specific number of protons and neutrons.

Bohr 6. Scientist who discovered that electrons must reside in fixed energy levels around the nucleus.

Allotropes 7. A different structural form of the same element, resulting in different properties.

Metalloid 8. An element that has both metallic and nonmetallic properties.

Atomic Mass 9. The weighted average mass of all naturally-occurring isotopes in a sample of an element.

Electron 10. These negatively-charged subatomic particles can be found in a “cloud” surrounding the positive nucleus of an atom.

Ground State 11. The state of an atom when electrons fill the lowest energy levels.

Alkali Metal 12. An element of Group 1.

Noble Gas 13. A non-reactive element that can be found in Group 18 on the periodic table.

Ion 14. An atom that has either lost or gained electron(s).

Neutron 15. A subatomic particle with no charge, that can be found in the nucleus of an atom.

Valence Electrons 16. The outer electrons of an atom that can be exchanged or shared with other atoms.

Halogens 17. An element of Group 17.

Thomson 18. Scientist whose use of cathode ray tubes led to the discovery of the electron.

Proton 19. A subatomic particle with positive charge that tells the identity of an atom.

Ionization Energy 20. The amount of energy necessary to remove an outermost electron.

Rutherford 21. Scientist who performed the gold foil experiment, and concluded that an atom must be composed of mostly empty space with a small, dense, positively-charged nucleus.

Reactivity 22. For metals, it is the ability for metals to readily lose electrons. For nonmetals, it is the ability for nonmetals to readily gain electrons.

Bright-Line Spectrum 23. An element’s “fingerprint”, produced when electrons move from higher to lower energy levels.

Wave-Mechanical Model 24. The most current model of the atom states that electrons are found in “orbitals” regions of most probable location.

Excited State 25. The state of an atom where electrons occupy higher energy levels.

1. Where, generally, are the metals located on the periodic table?

*Left of staircase*

2. Where, generally, are the nonmetals located on the periodic table?

*Right of staircase*

3. List three physical properties of metals and one chemical property.

*Physical- Malleable, ductile, high melting points, conducts electricity and heat, and has luster*

*Chemical- reacts with acids*

4. List three physical properties of nonmetals and one chemical property.

*Physical- Brittle, dull, low melting points, and non-conductive*

*Chemical- reacts with acids*

5. What kinds of properties do metalloids have?

*An element that has properties of both a metal and nonmetal*

6. What are the diatomic elements?

*Diatomic elements are chemical elements whose stable form at STP consists of diatomic molecules.*

*The diatomic elements are H<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>, Cl<sub>2</sub>, Br<sub>2</sub>, and I<sub>2</sub>.*

7. What are the Group 1 elements called?

*Alkaline metals*

8. What are the Group 2 elements called?

*Alkaline earth metals*

9. What are the Group 17 elements called?

*Halogens*

10. What are the Group 18 elements called?

*Noble Gases*

11. List the three lightest members of the noble gases.

*Ne, Ar, Kr*

12. What is the heaviest noble gas?

*Radon*

13. What is the heaviest alkaline earth metal?

*Radium*

14. List all of the alkali metals

*Li, Na, K, Rb, Cs, Fr*

15. Which alkali metal belongs to the sixth period?

*Cs*

16. Which halogen belongs to the fourth period?

*Br*

17. What element is in the fifth period and the eleventh group?

Ag

18. Circle one or more in each group: (Use Table S to help with some of these)

- |                         |    |    |    |    |
|-------------------------|----|----|----|----|
| a) transition metal     | Cu | Al | Ag | Mg |
| b) alkali metal         | Al | Sn | Ag | Rb |
| c) largest radius       | Mg | Ca | Sr |    |
| d) lowest boiling point | Kr | Ni | Li |    |
| e) metalloid            | Sb | Cu | P  | Ne |
| f) halogen              | F  | Cl | O  | S  |

19. By what property did Mendeleev first arrange the Periodic Table?

Atomic number (number of protons)

20. What is the periodic law?

physical and chemical properties of the elements tend to recur in a systematic manner with increasing atomic number

21. What is a period? How many are there in the periodic table?

Horizontal row- 7

22. What is a group (also called a family)? How many are there in the periodic table?

Vertical column-18

23. List, by number, both the period and group of each of these elements.

	<u>Symbol</u>	<u>Period</u>	<u>Group</u>
a. beryllium	Be	2	2
b. iron	Fe	4	8
c. lead	Pb	6	14

24. Which of the following pairs of elements belong to the same period?

a. Na and Cl      b. Na and Li      c. Na and Cu      d. Na and Ne

25. Which of the following pairs of elements belong to the same group?

a. H and He      b. Li and Be      c. C and Pb      d. Ga and Ge

26. How does an element's period number relate to the number of the energy levels of its valence electrons?

**The period is the same as the number of energy levels.**

27. Why do all the members of a group have similar properties?

**They all have the same number of valence electrons.**

28. Would you expect strontium to be, chemically, more similar to calcium or rubidium? WHY?

**Calcium because they both are located in the same group, which means they have the same number of valence electrons, so they interact/react the same with other atoms, and therefore have the same chemical properties.**

29. In going from top to bottom of any group, each element has 1 more occupied energy level(s) than the element above it.

30. Which element on the periodic table is the most likely to lose an electron (that means it's the most active metal)? Explain.

**Francium is the most likely to lose an electron, because like all Group 1 elements it only has one valence electron to lose before becoming stable. It has more energy levels than the other elements, which means it has a larger radius, so there is less attraction between the positive nucleus and the outer electrons, making it easier for that e- to be lost.**

31. In which list are the elements arranged in order of increasing atomic mass?

(1) Cl, K, Ar                      (2) Fe, Co, Ni                      **(3) Te, I, Xe**                      (4) Ne, F, Na

32. Which element has both metallic and nonmetallic properties?

(1) Rb                      **(3) Si**  
(2) Rn                      (4) Sr

33. An element that is malleable and a good conductor of heat and electricity could have an atomic number of

(1) 16                      **(3) 29**  
(2) 18                      (4) 35

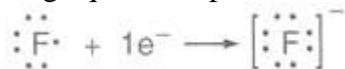
34. Which Group 14 element is classified as a metal?

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

35. As an atom becomes an ion, its mass number

(1) decreases                      (2) increases                      **(3) remains the same**

36. The following equation represents the formation of a



- (1) fluoride ion, which is smaller in radius than a fluorine atom  
(2) fluorine atom, which is smaller in radius than a fluoride ion  
**(3) fluoride ion, which is larger in radius than a fluorine atom**  
(4) fluorine atom, which is larger is radius than a fluoride ion

37. What is the total number of electrons in a  $\text{Cu}^+$  ion?  
 (1) 28 (2) 29 (3) 30 (4) 36
38. After a neutral sulfur atom gains two electrons, what is the resulting charge of the ion? -2
39. What is the total number of electrons in a  $\text{Cr}^{3+}$  ion?  
 (1) 18 (2) 21 (3) 24 (4) 27
40. How many electrons are contained in an  $\text{Au}^{3+}$  ion?  
 (1) 76 (2) 79 (3) 82 (4) 197
41. How are neutral atoms converted into cations? Electrons are lost.
42. How are neutral atoms converted into anions? Electrons are gained.
43. Metals usually form what type of ions? Cations
44. Nonmetals usually form what type of ions? Anions
45. When combining with non-metallic atoms, metallic atoms will lose \_\_\_\_\_ electrons to  
 (lose, gain)  
 form positive \_\_\_\_\_ ions.  
 (positive, negative)
46. Sulfur atoms can form anions \_\_\_\_\_ with a - 2 \_\_\_\_\_ charge in order to get a full octet.  
 (cations, anions) (+, -) (1,2,3,4)
47. When an atom becomes an anion, what happens to its radius?  
increases
48. When an atom becomes a cation, what happens to its radius?  
decreases
49. For each of the following pairs, circle the atom or ion having the larger radius.
- |                                  |  |   |
|----------------------------------|--|---|
| a. <u>S</u> or O                 | c. $\text{Na}^{1+}$ or <u><math>\text{K}^{1+}</math></u> | e. <u><math>\text{S}^{2-}</math></u> or $\text{O}^{2-}$ |
| b. <u>Ca</u> or $\text{Ca}^{2+}$ | d. Na or <u>K</u>  | f. F or <u><math>\text{F}^{1-}</math></u>               |
50. For each of the following pairs, identify the smaller ion.
- |  |   |   |
|--|---|---|
| a. $\text{K}^{1+}$ or $\text{Ca}^{2+}$ ( <u>same</u> )   | c. <u><math>\text{C}^{4+}</math></u> or $\text{C}^{4-}$ | e. $\text{O}^{2-}$ or $\text{F}^{1-}$ ( <u>same</u> )     |
| b. <u><math>\text{F}^{1-}</math></u> or $\text{Cl}^{1-}$ | d. $\text{S}^{2-}$ or <u><math>\text{F}^{1-}</math></u> | f. $\text{Fe}^{2+}$ or <u><math>\text{Fe}^{3+}</math></u> |

51. Draw Lewis dot structures for the following:

a. sulfide anion

b. magnesium cation

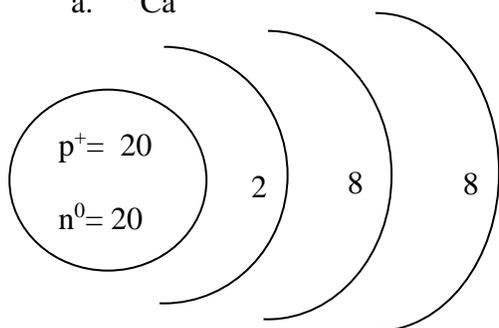
c. bromide anion

d.  $P^{3-}$

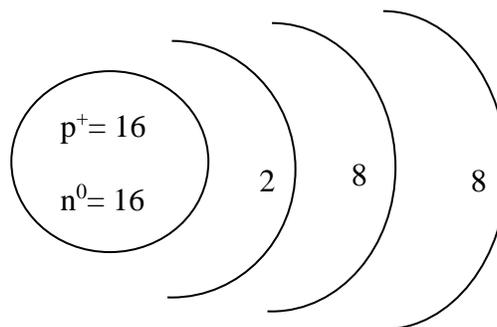


52. Draw Bohr diagrams for the following (include protons and neutrons in nucleus):

a.  $^{40}Ca^{2+}$



b.  $^{32}S^{2-}$



53. The **ions** which are normally formed from K and Cl have the same electron configuration.

What is it? 2-8-8.

This is the same configuration as which noble gas? Argon

How are the two ions different? **They have a different number of protons and neutrons in the nucleus and different charges ( $K^{+1}$ ,  $Cl^{-1}$ )**

54. Give the symbol for one (1) cation and one (1) anion that have the same electron configuration as the noble gas, krypton.

**Cations:  $Rb^{+1}$ ,  $Sr^{+2}$ ,  $Y^{3+}$     Anions:  $As^{3-}$ ,  $Se^{2-}$ ,  $Br^{-1}$**

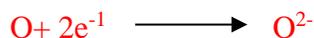
55. Write the equation (equation means reactants, products, and an arrow between them) for each of the following.

For example:  $Na \longrightarrow Na^{+1} + 1e^{-1}$

a. formation of  $Sr^{2+}$  from Sr



b.  $O^{2-}$  from O



56. What is the formula of the compound formed by

- a. lithium ion and chloride ion? LiCl
- b. potassium ion and nitride ion? K<sub>3</sub>N
- c. calcium ion and oxide ion? CaO
- d. aluminum ion and sulfide ion? Al<sub>2</sub>S<sub>3</sub>
- e. rubidium ion and iodide ion? RbI

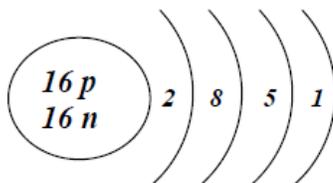
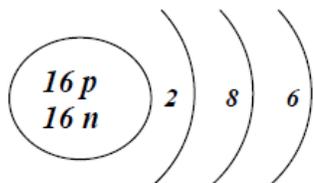
57. Find the number of p, n, and e- in the following species.

	Br	K <sup>+</sup>	N <sup>3-</sup>	Ti <sup>2+</sup>	H <sup>-</sup>	H <sup>+</sup>
p <sup>+</sup>	35	19	7	22	1	1
n <sup>o</sup>	45	20	7	26	0	0
e <sup>-</sup>	35	18	10	20	2	0

Draw Bohr diagrams for the following:

a.) <sup>32</sup>S in the ground state

b.) <sup>32</sup>S in the excited state



58. **True/False:** If the statement is true, tell how you know. If false, correct the statement to make it true.

False a.) When an electron moves from a higher to a lower energy level, the electron absorbs energy, producing a bright-line spectrum. releases (emits)

True b.) Emission of light occurs when an electron drops from the excited state to the ground state.

True c.) The amount of energy required to remove the outermost electron from a gaseous atom in the ground state is known as the first ionization energy.

59. Which of the following represents an excited state of an atom? (Circle all that apply.) Explain how you know.

(1) 2-7-1-1 (2) 2-7  
Ground state would be 2-8-1

(3) 2-8-8-1 (4) 2-8-7-1  
Ground state would be 2-8-8

60.) Which electron configuration represents the electrons of an atom in an excited state?

(1) 2-4 (2) 2-6 (3) 2-7-2 (4) 2-8-2

61.) When an electron moves from a higher to a lower energy level, the electron:

- (1) absorbs energy, producing a bright-line spectrum.
- (2) absorbs energy but no bright-line spectrum is produced.
- (3) releases energy, producing a bright-line spectrum.
- (4) releases energy but no bright-line spectrum is produced.

62.) Emission of light occurs when an electron

- (1) drops from a higher to a lower energy level
- (2) jumps from a lower to a higher energy level
- (3) moves around within its orbital
- (4) crashes into the nucleus

63) Which electron configuration represents an atom in an excited state?

- (1) 2-7      (2) 2-6-2      (3) 2-8-1      (4) 2-8-8-2

64.) What are isotopes? Give an example.

*Atoms of an element with a different mass number due to different amounts of neutrons in the nucleus.*

*Example: Isotopes of Carbon- C-12, C-13, and C-14*

65.) What is the atomic mass of the element "Q" if its isotopes are 45% Q-17, 50% Q-18, and 5% Q-19?

$$45\% = 45/100 = .45$$

$$50\% = 50/100 = .50$$

$$5\% = 5/100 = .05$$

$$Q-17 = 17 \times .45 = 7.65$$

$$Q-18 = 18 \times .50 = 9.00$$

$$Q-19 = 19 \times .05 = +0.95$$

$$17.60 \text{ amu}$$

66.) Carbon has three naturally occurring isotopes, C-12, C-13, and C-14. Diamond and graphite are familiar forms of solid carbon. Diamond is one of the hardest substances known, while graphite is a very soft substance. Diamond has a rigid network of bonded atoms. Graphite has atoms bonded in thin layers that are held together by weak forces. Recent experiments have produced new forms of solid carbon called fullerenes. One fullerene, C<sub>60</sub>, is a spherical, cage-like molecule of carbon.

Determine *both* the total number of protons and the total number of neutrons in an atom of the naturally occurring carbon isotope with the largest mass number.

*C-14 has six protons and 8 neutrons*

Base your answers to questions 67 and 68 on the information below.

### Naturally Occurring Isotopes of Sulfur

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

67.) State, in terms of the number of subatomic particles, *one* similarity and *one* difference between the atoms of these isotopes of sulfur.

*All isotopes of sulfur contain 16 protons. The isotopes of sulfur differ in the amount of neutrons they contain in the nucleus.*

68.) Show a correct numerical setup for calculating the atomic mass of sulfur.

$$S-32 = 31.97 \times .9493 = 30.349$$

$$S-33 = 32.97 \times .0076 = 0.251$$

$$S-34 = 33.97 \times .0429 = 1.457$$

$$S-36 = 35.97 \times .0002 = \underline{+0.007}$$

*amu*

---

69.) The table below shows the number of subatomic particles in atom X and in atom Z.

### Subatomic Particles in Two Atoms

Atom	Number of Protons	Number of Neutrons	Number of Electrons
X	6	6	6
Z	6	7	6

Atom X and atom Z are isotopes of the element

- (1) aluminum      (2) carbon      (3) magnesium      (4) nitrogen

70.) Which value of an element is calculated using both the mass and the relative abundance of each of the naturally occurring isotopes of this element?

- (1) atomic number      (2) atomic mass      (3) half-life      (4) molar volume

71.) Which two notations represent different isotopes of the same element?

- (1)  ${}^6_4\text{Be}$  and  ${}^9_4\text{Be}$       (3)  ${}^{14}_7\text{N}$  and  ${}^{14}_6\text{C}$   
(2)  ${}^7_3\text{Li}$  and  ${}^7_3\text{Li}$       (4)  ${}^{32}_{15}\text{P}$  and  ${}^{32}_{16}\text{S}$

## Atomic and Ionic Radii

Particle	Radius (pm)
Na atom	190.
Na <sup>+</sup> ion	102
Cl atom	97
Cl <sup>-</sup> ion	181

72. a. List three physical properties of metals.

*Malleable, ductile, high melting points, conducts electricity and heat, and has luster*

- b. List three physical properties of non-metals.

*Brittle, dull, low melting points, and non-conductive*

- c. What is a metalloid?

*An element that has properties of both a metal and nonmetal.*

73. When combining with non-metallic atoms, **metallic atoms** will lose electrons to form positive ions.  
(lose or gain)  
(positive or negative)

74. Sulfur atoms can form anions with a - 2 in order to get a full octet.  
(cations or anions) (+ or -) (1, 2, 3, 4)

75. Which element on the periodic table is the most metallic? Explain using the definition for a metal.

*Francium (Fr) is the most metallic element. A metal is defined as the ability to lose electrons. Francium most easily loses electrons because of its 7 shells and 1 valence electron. Since the electrons are farther away from its positively charged nucleus they are not held on (attracted) to and are easily lost.*

76. Which element on the periodic table is the most electronegative? Explain using the definition for electronegativity.

*Fluorine (F) is the most electronegative element. Electronegativity is the ability to attract electrons and fluorine most easily attracts electrons because it has 2 shells, and 7 valence electrons. Since the electrons are close to the positively charged nucleus they are held on (attracted to) strongly and can easily gain electrons.*

*Use the information below for questions 77 through 78.*

The atomic and ionic radii for sodium and chlorine are shown in the table.

77. Write the ground state electron configuration for the ion that has a radius of 181 picometers.

*2-8-7*

78. Explain, in terms of atomic structure, why the radius of an Na atom is larger than the radius of an Na<sup>+</sup> ion.

*1 meter = 1 x 10<sup>+12</sup> pm 102 pm 1 m = 1.02 x 10<sup>-10</sup>m or 0.00000000102 m  
1 x 10<sup>+12</sup>pm*

79. Is the ion formed from the S atom smaller or larger than the S atom itself? Larger

80. The most active metals are contained in which group of the periodic table? one

81. For the following, circle the element that can be characterized by the given property.

a) transition metal	Cu	Al	Ag	Mg
b) alkali metal	Al	Sn	Ag	Rb
c) largest radius	Mg	Ca	Sr	
d) lowest boiling point	Kr	Ni	Li	
e) metalloid	Cu	Sb	P	Ne
f) halogen	F	Cl	O	

82.

a.) According to Table S, how do the following properties change from **top to bottom** of a group of elements?

Atomic size *The atomic size increases from top to bottom.*

Electronegativity *The electronegativity decreases from top to bottom.*

Ionization Energy *The ionization energy decreases from top to bottom.*

b.) According to Table S, how do the following properties change from **left to right** of a period of elements?

Atomic size *decreases*

Electronegativity *increases*

Ionization Energy *increases*

83. 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

(3) Group 2, Period 3

(2) Group 2, Period 5

(4) Group 3, Period 4

84. Which element is a metalloid?

(1) Al

(2) Ar

(3) As

(4) Au

85. An element that is malleable and a good conductor of heat and electricity could have an atomic number of  
(1) 16                      (2) 18                      (3) 29                      (4) 35
86. On the ~~modern~~ Periodic Table, the elements are arranged in order of increasing  
(1) atomic mass                      (3) mass number  
(2) atomic number                      (4) oxidation number
87. An element that has low first ionization energy and is a good conductor of heat and electricity is classified as a  
(1) metal                      (2) metalloid                      (3) nonmetal                      (4) noble gas
88. How do the atomic radius and metallic properties of sodium compare to the atomic radius and metallic properties of phosphorus?  
(1) Sodium has a larger atomic radius and is more metallic.  
(2) Sodium has a larger atomic radius and is less metallic.  
(3) Sodium has a smaller atomic radius and is more metallic.  
(4) Sodium has a smaller atomic radius and is less metallic
89. As atomic number increases within Group 15 on the Periodic Table, atomic radius  
(1) decreases, only                      (3) decreases, then increases  
(2) increases, only                      (4) increases, then decreases
90. At STP, which element is solid, brittle, and a poor conductor of electricity?  
(1) Al                      (2) K                      (3) Ne                      (4) S
91. Which Group 14 element is classified as a metal?  
(1) carbon                      (2) germanium                      (3) silicon                      (4) tin
92. Which element is a solid at STP and a good conductor of electricity?  
(1) iodine                      (2) mercury                      (3) nickel                      (4) sulfur
93. Which element has both metallic and nonmetallic properties?  
(1) Rb                      (2) Rn                      (3) Si                      (4) Sr
94. Which of the following represent a pair of allotropes?  
(1)  $^{16}\text{O}$  and  $^{15}\text{O}$                       (2)  $\text{O}^0$  and  $\text{O}^{2-}$                       (3)  $\text{O}_2$  and  $\text{O}_3$                       (4)  $\text{O}_2$  and  $\text{S}_2$
95. Which element is a liquid at STP?  
(1) argon                      (2) bromine                      (3) chlorine                      (4) sulfur
96. Which statement correctly describes two forms of oxygen,  $\text{O}_2$  and  $\text{O}_3$ ?  
(1) They have identical molecular structures and identical properties.  
(2) They have identical molecular structures and different properties.  
(3) They have different molecular structures and identical properties.  
(4) They have different molecular structures and different properties.
97. Which Group 15 element exists as diatomic molecules at STP?  
(1) phosphorus                      (2) nitrogen                      (3) bismuth                      (4) arsenic

## **D. Unit 4 Bonding and Nomenclature**

### **Vocabulary Practice:**

Anion	Covalent Bonding	Mole	Octet rule
Balanced Equation	Electron Pair	Mole ratio	Polyatomic Ion
Cation	Endothermic	Molecular Bonding	Product
Chemical Formula	Exothermic	Molecular Formula	Reactant
Coefficient	Ionic Bonding	Molecule	Single Bond
Compound	Lewis Dot	Monatomic Ion	Subscript
Conservation of Mass	Molar Mass	Multiple Bond	Valence electrons

<u>Compound</u>	1. Substance in which the atoms exist in a fixed ratio
<u>Subscript</u>	2. The number that indicates the number of atoms present
<u>Coefficient</u>	3. The number that indicates the number of units or molecules of that substance
<u>Exothermic</u>	4. Process in which energy is released (occurs when bonds are formed)
<u>Endothermic</u>	5. Process in which energy is absorbed (occurs when bonds are broken)
<u>Polyatomic Ion</u>	6. A covalently bonded group of atoms that have a net electric charge
<u>Product</u>	7. Substance formed as a result of a chemical reaction, shown to the right of the arrow.
<u>Chemical Formula</u>	8. Combination of symbols and subscripts, used to represent the ratio of atoms of a substance
<u>Reactant</u>	9. A substance that a chemical reaction occurs upon, shown to the left of the arrow.
<u>Molecule</u>	10. The smallest unit of a covalently bonded substance that has the properties of that substance
<u>Covalent</u>	11a. Bond formed by the sharing of valence electrons between 2 nonmetallic nuclei.
<u>Molecular</u>	11b. Bond formed by the sharing of valence electrons between 2 nonmetallic nuclei.
<u>Molar Mass</u>	12. The mass of one mole of a substance
<u>Lewis Dot</u>	13. A type of diagram Chemist's use to show how atoms bond
<u>Cation</u>	14. An atom that has lost electrons to obtain a positive charge
<u>Anion</u>	15. An atom that has gained electrons to obtain a negative charge
<u>Valence electrons</u>	16. The outer electrons of an atom that can be exchanged or shared with other atoms.
<u>Single Bond</u>	17. Occurs when only one pair (2 electrons) are shared between two nuclei.
<u>Multiple Bond</u>	18. Occurs when more than 1 pair (4 or more electrons) are shared between two nuclei
<u>Monatomic Ion</u>	19. A single element with a positive or negative charge due to the loss or gain of e <sup>-</sup> .
<u>Octet Rule</u>	20. The stable valence electron configuration of 8 electrons, which every element tries to obtain by bonding; the driving force behind why atoms bond the way they do
<u>Electron Pair</u>	21. Represented by a single line in a Lewis diagram of a covalent compound
<u>Ionic</u>	22. Bond formed by a transfer of valence electrons from a metal to a nonmetal
<u>Molecular Formula</u>	23. A specific type of chemical formula that tells exactly how many of each atom are in a substance, not just the ratio of these atoms
<u>Balanced Equation</u>	24. An equation that has the correct coefficients in place in order to demonstrate conservation of mass.
<u>Cons. of Matter</u>	25. The idea that matter can be changed, but an equation should always start and end with the same number and type of each atom.
<u>Mole</u>	26. A measure of the number of particles in a substance, which we use to calculate the number of grams of a substance
<u>Mole ratio</u>	27. The ratio of moles of atoms needed to complete a chemical reaction, depicted by a balanced equation

1. Which substance can *not* be decomposed (broken down) by a chemical change?  
 (1) ammonia (3) ammonium nitrate  
**(2) copper** (4) water
2. When a metal atom becomes an ion, it loses (*gains/loses*) electrons and has a +  (+/-) charge. The ion is called a(an) cation (*anion/cation*).
3. When a non-metal atom becomes an ion, it gains (*gains/loses*) electrons and has a -  (+/-) charge. The ion is called a(an) anion (*anion/cation*).

Write the names from the formula:

4. KBr potassium bromide
5. Al<sub>2</sub>O<sub>3</sub> aluminum oxide
6. MgS magnesium sulfide

Write the formula from the name:

7. Sodium Phosphide Na<sub>3</sub>P  $Na^{1+}$   $P^{3-}$
8. Barium Chloride BaCl<sub>2</sub>  $Ba^{2+}$   $Cl^{1-}$
9. Calcium Nitride Ca<sub>3</sub>N<sub>2</sub>  $Ca^{2+}$   $N^{3-}$
10. Gold (III) Sulfide Au<sub>2</sub>S<sub>3</sub>  $Au^{3+}$   $S^{2-}$
11. Chromium (II) Nitride Cr<sub>3</sub>N<sub>2</sub>  $Cr^{2+}$   $N^{3-}$

12. What is the IUPAC name for the compound FeS?  
 (1) iron (II) sulfate (3) **iron (II) sulfide** (*S = -2, therefore Fe = +2 for a 1:1 ratio*)  
 (2) iron (III) sulfate (4) iron (III) sulfide
13. In which compound is the ratio of metal ions to nonmetal ions 1 to 2?  
**(1) calcium bromide (CaBr<sub>2</sub>)** (3) calcium phosphide (Ca<sub>3</sub>P<sub>2</sub>)  
 (2) calcium oxide (CaO) (4) calcium sulfide (CaS)
14. In the formula X<sub>2</sub>O<sub>5</sub>, the symbol X could represent an element in Group:  
 (1) 1 (3) **15** *Since O = -2, X must be +5*  
 (2) 2 (4) 18
15. Which element forms a compound with chlorine with the general formula MCl?  
**(1) Rb** (3) Re *Since Cl = -1, M must be +1*  
 (2) Ra (4) Rn
16. Which formula represents copper (I) oxide?  
 (1) CuO (3) **Cu<sub>2</sub>O** *Cu = +1 and O = -2*  
 (2) CuO<sub>2</sub> (4) Cu<sub>2</sub>O<sub>2</sub>

17. Which element, represented by X, reacts with fluorine to produce the compound  $XF_2$ ?  
 (1) aluminum (2) argon (3) magnesium (4) sodium *Since F = -1, X must be +2*
18. The compound XCl is classified as ionic if X represents the element  
 (1) H (2) I (3) Rb (4) Br *Must be a metal with a +1 charge!*
19. What is the chemical formula for iron (III) oxide?  
 (1) FeO (2) Fe<sub>2</sub>O<sub>3</sub> (3) Fe<sub>3</sub>O (4) Fe<sub>3</sub>O<sub>2</sub> *Fe = +3 and O = -2*
20. An ionic compound is formed when there is a reaction between the elements  
 (1) strontium and chlorine (2) hydrogen and chlorine (3) nitrogen and oxygen (4) sulfur and oxygen *Must be a metal with a nonmetal!*
21. Which formula represents an ionic compound?  
 (1) H<sub>2</sub> (2) CH<sub>4</sub> (3) CH<sub>3</sub>OH (4) NH<sub>4</sub>Cl *Must be made of cations & anions!*
22. A barium atom attains a stable electron configuration when it bonds with  
 (1) one chlorine atom (*Ba would only lose 1 e<sup>-</sup>*) (2) two chlorine atoms (*Ba would lose 2 e<sup>-</sup>*) (3) one sodium atom (*metal does not want to react with metal*) (4) two sodium atoms (*metal does not want to react with metal*)
23. The nitrogen atoms in a molecule of N<sub>2</sub> share a total of  
 (1) one pair of electrons (2) one pair of protons (3) three pairs of electrons (4) three pairs of protons
24. It is possible for bonds to be single, double or triple covalent. Which molecule contains 3 single covalent bonds?  
 (1) H<sub>2</sub> (2) NH<sub>3</sub> (3) I<sub>2</sub> (4) H<sub>2</sub>O
25. When covalent compounds bond, they share valence electrons.
- If **one pair** of valence electrons are shared between two atoms, this is called a single covalent bond. It represents a total of 2 (*how many?*) **total shared** valence electrons.
  - If a **total of four** valence electrons are shared between two atoms, this is called a double covalent bond. It represents 2 (*how many?*) **pairs** of shared valence electrons.
  - If **three pairs** of valence electrons are shared between two atoms, this is called a triple covalent bond. It represents a total of 6 (*how many?*) **total shared** valence electrons.

26. Which compound has both ionic and covalent bonding? **Must have a metal & polyatomic ion!**

- (1)  $\text{CaCO}_3$  (3)  $\text{CH}_3\text{OH}$   
(2)  $\text{CH}_2\text{Cl}_2$  (4)  $\text{C}_6\text{H}_{12}\text{O}_6$

27. The chemical bonding in sodium phosphate,  $\text{Na}_3\text{PO}_4$ , is classified as

- (1) ionic, only (3) **both covalent and ionic**  
(2) metallic, only (4) both covalent and metallic

28. Two categories of compounds are **Molecular = covalent!** (Two terms that mean the same thing!)

- (1) covalent and molecular (3) **ionic and molecular**  
(2) covalent and metallic (4) ionic and metallic

29. Which type of substance can conduct electricity in the liquid phase but *not* in the solid phase?

- (1) **ionic compound** (3) metallic element **Choices 2 & 4 never conduct,**  
(2) molecular compound (4) nonmetallic element **Choice 3 conducts as a solid**

30. The bonds in  $\text{BaO}$  are best described as

- (1) covalent, because valence electrons are shared  
(2) covalent, because valence electrons are transferred  
(3) ionic, because valence electrons are shared  
(4) **ionic, because valence electrons are transferred**

31. Which compound contains both ionic and covalent bonds?

**Metal & polyatomic ion**

- (1) ammonia (3) **sodium nitrate**  
(2) phosphate (4) potassium chloride

32. Tell whether the following are ionic, molecular (covalent), both, or neither. Name them.

a.)  $\text{Ag}_3(\text{PO}_4)$

b.)  $\text{Mg}$

c.)  $\text{Rb}(\text{CO}_3)_2$

d.)  $\text{PH}_3$

**Both**  
**silver phosphate**

**Neither**  
**magnesium**

**Both**  
**rubidium carbonate**

**Molecular**

e.)  $\text{MgBr}_2$

f.)  $\text{ClBr}$

g.)  $\text{Br}_2$

h.)  $\text{Al}_2\text{O}_3$

**Ionic**  
**magnesium bromide**

**Molecular**

**Neither**  
**bromine**

**Ionic**  
**aluminum oxide**

33. Draw Lewis dot structures for the following (Remember to first determine whether they are ionic or molecular (covalent)!!)

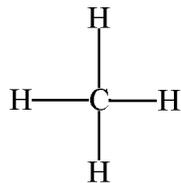
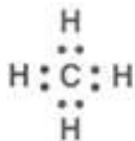
a.) Na<sub>2</sub>O

*ionic*



b.) CH<sub>4</sub>

*covalent*



c.) CaCl<sub>2</sub>

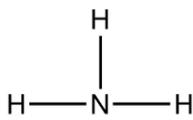
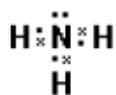
*ionic*



d.) NH<sub>3</sub>

*covalent*

OR



e.) N<sub>2</sub>

*covalent*



f.) Al<sub>2</sub>S<sub>3</sub>

*ionic*

34. Fill in the following chart, which compares characteristics of both ionic and covalent bonding.

Defining Characteristic	Ionic	Covalent (Molecular)
Type of atoms involved?	<i>Metal &amp; Nonmetal</i>	<i>2 Nonmetals</i>
Describe how the valence electrons are interacting in the bond	<i>They are transferred from metal (loses) to nonmetal (gains)</i>	<i>They are shared</i>
Does it have electrical conductivity as a solid?	<i>No</i>	<i>No</i>
Does it have electrical conductivity when/if dissolved in water?	<i>Yes! The more ions there are in the chemical formula, the more conductive it is!</i>	<i>No</i>
At STP, tend to be... → Brittle Solids? → Tend not to be a solid at STP?	<i>Brittle Solids</i>	<i>Tend not to be a solid at STP</i>
Relative melting/boiling point temperature: High or Low?	<i>High MP/BP</i>	<i>Low MP/BP</i>

Particle attractions are: Stronger or Weaker?	<i>Stronger</i>	<i>Weaker</i>
Describe how you would draw Lewis Structures. (Feel free to draw an example!)	<i>First, draw the Lewis structures for the atoms involved prior to bonding. Then draw arrows to show how e- are transferred. Rewrite these atoms as ions with brackets and charges (no electrons around metals, 8 electrons around nonmetals).</i>	<i>First, draw the Lewis structures for the atoms involved prior to bonding. Then draw loops around unpaired electrons to show how e- are shared. Rewrite these atoms showing the correct number of electrons shared between them, remember that one line= 2 electrons. Check your answer to make sure you have 8 electrons around each atom. (Hydrogen will only have 2 e<sup>-</sup>)</i>
Describe how you would name one of these compounds.	<i>Name the cation first. If it is a transition metal, use a roman numeral to indicate the correct charge. Next, name the anion. If it's a nonmetal, give it an "-ide" ending. Use Ref. Table E for any polyatomic ions. Remember that sometimes these will not be in parentheses!</i>	<b>NO NAME NECESSARY!!</b>

35. Which formula represents lead (II) chromate?

- (1) **PbCrO<sub>4</sub>** (3) Pb<sub>2</sub>CrO<sub>4</sub>  
 (2) Pb(CrO<sub>4</sub>)<sub>2</sub> (4) Pb<sub>2</sub>(CrO<sub>4</sub>)<sub>3</sub>

36. Which formula represents barium phosphate?

- (1) BaPO<sub>4</sub> (3) Ba<sub>2</sub>(PO<sub>4</sub>)<sub>3</sub>  
 (2) **Ba<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>** (4) Ba<sub>3</sub>PO<sub>8</sub>

37. Which polyatomic ion contains the greatest number of oxygen atoms?

- (1) acetate (3) hydroxide  
 (2) **carbonate** (4) peroxide

38 Given the formula: Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>

- a) How many sulfate ions are shown? **3**  
 b) How many total ions? **5**  
 c) How many atoms... Al? **2** S? **3** O? **12**  
 d) Describe how the atoms are bonded together.

*The nonmetallic sulfur and oxygen atoms are bonded to one another covalently, forming a negatively charged particle, which will then bond ionically to aluminum.*

