

Name

AP Chemistry Summer Packet

**Directions:** *You must show your work to receive credit.* The purpose of this packet is to ensure your success during the first four units of this course. The first four units cover 13 chapters, and the entire honors chemistry curriculum, with a few in-depth additions. The time frame is 3 months. The pace is VERY FAST. This packet is due the first day of school and will be graded for completion. After that, an answer key will be provided and after school review sessions will be offered. It is in your best interest to have a thorough understanding of this content PRIOR to the start of this course. Use your notes from Honors Chemistry and the internet/YouTube to help you. See you in August...

**Unit 1: Measurement and Atomic Structure**

\_\_\_\_\_ 1) Which of the following data sets is most precise?

- (a) 0.348 L, 0.350 L, 0.348 L.
- (b) 0.345 L, 0.345 L, 0.346 L
- (c) 0.344 L, 0.346 L, 0.350 L
- (d) 0.330 L, 0.332 L, 0.334 L
- (e) 0.350 L, 0.351 L, 0.352 L

\_\_\_\_\_ 2) How many significant figures are in 0.00230 mL?

3) A rectangular prism has a length of 6.4 cm, a width of 4.28 cm. and a height of 7.94 cm.

\_\_\_\_\_ (a) What will be the volume of the prism to the correct number of significant figures?

\_\_\_\_\_ (b) An identical prism is placed so that its length is added to that of the original prism. Will the volume of these combined prisms have the same number of significant figures as the volume of the original prism? Explain.

\_\_\_\_\_ 4) A piece of wood is 25.0 cm long is cut from a board that is 2.5 m long. What is the resulting length of the board to the correct number of significant figures?

\_\_\_\_\_ 5) Express the following numbers in scientific notation – don't forget significant figures!

- (a) 6500.
- (b) 0.00630
- (c) 860
- (d) 6501.0

6) Identify the following as chemical (C) or physical (P) properties.

\_\_\_\_\_ (a) Metallic sodium is soft enough to be cut with a knife

\_\_\_\_\_ (b) When sodium is cut, the surface is at first shiny; after a few seconds of exposure to air it turns dull gray

\_\_\_\_\_ (c) The density of sodium is 0.97 g/mL

\_\_\_\_\_ (d) When sodium comes in contact with water, it melts, and then evolves a flammable gas, and eventually disappears.

7) What are the oxidation numbers of the Group

\_\_\_\_\_ (a) IA

\_\_\_\_\_ (b) IIA

\_\_\_\_\_ (c) VA

\_\_\_\_\_ (d) VIA

\_\_\_\_\_ (e) VIIA

8) Which groups on the periodic table represent the

\_\_\_\_\_ (a) alkali metals

\_\_\_\_\_ (b) alkaline earth metals

\_\_\_\_\_ (c) halogens

9) Name the following ionic compounds:

\_\_\_\_\_ (a)  $\text{CaCl}_2$

\_\_\_\_\_ (b)  $\text{CuCl}_2$

10) Name the following molecules:

\_\_\_\_\_ (a)  $\text{N}_2\text{O}_4$

\_\_\_\_\_ (b)  $\text{PCl}_5$

11) Write the formulas for the following:

\_\_\_\_\_ (a) strontium nitrate

\_\_\_\_\_ (b) copper (II) sulfate

12) Write the formulas for the following:

\_\_\_\_\_ (a) dichlorine heptoxide

\_\_\_\_\_ (b) hydrofluoric acid

13) In the late 1880's JJ Thomson experimented with cathode rays by bending them in an applied electromagnetic field. He discovered that the charge/mass ( $e/m$ ) ration was the same no matter what the cathode was made of

(a) what did this suggest?

(b) What were these particles called?

14) Draw and label the basic parts of Rutherford's famous gold foil experiment.

(a) Describe his results and conclusions he reached.

15) What is the symbol of the atomic number of the element tungsten?

\_\_\_\_\_ (a) symbol

\_\_\_\_\_ (b) atomic number

16) How many... are in cobalt-60?

\_\_\_\_\_ (a) protons

\_\_\_\_\_ (b) neutrons

\_\_\_\_\_ (c) electrons

17) What is the... and .... of the nuclide  $\frac{96}{42}\text{Mo}$ ?

\_\_\_\_\_ (a) mass number

\_\_\_\_\_ (b) atomic number

## **Unit 2: Chemical Reactions**

18) Write and balance the following (yes, you are expected to write equations from words and balance).

(a) methane gas burns in oxygen

(b) hydrogen gas combusts

(c) aluminum metal is placed in hydrochloric acid

(d) aqueous silver nitrate and sodium chloride are mixed in a beaker

19) Determine the formula weight (molar mass) of the following *show your work*

(a) dinitrogen monoxide (nitrous oxide)

(b) benzoic acid,  $\text{HC}_7\text{H}_5\text{O}_2$

(c) magnesium hydroxide

20) Determine the % composition of the following *show your work*

(a) morphine,  $\text{C}_{17}\text{H}_{19}\text{NO}_3$

C:

H:

O:

21) Rank the following in terms of numbers of particles *show your work below*

(a) 0.50 mol  $\text{H}_2\text{O}$     (b) 23 g Na    (c)  $6.0 \times 10^{23}$  molecules  $\text{N}_2$

22) Use the space/set up below *to show your work* and determine the empirical formula for

(a) 55.3 % K, 14.6 % P, 30.1 % O

K:

P:

O:

23) Use the space/set up below *to show your work* and determine the molecular formula for

(a) MSG, a flavor enhancer in foods, contains 35.51% C, 4.77% H, 37.85% O, 8.29% N and 13.60% Na, and has a molar mass of 169 g/mol.

C:

H:

O:

N:

Na:

24) The combustion of acetylene gas is represented by this equation:  $2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$

(a) How many grams of  $\text{CO}_2$  are produced when 52.0 g of  $\text{C}_2\text{H}_2$  burn? *Show your work*

(b) How many moles of  $\text{H}_2\text{O}$  are produced when 64.0 g of  $\text{C}_2\text{H}_2$  burn? *Show your work*

25) The equation shows the incomplete combustion of ethane:  $\text{C}_2\text{H}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g}) + 2\text{H}_2\text{O}(\text{g})$

If 2.7 mol  $\text{C}_2\text{H}_4$  is reacted with 6.30 mol  $\text{O}_2$ ,

(a) Identify the limiting reagent *Show your work*

(b) Calculate the mass of water produced *Show your work*

26) Name the spectator ions in the following reactions

(a)  $\text{Na}_2\text{CO}_3(\text{aq})$  and  $\text{MgSO}_4(\text{aq})$

(b)  $\text{KOH}(\text{aq})$  and  $\text{Cu}(\text{NO}_3)_2(\text{aq})$

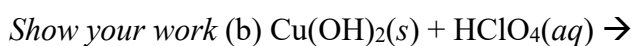
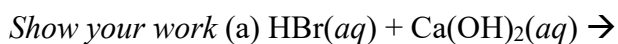
27) Write the balanced net ionic equation *Show your work below*

(a)  $\text{Cr}_2(\text{SO}_4)_3(\text{aq}) + (\text{NH}_4)_2\text{CO}_3(\text{aq}) \rightarrow$

28) Classify the following as a nonelectrolyte, weak electrolyte, or strong electrolyte in water

(a)  $\text{H}_2\text{SO}_3$    (b)  $\text{HClO}$    (c)  $\text{NH}_3$    (d)  $\text{LiClO}_4$

29) Complete and balance the molecular equations, then write the net-ionic equations for the following:



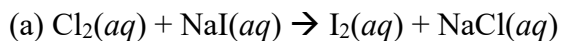
30) Determine the oxidation number of sulfur in each of the following substances:

*Show your work*



31) Identify who is oxidized and reduced in the following reaction

*Show your work*

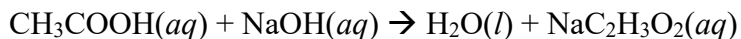


32) Calculate the

(a) molarity of a solution with 12.5 g  $\text{Na}_2\text{CrO}_4$  in enough water to make 550 mL of solution. *Show your work*

(b) how many moles of  $\text{KBr}$  are present in 150 mL of a 0.275 M solution? *Show your work*

33) The distinctive odor of vinegar is due to acetic acid,  $\text{CH}_3\text{COOH}$ , which reacts with sodium hydroxide in the following fashion:



(a) if 3.45 mL of vinegar needs 42.5 mL of 0.115 M NaOH to reach the equivalence point in a titration, how many grams of acetic acid are in 1.00-qt sample of this vinegar? *Show your work*

### Unit 3: Electrons, Periodicity, Bonding & Geometry

34) Wave calculations

(a) What is the frequency of radiation whose wavelength is  $5.0 \times 10^{-5}$  m? *Show your work*

(b) What is part of the spectrum does this wave fall into? *Show your work*

(c) How far does this wave travel in 10.5 fs? *Show your work*

(d) Calculate and compare the energy of a photon of a wavelength of 3.3  $\mu\text{m}$  (micrometers) with that of a wavelength of 0.154 nm. *Show your work*

35) Use the de Broglie relationship  $\lambda = \frac{h}{mv}$  to determine the wavelength of the following object:

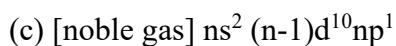
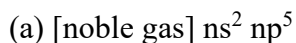
(a) an 85-kg person skiing at 50 km/hr. *Show your work*

36) How many possible values for  $l$  and  $m_l$  are there when  $n=3$ ?

37) For the table that follows, write which orbital goes with the quantum numbers. Don't worry about  $x$ ,  $y$ , or  $z$  subscripts. If the quantum numbers are not allowed, write "not allowed"

$n$	$L$	$m_l$	<i>orbital</i>
2	1	-1	2p orbital (example)
1	0	0	
3	-3	2	
3	2	-2	
2	0	-1	
0	0	0	
4	2	1	
5	3	0	

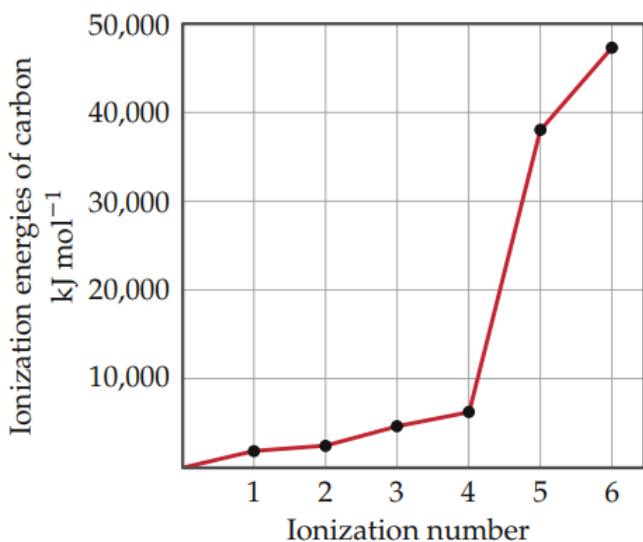
38) Identify the group of elements that corresponds to each of the following generalized electron configurations and indicate the number of unpaired electrons in each



39) Which will experience a greater effective nuclear charge, the electrons in the  $n = 3$  shell in At or the  $n = 3$  shell in Kr? Which will be closer to the nucleus? Explain.

40) How do the sizes of atoms change as we move (a) from left to right across a row in the periodic table (b) From top to bottom on the periodic table (c) arrange atoms in order of increasing atomic radius, O, Si, I, Ge.

41) Explain the variation in ionization energies of carbon, as displayed in this graph:



42) What are valence electrons? (a) How many valence electrons does a nitrogen atom have? (b) An atom has the electron configuration  $1s^2 2s^2 2p^6 3s^2 3p^2$ . How many valence electrons does the atom have?

43) Use Lewis symbols to represent the reaction that occurs between Ca and F ions.



44) Predict the chemical formula of the ionic compound formed between (a) Al and F (b) K and S

*Show your work*

45) Using Lewis symbols and Lewis structures, draw a molecule of (a)  $\text{CCl}_4$ . (b)  $\text{AsO}_3^{3-}$  (c)  $\text{XeF}_4$

46) Using only the periodic table as your guide, select the most electronegative atom in each of the following sets: (a) Na, Mg (b) P, S, As, Se

47) Which of the following bonds are polar? (a) B-F (b) Cl-Cl (c) Se-O (d) H-I

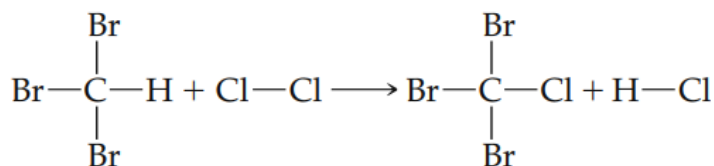
48) Describe the molecule xenon trioxide,  $\text{XeO}_3$ , using four possible Lewis structures, each with zero, one, two or three Xe-O double bonds.

(a) Do any of these Lewis structures satisfy the octet rule?

(b) Do any of these Lewis structures have multiple resonance structures? If so, which ones?

(c) Which of the four original Lewis structures yields the most favorable formal charges for the molecule?

49) Using Table 8.4 (ancillary materials), estimate the  $\Delta H$  for the following gas-phase reactions (formula:  $\Sigma$  bond broken –  $\Sigma$  bonds formed)



(a)

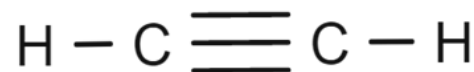
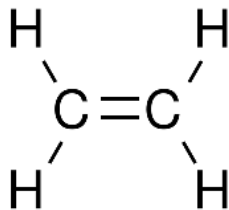
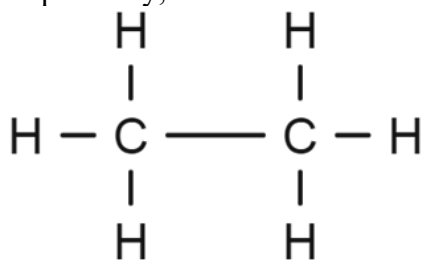
50) Use Table 9.2 & 9.3 (ancillary materials) and give the electron domain geometry and molecular geometry of the following molecules (complete the table)

<b>Molecule</b>	<b>Lewis Structure</b>	<b>electron-domain geometry</b>	<b>molecular geometry</b>
HCN			
SO <sub>3</sub> <sup>2-</sup>			
SF <sub>4</sub>			
PF <sub>6</sub> <sup>1-</sup>			

51) Predict whether the following molecules are polar or nonpolar:

<b>Molecule</b>	<b>Lewis Structure</b>	<b>Polarity</b>
CCl <sub>4</sub>		
NH <sub>3</sub>		
SF <sub>4</sub>		
XeF <sub>4</sub>		

52) Consider the Lewis structures for ethane (C<sub>2</sub>H<sub>6</sub>), ethylene (C<sub>2</sub>H<sub>4</sub>), and acetylene (C<sub>2</sub>H<sub>2</sub>) as shown, respectively, below.



(a) How many sigma and pi bonds are there in each molecule?

#### Unit 4: Solids, Liquids & Gases

##### *Formulas, Constants and Conversion Factors in Ancillary Materials*

53) Perform the following conversions: (a) 0.912 atm to torr, (b) 655 mm Hg to atm (c) 132.3 kPa to atm  
*Show your work*

54) A fixed quantity of gas at 21°C exhibits a pressure of 752 torr and occupies a volume of 5.12 L.

(a) Calculate the volume the gas will occupy if the pressure is increased to 1.88 atm while temperature is constant. *Show your work*

(b) Calculate the volume the gas will occupy if the temperature is increased to 175°C while the pressure is held constant. *Show your work*

55) Complete the following table for an ideal gas:

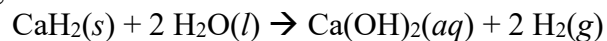
<b>P</b>	<b>V</b>	<b>n</b>	<b>T</b>
2.00 atm	1.00 L	0.500 mol	
0.300 atm	0.250 L		27°C

*Show your work*

56) Calculate the density of sulfur hexafluoride gas at 707 torr and 21°C. *Show your work*

(b) Calculate the molar mass of a vapor that has a density of 7.135 g/L at 12°C and 743 torr. *Show your work*

57) Calcium hydride,  $\text{CaH}_2$ , reacts with water to form hydrogen gas:



(a) How many grams of  $\text{CaH}_2$  are needed to prepare 145 L of  $\text{H}_2$  gas if the pressure of  $\text{H}_2$  is 825 torr and  $21^\circ\text{C}$ ?

*Show your work*

58) A mixture containing 0.765 mol  $\text{He}(g)$ , 0.330 mol  $\text{Ne}(g)$ , and 0.110 mol of  $\text{Ar}(g)$  is confined in a 10.00-L vessel at  $25^\circ\text{C}$ .

(a) Calculate the partial pressure of each of the gases in the mixture. *Show your work*

(b) Calculate the total pressure of the mixture. *Show your work*

59) Place the following gases in order of increasing average molecular speed at  $25^\circ\text{C}$ :  $\text{Ne}$ ,  $\text{HBr}$ ,  $\text{SO}_2$ ,  $\text{NF}_3$ ,  $\text{CO}$ .

(a) Calculate the root-mean-square speed ( $\mu_{\text{rms}} = \sqrt{\frac{3RT}{M}}$ ;  $M$  is molar mass;  $R = 8.31 \text{ kg}\cdot\text{m}^2/\text{s}^2\cdot\text{mol}\cdot\text{K}$ ) of  $\text{NF}_3$  molecules at  $25^\circ\text{C}$ . *Show your work*

60) List the three states of matter in order of

(a) increasing molecular disorder

(b) increasing intermolecular attraction

(c) Which state of matter is most easily compressed.

61) Which type of intermolecular attractions operates between

(a) all molecules

(b) polar molecules

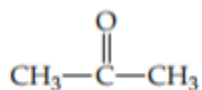
(c) the hydrogen atom of a polar bond with a nearby, small electronegative atom?

62) Which type of intermolecular forces accounts for each of these differences

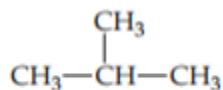
(a)  $\text{CH}_3\text{OH}$  boils at  $65^\circ\text{C}$  and  $\text{CH}_3\text{SH}$  boils at  $6^\circ\text{C}$

(b)  $\text{Xe}$  is a liquid at atmospheric pressure and 120 K whereas  $\text{Ar}$  is a gas under the same conditions

(c) acetone boils at  $56^\circ\text{C}$  whereas 2-methylpropane boils at  $-12^\circ\text{C}$ .



Acetone



2-Methylpropane

63) Use the vapor-pressure curves in Figure 11.25 (ancillary materials),

(a) estimate the boiling point of ethanol at a pressure of 200 torr

(b) estimate the pressure at which ethanol will boil at 60°C

64) Covalent bonding occurs in both molecular and covalent-network solids. Why do these two kinds of solids differ so greatly in their hardness and melting points?

65) What kinds of attractive forces exist between particles in

(a) molecular crystals

(b) covalent-network crystals

(c) ionic crystals

(d) metallic crystals?

66) Explain how the electron-sea model accounts for the high electrical and thermal conductivity of metals.

67) Both covalent-network solids and ionic solids can have melting points well in excess of room temperature, and both can be poor conductors of electricity in their pure form. However, in other ways their properties are quite different

(a) which type of solid is more likely to dissolve in water

(b) which type of solid can become an electrical conductor via chemical substitution?

68) In general, the attractive intermolecular forces between solvent and solute particles must be comparable or greater than solute-solute interactions for significant solubility to occur. Explain this statement in terms of the overall energetics of solution formation.

69) The solubility of  $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$  in water is 208 g per 100 g of water at  $15^\circ\text{C}$ . A solution of  $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$  in water at  $35^\circ\text{C}$  is formed by dissolving 324g in 100 g of water. When this solution is slowly cooled to  $15^\circ\text{C}$ , no precipitate forms

(a) what terms describes this solution?

(b) what action might you take to initiate crystallization?

70) Complete the following molarity calculations:

(a) a sulfuric acid solution contains 571.6 g per liter of solution, determine its molarity. *Show your work*

(b) calculate the number of moles of solute in 600 mL of 0.250 M  $\text{SrBr}_2$ . *Show your work*

(c) describe how you would prepare the following aqueous solution, starting with solid KBr:  
0.50 L of  $1.5 \times 10^{-2}$  M KBr

(d) calculate the molarity of a solution with a density of 0.876 g/mL contains 5.0 g of toluene ( $\text{C}_7\text{H}_8$ ) dissolved in 225 g of benzene ( $\text{C}_6\text{H}_6$ ) *Show your work*