

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 4 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/you tube 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) CaCl_2

_____ (b) CuCl_2

10) Name the following molecules:

_____ (a) N_2O_4

_____ (b) 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

(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

(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

(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 work below*

(a) 0.50 mol H_2O (b) 23 g Na (c) 6.0×10^{23} molecules N_2

22) Use the space/set up below 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 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 CO_2 are produced when 52.0 g of C_2H_2 burn?

(b) How many moles of H_2O are produced when 64.0 g of C_2H_2 burn?

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 C_2H_4 is reacted with 6.30 mol O_2 ,

(a) Identify the limiting reagent

(b) Calculate the mass of water produced

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

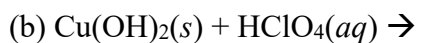
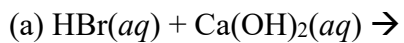
27) Write the balanced net ionic equation

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

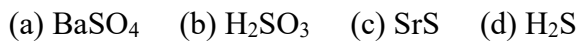
28) Classify the following as a nonelectrolyte, weak electrolyte, or strong electrolyte in water

(a) H_2SO_3 (b) HClO (c) NH_3 (d) LiClO_4

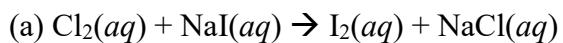
29) Complete and balance the molecular equations, then write the net-ionic equations for the following:



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



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

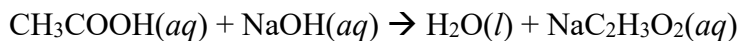


32) Calculate the

(a) molarity of a solution with 12.5 g Na_2CrO_4 in enough water to make 550 mL of solution.

(b) how many moles of KBr are present in 150 mL of a 0.275 M solution?

33) The distinctive odor of vinegar is due to acetic acid, CH_3COOH , 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?

Unit 3: Electrons, Periodicity, Bonding & Geometry

34) Wave calculations

(a) What is the frequency of radiation whose wavelength is 5.0×10^{-5} m?

(b) What part of the spectrum does this wave fall into?

(c) How far does this wave travel in 10.5 fs?

(d) Calculate and compare the energy of a photon of a wavelength of 3.3 μm (micrometers) with that of a wavelength of 0.154 nm.

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.

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	

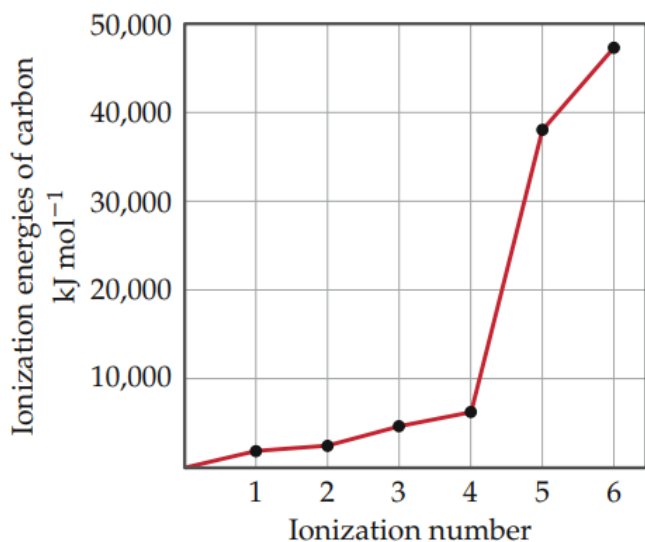
38) Identify the group of elements that corresponds to each of the following generalized electron configurations and indicate the number of unpaired electrons in each

- (a) [noble gas] $ns^2 np^5$
- (b) [noble gas] $ns^2 (n-1)d^2$
- (c) [noble gas] $ns^2 (n-1)d^{10} np^1$

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

45) Using Lewis symbols and Lewis structures, draw a molecule of (a) CCl_4 . (b) AsO_3^{3-} (c) 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

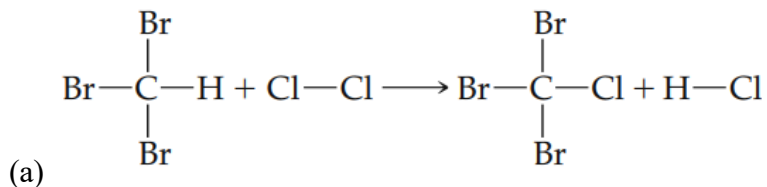
48) Describe the molecule xenon trioxide, XeO_3 , using four possible Lewis structures, each with zero, one, two or three Xe-O double bonds.

(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 ΔH for the following gas-phase reactions (formula: Σ bond broken $- \Sigma$ bonds formed)



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)

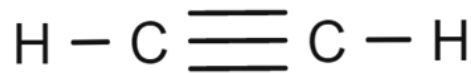
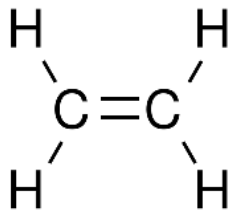
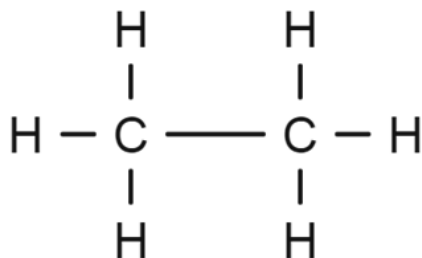
Molecule	Lewis Structure	electron-domain geometry	molecular geometry
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HCN			
SO ₃ ²⁻			
SF ₄			
PF ₆ ¹⁻			

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

Molecule	Lewis Structure	Polarity
CCl ₄		
NH ₃		
SF ₄		
XeF ₄		

52) Consider the Lewis structures for ethane (C₂H₆), ethylene (C₂H₄), and acetylene (C₂H₂) 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

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.

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

55) Complete the following table for an ideal gas:

P	V	n	T
2.00 atm	1.00 L	0.500 mol	
0.300 atm	0.250 L		27°C

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

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

57) Calcium hydride, CaH₂, reacts with water to form hydrogen gas:



(a) How many grams of CaH_2 are needed to prepare 145 L of H_2 gas if the pressure of H_2 is 825 torr and 21°C ?

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

(a) Calculate the partial pressure of each of the gases in the mixture.

(b) Calculate the total pressure of the mixture.

59) Place the following gases in order of increasing average molecular speed at 25°C : Ne , HBr , SO_2 , NF_3 , 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 NF_3 molecules at 25°C .

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

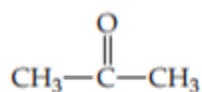
(c) the hydrogen atom of a polar bond with a nearby, small electronegative atom?

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

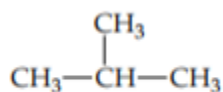
(a) CH_3OH boils at 65°C and CH_3SH boils at 6°C

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

(c) acetone boils at 56°C whereas 2-methylpropane boils at -12°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°C. A solution of $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ in water at 35°C is formed by dissolving 324g in 100 g of water. When this solution is slowly cooled to 15°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

(b) calculate the number of moles of solute in 600 mL of 0.250 M SrBr₂

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

(d) calculate the molarity of a solution with a density of 0.876 g/mL contains 5.0 g of toluene (C₇H₈) dissolved in 225 g of benzene (C₆H₆)