AP Chemistry Summary: Units 2 and 3

Ionic Bonding

1. What is an ionic bond?

2. Identify the ions present in the following ionic compounds.

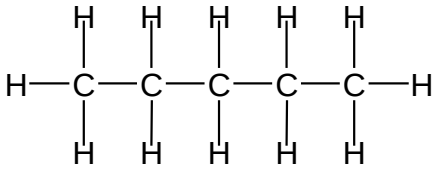
	Cation	Anion
$Mg(NO_3)_2$		
$Al_2(SO_4)_3$		
AlN		
Na_3P		
NH_4NO_2		

Covalent Bonding

3. What is a covalent bond?

4. What types of elements tend to form covalent bonds when they combine?

5. The structural formula of one isomer of pentane is shown below. Draw the structural formulas for the other two isomers of pentane. Be sure to include all atoms of hydrogen and carbon in your structures.



Lewis Structures, Shape and Hybridization

6. Complete this table.

Molecule or ion	Around the central atom					Lewis structure	Different molecule or ion with the same geometry
	# of bonding pairs (count multiple bonds as one pair)	# of Lone pairs	Atom geometry	Electron pair geometry	Hybridization		
PCl_6^-							
NH_4^+							
NO_3^-							
IBr_3							
CO_3^{2-}							

Sliding scale of bond type

7. Which of the following pairs of ionic compound would you expect to have the most covalent character? Why?

   $AlCl_3$ or NaCl _____ $BeCl_2$ or LiF _____

8. Using the electronegativities below, which of the following pairs of covalent compounds would you expect to exhibit the greater ionic character? Why?

   CH_4 or CO_2 _____ SO_2 or NO_2 _____

Element	Electronegativity
Carbon	2.5
Hydrogen	2.1
Sulfur	2.5
Oxygen	3.5
Nitrogen	3.0

Polarity

9. Complete the table by writing either YES or NO in each box.

	Polar Bonds?	Polar Molecule?
Carbon dioxide		
Boron trifluoride		
$CHCl_3$		
H_2		

Intermolecular Forces

10. What do you understand by the term “dipole?”

11. Describe hydrogen bonding.

12. State and explain the variation in one physical property that varies according to the amount of hydrogen bonding present.

13. Under what circumstances could a temporary dipole be induced in a molecule?

14. Butane, chloroethane, acetone, and 1-propanol all have approximately the same molecular weights. Data on their boiling points and solubilities in water are listed in the table below.

Compound	Formula	Boiling Pt.(°C)	Solubility in water
Butane	$CH_3CH_2CH_2CH_3$	0	Insoluble
Chloroethane	CH_3CH_2Cl	12	Insoluble
Acetone	$CH_3C(=O)CH_3$	56	completely miscible
1-Propanol	$CH_3CH_2CH_2OH$	97	completely miscible

On the basis of dipole moments (molecular polarities) and/or hydrogen bonding, explain in a qualitative way the differences in the following:

a. boiling points of butane and chloroethane

b. water solubilities of chloroethane and acetone

c. water solubilities of butane and 1-propanol

d. boiling points of acetone and 1-propanol.

15. Use the data in the table to answer the questions below:

Substance	Melting Point °C
H_2	-259
C_3H_8	-190
HF	-92
CsI	621
LiF	870
SiC	>2,000

a. Discuss how the trend in the melting points of the substances tabulated above can be explained in terms of the types of attractive forces and/or bonds in these substances.

b. For any pairs of substances that have the same kind(s) of attractive forces and/or bonds, discuss the factors that cause variations in the strengths of the forces and/or bonds.

Solids

16. In terms of its structure, explain the hardness of a diamond.

17. In terms of its structure, explain the fact that solid iodine will sublime.

18. When will ionic compounds conduct electricity? Explain.

19. What makes metals good conductors of electricity? Explain

Liquids & Gases

20. A liquid has a high vapor pressure. Explain what this suggests about its boiling point and the intermolecular forces present.

21. Explain the pattern of boiling points observed below, amongst the Group 16 hydrides.

22. Write mathematical expressions for the following gas laws. You should define all symbols and state any constant conditions. You must be able to derive these expressions from the ideal gas law.
    a. Boyle's
    b. Charles'
    c. Avogadro's
    d. Gay-Lussac's
    e. Combined
    f. Ideal

23. In gas law problems, the temperature should always be in what unit?

24. State a value of the gas law constant (R). Include units.

25. The gas laws can also be expressed graphically. Sketch the following plots for an ideal gas.
    a. V versus T, with p and n constant. At what value does the line you have drawn intercept the x-axis?
    b. P versus V, with T and n constant.

26. What pressure, in torr, would a sample of xenon gas exert if it were compressed from 4000.1 mL to 3002.0 mL at constant temperature, given that initially the pressure was 750.1 atm?

27. An almost empty aerosol can has an internal pressure of 1.030 atm when the temperature is 25.00°C. What would be the pressure in the can if it were placed in an incinerator for disposal, which would have the effect of raising the temperature inside the can to 1500.°C? Why is the incineration of aerosol cans not recommended?

28. In an industrial process, 200. L of a gas at 90.1 kPa and 21.0°C is compressed into a vessel that has a volume of 15.2 L and is heated to 420.°C. What is its final pressure?

29. Calculate the pressure inside a tube, given that the tube's volume is 5.0 L, its temperature is 23°C and it contains 0.010 mg of hydrogen gas.

30. Calculate the molar volume of an ideal gas at 1.00 atm and 25.0°C.

31. Re-write the ideal gas equation to make molar mass the subject of the equation.

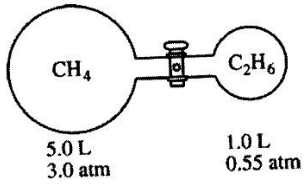
32. This question deals with gas mixtures.
    a. Write an equation for total pressure of a mixture of three gases, A, B and C, in terms of the partial pressure of the gases.
    b. Write an equation for the total pressure of a mixture of three gases in terms of moles of gas.

33. Small quantities of hydrogen gas can be prepared in the laboratory by the following reaction:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

In such an experiment, 454 mL of hydrogen gas were collected over water. The temperature of this gas mixture was 23.0°C and the total pressure was 712 mmHg. How many moles of hydrogen were collected? (The vapor pressure of water at 23.0°C is 19.8 mmHg.)

34. Two flasks are connected by a stopcock as shown below. The 5.0 L flask contains CH_4 at a pressure of 3.0 atm, and the 1.0 L flask contains $C_2H_{6(g)}$ at a pressure of 0.55 atm. Calculate the total pressure of the system after the stopcock is opened. Assume that the temperature remains constant.



35. A rigid 8.20 L flask contains a mixture of 2.50 moles of $H_{2(g)}$, 0.500 mole of $O_{2(g)}$, and sufficient argon so that the partial pressure of Ar in the flask is 2.00 atm. The temperature is 127 °C.
    a. Calculate the total pressure in the flask.

    b. Calculate the mole fraction of H_2 in the flask.

    c. Calculate the density (in g L^{-1}) of the mixture in the flask.

Calculations are not required for numbers 36 – 37.

36. In a given period of time, 0.21 mol of a gas of molar mass = 26 g mol^{-1} effuses. How many moles of ammonia vapor, NH_3 (more or less than 0.21 mol), would effuse in the same period of time. Explain.

37. Comment on the relative molar mass of a vapor that would effuse at a rate equal to 70.6% of the rate of a gas with a molar mass = 17.0 g mol^{-1}. Would the molar mass of the vapor be greater, equal to, or less than 17.0 g mol^{-1}?