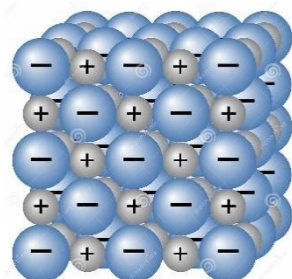


Name: _____

AP Chemistry Unit 2 Study Guide

1. Which of the following scientific claims about the bond in the molecular compound HF is most likely to be true?
 - a. There is a partial negative charge on the H atom.
 - b. Electrons are shared equally between the H and F atoms.
 - c. The bond is extremely weak.
 - d. The bond is highly polar.
2. Answer the following questions related to the chemical bonding in substances containing Cl.
 - a. What type of chemical bond is present in the Cl_2 molecule?
 - b. Cl_2 reacts with the element Sr to form an ionic compound. Based on periodic properties, identify a molecule, X_2 , that is likely to react with Sr in a way similar to how Cl_2 reacts with Sr. Justify your answer.
 - c. A graph of potential energy versus internuclear distance for two Cl atoms is given below. On the same graph, carefully sketch a curve that corresponds to the potential energy versus internuclear distance for two Br atoms.
- d. Draw a complete Lewis electron-dot diagram for the C_2Cl_4 molecule.
- e. Answer the following based on the diagram you drew for part d.
 - i. What is the hybridization on the diagram you drew in part d.
 - ii. What is the approximate chlorine-carbon-chlorine bond angle in C_2Cl_4 ?
 - iii. Is the C_2Cl_4 molecule polar?

3. Which of the following correctly indicates whether the solid represented by the particulate model shown below conducts electricity and explains why or why not?



- a. It conducts electricity because it is made of positive and negative ions.
 - b. It conducts electricity because it is made of particles of different sizes.
 - c. It does not conduct electricity because its ions cannot move freely within the solid.
 - d. It does not conduct electricity because there are small spaces between the particles.
4. The Lewis electron-dot diagram for C_2H_4 is shown below in the box on the left. In the box on the right, complete the Lewis electron-dot diagram for $\text{C}_2\text{H}_5\text{OH}$ (ethanol) by drawing in all of the electron pairs.

What is the approximate value of the C-O-H bond angle in the ethanol molecule?

5. Some binary compounds that form between fluorine and various nonmetals are listed in the table below. A student examines the data in the table and poses the following hypothesis: the number of F atoms that will bond to a nonmetal is always equal to 8 minus the number of valence electrons in the nonmetal atom.

Nonmetal	C	N	O	Ne	Si	P	S	Ar
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Formula of Compound	CF ₄	NF ₃	OF ₂	No compound	SiF ₄	PF ₃	SF ₂	No compound
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- Based on the student's hypothesis, what should be the formula of the compound that forms between chlorine and fluorine?
- In an attempt to verify the hypothesis, the student researches the fluoride compounds of the other halogens and finds the formula ClF₃. Draw a complete Lewis electron-dot diagram for a molecule of ClF₃.
- Two possible geometric shapes for the ClF₃ molecule are trigonal planar and T-shaped. The student does some research and learns that the molecule has a dipole moment. Which of the two shapes is consistent with the fact that the ClF₃ molecule has a dipole moment? Justify your answer in terms of bond polarity and molecular structure.
- In an attempt to resolve the existence of the ClF₃ molecule with the hypothesis stated above, the student researches the compounds that form between halogens and fluorine, and assembles the following list.

Halogen	Formula(s)
F	F ₂
Cl	
Br	BrF, BrF ₃ , BrF ₅
I	IF, IF ₃ , IF ₅ , IF ₇

Based on the concepts of atomic structure and periodicity, propose a modification to the student's previous hypothesis to account for the compounds that form between halogens and fluorine.

- Answer the following questions related to HF and the titration of HF_(aq).
 - Draw the complete Lewis electron-dot diagram of the HF molecule.
 - The net ionic equation of the titration of HF_(aq) with NaOH_(aq) can be written in particulate form. Using the following key, draw the correct products above their formulas.

7. The potential energy as a function of internuclear distance for three diatomic molecules, X_2 , Y_2 , and Z_2 , is shown in the graph below.

Based on the data in the graph, which of the following correctly identifies the diatomic molecules, X_2 , Y_2 , and Z_2 ?

- | | | |
|----------------|-------------|-------------|
| a. $X_2 = H_2$ | $Y_2 = N_2$ | $Z_2 = O_2$ |
| b. $X_2 = H_2$ | $Y_2 = O_2$ | $Z_2 = N_2$ |
| c. $X_2 = N_2$ | $Y_2 = O_2$ | $Z_2 = H_2$ |
| d. $X_2 = O_2$ | $Y_2 = H_2$ | $Z_2 = N_2$ |
8. Answer the following questions in terms of principles of chemical bonding and intermolecular forces. In each explanation where a comparison is to be made, a complete answer must include a discussion of both substances. The following complete Lewis electron-dot diagrams may be useful in answering parts of this question.

- a. Indicate the hybridization of the carbon atom in each of the following:
- Methanol
 - Methanoic (formic) acid
- b. Draw the complete Lewis electron-dot diagram for a molecule of propanoic acid, $\text{HC}_3\text{H}_5\text{O}_2$.
- c. Explain the following observations about the two carbon-oxygen bonds in the methanoate (formate) anion, HCO_2^- . You may draw a Lewis electron-dot diagram (or diagrams) of the methanoate ion as part of your explanations.
- The two carbon-oxygen bonds in the methanoate (formate) anion, HCO_2^- , have the same length.
 - The length of the carbon-oxygen bonds in the methanoate (formate) anion, HCO_2^- , is intermediate between the length of the carbon-oxygen bond in methanol and the length of the carbon-oxygen bond in methanal.
9. Steel is an alloy consisting of Fe with a small amount of C. Elemental Cr can be added to steel to make the steel less likely to rust; Cr atoms react with oxygen in the air to form a nonreactive layer of chromium oxide on the surface of the steel, preventing the oxidation of underlying Fe atoms. A sample of steel-chromium alloy contains 15 percent Cr by mass. Which of the following diagrams best shows a particle-level view of the surface section and an interior section of the alloy represented below at the left? (The atomic radii of the atoms involved are given in the table at the right.)

10. For the parts of the free response question that require calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Examples and equations may be included in your answers where appropriate. The following questions relate to sulfur and some of its compounds.
- Write the balanced equation for the combustion of $S_{8(s)}$ to form $SO_{2(g)}$.
 - A student claims that the combustion of S_8 is an oxidation-reduction reaction. Justify the claim by identifying the oxidation numbers of sulfur and oxygen both before and after the reaction.
 - Draw a Lewis electron-dot diagram for one valid resonance structure of SO_2 .
 - Based on the diagram you drew in part (c), what is the approximate oxygen-sulfur-oxygen bond angle in SO_2 ?
11. The electron-dot structure (Lewis structure) for which of the following molecules would have two unshared pairs of electrons on the central atom?
- H_2S
 - NH_3
 - CH_4
 - HCN
 - CO_2
12. The melting point of MgO is higher than that of NaF . Explanations for this observation include which of the following?
- Mg^{2+} is more positively charged than Na^+ .
 - O^{2-} is more negatively charged than F^- .
 - The O^{2-} ion is smaller than the F^- ion.
- II only
 - I and II only
 - I and III only
 - II and III only
 - I, II, and III

13. Which of the following is an isomer of CH_3OCH_3 ?

- a. CH_3CH_3
- b. CH_3COOH
- c. $\text{CH}_3\text{CH}_2\text{OH}$
- d. $\text{CH}_3\text{CH}_2\text{CH}_3$
- e. $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$

14. Answer the following questions about elements in Group 16 of the periodic table.

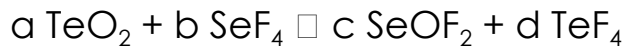
- a. Using the principles of atoms structure, explain why the atomic radius of Te is less than the ionic radius of Te^{2-} .
- b. Photoelectron spectroscopy data for the 1s sublevel of Te and the 1s sublevel of O are represented below. In terms of Coulomb's law and atomic structure, explain why the peak for O is positioned so far to the right of the peak for Te.

c. Which structure, B, C, or D, minimizes the formal charge for each atom in SeO_2F_2 ? Justify your choice.

d. A student proposes that the energy of the Se – to – F bond in the structure in diagram A is equal to that of the Se – to – F bond in the structure in diagram D. Do you agree or disagree with the student's claim? Justify your answer.

e. The dipole moment of the SeF_4 molecule (diagram E) is nonzero. Identify its molecular geometry and explain how its geometry and the polarity of its bonds result in a nonzero dipole moment.

- f. TeO_2 reacts with SeF_4 to produce SeOF_2 and TeF_4 . The unbalanced chemical equation for the reaction appears below.



Give the value of each of the following coefficients in the balanced equation.

a =

b =

c =

d =

15. Answer the following questions related to CO_2 .

- a. Two possible Lewis electron-dot diagrams for CO_2 are shown above.

Explain in terms of formal charges why diagram Z is the better diagram.

- b. Identify the hybridization of the valence orbitals of the C atom in the CO_2 molecule represented in diagram Z.

16. A Lewis diagram for the molecule C_2H_4 is shown below. In the actual C_2H_4 molecule, the H-C-H bond angles are closest to

- a. 90°
- b. 109.5°
- c. 120°
- d. 180°

17. While investigating the properties of other diatomic molecules, the student finds the diagram below, which shows the potential energy of two nitrogen atoms versus the distance between their nuclei. The student incorrectly sketches the potential energy curve for two fluorine atoms, shown by the dotted line in the diagram. Explain the error with the student's sketch for $\text{F}_{2(g)}$.

18. What is the hybridization of the carbon atoms in a molecule of ethyne, represented below?



- a. sp b. sp^2 c. sp^3 d. dsp^2 e. d^2sp

Questions 19 – 21 refer to the below molecules:

- b. CO_2 b. H_2O c. CH_4 d. C_2H_4 e. PH_3

19. The molecule with the largest dipole moment
20. The molecule with only one double bond
21. The molecule that has trigonal pyramidal geometry
22. Using the information in the table below, answer the following questions about organic compounds.

Compound Name	Compound Formula	$\Delta H_{\text{vap}}^\circ$ (kJ mol ⁻¹)
Propane	$\text{CH}_3\text{CH}_2\text{CH}_3$	19.0
Propanone	CH_3COCH_3	32.0
1-propanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	47.3

- a. For propanone,
i. draw the complete structural formula (showing all atoms and bonds);
ii. predict the approximate carbon-to-carbon bond angle.
b. Draw the complete structural formula for an isomer of the molecule you drew in part (a)(i).
c. Given the structural formula for propyne below,

- i. indicate the hybridization of the carbon atom indicated by the arrow in the structure above;
- ii. indicate the total number of sigma (σ) bonds and the total number of pi (π) bonds in the molecule.

23. According to the VSEPR model, the progressive decrease in the bond angles in the series of molecules CH_4 , NH_3 , and H_2O is best accounted for by the

- a. increasing strength of the bonds
- b. decreasing size of the central atom
- c. increasing electronegativity of the central atom
- d. increasing number of unshared pairs of electrons
- e. decreasing repulsion between hydrogen atoms

24. Which of the following has a zero dipole moment?

- a. HCN
- b. NH_3
- c. SO_2
- d. NO_2
- e. PF_5

25. The student claims that C is reduced when $\text{C}_2\text{H}_6\text{O}$ is converted to $\text{C}_2\text{H}_4\text{O}$.

Do you agree or disagree? Justify your answer in terms of oxidation numbers.

