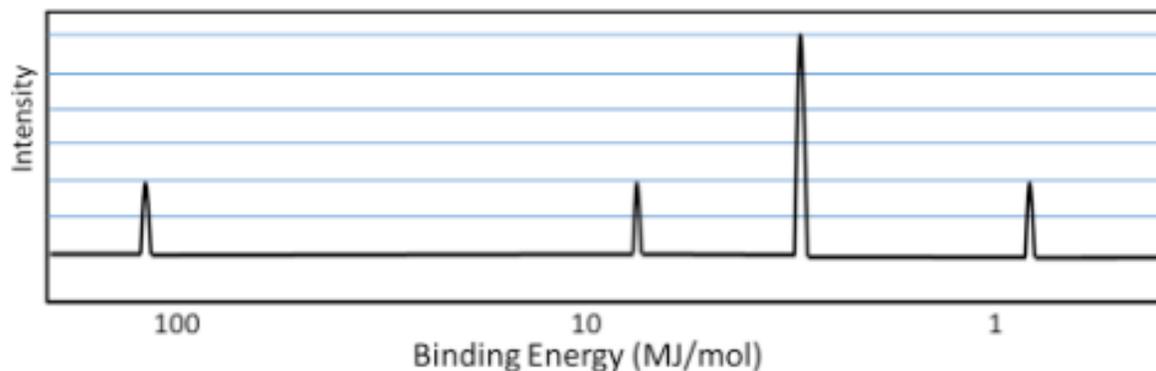


**ADVANCED PLACEMENT CHEMISTRY
CHAPTERS 7, 8 AND 9 REVIEW QUESTIONS**

1. What is the minimum wavelength (in nm) of a photon of light that can excite an electron in the hydrogen atom from the $n = 1$ to the $n = 8$ energy level?
2. A carbon-oxygen double bond in a certain organic molecule absorbs radiation that has a frequency of $6.0 \times 10^{13} \text{ s}^{-1}$.
 - a) What is the wavelength of this radiation?
 - b) To what region of the spectrum does this radiation belong?
 - c) What is the energy of this radiation per photon? Per mole of photons?
 - d) A carbon-oxygen bond in a different molecule absorbs energy with frequency equal to $5.4 \times 10^{13} \text{ s}^{-1}$. Does this radiation give more or less energy?
3. Which of the following is true concerning energy levels in the H atom?
 - a) A transition from $n = 5$ to $n = 3$ involves greater energy than one from $n = 4$ to $n = 2$.
 - b) A transition from $n = 4$ to $n = 2$ will emit radiation of longer wavelength than one from $n = 5$ to $n = 1$.
 - c) All transitions from states for which $n > 1$ to the $n = 1$ state involve the absorption of energy by the atom.
 - d) A transition from $n = 2$ to $n = \text{infinity}$ corresponds to the ionization energy of the H atom.
 - e) All of the above statements are false.
4. How many electrons can be contained in all of the orbitals with $n = 4$?
5. Give electron configurations for the following elements:
 - a) Br
 - b) Ba
 - c) Bi
 - d) Bk
6. Draw orbital diagrams for the following elements:
 - a) Si
 - b) Cu
 - c) Ag
 - d) Cr
7. Order the following groups from smallest to largest radius.
 - a) Ar, Cl^- , K^+ , S^{2-}
 - b) C, Al, F, Si
 - c) Na, Mg, Ar, P
 - d) I^- , Ba^{2+} , Cs^+ , Xe
8. Order the atoms in each of the following sets from the least exothermic electron affinity to the most.
 - a) S, Se
 - b) F, I, Br, Cl
9. Which of the following bonds would be the least polar?
 - a) H-F
 - b) Ca-F
 - c) I-F
 - d) O-F

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10. Use the photoelectron spectrum below to answer the following questions.



- Give the electron configuration and identify the element.
- Draw the photoelectron spectrum of aluminum superimposed on this diagram. Explain the reasons for your diagram.
- Draw the photoelectron spectrum of the ion of this element superimposed on this diagram. Explain the reasons for your diagram. (Use a separate version from part b)
- What is another term for binding energy?
- Why is the distance from 1 to 10 equal to the distance from 10 to 100 for the binding energy?
- Describe the process of photoelectron spectroscopy.

Consider the following orders for questions 11 and 12:

- $\text{Al} < \text{Si} < \text{P} < \text{Cl}$
- $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr}$
- $\text{I} < \text{Br} < \text{Cl} < \text{F}$
- $\text{Na}^+ < \text{Mg}^{2+} < \text{Al}^{3+} < \text{Si}^{4+}$

- Which of these give(s) a correct trend in size?
 - I
 - II
 - III
 - IV
 - II, IV
- Which of these give(s) a correct trend in ionization energy?
 - III
 - I, II
 - I, IV
 - I, III, IV
 - none of the above
- Which of the following statements is FALSE?
 - Ionization energies are always positive.
 - For any atom with at least two electrons, the first ionization energy is always smaller than the second ionization energy.
 - Electron affinities are usually negative.
 - Electron affinities decrease steadily in magnitude when going from left to right across the periodic table.
 - All are true.

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14. Which of the following do not have a molecular dipole moment?
HCl, CO, NCl₃, BCl₃, NO₂, PF₅, SO₂, HCN
15. There are several oxides of nitrogen; among the more common are N₂O, NO, NO₂, N₂O₄.
- Write the Lewis structures of these molecules.
 - Which of these molecules "violate" the octet rule?
 - Draw resonance structures for N₂O.
 - Describe each of the bonds in N₂O₄ as being polar or nonpolar. In the polar bonds, which atom acts as the positive dipole?
 - How would you expect the nitrogen to oxygen bond length in NO to compare to the average bond length in NO₂?
 - Calculate ΔH for the following reactions using bond energies.
$$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$$

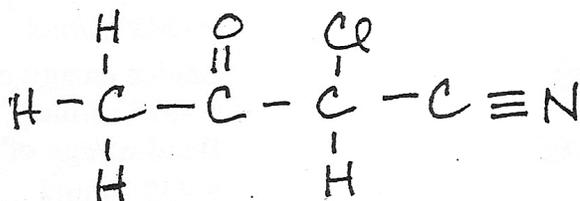
$$2\text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$$
16. A certain element reacts with chlorine to form a compound (XCl₃) that is a gas at 85 °C and 1.00 atm with a density of 4.66 g/L.
- What is the molar mass of the gas?
 - Identify the element involved.
 - Draw the Lewis structure of the molecule, state the geometry, and the ideal bond angle.
17. Order the following species with respect to carbon-oxygen bond length (longest to shortest).
CO, CO₂, CO₃²⁻, CH₃OH
18. Use bond energy values to calculate ΔH for the reaction of ethyne and hydrogen to form ethene.
19. Calculate the N₂ bond energy given the following information:
 $\Delta H_f^\circ \text{NH}_3 = -46.0 \text{ kJ/mol}$
N-H bond energy = 391 kJ/mol
H-H bond energy = 432 kJ/mol
20. Draw Lewis structures of the following, state the molecular geometry and ideal bond angle, and determine the polarity of all molecules.
- ICN
 - GaCl₄⁻
 - NH₂⁻
 - CSe₂
 - SeF₆
 - ClF₄⁺
 - SCl₄
 - H₂Se
 - XeO₄
 - TeCl₂
 - H₃O⁺
 - SbF₅
 - BrF₆⁺
 - IF₂⁻
 - AsF₃
21. Which of the following are nonlinear?
NO₂⁻, C₂H₂, N₃⁻, HCN, O₃, H₂O₂
22. Which of the following molecules have all of their atoms in the same plane?
C₂H₄, F₂O, H₂CO, NH₃, CO₂, BeCl₂, SiH₄

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23. A molecule has the condensed structural formula of $\text{CH}_3(\text{CH}_2)_3\text{CHCHCOCHNH}$. Using what you know about the number of bonds each element is expected to form,
- draw the structure of the molecule.
 - determine the number of single bonds in this molecule.
 - determine the number of multiple bonds in this molecule.
 - determine the number of sigma and pi bonds in this molecule.
24. Draw two equivalent resonance structures for the NO_2^- ion.
25. Use formal charge to determine the preferred Lewis structure of
- the thiocyanate ion.
 - dinitrogen oxide
26. Which of the following ionic compounds has the largest lattice energy?
 CsI , LiI , LiF , CsF , MgO , MgF_2 , BaO
27. Which of the following sets has elements with most nearly the same atomic radius?
- Cr, Mn, Fe, Co
 - Mg, Ca, Sr, Ba
 - Ne, Ar, Kr, Xe
 - Be, B, C, N
 - C, P, Se, I
28. One of the following compounds has a carbon-nitrogen bond length of 1.16 Å; the other has a carbon-nitrogen bond length of 1.47 Å. Match a bond length with each compound.
 CH_3NH_2 , CH_3CN
29. Which of the following is NOT assumed in the VSEPR theory?
- Lone pair electrons exert a stronger repulsive effect on adjacent electron pairs than do bonding pairs.
 - Multiple bonds do not affect the gross stereochemistry of the molecule.
 - Electron pairs in the valence shell of an atom are arranged around that atom in such a way as to minimize the repulsion.
 - The core electrons do not influence the shape of the molecule.
 - All of the above are correct assumptions of VSEPR theory.
30. Which of the following exhibit resonance?
 PF_5 , HNO_3 , SO_2 , NCl_3 , N_3^-
31. Which of the molecules below contains a central atom with sp^2 hybridization?
- | | |
|----------------------------|------------------|
| I) NH_2^+ | a) I and IV |
| II) BF_3 | b) II and IV |
| III) PH_3 | c) I, IV, and V |
| IV) N_2H_4 | d) I and II |
| V) BeCl_2 | e) I, II and III |

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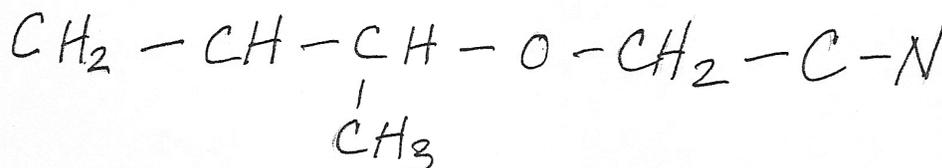
32. Which molecule contains the shortest C-C bond?
- C_2H_2
 - C_2H_4
 - C_2H_6
 - C_2Cl_4
 - two answers have the shortest comparable C-C bond
33. Which of the following is/are INCORRECT?
- The hybridization of SO_3 is sp^2 .
 - The molecule XeF_4 is nonpolar.
 - The bond order of N_2 is three.
 - The molecule HCN has two pi bonds and two sigma bonds.
- 2 is incorrect
 - 1 and 4 are incorrect
 - 1 and 3 are incorrect
 - 2, 3, and 4 are incorrect
 - all four statements are correct
34. Consider the following molecule and determine the hybridization of the specified atom



- What is the hybridization of the carbon atom that is double bonded to oxygen?
 - What is the hybridization of the carbon atom that is bonded to chlorine?
 - What is the hybridization of the nitrogen atom?
 - What is the hybridization of the oxygen atom?
35. In which of the compounds below is there more than one kind of hybridization for carbon?
- $CH_3CH_2CH_2CH_3$
 - $CH_3CH=CHCH_3$
 - $CH_2=CH-CH=CH_2$
 - C_2H_2
- II and III
 - II only
 - III and IV
 - I and IV
 - III

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36. Complete the Lewis structure and determine the number of sigma and pi bonds in the following molecule.



37. You are given the following information:

Heat of sublimation of Li = +161 kJ/mol

Bond Energy of HCl = +427 kJ/mol

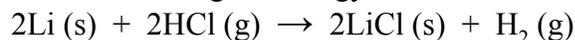
Ionization Energy of Li = +520 kJ/mol

Electron Affinity of Cl = -349 kJ/mol

Lattice energy of LiCl (s) = -829 kJ/mol

Bond energy of H₂ = 432 kJ/mol

Calculate the net change in energy for the reaction:



(You must write equations for each process and validate that they cancel to give the final equation)

ADDITIONAL PROBLEMS

1. Name the 4 ways we have learned to determine the ΔH of a reaction: How does the use of the values for products and reactants compare (where appropriate)?
2. List the regions of the electromagnetic spectrum and the wavelengths of radiation associated with each region. (Do not memorize this, simply interpret the EM spectrum)
3. Of the following types of radiation, which of the following have a greater wavelength greater than that of visible blue light: visible green, infrared, visible red, ultraviolet, x-rays?
4. Of the following types of radiation, which of the following have greater energy than that of visible blue light: visible green, infrared, visible red, ultraviolet, x-rays ?
5. Red light with a wavelength of 670.8 nm is emitted when lithium is heated in a flame.
 - a) What is the frequency of this radiation?
 - b) What is the energy of this radiation per photon? per mole of photons?
6. How much energy is required to ionize a mole of hydrogen atoms?

