

University of Kentucky

Department of Chemistry

READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!

It is *extremely* important that you fill in the answer sheet EXACTLY as indicated, otherwise your test may not be processed; ALL entries are to be made on SIDE 1 of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete. Use only the following categories:

NAME:	Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the <u>correct</u> circles below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.
STUDENT NUMBER:	This is <u>VERY IMPORTANT!</u> Under IDENTIFICATION NUMBER, put in your 8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number) beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking "0" for "1").
TEST FORM:	Fill in the "1" blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination I).
SPECIAL CODES:	Use for course and section number; in positions K-P write in one of the following: Dr. Ades 107-001, 107-002
SIGNATURE:	You <u>MUST</u> sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.

Answering Questions:

Starting with answer "1" on SIDE 1, fill in the circle indicating the one best answer for each of the 25 questions in this examination. Your score is the sum of the appropriate credit for each response. The day after the examination is finished, an examination key will be posted on Blackboard.

Grading and Reporting:

The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has been made in scoring your answers, tell your instructor within 48 hours of the posting of your score.

<p><u>BE SURE THAT YOUR TEST HAS 25 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER.</u> You may <u>NOT</u> use your own scratch paper during this examination. Cell phones and pagers are to be turned off and out of sight during the exams.</p>

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1. The basis of the **VSEPR** theory of molecular bonding is _____.
- A. atomic orbitals of the bonding atoms must overlap for a bond to form
 - B. electron clouds in the valence shell will arrange themselves to minimize repulsions
 - C. electron clouds in the valence shell of an atom must overlap for a bond to form
 - D. regions of electron density on an atom will organize themselves to maximize *s*-character
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2. Which of the following have tetrahedral **electron-pair** geometry?



- A. NH_2^- and PCl_3
 - B. PCl_3 and SO_3
 - C. SO_3 and BrF_3
 - D. NH_2^- and BrF_3
-

3. Which of the following have bent **molecular** geometry?

- A. NO_2^- and ICl_2^-
 - B. ICl_2^- and HCN
 - C. HCN and OF_2
 - D. NO_2^- and OF_2
-

4. The molecular compound XY_3 is polar? Which of the following **electron-pair** geometries is/are possible? (X is the central atom.)

trigonal planar tetrahedral trigonal bipyramidal

- A. trigonal planar and tetrahedral
 - B. tetrahedral and trigonal bipyramidal
 - C. trigonal bipyramidal
 - D. trigonal planar
-

5. The molecular geometry of IF_5 is _____ and this molecule is _____.

- A. trigonal bipyramidal, polar
 - B. trigonal bipyramidal, nonpolar
 - C. square pyramidal, nonpolar
 - D. square pyramidal, polar
-

6. What is the hybridization of Xe in XeF₂?

- | | |
|-----------|--------------|
| A. sp^2 | C. sp^3d |
| B. sp^3 | D. sp^3d^2 |

7. The nitrogen-nitrogen bond in FNNF consists of

- A. one sigma (σ) and one pi (π) bond.
B. one sigma (σ) and 2 pi (π) bonds.
C. two sigma (σ) bonds.
D. one sigma (σ) bond.

8. Which of the following are true after sp^2 hybridization of the carbon atom?

1. There are three equal energy hybrid orbitals and one unhybridized p orbital.
2. There are three unpaired electrons total.
3. There are hybrid orbitals of three distinctly different energies
4. The carbon atom can form 4 bonds.

- | | |
|------------|------------|
| A. 1 and 2 | C. 3 and 4 |
| B. 2 and 3 | D. 1 and 4 |

9. Which of the following types of overlap are possible for H₂C=C=CH₂?

1. sp with sp^2
2. p with p
3. sp with sp
4. sp^2 with sp^2

- | | |
|------------|------------|
| A. 1 and 2 | C. 3 and 4 |
| B. 2 and 3 | D. 1 and 4 |
-

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10. Which of the following are **correct** statements about molecular orbital theory?
1. Molecular orbitals are formed by the combination of atomic orbitals on one atom.
 2. When two atomic orbitals on adjacent atoms are combined, two molecular orbitals of different energies are formed.
 3. The combination of two *s* atomic orbitals on adjacent atoms produces one bonding σ orbital and one antibonding σ orbital.
 4. When *p* orbitals on adjacent atoms are combined, only π orbitals can be formed.
- A. 1 and 2 C. 3 and 4
B. 2 and 3 D. 1 and 4
-

11. What is the bond order of CN^- ? (Use the order of orbital filling for lithium through nitrogen.)
- A. 2 C. 3
B. 3/2 D. 5/2
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12. Which have two unpaired electrons according to molecular orbital theory?
- A. C_2 and F_2 C. C_2 and O_2
B. B_2 and O_2 D. B_2 and F_2
-

13. Which of the following exhibits both dispersion and dipole-dipole forces in the condensed phases?
- A. SF_6 C. CO_2
B. PF_5 D. CH_2Cl_2
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14. Which of the following have the species with the **higher** boiling point listed **first**?
1. HCl , HF 2. CH_3F , CH_3Br 3. N_2H_4 , O_2 4. H_2O , Cl_2
- A. 1 and 2 C. 3 and 4
B. 2 and 3 D. 1 and 4
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15. Which is a **reasonable** explanation of why $\text{H}_2\text{O}(\text{s})$ is less dense than $\text{H}_2\text{O}(\text{l})$?
- A. Water has a very low surface tension which leads to low density.
 - B. The intermolecular forces between water molecules are too weak to hold the water molecules close together.
 - C. Water is extensively hydrogen-bonded which leads to a very open crystal structure in the solid state.
 - D. Solids are rigid and the molecules can't get close together.
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16. _____ are particularly polarizable.

- A. Small nonpolar molecules
 - B. Large polar molecules
 - C. Large nonpolar molecules
 - D. Large molecules regardless of their polarity
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17. An oxide of rhenium crystallizes in a cubic structure with Re atoms on all corners and oxygen atoms on all edges of the crystal. What is the empirical formula of the oxide?

- A. ReO_3
 - B. ReO
 - C. Re_2O_3
 - D. Re_3O_4
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18. An unknown element crystallizes in a body-centered cubic (bcc) lattice with an edge length of 531 pm and a density equal to 0.867 g/cm^3 . What is the molar mass of the element?

- A. 78.2 g/mol
 - B. 156 g/mol
 - C. 39.1 g/mol
 - D. 117 g/mol
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19. A solid is soft and has a low melting point. The substance does not conduct electricity when melted or dissolved in water. Which of the following is most likely this substance?

- A. sulfur
 - B. platinum
 - C. boron (B_{12})
 - D. ammonium nitrate
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20. When X-rays of wavelength 0.154 nm are diffracted by a metallic crystal, the angle of first-order diffraction is found to be 28.3° . What is the distance, in pm, between the layers responsible for the diffraction?

- A. 325 pm
B. 162 pm
C. 81.2pm
D. 243 pm

21. The vapor pressure of any substance at its normal boiling point is

- A. 1 torr
B. Equal to atmospheric pressure
C. 1 atm
D. Equal to the vapor pressure of water

22. Diethyl ether has a vapor pressure of 401 mmHg at 18°C and a heat of vaporization of 26.0 kJ/mol. Estimate the normal boiling point of the diethyl ether.

- A. 291°C
B. 48.5°C
C. 86.4°C
D. 36.4°C

23. The slope of a plot of the natural log of the vapor pressure of dichloromethane versus $1/T$ was determined to be -3773 K^{-1} . What is the heat of vaporization of dichloromethane?

- A. -319.5 kJ/mol
B. -4538 kJ/mol
C. 31.37 kJ/mol
D. 3773 kJ/mol

24. The vapor pressure of a species increases as the temperature _____ and the strength of the intermolecular forces _____.

- A. increases, increase
B. increases, decreases
C. decreases, decreases
D. decreases, increases

25. How much heat is needed to sublime 75.0 g of solid dry ice (CO_2) at its sublimation temperature? The heat of sublimation for carbon dioxide is 32.3 kJ/mol.

- A. 55.1 kJ
B. 23.2 kJ
C. $2.42 \times 10^3\text{ kJ}$
D. 102 kJ
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