

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 answer sheet 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 circles</u> below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.
STUDENT NUMBER:	This is <b>VERY IMPORTANT!</b> Under IDENTIFICATION NUMBER, put in your <b>8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number)</b> 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 "4" blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination IV).
SPECIAL CODES:	Use for course and section number; in positions K-P write in one of the following:  <div style="text-align: center;">           Dr. Woodrum            105-001, 105-005            Dr. Guzman            105-002            Dr. Soult                105-003, 105-004            Dr. Ladipo              105-006            Dr. Kuhler              105-007            Dr. Holler              105-401         </div>
SIGNATURE:	You <b>MUST</b> 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 **30 questions** in this examination. Your score is the sum of the appropriate credit for each response. On the day following the examination, 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 occurred in scoring your answers, inform your instructor within 48 hours of the posting of your score.

**BE SURE THAT YOUR TEST HAS 60 QUESTIONS, A PERIODIC TABLE, AND TWO SHEETS OF SCRATCH PAPER.** You may **NOT** use your own scratch paper during this examination. Cell phones, computer, and pagers are to be turned off and out of sight during the exam. **All** exam paper, scratch paper, and scantrons must be handed in at the end of the exam. You may **not** take any exam materials away from the exam room.

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**Questions 1 – 15 cover Exam I material**

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1. Which of the following is an example of a chemical property?
- A. The tendency of methanol to burn.
  - B. The odor of paint thinner.
  - C. The dissolution of sugar in water.
  - D. A platinum ring becomes dull because of continued abrasion.
- 
2. The SI prefixes *milli* and *mega* represent, respectively:
- A.  $10^6$  and  $10^{-6}$
  - B.  $10^{-3}$  and  $10^6$
  - C.  $10^3$  and  $10^{-6}$
  - D.  $10^{-3}$  and  $10^9$
- 
3. Express  $5.00 \times 10^{-2}$  m in standard notation using the correct number of significant figures.
- A. 0.05 cm
  - B. 50 mm
  - C. 50.0 mm
  - D. 500 m
- 
4. A metal cube has an edge length of 11.4 mm and a mass of 4.00 g. Calculate the density of the metal?
- A.  $3.51 \text{ g/cm}^3$
  - B.  $0.64 \text{ g/cm}^3$
  - C.  $3.08 \text{ g/cm}^3$
  - D.  $2.70 \text{ g/cm}^3$
- 
5. Carry out the following operations and express the answer with the correct number of significant figures.
- $(3.2 \times 29.78) / 3.10 =$
- A. 30.6
  - C. 30.7
-

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B. 31

D. 30.64

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6. What is the volume, in cubic centimeters, of a brick that is 12.0 in.  $\times$  20. mm  $\times$  2.0 cm?

A. 10 cm<sup>3</sup>

C. 120 cm<sup>3</sup>

B. 48 cm<sup>3</sup>

D. 480 cm<sup>3</sup>

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7. J. J. Thompson's work with the cathode ray tube determined

A. that electrons carry a negative charge.

C. that electrons are quantized in energy.

B. the mass of an electron.

D. the charge on an electron in coulombs.

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8. Which of the following statements about subatomic particles is **true**?

A. Protons and electrons have nearly identical masses.

B. The charge of the proton and the electron are equal in magnitude but opposite in sign.

C. The mass of the electron is approximately 1 amu.

D. A sample of matter composed of only electrons would have attractive forces and be stable.

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9. A magnesium ion, Mg<sup>2+</sup>, has

A. 12 protons and 13 electrons.

C. 12 protons and 14 electrons.

B. 24 protons and 26 electrons.

D. 12 protons and 10 electrons.

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10. What is the total number of moles of atoms in a mixture of 3.0 grams of iron and 3.0 grams of aluminum?

A. 0.13 mol

C. 0.074 mol

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B. 0.22 mol

D. 0.16 mol

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11. How many silver atoms are there in a 21.3-g ring of pure silver?

A.  $1.19 \times 10^{23}$  silver atoms

C.  $1.21 \times 10^{23}$  silver atoms

B.  $1.14 \times 10^{23}$  silver atoms

D.  $6.51 \times 10^{22}$  silver atoms

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12. Which of the following statements is **true**?

A. A sodium atom will transfer an electron to a chlorine atom and form an ionic bond.

B. A sodium atom will share an electron with a chlorine atom and form an ionic bond.

C. A sodium atom will transfer an electron to a chlorine atom and form a covalent bond.

D. A sodium atom will share an electron with a chlorine atom and form a covalent bond.

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13. What is the formula for the ionic compound that forms between aluminum and chlorine?

A.  $\text{Al}_2\text{Cl}_3$

C.  $\text{AlCl}_3$

B.  $\text{AlCl}_2$

D.  $\text{Al}_2\text{Cl}$

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14. Which of the following is the correct name for  $\text{FePO}_4$ ?

A. Iron(I) phosphate

C. Iron(II) phosphide

B. Iron(III) phosphate

D. Iron phosphorus tetroxide.

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15. Which of the following compounds is named **incorrectly**?

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A.  $\text{P}_2\text{O}_5$ , diphosphorus pentoxide

C.  $\text{Cl}_2\text{O}_7$ , dichlorohexoxide

B.  $\text{P}_4\text{O}_{10}$ , tetraphosphorus decoxide

D.  $\text{SO}_2$ , sulfur dioxide

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**Questions 16 – 30 cover Exam II material**

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16. How many atoms of carbon are in 100.0 g of propane ( $\text{C}_3\text{H}_8$ )?

A.  $4.11 \times 10^{24}$  atoms

C.  $7.95 \times 10^{27}$  atoms

B.  $1.37 \times 10^{24}$  atoms

D.  $1.81 \times 10^{26}$  atoms

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17. What is the mass of nitrogen in 7.5 g of  $\text{Ca}(\text{NO}_3)_2$ ?

A. 1.3 g

C. 0.15 g

B. 0.64 g

D. 1.15 g

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18. When the equation for the reaction between solid silicon dioxide and solid carbon to produce solid silicon carbide and carbon monoxide gas is balanced with the lowest whole numbers, what is the coefficient of solid carbon?

A. 2

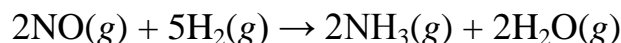
C. 3

B. 4

D. 5

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19. What mass of  $\text{H}_2$  will react with 15.0 g of  $\text{NO}$  according to the following reaction? The molar masses of  $\text{NO}$  and  $\text{H}_2$  are 34.00 g/mol and 2.003 g/mol, respectively.



A. 37.9 g

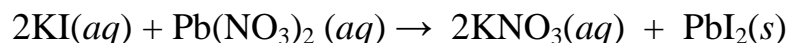
C. 0.895 g

B. 2.21 g

D. 0.335 g

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20. Potassium iodide reacts with lead(II) nitrate according to the reaction:



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What mass of  $\text{PbI}_2$  will form when an aqueous solution containing 12.7 g of  $\text{KI}$  is added to an

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aqueous solution containing 10.8 g of  $\text{Pb}(\text{NO}_3)_2$ ? Molar masses:  $\text{PbI}_2 = 461.0 \text{ g/mol}$ ,  $\text{KI} = 166.0 \text{ g/mol}$ ,  $\text{Pb}(\text{NO}_3)_2 = 331.2 \text{ g/mol}$ .

- A. 15.0 g                                    C. 35.3 g  
B. 30.0 g                                    D. 17.9 g
- 

21. What volume of 0.100 M NaCl contains 0.0100 moles of the solute?

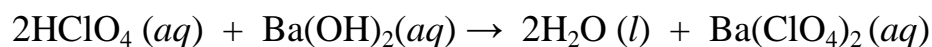
- A. 1.00 mL                                    C. 0.100 L  
B. 10.0 mL                                    D. 0.0100 mL
- 

22. Which of the following aqueous solutions will result in the formation of a precipitate when combined?

- A.  $\text{LiNO}_3$  and  $\text{Ca}(\text{OH})_2$                                     C.  $\text{Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$  and  $\text{NH}_4\text{NO}_3$   
B.  $\text{K}_2\text{S}$  and  $\text{CaNO}_3$     D.  $\text{CaCl}_2$  and  $\text{K}_2\text{SO}_4$
- 

23. A 35.00 mL sample of a solution of  $\text{HClO}_4$  requires titration with 23.10 mL of 0.220 M  $\text{Ba}(\text{OH})_2$  to reach the equivalence point. What is the concentration of the  $\text{HClO}_4$  solution?

The neutralization reaction is



- A. 0.145 M                                    C. 0.0726 M  
B. 0.290 M                                    D. 0.667 M
- 

24. The oxidation number of chromium in  $\text{Rb}_2\text{Cr}_2\text{O}_7$  is

- A. +4.    C. +6.  
B. +5.    D. +7.
- 

25. A 3.0-mole sample of nitrogen gas with a volume of 1.5 L is added to a 2.5-mol sample of oxygen gas. Both samples and the final mixture are at constant temperature and pressure. What is the volume of the combined gases?

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- A. 5.0 L  
B. 2.8 L
- C. 1.8 L  
D. 3.3 L
- 

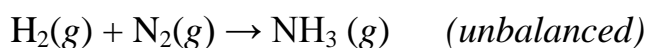
26. The label on most aerosol cans warns against incineration, that is, disposal by burning. Which of the following uses the properties of gases to explain this warning?

- A. At constant pressure and number of moles, as the temperature increases, the volume will decrease. The can could be crushed, lose a seal, and leak its contents.
- B. The fire used in incineration may cause a chemical reaction with the contents of the aerosol can. This could lead to a deadly poison and leak from the can.
- C. At constant volume and number of moles, as the temperature increases the pressure will increase. The can could explode due to this high pressure.
- D. As the temperature increases for any substance, the number of moles will increase. The can may not be able to handle the increased number of moles and may explode.
- 

27. A 7.85-L tire contains 0.498 moles of gas at a temperature of 278 K. What is the pressure of the gas in the tire?

- A. 1450 mmHg  
B.  $1.10 \times 10^3$  mmHg
- C.  $21.3 \times 10^2$  mmHg  
D.  $1.18 \times 10^3$  mmHg
- 

28. Balance the equation below, and predict the total volume of the system after 9.0 L of  $\text{H}_2$  reacts quantitatively with 5.0 L of  $\text{N}_2$  at  $400^\circ\text{C}$ . The volume of the reaction container is variable, and the pressure and temperature are constant throughout the course of the reaction.



- A. 2.0 L  
B. 3.0 L
- C. 6.0 L  
D. 8.0 L
- 

29. For a system that releases 550 J of heat ( $q$ ) and does 240 J of work ( $w$ ) on its surroundings, the sign for  $q$  is \_\_\_\_\_ and the sign for  $w$  is \_\_\_\_\_.

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- A. negative; negative  
B. negative; positive  
C. positive; negative  
D. positive; positive
- 

30. A gas is allowed to expand, at constant temperature, from a volume of 1.0 L to 10.1 L against an external pressure of 0.50 atm. If the gas absorbs 250 J of heat from the surroundings, what is the value of  $\Delta E$ ?

- A. -710 J  
B. 710 J  
C. -210 J  
D. 210 J
- 

**Questions 31 – 45 cover Exam III material**

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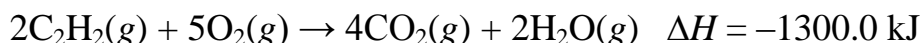
31. A 45.3-g copper rod initially at 87.4 °C is submerged into 37.8 g of water at 19.5 °C . What is the final temperature of both substances at thermal equilibrium? Assume that the copper rod and the water are thermally isolated from everything else.  
( $C_{s, \text{Cu}} = 0.385 \text{ J/g} \cdot ^\circ\text{C}$  and  $C_{s, \text{H}_2\text{O}} = 4.18 \text{ J/g} \cdot ^\circ\text{C}$  )

- A. 11.5 °C  
B. 32.3 °C  
C. 26.2 °C  
D. 53.4 °C
- 

32. An exothermic reaction only occurs

- A. when bonds in the reactants are broken.  
B. when bonds in the products are formed.  
C. when the energy required to break the bonds of the reactants is larger in magnitude than the energy of bonds formed in the products.  
D. when the energy required to break the bonds of the reactants is smaller in magnitude than the energy of bonds formed in the products.
- 

33. Given the following thermochemical equation, how much heat is released when 50.0 grams of acetylene,  $\text{C}_2\text{H}_2$ , undergoes combustion? The molar mass of  $\text{C}_2\text{H}_2$  is 26.04 g/mol.





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A.  $6.29 \times 10^2$  kJ

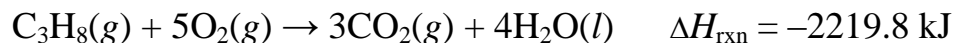
B. 3.29 J

C.  $2.41 \times 10^3$  kJ

D.  $1.25 \times 10^3$  kJ

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34. What is  $\Delta H_f^\circ$  for propane ( $C_3H_8$ ) given the following information?



$\Delta H_f^\circ(CO_2(g)) = -393.5 \text{ kJ/mol}$

$\Delta H_f^\circ(H_2O(l)) = -285.8 \text{ kJ/mol}$

A.  $-103.9 \text{ kJ/mole}$

B.  $103.9 \text{ kJ/mole}$

C.  $-1540.5 \text{ kJ/mol}$

D.  $1540.5 \text{ kJ/mol}$

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35. Calculate the wavelength (in km) of our local Lexington radio station WLXG AM broadcasting at 1300 kHz.

A.  $2.31 \times 10^{-1} \text{ km}$

B.  $8.61 \times 10^{-2} \text{ km}$

C.  $4.33 \times 10^{-3} \text{ km}$

D.  $3.48 \times 10^{-4} \text{ km}$

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36. What is the energy in joules of one photon of microwave radiation with a wavelength 0.122 m?

A.  $2.70 \times 10^{-23} \text{ J}$

B.  $5.43 \times 10^{-33} \text{ J}$

C.  $4.07 \times 10^{-21} \text{ J}$

D.  $1.63 \times 10^{-24} \text{ J}$

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37. What is the value of  $l$  (angular momentum quantum number) for a  $p$  orbital?

A. 0

B. 1

C. 2

D. 3

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38. When  $l = 2$ , which of the following cannot be a possible value for  $m_l$ ?

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A. 3

C. -1

B. 2

D. 1

---

39. Calculate the wavelength of the radiation that is absorbed by a hydrogen atom when its electron makes the transition from the  $n = 1$  to the  $n = 4$  level.

A. 97.2 nm

C. 275 nm

B. 10.7 nm

D. 2040 nm

---

40. Electrons in the ground state of an atom occupy orbitals so as to

A. maximize the energy of the atom.

B. fill a sublevel with the same set of four quantum numbers.

C. fill the  $(n-1)d$  sublevel prior to the  $ns$  shell of the atom.

D. minimize the energy of the atom.

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41. Which element has the electron configuration  $[\text{Ne}]3s^23p^5$ ?  
 $[\text{Ne}]3s^23p^5$

A. Fluorine

C. Oxygen

B. Chlorine

D. Argon

---

42. What is the electron configuration of bromine?

A.  $1s^22s^22p^5$

C.  $1s^22s^22p^63s^23p^64s^23d^54p^65s^24d^2$

B.  $1s^22s^22p^63s^23p^64s^23d^{10}4p^5$

D.  $1s^22s^22p^63s^23p^64s^23d^94p^6$

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43. Which of the following elements has the greatest effective nuclear charge?

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A. Cl

B. S

C. Cs

D. I

---

44. What is the ground state electron configuration of  $\text{Sb}^{3+}$ ?

A.  $[\text{Kr}]5s^24d^{10}5p^3$

B.  $[\text{Kr}]5s^24d^75p^3$

C.  $[\text{Kr}]5s^24d^{10}$

D.  $[\text{Kr}]5s^24d^{10}5p^6$

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45. Which of these elements has the smallest first ionization energy?

A. Na

B. K

C. Be

D. Cl

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**Questions 46 – 60 cover the material after Exam III**

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46. The electron dot structure for  $\text{AsCl}_3$  shows

A. three single bonds and one lone pair.

B. one single bond, two double bonds, and 8 lone pairs.

C. three single bonds and 10 lone pairs.

D. two single bonds, one double bond, and 9 lone pairs.

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47. Which one of the following compounds would you predict will have the **largest** lattice energy?

A.  $\text{Na}_2\text{S}$

B. NaF

C. MgS

D. CaS

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48. Predict which compound has the largest electronegativity difference from their positions in the periodic table?

A. NO

C. HI

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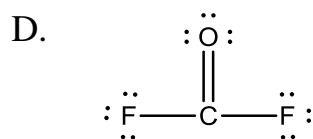
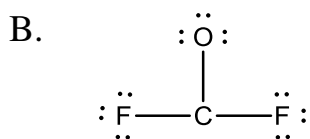
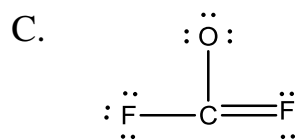
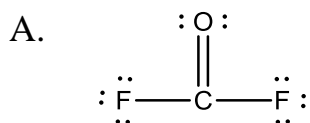
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B. CsF

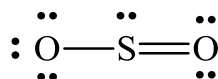
D. LiBr

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49. Which of the following is the **best** Lewis structure for CF<sub>2</sub>O? Use formal charges, if necessary.



50. What is the formal charge on sulfur in the following Lewis structure?



A. +1

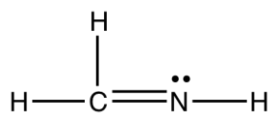
C. 0

B. -1

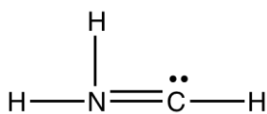
D. +2

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51. Calculate the formal charges of the carbon and nitrogen atoms present in the Lewis structures (**I** and **II**) shown below. Which Lewis structure is better?



**I**



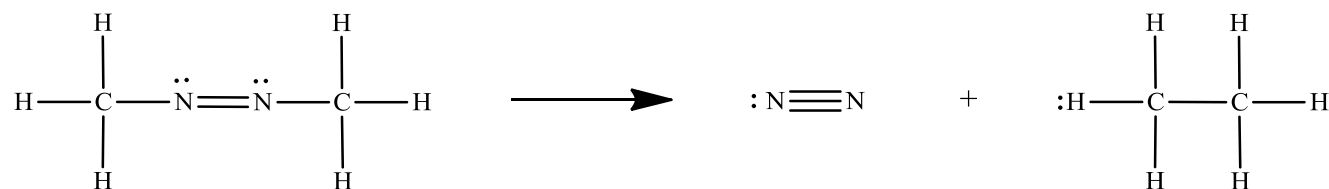
**II**

- A. **I** is the better Lewis structure because the C and N atoms have +1 and -1 formal charges, respectively
- B. **II** is the better Lewis structure because the C and N atoms each have a formal charge of 0.
- C. **I** is the better Lewis structure because the C and N atoms each have a formal charge of 0.
- D. **II** is the better Lewis structure because the C and N atoms have +1 and -1 formal charges, respectively
-

52. Which molecule has a Lewis structure that **does not** obey the octet rule?

- A.  $N_2O$                                       C.  $PH_3$   
 B.  $CS_2$                                         D.  $NO_2$

53. When heated, azomethane decomposes into nitrogen gas and methane gas.



Calculate an estimate of the enthalpy of this reaction.

Bond	Bond Enthalpy (kJ/mol)	Bond	Bond Enthalpy (kJ/mol)
C-H	413	N-N	163
C-N	305	N=N	418
C-C	346	N $\equiv$ N	945

- A. -609 kJ/mol                                      C. -462 kJ/mol  
 B. -583 kJ/mol                                      D. -263 kJ/mol

54. Write the Lewis structure for each molecule in the series below and order them in order of increasing carbon-carbon bond length.



- A.  $H_3CCH_3 < H_2CCH_2 < HCCH$                                       C.  $HCCH < H_2CCH_2 < H_3CCH_3$   
 B.  $H_2CCH_2 < HCCH < H_3CCH_3$                                       D.  $HCCH < H_3CCH_3 < H_2CCH_2$

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55. What is the electron pair geometry of  $\text{CCl}_4$ ?

- A. Square planar  
B. Tetrahedral  
C. Octahedral  
D. Trigonal pyramid

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56. Which of the following compounds has the same molecular geometry as its electron pair geometry?

- A.  $\text{SO}_2$   
B.  $\text{NH}_3$   
C.  $\text{H}_2\text{O}$   
D.  $\text{NH}_4^+$

---

57. Which one of the following molecules adopts tetrahedral geometry and is polar?

- A.  $\text{CCl}_4$   
B.  $\text{CHBr}_3$   
C.  $\text{SF}_3\text{Cl}$   
D.  $\text{ICl}_4^-$

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58. Which one of the following best describes the bond in  $\text{F}_2$  using valence bond theory?

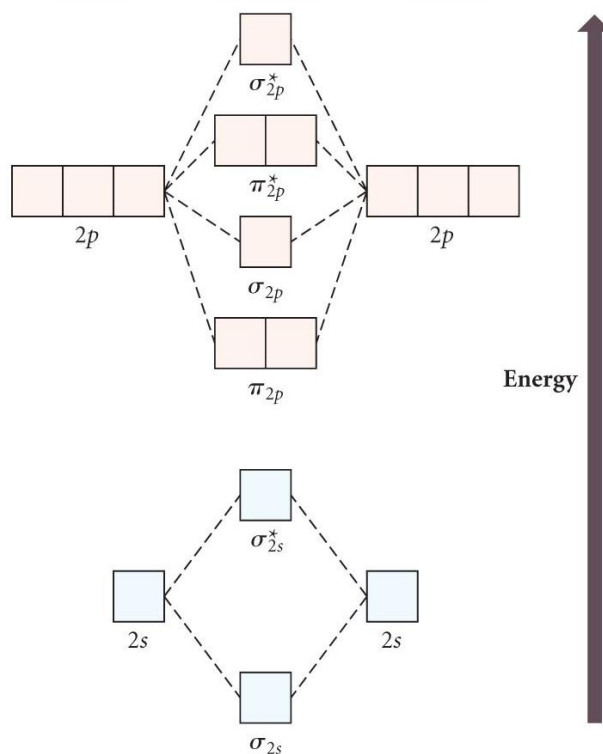
- A. The end-to-end overlap of a  $2p$  orbital of one fluorine atom with a  $2p$  orbital of the other fluorine atom.  
B. The sideways overlap of a  $2p$  orbital of one fluorine atom with a  $2p$  orbital of the other fluorine atom.  
C. The overlap of a  $2s$  orbital of one fluorine atom with a  $2s$  orbital of the other fluorine atom.  
D. The overlap of a  $2s$  orbital of one fluorine atom with the  $2p$  orbital of the other fluorine atom.

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59. What is the bond order of  $\text{F}_2^{2-}$ ?

- A. 0  
B.  $\frac{1}{2}$   
C. 1  
D. 2
-

60. Complete the molecular orbital diagram for the  $N_2^+$  ion and choose the FALSE statement.



- A. The bond order of  $N_2^+$  is 2.5.
- B. The  $N_2^+$  ion is paramagnetic.
- C. The Bond order is lower than in the  $N_2$  molecule.
- D. The  $N_2^+$  ion is diamagnetic.

CHE 105 FALL 2011 Final Exam Key

1. A
2. B
3. C
4. D
5. B
6. C
7. A
8. B
9. D
10. D
11. A
12. A
13. C
14. B
15. C
16. A
17. A
18. C
19. B
20. A
21. C
22. D
23. B
24. C
25. B
26. C
27. B
28. D
29. A
30. C
31. C
32. D
33. D
34. A
35. A
36. D
37. B
38. A
39. A
40. D
41. B
42. B
43. A



- 44. C
- 45. B
- 46. C
- 47. C
- 48. B
- 49. A
- 50. A
- 51. C
- 52. D
- 53. D
- 54. C
- 55. B
- 56. D
- 57. B
- 58. A
- 59. A
- 60. D