

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 "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: <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Dr. Woodrum</td> <td>105-001, 105-002</td> </tr> <tr> <td>Mr. Harris</td> <td>105-003, 105-006</td> </tr> <tr> <td>Dr. Ades</td> <td>105-004</td> </tr> <tr> <td>Dr. Knecht</td> <td>105-005</td> </tr> <tr> <td>Dr. Testa</td> <td>105-008, 105-009</td> </tr> <tr> <td>Dr. Guzman</td> <td>105-401</td> </tr> </table>	Dr. Woodrum	105-001, 105-002	Mr. Harris	105-003, 105-006	Dr. Ades	105-004	Dr. Knecht	105-005	Dr. Testa	105-008, 105-009	Dr. Guzman	105-401
Dr. Woodrum	105-001, 105-002												
Mr. Harris	105-003, 105-006												
Dr. Ades	105-004												
Dr. Knecht	105-005												
Dr. Testa	105-008, 105-009												
Dr. Guzman	105-401												
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 **60 questions** in this examination. Your score is the sum of the appropriate credit for each response. Soon 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.

BE SURE THAT YOUR TEST HAS 60 QUESTIONS, A PERIODIC TABLE, AND ONE SHEET OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones and pagers are to be turned off and out of sight during the exams. **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.

Questions 1 thru 15 cover the material after Exam III.

1. A covalent double bond contains how many electrons?

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

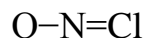
2. Which compound below contains the most polar bond?

- A. Cl_2
B. NaCl
C. MgS
D. FrF

3. How many single and double bonds are in the most stable resonance structure of NO_3^- ?

- A. 3 single bonds, 0 double bond
B. 0 single bond, 3 double bonds
C. 1 single bond, 2 double bonds
D. 2 single bonds, 1 double bond

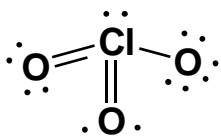
4. What are the formal charges on O, N, and Cl in the Lewis structure below? Only the bonds are shown; lone pair are not shown.



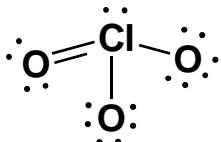
- A. $\text{O} = -1$; $\text{N} = 0$; $\text{Cl} = +1$
B. $\text{O} = +1$; $\text{N} = -1$; $\text{Cl} = 0$
C. $\text{O} = -1$; $\text{N} = +1$; $\text{Cl} = -2$
D. $\text{O} = -1$; $\text{N} = +2$; $\text{Cl} = -1$

5. Using formal charges, which one of the following Lewis structures is correctly drawn for the ClO_3^- ion? The electronegativity values for Cl and O are 3.0 and 3.5, respectively.

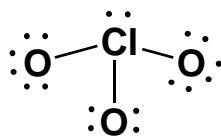
A.



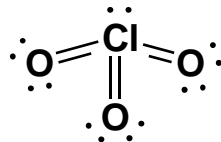
B.



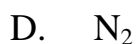
C.



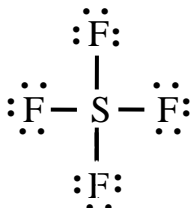
D.



6. When drawing Lewis structures, which one of the following compounds violates the octet rule?



7. What is wrong with the structure of SF_4 below, if anything?



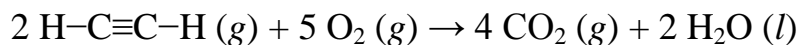
A. The Lewis structure is correct.

B. There should be a lone pair of electrons on S.

C. There should be a double bond between S and F.

D. One of the F atoms should be the central atom in order to have the correct formal charges.

8. Using average bond energies, calculate ΔH_{rxn} for the combustion of acetylene, shown in the reaction below.



Bond	Bond Energy (kJ/mol)
C-H	414
C-C	347
C≡C	837
O=O	498
C=O in CO_2	79
O-H	464

A. -1500. kJ

C. -2428 kJ

B. -3256 kJ

D. -4918 kJ

9. What is the molecular geometry of PF₅?

- A. octahedral
B. trigonal bipyramidal
C. tetrahedral
D. trigonal pyramidal

10. What is the molecular geometry of the sulfite ion?

- A. trigonal planar
B. tetrahedral
C. trigonal pyramidal
D. T-shaped

11. Which one of the following molecules has a permanent dipole moment?

- A. H₂
B. CH₂Cl₂
C. XeF₂
D. BF₃

12. Which of the following describes the bond formed between oxygen and fluorine in the OF₂ molecule? Please note that in this structure oxygen is the central atom.

- A. overlap of an *sp* orbital on fluorine with an *sp* orbital on oxygen
B. overlap of a *p* orbital on fluorine with an *sp*³ orbital on oxygen
C. overlap of an *p* orbital on fluorine with an *sp*² orbital on oxygen
D. overlap of an *sp* orbital on fluorine with a *p* orbital on oxygen

13. A molecule containing a central atom with *sp*² hybridization has which one of the following electron geometries?

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

14. Which of the following statements is TRUE?

- A. The total number of molecular orbitals formed does not always equal the number of atomic orbitals combined.
- B. In H_2 molecules, the two $1s$ orbitals combine constructively, which results in one bonding orbital and one nonbonding orbital
- C. Electrons placed in antibonding orbitals stabilize the species.
- D. When filling degenerate π orbitals, electrons will fill the orbitals singly, and with parallel spin, before pairing.

15. Using Molecular Orbital Theory, determine the bond order for O_2^{2-} .

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

Questions 16 thru 30 cover Exam I material.

16. Which one of the following describes a chemical property of matter?

- A. A piece of paper floats on water.
- B. Sulfur is yellow.
- C. A piece of paper spontaneously burns at 452°F .
- D. Sodium metal can be cut with a knife.

17. How many picometers are present in 1.00 m ?

- A. 1.00×10^{12}
- B. 1.00×10^9
- C. 1.00×10^{15}
- D. 1.00×10^6

18. Determine the volume of an object that has a mass of $4.556 \times 10^2\text{ g}$ and a density of 19.3 g/cm^3 .

- A. $8.79 \times 10^2\text{ mL}$
 - B. $2.36 \times 10^1\text{ mL}$
 - C. $2.36 \times 10^2\text{ mL}$
 - D. $8.79 \times 10^3\text{ mL}$
-

19. How many significant figures are in the answer to the following calculation?

$$\frac{32.4 + 1.3}{21.7}$$

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

20. How many mL are contained in $3.77 \times 10^4 \text{ mm}^3$?

- A. $3.77 \times 10^1 \text{ mL}$
B. $5.23 \times 10^1 \text{ mL}$
C. $4.39 \times 10^{-2} \text{ mL}$
D. $9.42 \times 10^3 \text{ mL}$

21. Which one of the following statements correctly describes Millikan's contribution to modern atomic theory?

- A. He used the cathode ray tube experiment to measure the charge-to-mass ratio of the electron.
B. He theorized that atoms combine in simple, whole-number ratios to form compounds.
C. He used the oil drop experiment to measure the charge of the electron.
D. He used the gold foil experiment to theorize that protons exist in an atoms nucleus.

22. Which statement is FALSE with regard to protons, neutrons and electrons?

- A. Protons and electrons have the same magnitude of charge but opposite in sign.
B. Electrons were the first subatomic particle discovered.
C. Protons and neutrons are located in the nucleus.
D. Protons and electrons have approximately the same mass.

23. Which of the following is the correct symbol for a species with a mass number of 54, 30 neutrons and 21 electrons?

- A. ^{54}Zn
B. $^{54}\text{Cr}^{3+}$
C. $^{54}\text{Ca}^{2+}$
D. $^{54}\text{Cl}^{-}$
-

24. Predict the charge on the monoatomic ions formed by aluminum.

- A. +3
B. -5
C. -3
D. +5

25. How many atoms are contained in 193.9 g of strontium?

- A. 2.213×10^{24} atoms
B. 1.333×10^{24} atoms
C. 1.332×10^{-24} atoms
D. 3.675×10^{-24} atoms

26. What is the empirical formula of glucose? The molecular formula of glucose is $C_6H_{12}O_6$.

- A. $C_6H_{12}O_6$
B. $C_2H_4O_2$
C. $C_3H_6O_3$
D. CH_2O

27. Which one of the following chemical species is a molecular compound?

- A. ZnO
B. P_4O_{10}
C. SrF_2
D. LiOH

28. Write the formula for the compound formed when magnesium reacts with oxygen.

- A. Mg_2O
B. MgO_2
C. Mg_2O_2
D. MgO

29. What is the name of the chemical compound with a molecular formula N_2O_5 .

- A. nitrogen oxide
B. nitrogen (V) oxide
C. dinitrogen pentoxide
D. nitrogen (II) oxide
-

30. Calculate the molar mass of sodium carbonate.

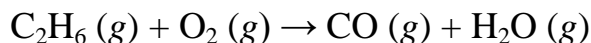
- A. 106.0 g/mol
B. 82.99 g/mol
C. 89.98 g/mol
D. 122.0 g/mol

Questions 31 thru 45 cover Exam II material.

31. How many atoms of oxygen are in 47.6 g of $\text{Al}_2(\text{CO}_3)_3$? The molar mass of $\text{Al}_2(\text{CO}_3)_3$ is 233.99 g/mol.

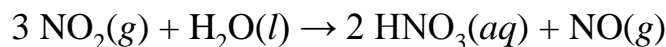
- A. 1.23×10^{23} O atoms
B. 2.96×10^{24} O atoms
C. 2.87×10^{25} O atoms
D. 1.10×10^{24} O atoms

32. When gaseous ethane (C_2H_6) is reacted with gaseous oxygen to form carbon monoxide gas and water vapor in the reaction below, what is the coefficient on CO when the reaction is properly balanced?



- A. 4
B. 2
C. 3
D. 5

33. Consider the following balanced chemical equation. How many grams of water (molar mass = 18.02 g/mol) are required to form 151.8 g of HNO_3 (molar mass = 63.01 g/mol)? Assume that NO_2 (molar mass = 46.01 g/mol) is in excess.



- A. 76.0 g H_2O
B. 21.7 g H_2O
C. 43.4 g H_2O
D. 86.8 g H_2O
-

-
34. When 4.0 moles of CaCO_3 are heated, it decomposes to produce 2.9 moles of CaO according to the reaction below. What is the percent yield of CaO ?



- A. 29% C. 73%
B. 40% D. 1.4%
-

35. What is the concentration of a solution prepared by diluting 25.0 mL of a stock 0.188 M $\text{Ca}(\text{NO}_3)_2$ solution to 150.0 mL.

- A. 1.13 M C. 0.0887 M
B. 0.0313 M D. 0.0199 M
-

36. How many moles of solute are required to make 250. mL of a 3.00 M aqueous NaCl solution?

- A. 0.750 moles C. 0.250 moles
B. 3 moles D. 750 moles
-

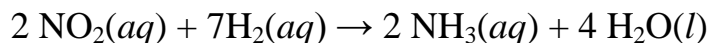
37. Write the molecular equation for the precipitation reaction that occurs (if any) when solutions of calcium nitrate and ammonium sulfate are mixed.

- A. $\text{Ca}(\text{NO}_3)_2(aq) + (\text{NH}_4)_2\text{SO}_4(aq) \rightarrow 2 \text{NH}_4\text{NO}_3(s) + \text{CaSO}_4(aq)$
B. $2 \text{Ca}(\text{NO}_3)_2(aq) + 2 (\text{NH}_4)_2\text{SO}_4(aq) \rightarrow 4 \text{NH}_4\text{NO}_3(aq) + \text{CaSO}_4(s)$
C. $\text{Ca}(\text{NO}_3)_2(aq) + (\text{NH}_4)_2\text{SO}_4(aq) \rightarrow 2 \text{NH}_4\text{NO}_3(aq) + \text{CaSO}_4(s)$
D. No reaction occurs.
-

38. Calculate the molarity of a NaOH solution if 26.7 mL of 0.10 M HCl is required to completely neutralize 25.0 mL of the NaOH solution.

- A. 9.4 M C. 0.11 M
B. 0.10 M D. 0.093 M
-

39. Which compound is the oxidizing agent in the following reaction?



- A. NO_2 C. NH_3
B. H_2 D. H_2O

40. What will the volume of a balloon be at 1.0 atm, if the same balloon has a volume of 7.6 L at 3.8 atm?

- A. 5.0 L C. 17 L
B. 35 L D. 29 L

41. Which of the following will have the greatest volume at STP?

- A. 22 g CO C. 22 g He
B. 22 g O_2 D. 22 g Cl_2

42. What is the molar mass of a gas whose density is 0.841 g/L at 415 K and 725 torr?

- A. 25.3 g/mol C. 1.52 g/mol
B. 32.0 g/mol D. 30.0 g/mol

43. A mixture of N_2 , O_2 and Ar has mole fractions of 0.25, 0.65, and 0.10, respectively, for each gas. What is the pressure of N_2 if the total pressure of the mixture is 3.9 atm?

- A. 0.98 atm C. 0.67 atm
B. 0.39 atm D. 1.3 atm
-

44. Calculate the change in internal energy (ΔE) for a system that absorbs 32.0 kJ of heat and does 655 J of work on the surroundings.

- A. -32.7 kJ
B. -31.3 kJ
C. 32.7 kJ
D. 31.3 kJ

45. Calculate the amount of heat required to raise the temperature of a 79.0 g sample of ethanol from 298.0 K to 385.0 K. The specific heat capacity of ethanol is 2.42 J/g °C.

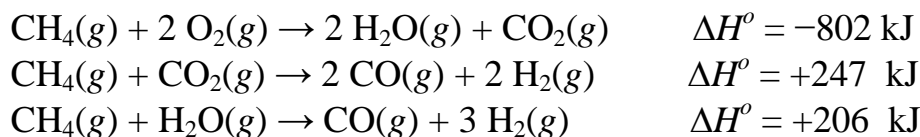
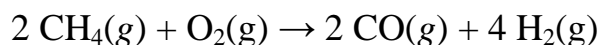
- A. 57.0 kJ
B. 16.6 kJ
C. 73.6 kJ
D. 28.4 kJ

Questions 46 thru 60 cover Exam III material.

46. Which statement is FALSE?

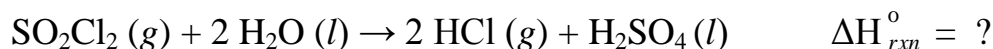
- A. An exothermic reaction gives off heat to the surroundings.
B. Enthalpy is the sum of a system's internal energy and the product of pressure times volume.
C. The total energy of the universe is constantly changing.
D. ΔH_{rxn} is the heat of reaction.

47. Calculate ΔH° for the following reaction using the data listed below



- A. -71.5 kJ
B. -349 kJ
C. 843 kJ
D. -47.3 kJ
-

-
48. Use the ΔH_f° information provided below to calculate the ΔH_{rxn}° for the following reaction:



ΔH_f° (kJ/mol)

$\text{SO}_2\text{Cl}_2 (g)$ -364

$\text{H}_2\text{O} (l)$ -286

$\text{HCl} (g)$ -92

$\text{H}_2\text{SO}_4 (l)$ -814

A. -62.0 kJ

C. +161 kJ

B. -256 kJ

D. -422 kJ

49. What is the wavelength of the blue light emitted by a mercury lamp with a frequency of 6.88×10^{14} Hz?

A. 436 nm

C. 485 nm

B. 229 nm

D. 206 nm

50. What is the energy of a photon emitted when an electron in the hydrogen atom drops from the $n = 6$ energy level to the $n = 5$ energy level?

A. 7.27×10^{-20} J

C. 2.18×10^{-18} J

B. 2.66×10^{-20} J

D. 5.98×10^{-19} J

51. When $n = 3$, what sublevel values are possible (values of l)?

A. 0

C. 0, 1, 2

B. 0, 1

D. 0, 1, 2, 3

52. Which of the following is a possible set of quantum numbers $[n, l, m_l, m_s]$ for an electron in a 3p orbital?

A. $[3, 3, 3, \frac{1}{2}]$

C. $[3, 2, 0, 1]$

B. $[3, 1, -2, -\frac{1}{2}]$

D. $[3, 1, 0, -\frac{1}{2}]$

53. How many different m_l values are possible in the $4f$ sublevel?

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

54. What is the ground state electron configuration for a silicon atom?

- A. $1s^2 2s^2 2p^6 3s^2 3p^1$
B. $1s^2 2s^2 2p^6 3s^2 3p^2$
C. $1s^2 2s^2 2p^6 3s^2 3d^4$
D. $1s^2 2s^2 2p^6 3s^2 3p^5$

55. Which of the following electron configurations have the same number of valence electrons as an oxygen atom?

- A. $[\text{He}] 2s^2 2p^6$
B. $[\text{Ar}] 4s^2 3d^4$
C. $[\text{Ar}] 4s^2 3d^{10} 4p^4$
D. $[\text{Ne}] 3s^2 2p^6$

56. Place the following elements in order of increasing atomic radius.

Ba Cl P

- A. $\text{Ba} < \text{P} < \text{Cl}$
B. $\text{Cl} < \text{Ba} < \text{P}$
C. $\text{Ba} < \text{Cl} < \text{P}$
D. $\text{Cl} < \text{P} < \text{Ba}$

57. Place the following elements in order of increasing effective nuclear charge.

B C N

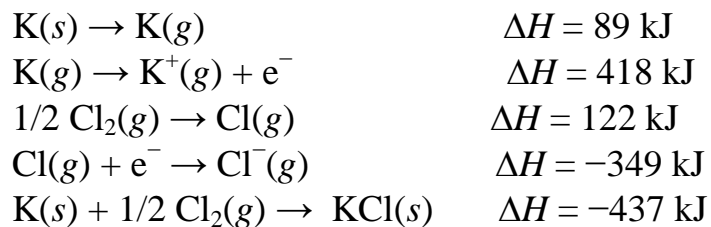
- A. $\text{N} < \text{C} < \text{B}$
B. $\text{N} < \text{B} < \text{C}$
C. $\text{B} < \text{C} < \text{N}$
D. $\text{C} < \text{B} < \text{N}$

58. Place the following elements in order of increasing first ionization energy.

K Ca Rb

- A. $\text{Ca} < \text{K} < \text{Rb}$
B. $\text{Rb} < \text{Ca} < \text{K}$
C. $\text{Ca} < \text{Rb} < \text{K}$
D. $\text{Rb} < \text{K} < \text{Ca}$
-

59. Use the data below to determine the lattice energy of $\text{KCl}(s)$?



A. -57 kJ

C. -473 kJ

B. -717 kJ

D. -528 kJ

60. Arrange the following ionic compounds in order of increasing lattice energy:

MgS , RbBr , NaBr , SrS

A. $\text{NaBr} < \text{RbBr} < \text{SrS} < \text{MgS}$

C. $\text{RbBr} < \text{NaBr} < \text{MgS} < \text{SrS}$

B. $\text{MgS} < \text{SrS} < \text{NaBr} < \text{RbBr}$

D. $\text{RbBr} < \text{NaBr} < \text{SrS} < \text{MgS}$

CHE 105 FALL 2010 Final Exam Key

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

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