

## Chem 201

## FINAL EXAM

December 12, 2015

Prof. Hoyt TTh 11am	Prof. Powe MWF 11am	Prof. Franco MWF 9am	Prof. Noble TTh 4pm	Prof. Kuta MWF 2pm	Prof. Hutcherson TTh 8am	Prof. Franco online	Prof. Kuta TTh 5:30pm
01 W 4	05 W 12	11 Th 11	18 M 8	25 M 12		50	75 T 7
02 W 10	06 Th 8	12 W 1	19 M 9	26 W 12	31 M 1		76 Th 7
03 W 12	07 F 10	13 W 10	20 M 12	27 F 12	32 W 11		77 Th 7
04 W 9	08 W 2	14 Th 1	21 W 8	28 T 2	34 T 11		78 Th 4:30
	09 Th 9	15 T 1	22 W 3	29 Th 12			79 T 4:30
	10 F 1	16 T 3	23 F 10	30 T 3			80 T 7
		17 F 11	24 F 8				

This exam will be graded by the SCANTRON Form provided. Be certain that you fill it in correctly. On the front side in the spaces as shown below, enter your name (print and sign), your instructor's name, and the number for your recitation section (from the above list).

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NAME \_\_\_\_\_ print your name and sign your name  
 SUBJECT \_\_\_\_\_ your instructor's name TEST NO. \_\_\_\_\_ section number  
 DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

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On the back side of the Form in the colored portion where it says "NAME", print your last name. BE CERTAIN TO ENTER THE CORRECT INFORMATION.

This exam has 35 questions. Part 1 has 15 questions worth four points each and covers newer material; this Part must be answered on the FRONT side of the SCANTRON Form in spaces 1-15. Part 2 has 20 questions worth two points each and covers older material; this Part must be answered on the BACK side of the SCANTRON Form in spaces 26-45. Because of this arrangement, THERE ARE NO QUESTIONS NUMBERED 16-25. Skip 16-25 on the SCANTRON Form.

Be certain no stray marks are on the Form. Be certain you fill in all spaces properly. Be certain you cleanly erase any changes. You must use a pencil.

For every question there is only one correct answer. Be certain you have all questions 1-15 and 26-45.

None of the exam pages will be collected. You may tear pages off. TURN IN ONLY THE SCANTRON CARD. Give the card to your (or another) TA in the room. Have your picture ID ready.

The key for the exam will be posted shortly afterwards at [noblereaction.org/gc/201misc.htm](http://noblereaction.org/gc/201misc.htm). If you record your answers, you will be able to grade your exam.

## INFORMATION PAGE

This page contains information which may or may not be needed.

## SOLUBILITY TRENDS

For purposes of this course, we will use the following trends to predict whether a compound is soluble or insoluble. These guidelines are given in a priority sequence: use them in this order.

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium sulfate and barium sulfate.
6. Compounds with anions of 2- or 3- charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

Avogadro's number  $6.022 \times 10^{23}$

Temperature conversion  $T(\text{K}) = T(^{\circ}\text{C}) + 273$

Gases  $PV = nRT$

$$R = 0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}}$$

$$\text{atm} = 760 \text{ mmHg} = 760 \text{ Torr}$$

$$d = \frac{PM}{RT}$$

Standard Molar Enthalpies of Formation (in kJ/mol)

$$\text{H}_2\text{O}(l) \quad -285.83 \quad \text{H}_2\text{O}(g) \quad -241.83 \quad \text{NH}_3(g) \quad -45.90 \quad \text{NO}(g) \quad 90.29$$

Electromagnetic Radiation  $c = \lambda\nu = 3.00 \times 10^8 \text{ m/s}$

$$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$E = h\nu = hc/\lambda$$

Transition Energy 
$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{1}{n_{\text{final}}^2} - \frac{1}{n_{\text{initial}}^2} \right)$$

Molecular Orbital Approach B/C/N:  $(\sigma_{2s})(\sigma_{2s}^*)(\pi_{2p})(\sigma_{2p})(\pi_{2p}^*)(\sigma_{2p}^*)$   
(and heteronuclear)

O/F/Ne:  $(\sigma_{2s})(\sigma_{2s}^*)(\sigma_{2p})(\pi_{2p})(\pi_{2p}^*)(\sigma_{2p}^*)$

**KEEP YOUR WORK COVERED.**

This includes your exam papers, your scrap work, and your Scantron card.

**Part 1. Newer Material**

- Which of the following statements is FALSE?
  - Higher charges for ions give stronger ionic bonds.
  - Of NaF, MgO and CaS, MgO has the highest lattice energy.
  - Chlorine is more electronegative than arsenic.
  - HF is more polar than NO.
  - For covalent bonds, bond energy increases as bond order decreases.
  
- Which of the compounds below has a central atom with fewer than an octet of electrons?
  - BF<sub>3</sub>
  - CH<sub>4</sub>
  - CO<sub>2</sub>
  - SF<sub>6</sub>
  - H<sub>2</sub>CCl<sub>2</sub>
  
- How many resonance structures are there for sulfur dioxide?
  - one
  - two
  - three
  - four
  - six
  
- For the optimal Lewis structure for OCN<sup>-</sup>, what are the formal charges for each atom?

	O	C	N
(A)	+1	0	-2
(B)	0	0	-1
(C)	0	-1	0
(D)	-1	0	0
(E)	-2	+1	0

5. What are the ideal bond angles in  $\text{PF}_3$ ?
- (A)  $45^\circ$       (B)  $90^\circ$       (C)  $109.5^\circ$       (D)  $120^\circ$       (E)  $180^\circ$

6. Consider the following shapes.

bent                  linear                  seesaw                  square planar

Which of these CANNOT be derived from the trigonal bipyramidal (tbp) orientation of least repulsion (OLR)?

- (A) bent only                  (B) square planar only                  (C) bent and linear  
(D) square planar and seesaw                  (E) bent and square planar
7. According to VSEPR, which of the following is square pyramidal?
- (A)  $\text{IF}_5$       (B)  $\text{XeO}_4$       (C)  $\text{PCl}_5$       (D)  $\text{ClF}_3$       (E)  $\text{XeF}_4$

8. How many of the following substances is/are polar?

$\text{NO}_3^-$        $\text{ClO}_3^-$        $\text{XeF}_4$        $\text{BF}_3$        $\text{CH}_4$        $\text{ClF}_3$        $\text{SF}_6$

- (A) one      (B) two      (C) three      (D) four      (E) five
9. Which one of the following statements is FALSE?
- (A) The carbon atom in  $\text{CH}_4$  is  $sp^3$  hybridized.  
(B) The carbon atom in  $\text{CO}_2$  is  $sp$  hybridized.  
(C) The nitrogen atom in  $\text{NH}_3$  is  $sp^2$  hybridized.  
(D)  $sp$  hybrid orbitals lie at  $180^\circ$  to each other.  
(E)  $sp^2$  hybrid orbitals are all in the same plane and  $120^\circ$  to each other.

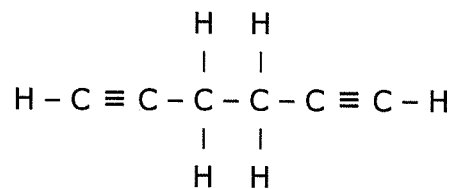
10. How many of the following have a central atom with  $sp^3$  hybridization?

$\text{PCl}_4^+$        $\text{SO}_2$        $\text{CCl}_4$        $\text{NO}_3^-$        $\text{CO}_3^{2-}$        $\text{PCl}_3$

- (A) one      (B) two      (C) three      (D) four      (E) five

11. How many  $\pi$  bonds are present in the molecule at right?

- (A) 2      (B) 4      (C) 6      (D) 10      (E) 15



12. Consider the ion  $\text{BH}_4^-$ . For this ion, which of the following statements is FALSE?

- (A) The boron has a formal charge of  $-1$ .  
(B) The oxidation number of each hydrogen is  $+1$ .  
(C) All bonds are  $\sigma$  type.  
(D) The shape is tetrahedral.  
(E) Boron is  $sp^3$  hybridized.

13. According to Molecular Orbital Approach, which of the following has the strongest OO bond?

- (A)  $\text{O}_2^{2+}$       (B)  $\text{O}_2^+$       (C)  $\text{O}_2$       (D)  $\text{O}_2^-$       (E)  $\text{O}_2^{2-}$

14. According to Molecular Orbital Approach, how many of the following are paramagnetic?

- $\text{Be}_2$        $\text{B}_2$        $\text{C}_2$        $\text{CN}^-$        $\text{O}_2$        $\text{O}_2^{2-}$
- (A) none      (B) two      (C) three      (D) five      (E) six

15. Consider the Molecular Orbital electron configuration for  $\text{N}_2$ . For this species, which of the following statements is FALSE?

- (A) Removing one electron results in a lower bond order.  
(B) Adding one electron results in a lower bond order.  
(C) The highest-energy occupied orbital is  $\sigma_{2p}$ .  
(D) This species has no electrons in any antibonding orbital.  
(E) This species is diamagnetic.

**16-25: LEAVE THESE SPACES BLANK ON THE SCANTRON CARD.  
GO TO NUMBER 26 ON THE BACKSIDE OF THE CARD.**

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**Part 2. Older Material**

26. Which of the following has 46 electrons and 48 protons?

- (A) Cd      (B) Cd<sup>2+</sup>      (C) Pd      (D) Sn<sup>2+</sup>      (E) Sn<sup>2-</sup>

27. What is the chemical formula of iron(III) sulfate?

- (A) Fe<sub>2</sub>S<sub>3</sub>      (B) Fe<sub>3</sub>(SO<sub>3</sub>)<sub>2</sub>      (C) FeSO<sub>3</sub>      (D) Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>      (E) Fe<sub>3</sub>(SO<sub>4</sub>)<sub>2</sub>

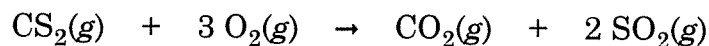
28. What is the empirical formula of a compound which contains 47.50% of sulfur and 52.50% of chlorine by mass?

- (A) SCl      (B) S<sub>2</sub>Cl      (C) SCl<sub>2</sub>      (D) S<sub>2</sub>Cl<sub>3</sub>      (E) S<sub>3</sub>Cl<sub>2</sub>

29. Consider the combustion reaction of butane, C<sub>4</sub>H<sub>10</sub>. For the correctly balanced equation with the smallest, whole-number coefficients, what is the coefficient of O<sub>2</sub>?

- (A) 5      (B) 7      (C) 9      (D) 11      (E) 13

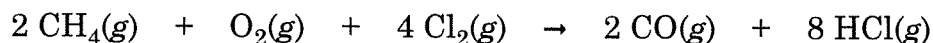
30. Consider the following reaction.



For a reaction which starts with 30.0 g CS<sub>2</sub>, how much SO<sub>2</sub> (in g) can be produced?

- (A) 42.9      (B) 47.1      (C) 50.5      (D) 57.1      (E) 63.9

31. Hydrogen chloride can be prepared by the reaction of methane with chlorine and oxygen.



Starting with 46.0 g  $\text{CH}_4$ , 131 g  $\text{Cl}_2$ , and excess  $\text{O}_2$ , how many grams of  $\text{HCl}$  can be produced?

- (A) 118            (B) 135            (C) 176            (D) 257            (E) 418
32. Consider a 250. mL solution which contains 50.0 g silver nitrate. What is the molarity of the silver nitrate?
- (A) 0.200            (B) 0.294            (C) 0.588            (D) 1.18            (E) 1.53
33. Sodium nitrate dissolves well in water. Based on this observation, which of the following statements is TRUE?
- (A) Sodium ions and nitrate ions repel each other.  
(B) Sodium ions and nitrate ions have unusually strong ionic interactions.  
(C) Sodium nitrate molecules are easily hydrated by water molecules.  
(D) Sodium nitrate has a low melting point.  
(E) Sodium ions and nitrate ions interact more strongly with water molecules than with each other.
34. Which of the following correctly pairs the name with the formula of an acid?
- (A) oxalic acid,  $\text{HC}_2\text{H}_3\text{O}_2$       (B) fluoric acid,  $\text{HF}$       (C) chromous acid,  $\text{H}_2\text{CrO}_4$   
(D) chloric acid,  $\text{HClO}_3$                       (E) phosphoric acid,  $\text{H}_2\text{PO}_4$
35. Which of the combinations below will NOT produce a precipitate?
- (A) ammonium sulfate and lead(II) nitrate  
(B) sodium phosphate and calcium hydroxide  
(C) potassium acetate and barium nitrate  
(D) silver nitrate and sodium sulfide  
(E) iron(II) chloride and ammonium hydroxide

36. What are the oxidation numbers for each atom of each element in  $\text{HNO}_3$ ?

- |     | H  | N  | O  |
|-----|----|----|----|
| (A) | -1 | -5 | +2 |
| (B) | -1 | -5 | +6 |
| (C) | +1 | +5 | +6 |
| (D) | +1 | +5 | -6 |
| (E) | +1 | +5 | -2 |

37. The following equation is not balanced.



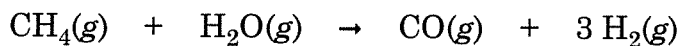
For the correctly balanced equation with smallest, whole-number coefficients, how many electrons are transferred?

- (A) 2                      (B) 3                      (C) 5                      (D) 6                      (E) 7

38. 22.34 mL of  $\text{HCl}(aq)$  are titrated to the endpoint (equivalence point) using 25.00 mL of 0.1023 M  $\text{NaOH}(aq)$ . What was the molarity of the original  $\text{HCl}$  solution?

- (A) 0.07511      (B) 0.09036      (C) 0.1145      (D) 0.1337      (E) 0.1509

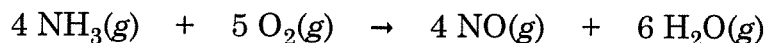
39. The following equation is balanced.



What mass of hydrogen (in g) can be formed if 275 L of methane at STP are reacted?

- (A) 12.3                      (B) 24.7                      (C) 37.1                      (D) 49.4                      (E) 74.2

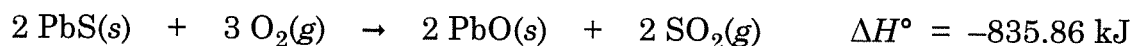
40. Calculate  $\Delta H_{\text{rxn}}^\circ$  (in kJ) for the following reaction.



- (A) -906.22      (B) -197.41      (C) -105.63      (D) 197.41      (E) 906.22



41. Consider the following reaction.



How many grams of galena (lead(II) sulfide) are converted to lead(II) oxide if 975 kJ of heat are released in the process?

- (A) 203            (B) 279            (C) 406            (D) 478            (E) 558

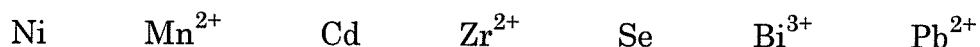
42. For a relaxation from  $n = 6$  to  $n = 3$  in a hydrogen atom, what is the wavelength (in nm) of the photon which would be emitted?

- (A) 832            (B) 877            (C) 906            (D) 968            (E) 1,090

43. Which of the following statements about ground state configurations is FALSE?

- (A) The configuration of mercury ends in  $\dots 6d^{10}$ .  
(B) The configuration of bromide ion ends in  $4p^6$ .  
(C) Every  $2+$  cation for Group 12 is diamagnetic.  
(D) Barium has two valence electrons in the  $n = 6$  shell.  
(E) All neutral atoms of all elements in Groups 2, 12 and 18 are diamagnetic.

44. Consider the following atoms and ions.



How many of these have three unpaired electrons?

- (A) none            (B) one            (C) two            (D) three            (E) five

45. Which of the following statements is TRUE?

- (A) An atom of sulfur is larger than an atom of phosphorus.  
(B) Out of all metals in the s-block, beryllium (Be) has the strongest hold on its electrons.  
(C) The third ionization of indium (In) involves a core electron.  
(D) The first IE of potassium is greater than the second IE for calcium.  
(E) An oxygen atom has a greater desire for an electron than a fluorine atom.