

CHEM 107 (Spring-2005)
Final Exam (100 pts)

Name: _____, Clid # _____

LAST NAME, First

(Circle the alphabet segment of your LAST NAME): A, B C-G H-N O-S T-Z

Please answer the following questions:

Part I: Multiple Choices (40 pts: 20 @ 2 pts each + 4 pts bonus). Circle the ONE best answer:

- Consider four identical 1.0 L flasks containing the following gases each at 25 °C and 1 atm pressure. For which gas do the molecules have the highest average kinetic energy?
a) SO₂ b) O₂ c) H₂ d) same for all
- Which of the following statements is false?
a) An electron transition from $n = 3$ to $n = 1$ gives off energy.
b) Light emitted by an $n = 4$ to $n = 2$ transition will have a longer wavelength than that from $n = 5$ to $n = 2$ transition.
c) An atom of group 16 has four unpaired electrons.
d) A sublevel of $\ell = 2$ has a capacity of ten electrons.
- In the BrCN molecule:
a) The molecule has a linear shape with 2 σ and 2 π bonds.
b) The molecule has an angular shape with 2 σ and 2 π bonds.
c) The molecule has a linear shape with 2 σ and 1 π bonds.
d) The molecule has a linear shape with 3 σ and 1 π bonds.
- Which of the following is most likely to involve sp^3d hybrid orbitals at the central atoms?
I) ClF₃ II) BrF₅ III) XeF₄ IV) SF₄
a) I and IV b) only II
c) only IV d) II and III
- What is the proper order of decreasing F-X-F angle in the compounds (largest angle first)?
I) BF₃ II) BeF₂ III) CF₄
a) II > I > III b) I > II > III
c) II > III > I d) III > II > I
- If the specific heat capacity of a ceramic cup is 0.820 J/°C, how much heat is required to raise the temperature of the cup from 25.0° C to 50.0° C?
a) 82.0 J b) 20.5 J
c) 41.0 J d) 25.0 J
- Which of the following ions is paramagnetic with four unpaired electrons?
a) Cr³⁺ b) Fe²⁺
c) Se²⁻ d) Cu²⁺

8. Which statement is incorrect?
- Decreasing the external pressure decreases the boiling point of a liquid.
 - The normal boiling point is the temperature at which the vapor pressure is equal to 1 atm.
 - The density of a liquid decreases with increasing temperature, while that of the vapor increase.
 - All of the above.
9. Calculate the molarity of Cl^- when 11.7 g of NaCl is dissolved in a 500.0 mL solution containing 0.040 M CaCl_2 (assume no change in volume)?
- 0.480 M
 - 0.240 M
 - 0.440 M
 - no answer was given
10. Naturally occurring lithium consists of two isotopes Li-6 and Li-7. The atomic mass of Li is approximately 6.9. What are the reasonable estimate of the relative percentages of Li-6 and Li-7, respectively?
- 10, 90
 - 25, 75
 - 50, 50
 - 75, 25
 - 90, 10
11. Aluminum and oxygen react according to the following equation:
- $$4 \text{ Al (s)} + 3 \text{ O}_2 \text{ (g)} \longrightarrow 2 \text{ Al}_2\text{O}_3 \text{ (s)}$$
- What mass of Al_2O_3 (102.0 g/mol), in grams, can be made by reacting 4.6 g of Al with excess oxygen?
- 8.7 g
 - 17 g
 - 1.2 g
 - 35 g
12. Which of the following molecules is expected to be polar?
- BeCl_2
 - CO_2
 - SO_2
 - BCl_3
13. Which name is incorrect?
- $\text{Mg}(\text{NO}_3)_2$: magnesium nitrate
 - CoSO_4 : cobalt(II) sulfate
 - Fe_2S_3 : diiron trisulfide
 - S_2F_4 : disulfur tetrafluoride
14. If 400.0 mL of 0.375 M NaOH is added to 280.0 mL of 0.600 M HNO_3 , will the mixture be
- neutral
 - basic
 - acidic
 - amphoteric
15. Potassium metal and bromine react vigorously to form potassium bromide. Which statement is correct?
- K atoms lose electron and become Ar atoms.
 - Br atoms gain an electron and become Kr atoms
 - The K and Br atoms change into different, more stable atoms.
 - Br gains an electron and attain the same electron configuration as a Kr atom.

Part II. Bonding and Chemical Equations (28 pts):

A) Bonding & molecular structure (12 pts):

1. Draw the Lewis structure for the ozone molecule, O_3 , draw the resonance structures, if there is any then predict:
- a) the molecular shape
 - b) hybridization of the central atom
 - c) number σ and π bonds
 - d) bond angle

Lewis Structure & resonance structures (if any)

a) Molecular shape: -----
b) Hybridization of the central atom: -----
c) # of σ bonds -----
and # of π bonds -----
d) Bond angle: -----

B) Chemical Equations (16 pts):

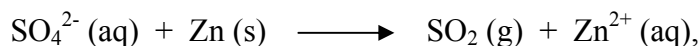
1. (6 pts) Write the balanced chemical equation and the net ionic equation for the reaction between aqueous solutions of $AgNO_3$ and $CaBr_2$ and then identify the spectator ion(s)

Chemical equation:
Net ionic equation:
Spectator ion(s):

2. (2 pts) Write the balanced chemical equation for the reaction, if any occurs between aqueous solutions of NH_4Cl and KNO_3 (write N.R. if they do not react; no chemical equation)

Chemical equation:

3. (8 pts) Balance the following redox equation in acidic solution:



Then identify the oxidizing agent and how many electron(s) are transferred per one mole of the oxidizing agent.

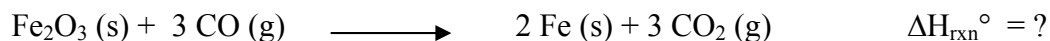
Balanced equation:

Oxidizing agent: -----

Number of electrons/mole of oxidizing agent: -----

Part III. Calculations (32 pts) Show all work for full credit. Please express all answers with the proper units and correct number of significant figures.

1. a) (5 pts) Carbon monoxide is often used in metallurgy to remove oxygen from metal oxides and thereby give the free metal. The thermochemical equation for the reaction of CO with Fe_2O_3 is



Give that $\Delta H_f^\circ \text{Fe}_2\text{O}_3 (\text{s}) = -824.2 \text{ kJ/mol}$, $\Delta H_f^\circ \text{CO} (\text{g}) = -110.5 \text{ kJ/mol}$ and $\Delta H_f^\circ \text{CO}_2 (\text{g}) = -393.5 \text{ kJ/mol}$, determine the enthalpy change, $\Delta H_{\text{rxn}}^\circ$ for the reaction given above.

$$\Delta H_{\text{rxn}}^\circ =$$

b) (3 pts) Given that: $2 \text{NO} (\text{g}) + \text{O}_2 (\text{g}) \longrightarrow 2 \text{NO}_2 (\text{g}) \quad \Delta H_{\text{rxn}}^\circ = -114.0 \text{ kJ}$

Calculate ΔH° for the following reaction:



$$\Delta H_{\text{rxn}}^\circ =$$

2. (6 pts) If 7.25 g of Al and 30.7 mL of 1.22 M HNO₃ are allowed to react according to the equation given below:

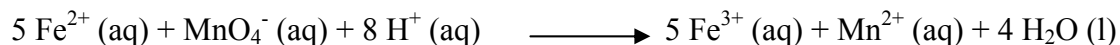


- a) Determine the limiting reactant.
b) What is the volume of hydrogen in liters that produced at 699 torr and 27°C?

a) L. R.: HNO₃

b) 0.501 L of H₂

3. (6 pts) A 1.45 g sample of an iron ore is dissolved in an acid and the iron is obtained as Fe²⁺ (aq). To titrate the solution, 21.6 mL of 0.102 M KMnO₄ (aq) is required. The Fe²⁺ solution reacts with MnO₄⁻ as follows:



What is the percent of iron in the ore?

% Fe in the ore = 42.4

4. (6 pts) One procedure used to separate the isotope of uranium to obtain material to construct a nuclear weapon employs a uranium compound with the formula UF_6 . The compound boils at about 56°C , so at $100.^\circ\text{C}$ it is a gas. What is the density of UF_6 at $100.^\circ\text{C}$ if the pressure of the gas is 740. torr? (Assume the gas contains the mix of uranium isotopes commonly found in nature; MM $\text{UF}_6 = 352.0\text{ g/mol}$)

$$d = 11.2\text{ g/L}$$

5. (6 pts) One compound of mercury with a molecular mass of 519 contains 77.26% Hg, 9.25% C, and 1.17% H and the balanced oxygen. Determine the simplest and molecular formulas of the compound.

Simplest formula
 $\text{HgC}_2\text{H}_3\text{O}_2$

Molecular formula
 $\text{Hg}_2\text{C}_4\text{H}_6\text{O}_4$

PREFERENCE SHEET FOR CHEM 107

Final Exam – Spring 2005

You will have **140 minutes** to complete this exam. The exam has **7 pages** plus the Periodic Table and Reference page.

When you are told to do so, **tear off** the Periodic Table cover sheet and use as required during the exam.

Equations and Constants:

Density (d) = mass/volume

$$q = m \times c \times \Delta T$$

$$PV = nRT$$

$$\text{K.E.} = \frac{1}{2} mv^2$$

$$\text{Average speed of a gas, } u = (3RT/M)^{1/2}$$

$$(\text{Rate of effusion of B/Rate of effusion of A}) = (M_A/M_B)^{1/2}$$

$$v = R_H/h [1/(n_{lo})^2 - 1/(n_{hi})^2]$$

$$E = h \nu$$

$$c = \lambda \nu$$

$$R_H = 2.180 \times 10^{-18} \text{ J}$$

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

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$\text{Avogadro's Number} = 6.022 \times 10^{23}$$

$$R = 0.0821 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mmHg}$$

$$\text{At STP 1 mol of a gas} = 22.414 \text{ L}$$

$$\text{At STP: } T = 273 \text{ K, } P = 1 \text{ atm}$$

General Solubility Guidelines

All nitrates are soluble.

All salts of sodium, potassium and ammonium are soluble.

All chlorides, bromides and iodides are soluble except Ag^+ , Hg_2^{2+} , and Pb^{2+} .

All sulfates are soluble except Ba^{2+} , Sr^{2+} , Pb^{2+} and Hg_2^{2+} .

All acetates, chlorates and perchlorates are soluble.

Everything else will be considered insoluble.

Periodic Table of the Elements																		
1	H 1.01																2	He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.08	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.1	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.1
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Uun (269)	111 Uuu (272)	112 Uub (277)						

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)