NAME:_____

Lab Section (*2 points*): __1(TuTh@3) __2(TuTh@9) __3(MW@1)

CHM 101 Fall 2007

EXAM QUESTIONS

Chemistry, 7th ed., Zumdahl & Zumdahl, chapters 4-6

Wallace *revised 11/16/2007*

Unless otherwise specified, each question is worth 6 points.

1. Ammonia (a polar compound and a weak electrolyte) and ammonium chloride both dissolve in water, but the way they dissolve is very different. Write the formulas for each of these compounds as they exist in water. (*ref. ch. 4, #9 & 17*)

2. Calculate the concentration (as molarity) of bromide ions in a 0.256 *M* $FeBr_3$ solution. (*ref. ch. 4, #23 & 25*)

3. When the following are mixed together, what precipitate, if any, will form? If no precipitate will form, write "NO REACTION". (*2 points each*) (*ref. ch. 4, #37*)

   a. $Na_2SO_4(aq) + Hg_2(NO_3)_2(aq) \rightarrow$

   b. $(NH_4)_2S(aq) + FeCl_3(aq) \rightarrow$

   c. $K_3PO_4(aq) + (NH_4)_2Cr_2O_7(aq) \rightarrow$

4. *Separate samples of a solution of an unknown soluble ionic compound are treated with $NaBr(aq)$, $K_2SO_4(aq)$, and $FeCl_3(aq)$. NaBr and $FeCl_3$ solutions produce a precipitate, but the K_2SO_4 solution produces no reaction. What is the cation in the unknown solution? (*ref. ch. 4, #45*)

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5. For the following precipitation reaction, write the (a) balanced formula (molecular) equation, (b) complete ionic equation, and (c) net ionic reaction. (*2 points each*) (*ref. ch. 4, #39, 55 & 57*)

$$Ba(NO_3)_2(aq) + CuSO_4(aq) \rightarrow$$

(a)

(b)

(c)

6. What mass of calcium carbonate can be produced from mixing 50.0 mL of 0.360 *M* $Na_2CO_3(aq)$ and 100.0 mL 0.225 *M* $CaCl_2(aq)$? (*ref. ch. 4, #49*)

7. If 13.7 mL of an HCl solution is required to react completely with 25.00 mL of 0.300 *M* NaOH, what is the concentration of the HCl solution? (*ref. ch. 4, #61*)

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8. A solution is made by combining 75.0 mL of 0.288 *M* HBr and 50.0 mL of 0.326 *M* KOH. (*ref. ch. 4, #61*)
   a. After the reaction, are H^+ or OH^- ions left in solution? (*Justify your answer by showing your calculations.*) (*4 points*)

   b. What is the concentration of H^+ or OH^- ions (from question a) in the final mixture? (*2 points*)

9. Consider the following oxidation-reduction ("redox") reaction: (*1 point ea.*) (*ref. ch. 4, #71*)

$$4\ Zn(s) + 10\ H^+ + 2\ NO_3^- \rightarrow 4\ Zn^{2+} + N_2O(g) + 5\ H_2O(liq)$$

   a. Which ELEMENT was reduced? ..... _____
   b. Which ELEMENT was oxidized? ..... _____
   c. What is the REDUCING AGENT? ..... _____
   d. What is the OXIDIZING AGENT? ..... _____

10. What is the oxidation state for CARBON in each of the following: (*1 point ea.*) (*ref. ch. 4, #67 & 69*)
   a. CO_3^{2-} ..... _____
   b. CO_2 ..... _____
   c. CO ..... _____
   d. CH_2O ..... _____

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11. Balance the following oxidation-reduction ("redox") reaction that occurs in an acidic solution: (*ref. ch. 4, #*)

$$Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$$

12. A student uses a balloon to collect 256 mL of gas at 85.1°C and at barometric pressure (621 mmHg) from a chemical reaction. Later the gas is cooled down to 22.3°C; assume that the pressure remains constant. What is the new volume of the balloon? (*ref. ch. 5, #33 & 49*)

13. A student carefully fills a 280.-mL flask with vapor at 92.3°C and at a pressure of 612 mmHg. How many moles of gas were collected in the flask? (*ref. ch. 5, #37b*)

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14. When I was a kid, I used to make hydrogen balloons by reacting aluminum foil with Drano (sodium hydroxide). If the balloons had a volume of about 2.0 L, and the conditions were about 30.°C with a barometric pressure of around 780 mmHg, what mass of aluminum was I using per balloon? I didn't know it at the time, but the chemical reaction is: (*ref. ch. 5, #55, 57, 59*)

$$2\ Al(s) + 2\ NaOH(aq) + 6\ H_2O(liq) \rightarrow 2\ Na^+ + 2\ Al(OH)_4^-(aq) + 3\ H_2(g)$$

15. A student collects oxygen gas and water vapor from a chemical reaction that occurs in water. The total pressure is 658 mmHg, and the partial pressure of the water vapor is 29 mmHg. If the total amount of gas (water vapor + oxygen) collected was 0.0844 moles, how many moles of oxygen were collected? (*ref. ch. 5, #71*)

16. A hydrate sample weighing 1.002 g was heated over a flame for several minutes to form anhydrous nickel(II) nitrate. After cooling, the dehydrated salt was found to have a mass of 0.630 g. What was the formula for the hydrate? (*ref. Hydrates exp.*)

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17. The pressure inside a 1.00-L rigid container was measured at different temperatures; the results are presented in the table below. What would the temperature be if the pressure was (theoretically) zero? (*ref. Verifying Absolute Zero of Temp exp. and ch. 5*)

Temp (°C)	Pressure (mmHg)
20.0	620.3
25.0	630.9
30.0	641.5
35.0	652.1
40.0	662.6

11. When 2 mol of sodium metal and 2 mol of water react in a beaker, 1 mol of hydrogen gas forms and heat evolves. If you measured this heat, you would find it to be –368.6 kJ. At 1.00 atm pressure and 25ºC, the volume of hydrogen gas formed is 24.5 L. What is the change in internal energy, ΔE, for this reaction? Note that 1 L·atm = 101.3 J precisely.

12. When 2 mol hydrogen gas and 1 mol Oxygen gas react to produce liquid water, 572 kJ of heat evolves:

$$2H_2(g) + O_2(g) \rightarrow 2\ H_2O(liq);\ \ \Delta H = -572\ kJ$$

What is the value for ΔH when 1 mole of liquid water is decomposed into hydrogen and oxygen gas?

Unless otherwise specified, each question is worth 6 points.

13. How much heat is evolved (at constant pressure) when 9.07×10^5g of ammonia is produced according to the following equation?

$$N_2(g) + 3H_2(g) \rightarrow 2\ NH_3(g);\ \ \Delta H = -91.8\ kJ$$

14. Calculate the heat absorbed by 15.0 g of water to raise its temperature from 20.0°C to 50.0°C (at constant pressure). The specific heat of water is 4.18 [J/g·°C].

15. Given the heats of combustion for the following reactions:

$2W(s) + 3O_2(g) \rightarrow 2WO_3(s);\ \ \Delta H = -1{,}686$ kJ
$C(graphite) + O_2(g) \rightarrow CO_2(g);\ \ \Delta H = -394$ kJ
$2WC(s) + 5O_2(g) \rightarrow 2WO_3(s) + 2CO_2(g);\ \ \Delta H = -2{,}392$ kJ

Unless otherwise specified, each question is worth 6 points.

What is the enthalpy of reaction, ΔH, for the formation of tungsten carbide, WC, from the elements?

$$W(s) + C(graphite) \rightarrow WC(s)$$

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16. Large quantities of ammonia are used to prepare nitric acid. The first step consists of oxidation of ammonia to nitric oxide, NO.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

What is the standard enthalpy change for this reaction?

compound	ΔH_f^o [kJ/mol]
$H_2O(g)$	-242
$NH_3(g)$	-46
$NO(g)$	90.

17. When fossil fuels are burned, what is the major greenhouse gas that is produced? (*10 points*)

Unless otherwise specified, each question is worth 6 points.

Abbreviated **Periodic Table of the Elements**

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	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
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 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	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)
87 Fr (223)	88 Ra 226	89 Ac** (227)	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

POSSIBLY HELPFUL INFORMATION:

R (gas constant) = 0.08206 ($\frac{\text{L}\bullet\text{atm}}{\text{mol}\bullet\text{K}}$)

K = °C + 273.15

1 atm = 760 mmHg = 760 torr

Water Solubility Rules (ref. Table 4.1, p. 144, *Chemistry, seventh edition*, Zumdahl & Zumdahl)

Note that there may be a number of exceptions to these rules, and/or there are more subtle classifications ("partially soluble", "somewhat soluble", "marginally soluble", etc.), but these are the rules that we will use in CHM 101.

1. (*Required memorization*)
2. (*Required memorization*)
3. Most chloride, bromide, and iodide salts are soluble. EXCEPTIONS (for CHM 101): chloride, bromide, and iodide salts containing Ag^+, Pb^{2+}, and Hg_2^{2+} are INSOLUBLE.
4. Most sulfate salts are soluble. EXCEPTIONS (for CHM 101): $BaSO_4$, $PbSO_4$, Hg_2SO_4, and $CaSO_4$, are INSOLUBLE.
5. Most hydroxide salts are insoluble, unless rule #2 applies to the compound.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), chromate (CrO_4^{2-}), and phosphate (PO_4^{3-}) salts are insoluble, unless rule #2 applies to the compound.

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SOME of the Rules for ASSIGNING OXIDATION NUMBERS: (ref. Table 4.2, p. 156, *Chemistry, seventh edition*, Zumdahl & Zumdahl)

1. (*required memorization*)
2. (*required memorization*)
3. **fluorine = –1** (HF, CF_4, ...)
4. **oxygen = –2** (H_2O, CO_2, ...); except peroxide = O_2^{2-} = -1 (H_2O_2, NaO,...)
5. **hydrogen = +1** (H_2O, NH_3,...)
6. (*required memorization*)
7. (*required memorization*)

SOME of the steps for Balancing Oxidation-Reduction ("Redox") Reactions (ref. chapter 4, section 4.10, *Chemistry, seventh edition*, Zumdahl & Zumdahl)

2a. balance all elements other than O & H
2b. balance O with H_2O
2c. balance H with H^+
2d. balance charge with electrons (e^-)