CHEM 141-04 Name_____
Fall 2004
Exam # 2 Date_____

1. (2 points) How many atoms or molecules is a mole.
Avogadro's number of specific kind of atom or molecule.

2. (3 points) Circle all the ion pairs which can form precipitates?
(A) Li^+ and NO_3^-
(B) Pb^+ and Br^-
(C) Ag^+ and SO_4^{2-}
(D) Ca^{2+} and OH^-

3. (3 points) Which of the following compounds are strong electrolyte _____
Which of the following compounds are weak electrolyte _____
A. HCl - strong
B. CH_3COOH (acetic acid)
C. $C_6H_{12}O_6$ (glucose) - nonelectrolyte
D. NaCl - strong

4. (3 points) What is the average mass, in grams, of one atom of calcium?
A. 6.02×10^{23} g
B. 1.50×10^{-24} g
C. 6.66×10^{-23} g
D. 40.08 g
E. 40.08×10^{-23} g

5. (3 points) Which one of the following does not represent 1.00 mol of the indicated substance?
A. 6.02×10^{23} C atoms
B. 55.85.0 g Fe
C. 12.01 g C
D. 27.5 g Zn
E. 6.02×10^{23} Fe atoms

6. (3 points) What is the chemical formula of the salt produced by neutralization of potassium hydroxide ($Ca(OH)_2$) with sulfuric acid (H_2SO_4)?

A. $CaSO_3$ B. $Ca_2(SO_4)_3$ C. Ca_2SO_4 D. $Ca(SO_4)_2$ E. $CaSO_4$

7. (3 points) The oxidation number of Cr in $K_2Cr_2O_7$ is

A. +8 B. +7 C. +6 D. -7 E. -8

8. (5 points) How many moles of CCl_4 are there in 171 g of CCl_4?
A. 26.30 mol
B. 0.90 mol
C. 1.11 mol
D. 153.8 mol
E. 171 mol

9. (5 points) Balance the following equation with the smallest set of whole numbers.

$$2C_2H_6 + 7O_2 \rightarrow 6H_2O + 4\,CO_2$$
$$3\,KOH + H_3PO_4 \rightarrow K_3PO_4 + 3\,H_2O$$
$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3\,CO_2$$

10. (10 points) Nitric Oxide (NO) reacts with oxygen gas to form nitrogen dioxide (NO_2), a dark-brown gas:

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

In one experiment 0.886 mole of NO is mixed with 0.503 mole of O_2. (a) Calculate which of the two reactants is the limiting reagent. (b) Calculate also the number of moles of NO_2 produced.

This is a limiting reagent problem. Let's calculate the moles of NO_2 produced assuming complete reaction for each reactant.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

$$0.886\ \text{mol NO} \times \frac{2\ \text{mol NO}_2}{2\ \text{mol NO}} = 0.886\ \text{mol NO}_2$$

$$0.503\ \text{mol O}_2 \times \frac{2\ \text{mol NO}_2}{1\ \text{mol O}_2} = 1.01\ \text{mol NO}_2$$

NO is the **limiting reagent**; it limits the amount of product produced. The amount of product produced is
0.886 mole NO_2.

11. (10 points) Identify the element being oxidized, the element being reduced, the oxidizing agent, and the reducing agent in the following reaction.

$$2KI + F_2 \rightarrow I_2 + 2KF$$

Element oxidized: I^- Element reduced: F_2

Oxidizing agent: F_2 Reducing agent: I^-

12. (10 points) Calculate the percent composition by mass of all the elements in Na_2CO_3.

$M(Na_2CO_3) = (2 \times 23) + (1 \times 12) + (3 \times 16) = 106$ g/mol

$$\%Na = \frac{2 \times 23}{106} = 0.434 = 43.4\%$$
$$\%C = \frac{12}{106} = 0.113 = 11.3\%$$
$$\%O = \frac{3 \times 16}{106} = 0.453 = 45.3\%$$

13. (10 points) A sample of unknown compound was analyzed and found to contain 44.4% C, 6.21% H, 39.5% S and 9.86% O. What is the empirical formula of this compound?

Assume that we have 100g of a substance. Then:

$$n_C = 44.4 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 3.70 \text{ mol C}$$
$$n_H = 6.21 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 6.16 \text{ mol H}$$
$$n_S = 39.5 \text{ g S} \times \frac{1 \text{ mol S}}{32.07 \text{ g S}} = 1.23 \text{ mol S}$$
$$n_O = 9.86 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 0.616 \text{ mol O}$$

Thus, we arrive at the formula $C_{3.70}H_{6.16}S_{1.23}O_{0.616}$. Dividing by the smallest number of moles (0.616 mole) gives the empirical formula, **$C_6H_{10}S_2O$.**

14. (10 points) Balance the following equation and write the corresponding ionic and net ionic equations.

$$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + NaCl(aq)$$

Balanced equation: $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2\,NaCl(aq)$

Ionic equation: $Ba^{2+} + 2Cl^- + 2Na^+ + SO_4^{2-} \rightarrow BaSO_4(s) + 2Na^+ + 2Cl^-$

Net ionic equation: $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$

15. (10 points) What volume of concentrated nitric acid (4.0 M) is required to make 60.0 mL of a 0.3 M nitric acid solution? What volume of water is required?

$$M_iV_i = M_fV_f$$

$M_i = 4.0$ mol/L
$M_f = 0.2$ mol/L
$V_f = 60$mL

$$M_iV_i = M_fV_f$$
$$4.0 \text{ mol/L} \times Vi = 0.2 \text{ mol/L} \times 60.0 \text{ mL}$$
$$Vi = 0.2 \text{ mol/L} \times 60.0 \text{ mL} / 4.0 \text{ mol/L} = 3\text{mL}$$

60 mL – 3 mL =57.0 mL

16. (10 points) Calculate the mass of KI in grams required to prepare 5.00×10^2 mL of a 2.80 *M* solution.

Convert the volume into Liters: 5.00×10^2 mL = 0.5 L

The number of moles of KI in 0.5 L of the 2.80 *M* solution will be:

n(KI) = 0.5 L × 2.80 mol/L = 1.40 mol

Molar mass of KI is *M*(KI) = 39 + 127 = 166 g/mol

The mass of required KI will then be m = n × *M* = 1.40 mol × 166 g/mol = 232 g.

BONUS
1. (5 points) Identify the Brønsted acid in the following reactions. Explain.

$$(1)\ NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

$$(2)\ HI \rightarrow H^+ + I^-$$

$$(3)\ CH_3COO^- + H^+ \rightarrow CH_3COOH$$

H_2O, HI, CH_3COOH is the Brønsted acid because it donates a proton to NH_3, H^+.

2. (5 points) Predict the products of the following single replacement reaction.

$Fe(s) + CuSO_4(aq) \rightarrow$

A. $Cu(s) + FeSO_4(aq)$
B. $Fe(s) + Cu(s) + SO_4(aq)$
C. $CuS(s) + Fe_2SO_4(aq)$
D. $FeCuSO_4(aq)$
E. $FeO(s) + CuSO_3(aq)$

Answer: A

3. (2 points) Which of the following is an example of a *disproportionation reaction*?

A. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
B. $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
C. $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$
D. $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
E. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Answer: C

4. (2 points) Which of the following represents a *halogen displacement reaction*?

A. $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
B. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$
C. $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
D. $2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$
E. $2LiOH(aq) + H_2SO_4(aq) \rightarrow Li_2SO_4(aq) + 2H_2O(l)$

Answer: A

5. (2 points) Which of the following represents an *acid-base neutralization reaction*?

A. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
B. $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(g)$
C. $LiOH(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(l)$
D. $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
E. $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$

Answer: C

6. (2 points) Which of the following represents a *hydrogen displacement reaction*?

A. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
B. $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
C. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
D. $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
E. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Answer: E

7. (2 points) Which of the following represents a *combustion reaction*?

A. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
B. $LiOH(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(l)$
C. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

D. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$
E. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
Answer: A

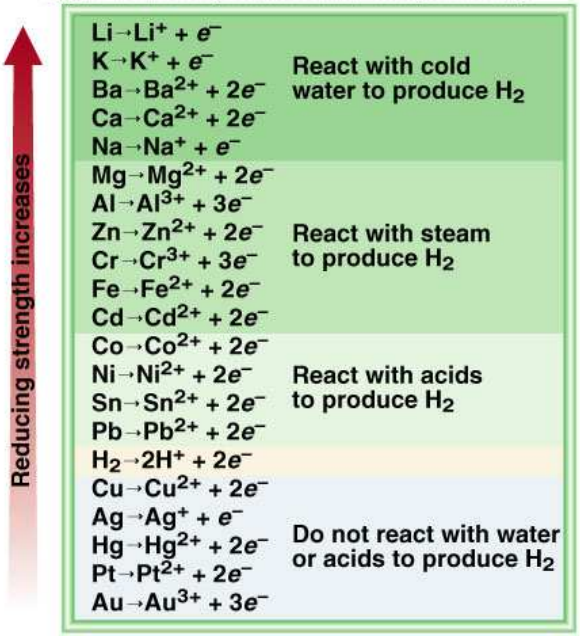

TABLE 4.2 Solubility Rules for Common Ionic Compounds in Water at 25°C

Soluble Compounds	Exceptions
Compounds containing alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+)	
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Hg^{2+}, and Pb^{2+}
Insoluble Compounds	**Exceptions**
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^{2-}), sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion

PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII		IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES
1 H 1.00797															1 H 1.00797	2 He 4.0026
3 Li 6.939	4 Be 9.0122										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183
11 Na 22.9898	12 Mg 24.312										13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	✳57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	‡89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

✳ Lanthanide Series

58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97

‡ Actinide Series

90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)