CHEM 101 Exam 2

Student: _____

I Multiple Choice (20 points)

1. Which of these compounds is a *strong electrolyte*?
A. H_2O
B. N_2
C. CH_3COOH (acetic acid)
D. C_2H_6O (ethanol)
(E.) KOH

- strong base; v. soluble ionic compound
cf. slide 9; text 112-114

2. Which of these compounds is a *weak electrolyte*?
A. HCl
(B.) CH_3COOH (acetic acid)
C. $C_6H_{12}O_6$ (glucose)
D. O_2
E. NaCl

weak acid = weak electrolyte
slide 7; Text pp. 112, 113, 116.

3. Which of these compounds is a *nonelectrolyte*?
A. NaOH
B. HNO_3
(C.) C_2H_6O (ethanol)
D. KF
E. CH_3COOH (acetic acid)

not ionic. slide 3; slide 9; Sample problem 4.2 (methanol)

4. Identify the *reducing agent* in the chemical reaction
$Cd + NiO_2 + 2H_2O \rightarrow Cd(OH)_2 + Ni(OH)_2$.
(A.) Cd
B. NiO_2
C. H_2O
D. $Cd(OH)_2$
E. $Ni(OH)_2$

$Cd^0 \rightarrow Cd^{2+}$ loses e^- ∴ oxidized
∴ reducing agent

5. Sulfur dioxide reacts with chlorine to produce thionyl chloride (used as a drying agent for inorganic halides) and dichlorine oxide (used as a bleach for wood pulp and textiles).

$SO_2(g) + 2Cl_2(g) \rightarrow SOCl_2(g) + Cl_2O(g)$

If 0.400 mol of Cl_2 reacts with excess SO_2, how many moles of Cl_2O are formed?
A. 0.800 mol
B. 0.400 mol
(C.) 0.200 mol
D. 0.100 mol
E. 0.0500 mol

$0.4 \text{ mol } Cl_2 \times \frac{1 \text{ mol } Cl_2O}{2 \text{ mol } Cl_2} = 0.2 \text{ mol } Cl_2O$

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II Short Answer (41 points)

6. (16 points) Give the product(s) for the following reactions, and balance the equations.

a) $2\,AgNO_3(aq) + CaCl_2(aq) \rightarrow 2\,AgCl(s) + Ca(NO_3)_2(aq)$ 5 pts

cf. Sample 4.4 in text; Checkpoint 4.6.1 text

b) $H_2SO_4(aq) + 2\,NaOH(aq) \rightarrow 2\,H_2O(l) + Na_2SO_4(aq)$ 5 pts

page 124 text

c) $2\,C_2H_6(g) + 7\,O_2(g) \rightarrow 4\,CO_2(g) + 6\,H_2O(g)$ 6 pts

7.(10 points) Write the *net ionic equation* for the following reaction. First expand the equation to show all ions, then cancel all spectator ions, and finally write the net ionic equation.

$$Fe_2(SO_4)_3(aq) + 3Na_2S(aq) \rightarrow Fe_2S_3(s) + 3Na_2SO_4(aq)$$

$2Fe^{3+}(aq) + 3SO_4^{2-}(aq) + 6Na^{+}(aq) + 3S^{2-}(aq) \longrightarrow Fe_2S_3(s) + 6Na^{+}(aq) + 3SO_4^{2-}(aq)$ } 4 pts expand

2 pts cancel

$2Fe^{3+}(aq) + 3S^{2-}(aq) \rightarrow Fe_2S_3(s)$ 4 pts

text: p. 120; 4.21 - 4.22

slides 16-21

Student: _____

8. (15 points) For the following unbalanced reaction:

$$KClO_3 \rightarrow KCl + O_2$$

a) For the reactant and the products, show the oxidation number of each atom of each element.

$KClO_3$: K +1, Cl +5, O -2 KCl: K +1, Cl -1 O_2: O 0

6 pts

Slides 35-42

Problem 4.8

b) Write the half-reaction for the oxidation step:

$2\,O^{2-} \longrightarrow O_{2(g)} + 4e^-$

(or " ÷2)

3 pts

c) Write the half-reaction for the reduction step:

$Cl^{+5} + 6e^- \longrightarrow Cl^{-1}$

3 pts

d) Balance the equation below by filling the blanks with the proper coefficients (lowest whole-number ratios) :

$$\underline{2}\,KClO_3 \rightarrow \underline{2}\,KCl + \underline{3}\,O_2$$

3 pts

III Calculations (39 points)

9.(9 points) What is the molarity of 250.0 mL of a solution containing 5.9 g of sodium chloride?

NaCl: (22.98977 + 35.453) g/mol = 58.4428 g/mol 2 pts

$\frac{5.9\,g}{58.4428\,g/mol} = 0.101\,mol$ 2 pts

$250.0\,mL \times \frac{1\,L}{1000\,mL} = 0.2500\,L$ 2 pts

$\frac{0.101\,mol}{0.2500\,L} = 0.404\,M = 0.40\,M$ 3 pts

See 4.63c)

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10. (8 points) Water is added to 25.0 mL of a 0.866 *M* KNO_3 solution until the volume of the solution is 500.0 mL. What is the concentration of the final solution?

$M_1L_1 = M_2L_2$

$(25.0\,mL)(0.866\,M) = (500.0\,mL)\,M_2$ (mL cancel in this case ... conversion to L not required)

$M_2 = 0.0433\,M$

text: 4.68
Chatellier Exam 2 #4

11. (8 points) Calculate the concentration (in molarity) of an NaOH solution if 25.0 mL of the solution is needed to neutralize 17.4 mL of a 0.312 *M* HCl solution. text 4.87

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

1 : 1

moles HCl: $(0.0174\,L)(0.312\,mol/L) = 5.429\times10^{-3}\,mol\ HCl$

$\times \frac{1\,mol\ NaOH}{mol\ HCl} = 5.429\times10^{-3}\,mol\ NaOH$

$\div 0.0250\,L = 0.217\,M$

Student: _____

12.(14 points) The insecticide DDT was formerly in widespread use, but now it is severely restricted owing to its adverse environmental effects. It is prepared as follows:

Text: 3.104
Chatellier Exam 2 #5

$$C_2HCl_3O + 2\,C_6H_5Cl \rightarrow C_{14}H_9Cl_5 + H_2O$$

chloral *chlorobenzene* *DDT*

If 10.00 g of chloral were reacted with 10.00 g of chlorobenzene:
a. what is the maximum amount (mol) of DDT which could be formed?
b. what is the limiting reagent?
c. what is the % yield, if 12.15 g of DDT is produced?

chloral: 147.39 g/mol $\frac{10.00\text{g}}{147.39\text{g/mol}} = 0.067847\text{ mol}$ 3 pts

C_6H_5Cl : 112.56 g/mol $\frac{10.00\text{g}}{112.56\text{g/mol}} = 0.088842\text{ mol}$ 3 pts

DDT: 354.49 g/mol

Balanced equation: $\frac{\text{chlorobenzene}}{\text{chloral}} = \frac{2}{1}$

here: $\frac{0.088842}{0.067847} = \frac{1.309}{1}$

not enough chlorobenzene ∴ it's limiting reagent
b) 2 pts

$\frac{\text{DDT}}{\text{chlorobenzene}} = \frac{1}{2} = \frac{x}{0.088842}$

x = 0.04421 mol DDT a) 2 pts

c) 0.04421 mol × 354.49 g/mol = 15.747 g theoretical yield 2 pts

$\frac{12.15\text{g}}{15.747\text{g}} \times 100\% = 77.16\%$ 2 pts.

(Your method of calculating may vary)