Final Examination Rules

Before you begin your exam:

→ Any student found with an electronic communication device IN THEIR POSSESSION (from the moment they step into the exam room until they pick up their bags after finishing their exam, whether or not they use them) WILL BE DISQUALIFIED.
(If you do have an electronic device, notify an invigilator immediately.)
→ All pencil cases, calculator covers must be below your chair and only I.D. cards, pens, pencils, erasers, calculators and any other allowed course specific materials can be on your desk.
→ Programmable calculators are not permitted. Calculators may not be shared.
→ You may not open the examination booklets, or read examination questions prior to the commencement of the exam. The examination coordinator or his/her representative will announce the beginning and the end of each examination.
→ Write your name and fill out any other required information on the cover page of your exam.

During the exam:

→ You are not allowed under any circumstances to get up during the exam without permission.
→ Look for your exam number on the SIGN IN sheet that will be brought around by your teacher and sign your name.
→ You are not allowed to leave the gym area during the first hour of the exam.
→ If you need to use the washroom, raise your hand and an invigilator will come see you.
→ You are expected to abide by the rules outlined by the examination proctor or his/her delegate and be aware of College policy regarding cheating and plagiarism.

Once you finished your exam:

→ Raise your hand and stay seated until your teacher will come see you to SIGN OUT next to your exam number.
→ During the last 15 minutes of the exam, no students are allowed to leave.
→ Once the examination coordinator announces the end of the exam, everyone must stay seated, quietly, until all exams are collected.
DAWSON COLLEGE  
DEPARTMENT OF CHEMISTRY AND CHEMICAL TECHNOLOGY  
CHEMISTRY 202-001-50  
FALL 2010  
FINAL EXAMINATION  
December 14th, 2010  
2:00 PM – 5:00 PM

Student Name: ____________________________________________
Student Number: __________________________________________

INSTRUCTOR: Underline the name of your instructor  
M. Haniff  
R. Squire

INSTRUCTIONS

1. Electronic calculators (Non-Programmable) are allowed but must not be passed around
2. Answer each problem within the space provided
3. Show complete work where it is required in order to get full credit  
   A correct answer with no work shown will carry a zero mark
4. Messy work and messy answer will not be marked
5. All work must be done in INK so as to preserve your right to grieve (Your attention is drawn to the college’s policy on cheating and plagiarism)
6. Gas constant  $R = 0.0821 \text{ L.atm/K.mol}$  
   $= 8.3143 \text{ kPa.L/K.mol}$
   Avogadro’s constant, $N_a = 6.0221\times10^{23} \text{ /mole}$
   Standard Pressure = 1.000 atm. = 760.0 mm Hg = 760.0 torr = 101.325 kPa
   Specific Heat Capacity of water = 4.184 J/g $^\circ\text{C}$

MARK DISTRIBUTION

1. ________/8  
2. ________/5  
3. ________/11  
4. ________/3  
5. ________/3  
6. ________/6  
7. ________/6  
8. ________/7  
9. ________/6  
10. ________/10  
11. ________/3  
12. ________/3  
13. ________/4  
14. ________/6  
15. ________/6  
16. ________/9  
17. ________/3  
18. ________/3

Total ________/36  
Total ________/35  
Total ________/28

Sig Figs ________/1

GROSS TOTAL ________/100
Q. 1  
(a) Write the names for the following chemical species:  
[4 Marks]

(i) HCl (aq)  
(ii) \( \text{Hg}^{2+} \)  
(iii) HNO\(_3\) (aq)  
(iv) CaF\(_2\)  
(v) \( \text{Pb} (\text{SO}_4)_2 \)  
(vi) \( \text{BaCl}_2 \cdot 2\text{H}_2\text{O} \)  
(vii) \( \text{N}_2\text{O}_5 \)  
(viii) \( \text{NaClO}_4 \)  

(b) Write formulas for the following compounds whose names are given below:  
[4 Marks]

(i) Carbonate ion  
(ii) Hydrobromic acid  
(iii) Sulfur hexafluoride  
(iv) Tin (II) oxide  
(v) Potassium permanganate  
(vi) Silver chloride  
(vii) Copper (II) sulfide  
(viii) Ammonium nitrate
Q.2. Complete the following table for each isotope [5 Marks]

<table>
<thead>
<tr>
<th>Name</th>
<th>Isotopic symbol</th>
<th>Atomic number</th>
<th>Mass number</th>
<th>Number of neutrons</th>
<th>Number of protons</th>
<th>Number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>23 (^{23})Na</td>
<td>11</td>
<td>16</td>
<td>16</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Chromium (III)</td>
<td>52</td>
<td>23</td>
<td>16</td>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>P⁻³</td>
<td>31 (^{31})P⁻³</td>
<td>15</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q.3 (a) Read the following scales up to the doubtful digit. [3 Marks]

i) _____________ mL  ii) _________________ g  iii) _________________ cm
(b) Convert \( \frac{2.85 \text{ g}}{\text{mL}} \) to \( \frac{\text{mg}}{\text{L}} \) (Given: 1 g = 10³ mg; 1 L = 10³ mL) [1 Marks]

(c) The boiling point for liquid oxygen is – 183.0 °C. What is this temperature in (i) K and (ii) °F? [2 Marks]

i) 

ii) 

(d) Carry out the following calculation: [1 Marks]

\[
\frac{(2.24 \times 10^{-3}) \times (5.464 \times 10^4)}{1.0 \times 10^2} - 0.200
\]
(e) A rectangular container with dimensions of 5.00 cm long, 4.00 cm wide and 12.0 cm high is filled with maple syrup that has a density of 1.28 g/ml. Calculate the mass (in kg) of the maple syrup in the container (Given: 1 mL = 1 cm$^3$; 1 kg = 10$^3$ g) [1 Marks]

(f) **Round off each of the following numbers** to three significant digits and express your result in scientific notation [3 Marks]

(i) 0.04568

(ii) 5.1

(iii) 786936.25
Q.4. Balance the equations for the following reactions:         [3 Marks]

(a) \[ \text{Ga}(s) + \text{O}_2(g) \rightarrow \text{Ga}_2\text{O}_3(s) \]

(b) \[ \text{C}_3\text{H}_6(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(l) \]

(c) \[ \text{Mg}(s) + \text{Mn}_2\text{O}_3(s) \rightarrow \text{MgO}(s) + \text{Mn}(s) \]

Q.5. Chlorine dioxide, \(\text{ClO}_2\), has been used as a disinfectant in air conditioning systems. It reacts with water according to the equation below:         [3 Marks]

\[ 6 \text{ClO}_2(g) + 3\text{H}_2\text{O}(l) \rightarrow 5 \text{HClO}_3(aq) + \text{HCl}(l) \]

If 142.0 g of \(\text{ClO}_2\) is reacted with 38.0 g of \(\text{H}_2\text{O}\),

(a) Which reactant is the limiting reactant?

(b) Determine the theoretical yield of \(\text{HClO}_3\).

(c) If the actual yield of \(\text{HClO}_3\) is 80.00 g, what is the percent yield of \(\text{HClO}_3\)?

a) Limiting reactant is  

b) Theoretical yield of \(\text{HClO}_3\) is  

c) Percent yield of \(\text{HClO}_3\)  

Q.6 (a) A sample of argon gas was put in a boiling water bath whose temperature was 100.0 °C and the gas allowed to expand to a volume of 1.88 L. The water bath was then allowed to cool to the laboratory temperature of 21.0 °C. What is the new volume (in mL) of the argon gas sample at the new temperature? [2 Marks]

New volume of the argon gas sample ____________________________

(b) What mass of neon gas is required to fill a 2.50 L container so that the pressure inside the container will be 1.35 atm at a temperature of 30.0 °C? [2 Marks]

Mass of neon gas _______________________________
c) A student completely burns 0.500 L of gaseous ethylene, C₂H₄, in oxygen. What volume of oxygen is required for this process if both gas volumes are measured at STP? The following equation represents the reaction: [STP is 1 atm and 0 °C or 273 K] [2 Marks]

\[ \text{C}_2\text{H}_4 (g) + 3\text{O}_2 (g) \rightarrow 2\text{CO}_2 (g) + 2\text{H}_2\text{O}(l) \]
Q.7 a) A 100.0 mL mercury sample is put in a container and a 100.0 g of Sulfur added to it. The two substances are reacted by heating the container. A dark solid is produced at the end. [2.5 Marks]

i) Is the material produced an element, a compound or a mixture?

The material produced is ________________________________

ii) Is the process leading to the production of the dark solid a physical or chemical change? Explain.

The process is a ________________________________

Explanation ______________________________________________________

iii) How many grams of mercury is put in the container? [Density of liquid mercury is 13.6 g/mL]

Mass of mercury in the container is ________________________________

b) Name three methods for the separation of mixtures. [1.5 Marks]

i) ________________________________

ii) ________________________________

iii) ________________________________
c) State the difference between a mixture and a compound [1 Mark]

________________________________________________________________________

________________________________________________________________________

d) State the difference between homogeneous and heterogeneous mixtures. [1 Marks]

________________________________________________________________________

________________________________________________________________________

Q.8 a) Complete the table below by classifying each of the sets of elements as noble gases, halogens, alkali metals, alkaline earth metals or transition metals. [3 Marks]

<table>
<thead>
<tr>
<th>Elements</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti, Fe, Ag</td>
<td></td>
</tr>
<tr>
<td>Mg, Sr, Ba</td>
<td></td>
</tr>
<tr>
<td>Li, K, Rb</td>
<td></td>
</tr>
<tr>
<td>Ne, Kr, Xe</td>
<td></td>
</tr>
<tr>
<td>F, Br, I</td>
<td></td>
</tr>
</tbody>
</table>
b) Which of the following statement(s) is (are) true? For the false statement, give the correct form of that statement. [4 Marks]

i) All particles in the nucleus of an atom are charged. 
   True [ ] False [ ]
   Correct statement: ________________________________________________________________
   ______________________________________________________________________________

ii) The atom is best described as a uniform sphere of matter in which electrons are embedded
   True [ ] False [ ]
   Correct statement: ________________________________________________________________
   ______________________________________________________________________________

iii) The mass of the nucleus is only a small fraction of the mass of the entire atom
   True [ ] False [ ]
   Correct statement: ________________________________________________________________
   ______________________________________________________________________________

iv) The number of neutrons in a neutral atom must equal the number of electrons in the atom
   True [ ] False [ ]
   Correct statement: ________________________________________________________________
   ______________________________________________________________________________
Q.9 Complete and balance each of the following reactions; in each case give the states of all substances in the equation. Classify each reaction equation as precipitation, redox, acid-base, decomposition or combustion reaction: [6 Marks]

i) $\text{H}_3\text{PO}_4 (\quad ) + \text{NaOH (\quad )} \rightarrow$

Classification: _________________________________________________

ii) $\text{CaCl}_2 (\quad ) + \text{Na}_2\text{SO}_4 (\quad ) \rightarrow$

Classification: _________________________________________________

iii) $\text{C}_6\text{H}_{11}\text{OH (\quad )} + \text{O}_2 (\quad ) \rightarrow$

Classification: _________________________________________________
Q.10 a) Assign oxidation states for all atoms in each of the following compounds: [6 Marks]

i) Fe₂(SO₄)₃  
Fe _______  S _______  O _______

ii) P₄O₆  
P _______  O _______

iii) (NH₄)₂C₂O₄  
N _______  H _______  C _______  O _______

iv) SrCr₂O₇  
Sr _______  Cr _______  O _______
b) Balance the following oxidation reduction reaction using the electron flow method. Identify the oxidizing and reducing agents as well as the oxidized and reduced species (atoms).[4 Marks]

\[
\text{SiCl}_4(\text{l}) + \text{Mg (s)} \rightarrow \text{MgCl}_2(\text{s}) + \text{Si (s)}
\]

Oxidizing agent _______  Reducing agent _______

Oxidized species (atoms) _______  Reduced species (atoms) _______

Q.11 Complete and balance the following molecular equation. [3 Marks]

\[
\text{Na}_2\text{CO}_3(\text{aq}) + \text{HCl (aq)} \rightarrow
\]

Write complete ionic and net ionic equations for the balanced molecular equation above. Identify the spectator ions.

CIE: ________________________________________________________________

NIE ________________________________________________________________

Spectator ions: _________________________________________________________
Q.12 A 0.7221 g sample of a new compound has been analyzed and found to contain the following masses of elements: carbon, 0.2990 g; hydrogen, 0.05849 g; nitrogen, 0.2318 g; oxygen, 0.1328 g. Calculate the empirical formula of the compound. [2 Marks]

Empirical formula is _____________________________________________________

b) If the molar mass of the compound is found to be between 86.0 g – 89.0 g determine the molecular formula of the compound [1 Marks]
Although elemental chlorine (Cl₂) is added to drinking water supplies primarily to kill microorganisms, another beneficial reaction that also takes place is the removal of sulfides which impart unpleasant odour or taste to the water. In the reactions that occur, the foul smelling gas, Hydrogen sulfide, H₂S, is removed according to the following reaction:

$$8 \text{H}_2\text{S (aq)} + 8 \text{Cl}_2 \text{(aq)} \rightarrow 16 \text{HCl (aq)} + \text{S}_8 \text{(s)}$$

Find the limiting reagent and calculate the mass of excess reagent when 50.0 L of water containing $2.40 \times 10^{-5}$ g of H₂S per litre, is treated with 1.80 g of Cl₂ (g). What mass of sulfur (theoretical yield) is removed from the water during this treatment? [3 Marks]

Limiting reagent _______________ Excess reagent _______________

Mass of excess reagent ____________ Mass of sulfur removed ____________

b) Before going to the lab a student read in the lab manual that the percent yield for a difficult reaction for the day is only 40.0%. The student calculated before going to the lab using the given stoichiometric equation and found that the theoretical yield should be 18.65 g of the desired compound. What is the likely expected actual yield of the desired compound? [1 Marks]
Q.14  For each of the following questions A, B and C complete the table below using the given possibilities i), ii) and iii): [6 Marks]

POSSIBILITIES: The final temperature of the water should be

i) Between 50 °C and 90 °C

ii) Exactly 50 °C

iii) Between 10 °C and 50 °C

<table>
<thead>
<tr>
<th>EXPERIMENT</th>
<th>SITUATION</th>
<th>FINAL TEMPERATURE OF WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A 100.0 g sample of water at 90 °C is added to a 100.0 g sample of water at 10 °C</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>A 100.0 g sample of water at 90 °C is added to a 500.0 g sample of water at 10 °C</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>You have a Styrofoam cup containing 50 g of water at 10 °C. You add a 50.0 g iron ball at 90 °C to this water</td>
<td></td>
</tr>
</tbody>
</table>

USE THE SPACE BELOW FOR YOUR CALCULATIONS

A

______________________________________________________________________________

B

______________________________________________________________________________

C

______________________________________________________________________________
Q.15 a) To analyze the alcohol content of a certain wine, a chemist needs 1.50 L of a 0.220 M $\text{K}_2\text{Cr}_2\text{O}_7$ (potassium dichromate) solution. How much solid $\text{K}_2\text{Cr}_2\text{O}_7$ (molar mass 294.3 g/mole) must be weighed out to make this solution? [2 Marks]

b) What volume of a 16 M sulfuric acid must be used to prepare 1.5 L of a 0.1M $\text{H}_2\text{SO}_4$ solution? [1 Marks]
c) In a recent laboratory experiment, you were asked to determine the concentration of a sodium hydroxide (NaOH) solution. You decided to titrate the sodium hydroxide solution with sulfuric acid (H₂SO₄).

i) Which reagent will you put in the burette? ________________________________

ii) Which reagent will you pipette into the Erlenmeyer flask? _________________________

iii) Write the balanced molecular equation for the reaction

______________________________________________________________________________

iv) Calculate the concentration of the sodium hydroxide solution if 57.2 mL of the NaOH solution are needed to neutralize exactly 14.2 mL of 0.141 M H₂SO₄?
Q.16. a) What is meant by the term chemical equilibrium? [1 Marks]

i) The term Chemical equilibrium is ______________________________________

ii) Write the equilibrium expression for the reaction below:

\[ 2 \text{SiO (s)} + 4 \text{Cl}_2 (g) \rightleftharpoons 2 \text{SiCl}_4 (l) + \text{O}_2 (g) \]

b) The synthesis of ammonia is given by the following equilibrium equation

\[ \text{N}_2 (g) + \text{H}_2 (g) \rightarrow \text{NH}_3 (g) \]

i) Write a balanced chemical equation for this reaction. [1 Marks]

ii) Write the equilibrium expression for this reaction. [1 Marks]
iii) Using the balanced chemical equation above, complete the table below for the calculation of the equilibrium constant for the production of ammonia which is carried out at 500°C.

[6 Marks]

<table>
<thead>
<tr>
<th>Initial Concentration (M)</th>
<th>Equilibrium Concentration (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment No.</td>
<td>[N&lt;sub&gt;2&lt;/sub&gt;]&lt;sub&gt;o&lt;/sub&gt;</td>
</tr>
<tr>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>2</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>2.00</td>
</tr>
</tbody>
</table>

WORKING SPACE

Expt. 1

Expt. 2

Expt. 3

c) Why is K the same for all three experiments? Give your answer by putting a circle around one of the answers below:

[1 Mark]

i) Because the pressure of the reaction is constant

ii) Because the temperature of the reaction is constant

iii) Because the concentration of the reactants is what matters in the process
Q. 17 The decomposition of hydrogen bromide gas \([\text{HBr} \ (g)]\) leading to the formation of hydrogen gas and bromine gas is given by the equation below:

\[ 2 \text{HBr} \ (g) \rightarrow \text{H}_2 \ (g) + \text{Br}_2 \ (g) \]

i) Express the rate of the reaction with respect to each of the reactants and products \[1 \text{ Mark}\]

ii) In the first 15.00 seconds of the reaction, the concentration of HBr dropped from 0.500 M to 0.455 M. Calculate the average rate of the reaction over this time interval. \[2 \text{ Marks}\]