**FI AL EXAMI ATIO**
**CHEMISTRY 202- YA-05**
**Monday, December 13, 2010**
**9:30 AM-12:30 PM**

**Print your ame:_____ Student umber:_____**

## Final Examination Rules

**Before you begin your exam:**

1. 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 it is used or not** WILL BE DISQUALIFIED. *(If you do have an electronic communication device, notify an invigilator immediately.)*
2. 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.
3. Programmable calculators are not permitted. Calculators may not be shared.
4. You may not open the examination booklets, or re

Q1. a) Name the following compounds.

i. $Mg(ClO_4)_2$

Q3. Classify each of the reactions given below as: precipitation *and/or* acid-base *and/or* oxidation-reduction.

| | **Chemical Reactions** | **Classification** |
|---|---|---|
| i. | $2\ Na_3PO_4\ (aq) + 3\ Pb(NO_3)_2\ (aq) \quad Pb_3(PO_4)_2\ (s) + 6\ NaNO_3\ (aq)$ | |
| ii. | $2\ PbS\ (s) + 3O_2\ (g) \quad 2\ PbO\ (s) + 2SO_2\ (g)$ | |
| iii. | $H_2SO_4\ (aq) + 2\ NaOH\ (aq) \quad Na_2SO_4\ (aq) + 2\ H_2O\ (l)$ | |
| iv. | $2\ Cu(SO_4)\ (aq) + 4\ KI\ (aq) \quad 2\ CuI\ (s) + I_2\ (aq) + 2\ K_2(SO_4)\ (aq)$ | |

Q4. a) Assign an oxidation number to each atom of $IO_3^-$.

$$MnO_4^-{}_{(aq)} + IO_3^-{}_{(aq)} \rightarrow MnO_{2\ (s)} + IO_4^-{}_{(aq)}$$

I:____ O:____

b) What is the oxidising agent in the reaction above? Answer:_____

c) Balance the above reaction in <u>basic media</u> using the half reaction method. Identify the oxidation and reduction half equations.

Q5. Qualitative tests on a sample of waste water resulted in a positive test for the presence of $Fe^{3+}$ ion. A 20.00 ml sample of the waste water was diluted to 100.00 mL with distilled water. Titration of the ***diluted*** solution required 31.76 mL of a 3.664 $10^{-3}$ ***M*** KOH solution to fully precipitate the $Fe^{3+}$ as a reddish-brown precipitate.

a) Write the net ionic equation (include states of matter) for the reaction of KOH solution and $Fe^{3+}$ ion in the waste water. *(1 mark)*

b) Determine the molar concentration of $Fe^{3+}$ ion in the original 20.00 mL sample of waste water. *(4 marks)*

Q6. a) Write the complete molecular, complete ionic, and net ionic equations for the reaction that takes place when the following aqueous solutions are mixed. Identify the spectator ion(s). Include all charges and the states of matter for each species. *(4 marks)*

*mercury (II) nitrate and potassium phosphate* → ?

C.M.E.: . . . . . .

C.I.E. : . . . . . .

Spectator Ion(s): . . . . . .

N.I.E. : . . . . . .

b) Write the ***net ionic equation*** for the reaction between sodium carbonate and hydrochloric acid. *(1 mark)*

Q7. Sublimation of dry ice (frozen $CO_2$) is used to create special effects in many concerts. How many litres of $CO_2$ gas will be formed at a pressure of 775 mmHg and a temperature of 27.0 C if a 2.20 g sample of dry ice is used? Assume that the gas is ideal. *(3 marks)*

Q8. a) Determine the empirical formula of the compound that has the following mass percentage: C = 40.0%, H = 7.00%, O = 53.0% . (*3 marks*)

b) Determine the molecular formula of the acid produced if the molar mass of the compound is between 58 – 66 g/mol. *(1 mark)*

Q10. a) Which of the four quantum numbers ($n$, $l$, $m_l$ and $m_s$) determine . . .

i. . . . .the energy level of an orbital in a hydrogen atom. Answer:___

ii. . . . . the shape of an orbital. Answer:____

iii. . . . . the size of an orbital Answer:____

iv. . . . . the spatial orientation of an orbital. Answer:____

b) Draw the orbital (box) diagram for the atom with the following electron configuration. Name the element represented by the electron configuration.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$ Element:_____

c) Which of the following sets of quantum numbers are allowed and which are not allowed to specify an electron? For the set of quantum numbers that are incorrect, state what is wrong in each set.

i. $n = 1, l = 1, m_s = -\frac{1}{2}$ . . . . . .

ii. $n = 4, l = 3, m_l = -2, m_s = +\frac{1}{2}$ . . . . . .

d) Answer the following questions (i. to iii.) for an atom of gallium, Ga.

i. Write the complete ground state electron configuration.

Answer:_____

ii. How many valence electrons does Ga have? Answer:_____

iii. How many *s*

Q12. Use the molecular orbital diagram (right)

Q15. a) Iron(III) oxide is reduced by carbon monoxide in a blast furnace through a series of reactions to produce two final products - iron metal ( Fe (*s*) ) and one other product. *(3 marks)*

Use the equations below to determine the overall balanced equation for the reaction of iron(III) oxide and carbon monoxide to give Fe (*s*) and the unnamed product and calculate the $H^O_{rxn}$ for this process.

Reaction 1: $3Fe_2O_3(s) + CO(g) \longrightarrow 2Fe_3O_4(s) + CO_2(g)$ $\quad H^O = -48.5$ kJ

Reaction 2: $Fe(s) + CO_2(g) \longrightarrow FeO(s) + CO(g)$ $\quad H^O = -11.0$ kJ

Reaction 3: $Fe_3O_4(s) + CO(g) \longrightarrow 3FeO(s) + CO_2(g)$ $\quad H^O = +22.0$ kJ

b) i. Write the balanced equation (including states of matter) that represents the standard heat of formation, $\Delta H°_f$, of ammonia gas ($NH_3$). *(3 marks)*

ii. Calculate the $\Delta H°_f$ for $NH_3$ (in kJ/mol) using the table of bond energies, right.

| Bond | Bond Energy (kJ/mol) |
|---|---|
| H – H | 432 |
| H – N | 391 |
| N – N | 160 |
| N = N | 418 |
| N ≡ N | 941 |

Q16. *continued*

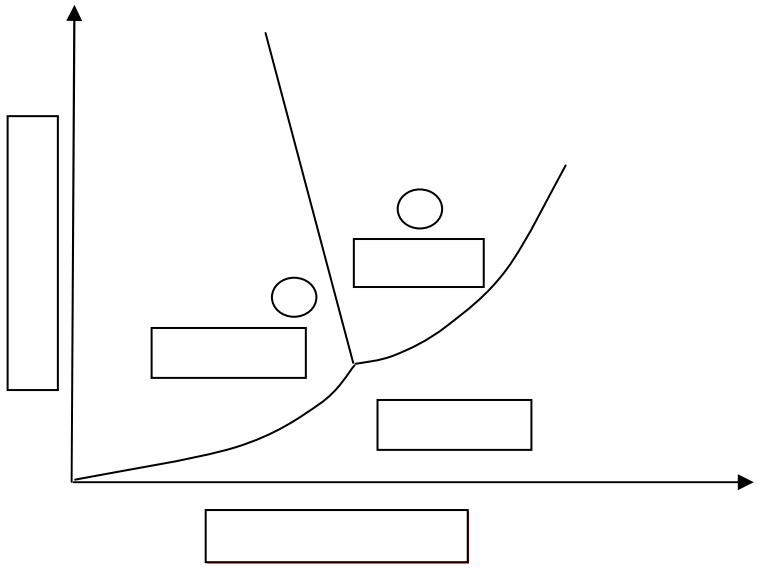
e) Is the molecule $ClF_5$ polar or nonpolar? Explain your answer by drawing and naming its 3D-molecular structure (including all lone-pair electrons). If the molecule is polar draw the molecule's dipole moment. *(2 marks)*

Q18. a) Complete the phase diagram of $H_2O$ below. *(2 marks)*

i. Label the axes.

ii. Label the physical state that corresponds to each region.

iii. Circle the triple point.



b) Name all of the physical changes (*eg* "sublimation") that would occur to a sample of $H_2O$ if the following procedures were carried out? *(1 mark)*

i. Starting at point (A), the temperature is raised at constant pressure.

ii. Starting at point (B), the pressure is lowered at constant temperature.

c) What is the physical significance of the critical point of water? *(1 mark)*

Q19. The following information describes the procedure and results for the reaction of calcium chloride with sodium carbonate to produce calcium carbonate. Answer the following questions based on the data supplied.

**PROCEDURE**

i. Weigh the $CaCl_2 \cdot 2H_2O$ and record the mass on the data sheet
ii. Transfer the solid $CaCl_2 \cdot 2H_2O$ into a volumetric flask, dissolve the solid with distilled water and fill the flask to the 100.0 mL mark.
iii. Pipette 10.00 mL of this solution into a 150 mL beaker
iv. Record the concentration of the $Na_2CO_3$ solution and add, to the same 150 mL beaker a precise volume of $Na_2CO_3$ solution. Record this volume on your datasheet.
v. On a clean and dry watch glass, put a filter paper and weigh both of them together.
vi. Use this filter paper to filter the solid $CaCO_3$ obtained, dry your filter paper containing the

Q19. *continued.*

c) Identify the limiting reactant. *(2 marks)*

d) Calculate the theoretical yield (in grams). *(2 marks)*

e) Calculate the actual yield and the % yield of the reaction. *(2 marks)*

**USEFUL DATA:**

Bohr constant $B = 2.178 \quad 10^{-18}$ J

Rydberg constant $R_H = 1.0974 \quad 10^{7}$ $m^{-1}$

Gas constant $R = 0.08206$ L atm $mol^{-1}$ $K^{-1} = 8.314$ L kPa $mol^{-1}$ K