

FINAL EXAMINATION
CHEMISTRY 202- YA-05
Monday, December 13, 2010
9:30 AM-12:30 PM

Print your name: _____ **Student number:** _____

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.



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

Chemical Reactions		Classification
i.	$2 \text{Na}_3\text{PO}_4 (aq) + 3 \text{Pb}(\text{NO}_3)_2 (aq) \rightarrow \text{Pb}_3(\text{PO}_4)_2 (s) + 6 \text{NaNO}_3 (aq)$	
ii.	$2 \text{PbS} (s) + 3 \text{O}_2 (g) \rightarrow 2 \text{PbO} (s) + 2 \text{SO}_2 (g)$	
iii.	$\text{H}_2\text{SO}_4 (aq) + 2 \text{NaOH} (aq) \rightarrow \text{Na}_2\text{SO}_4 (aq) + 2 \text{H}_2\text{O} (l)$	
iv.	$2 \text{Cu}(\text{SO}_4) (aq) + 4 \text{KI} (aq) \rightarrow 2 \text{CuI} (s) + \text{I}_2 (aq) + 2 \text{K}_2(\text{SO}_4) (aq)$	

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



I: _____ O: _____

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

c) Balance the above reaction in basic media 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 $3.664 \times 10^{-3} \text{ M}$ 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 CO₂) is used to create special effects in many concerts. How many litres of CO₂ 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:_____

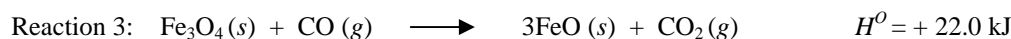
ii. How many valence electrons does Ga have? Answer:_____

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°_{rxn} for this process.



- b) i. Write the balanced equation (including states of matter) that represents the standard heat of formation, H°_f , of ammonia gas (NH₃). (3 marks)

- ii. Calculate the H°_f for NH₃ (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

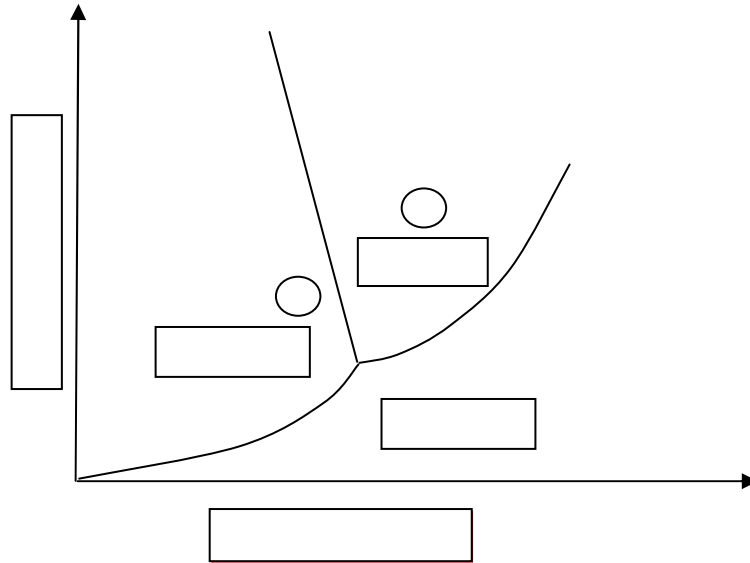
Q16. *continued*

- 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 H₂O 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 H₂O 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 $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ and record the mass on the data sheet
- ii. Transfer the solid $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ 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 $B = 2.178 \times 10^{-18} \text{ J}$

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

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