



Final Examination 2009

Question/Answer Booklet

CHEMISTRY

2A-2B

Student Name: _____

Teacher Name: _____

Time allowed for this paper

Reading/planning time before commencing work: Ten minutes
Working time for paper: Two hours and thirty minutes

Material required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Data Sheet

To be provided by the candidate

Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter

Special items: Scientific Calculator

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

This paper is for students who have completed Units 2A and 2B only

Structure of this paper

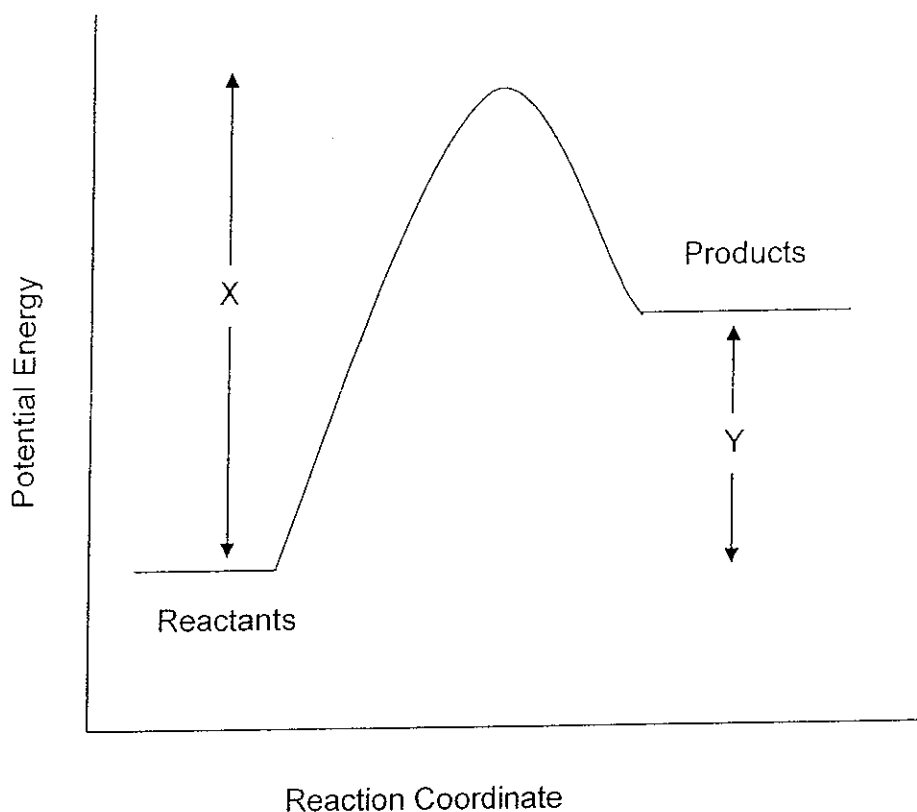
Section	Suggested working time	Marks	Percentage	Number of questions available	Number of questions to be attempted
A	45 minutes	50	33%	25	25
B	55 minutes	60	40%	9	9
C	50 minutes	40	27%	4	4

Instructions to candidates

- The rules for the conduct of Curriculum Council examinations are detailed in the *Student Information Handbook*. Sitting this examination implies that you agree to abide by these rules.
- Answer the questions according to the following instructions.
Section A Answer **ALL** questions in the spaces provided in this Question/Answer Booklet.
Section B Answer **ALL** questions in the spaces provided in this Question/Answer Booklet.
- A blue or black ball point or ink pen should be used.
- For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be ions, molecules or solids.

3. Which one of the following does **not** contain a homogeneous solution?
- (A) An unopened can of cool drink.
 - (B) A gas cylinder of air
 - (C) Cigarette smoke
 - (D) Solid solder, which is an alloy of lead and tin.
4. Which of the following solutions would have the greatest number of ions in total?
- (A) 13.3 g of aluminium chloride dissolved in 100 mL of water.
 - (B) 200 mL of 0.2 mol L⁻¹ magnesium chloride solution
 - (C) 100 mL of 0.1 mol L⁻¹ sodium chloride solution.
 - (D) 0.224 L of hydrogen chloride gas (originally at STP) dissolved on 0.5 L of water.
5. When 1.0 mol L⁻¹ of the following pairs of aqueous solutions are mixed, in which case will a precipitate form?
- (A) NaCl and Co(NO₃)₂
 - (B) NH₄Cl and K₂CO₃
 - (C) CuI and Zn(NO₃)₂
 - (D) ZnCl₂ and NaOH
6. The aluminium ion, ${}_{13}^{27}\text{Al}^{3+}$ contains which of the following:
- (A) 13 protons, 14 neutrons and 10 electrons
 - (B) 14 protons, 13 neutrons and 13 electrons
 - (C) 13 protons, 14 neutrons and 13 electrons
 - (D) 14 protons, 13 neutrons and 16 electrons
7. Which one of the following does NOT have the same electron configuration as S²⁻?
- (A) Ar
 - (B) Cl⁻
 - (C) Mg²⁺
 - (D) K⁺
8. Which one of the following substances has the lowest ability to conduct electricity?
- (A) Dilute HCl solution
 - (B) Solid graphite
 - (C) Concentrated acetic acid (CH₃COOH)
 - (D) Solid silica (SiO₂)

9. Consider the following potential energy diagram for a chemical reaction.



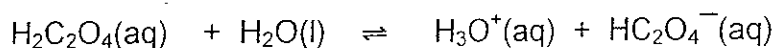
Which one of the following statements about this reaction is **correct**?

- (A) The rate of forward reaction must be greater than the reverse.
- (B) The activation energy for the reverse reaction is X.
- (C) The ΔH for the reverse reaction is $-Y$.
- (D) The temperature of the reaction mixture will decrease as the reaction proceeds

10. One mol of H_3PO_4 is added to 1 L of water. The species in the resulting solution, listed from highest to lowest concentration are:

- (A) H_3O^+ H_2PO_4^- HPO_4^{2-} H_3PO_4
- (B) H_3PO_4 H_3O^+ H_2PO_4^- HPO_4^{2-}
- (C) H_3O^+ H_2PO_4^- HPO_4^{2-} H_3PO_4
- (D) H_3O^+ H_2PO_4^- PO_4^{3-} HPO_4^{2-}

11. Consider the following acid-base reaction



Which one of the following correctly identifies the acid-base conjugate pairs in this system?

	Acid	Conjugate Base	Base	Conjugate acid
(A)	H_3O^+	H_2O	HC_2O_4^-	$\text{H}_2\text{C}_2\text{O}_4$
(B)	$\text{H}_2\text{C}_2\text{O}_4$	HC_2O_4^-	H_2O	H_3O^+
(C)	$\text{H}_2\text{C}_2\text{O}_4$	HC_2O_4^-	H_3O^+	H_2O
(D)	HC_2O_4^-	$\text{H}_2\text{C}_2\text{O}_4$	H_3O^+	H_2O

12. Which one of the following solutions would have a pH of 8?

- (A) $1 \times 10^{-8} \text{ mol L}^{-1}$ sodium hydroxide
- (B) $5 \times 10^{-5} \text{ mol L}^{-1}$ barium hydroxide
- (C) $5 \times 10^{-7} \text{ mol L}^{-1}$ calcium hydroxide
- (D) $1 \times 10^{-6} \text{ mol L}^{-1}$ nitric acid

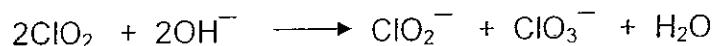
13. Which one of the following has the highest pH?

- (A) 0.1 mol L^{-1} ammonia solution
- (B) 0.1 mol L^{-1} magnesium chloride
- (C) 0.2 mol L^{-1} hydrochloric acid
- (D) 0.2 mol L^{-1} potassium hydroxide.

14. Which one of the following equations does **not** involve transfer of protons from one substance to another?

- (A) $2\text{H}_2\text{O}_2(\text{aq}) \rightleftharpoons \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$
- (B) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{H}_2\text{O}(\ell)$
- (C) $\text{H}_2\text{O}_2(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{HO}_2^-(\text{aq}) + \text{H}_2\text{O}(\ell)$
- (D) $\text{H}_2\text{C}_2\text{O}_4(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightleftharpoons \text{HC}_2\text{O}_4^-(\text{aq}) + \text{HCO}_3^-(\text{aq})$

15. For the following equation



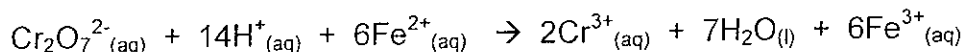
Which one of the following statements is true?

- (A) ClO_2 is acting as an acid.
- (B) ClO_2 is acting as an acid and a base.
- (C) ClO_2 is acting as an oxidising agent only.
- (D) ClO_2 is acting as an oxidising and reducing agent.

16. In which one of the following pairs of substances does the bolded species have the same oxidation state?

- (A) **Mn_2O_3** **MnO_2**
- (B) **Mn^{2+}** **MnO_2**
- (C) **CrO_4^{2-}** **$\text{Cr}_2\text{O}_7^{2-}$**
- (D) **CrO_4^{2-}** **Cr^{3+}**

17. In the following reaction, which one of the species is the oxidising agent?



- (A) $\text{Cr}_2\text{O}_7^{2-}$
- (B) Cr^{3+}
- (C) H^+
- (D) Fe^{2+}

18. Which of the following are isomers of each other?

- I $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- II $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{OH}$
- III $\text{CH}_3\text{CHOHCH}=\text{CHOH}$

- (A) I and II
- (B) I and III
- (C) They are all isomers of each other
- (D) None of them are isomers of each other

19. Which one of the following compounds will exist as a geometric (cis and a trans) isomer?

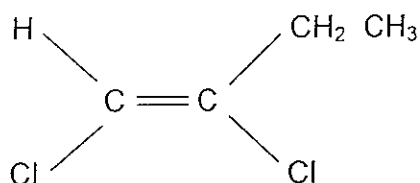
- (A) 1,1- dibromoethane
- (B) 1,2- dibromoethane
- (C) 1,1- dibromoethene
- (D) 1,2- dibromoethene

20. What types of reactions can hexene undergo?

- I Substitution
- II Addition
- III Combustion

- (A) I only
- (B) I and II only
- (C) I and III only
- (D) I, II and III

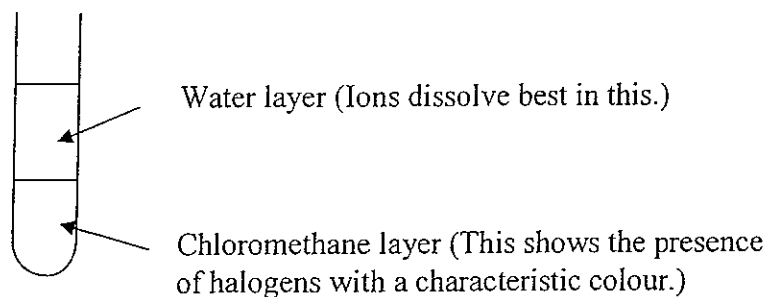
21. What is the correct name for the compound with the following formula?



- (A) 1,2-dichloro-2-ethyl ethene
- (B) 1,2-dichloro butene
- (C) cis-1,2-dichloro-1-butene
- (D) cis- 1,2-dichloro-2-ethyl ethene

22. A chemist mixes 5 mL of bromine water, $\text{Br}_2(\text{aq})$, with 5 mL of a dilute solution of potassium chloride in a test tube. 10 mL of chloromethane is added, and then the mixture is shaken.

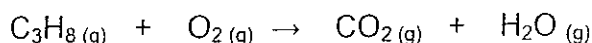
After allowing the mixture to separate, two layers are observed: a layer of water on top of an organic layer of chloromethane.



Which one of the following statements is FALSE about this reaction?

- (A) The top layer is observed to be almost colourless
- (B) There is no reaction between bromine water and potassium chloride
- (C) This experiment shows bromine is a stronger oxidant than chlorine.
- (D) The bottom layer is observed to be dark brown.

23. Propane burns in an oxygen rich environment to yield carbon dioxide and water.



Balance the equation and determine the volume of carbon dioxide $\text{CO}_2(\text{g})$ produced at STP by complete combustion of 2.24 L of propane.

- (A) 6.72 L
(B) 2.24 L
(C) 4.48 L
(D) 1.00 L
24. Which of the following statements is NOT consistent with the kinetic theory of gases?
- (A) The molecules of a gas move in random, straight line motion, colliding with the walls of their container and each other
(B) The average distance between gas molecules is large compared to the relatively small size of the molecules themselves.
(C) There is some loss of energy as gas molecules collide because these collisions are not perfectly elastic.
(D) When the molecules within a gas come into close contact there are no attractive or repulsive forces between them.
25. Which one of the following statements about chemical reactions is correct?
- (A) An exothermic reaction absorbs heat and has a negative ΔH .
(B) In an exothermic reaction, the products have a lower heat content than the reactants.
(C) An example of an endothermic reaction is the combustion of ethane
(D) In an endothermic reaction the temperature of the surroundings would increase.

END OF SECTION A

SECTION B

This section has **9 Short Answer** questions. Any calculations are to be set out in detail. Marks will be awarded for correct equations and clear setting out, even if you cannot complete the calculation. Express numerical answers to three (3) significant figures and provide units where appropriate.

Attempt **ALL** questions in SECTION B in the spaces provided below. Allow approximately 55 minutes for this section [60 marks].

Question 1

[8 marks]

Write the equation for the reaction that occurs in each of the following procedures. If no reaction occurs write 'no reaction'.

Following this, describe **in full** what you would observe in each case, including any

- colours
- odours
- precipitates (give the colour)
- gases evolved (give the colour or describe as colourless).

If no change is observed, you should state this.

(a) Solid calcium hydrogencarbonate is added to 1.0 mol L⁻¹ hydrochloric acid.

Equation: _____

Observation: _____

(b) Silver nitrate solution is added to sodium chloride solution.

Equation: _____

Observation: _____

(c) A small piece of sodium metal is added to water.

Equation: _____

Observation: _____

(d) Propene is shaken with bromine water.

Equation: _____

Observation: _____

Question 2

[6 marks]

Complete the following table by:

- Drawing electron dot diagrams for the species listed.
- Stating the type of bonding within the species drawn.

Species	Electron dot diagram	Type of bonding
CO_3^{2-}		
C_2H_4		
NaCl		

Question 3

[10 marks]

In 1883 German chemist Dr Hans Goldschmidt discovered a highly reactive mixture called THERMITE.

Thermite is made by mixing iron oxide powder (Fe_2O_3) and aluminium powder, finely divided and thoroughly mixed. When ignited, an extremely exothermic reaction occurs producing molten iron and aluminium oxide.

The first commercial application was the welding of tram tracks in 1899. It was recently used in the welding of tracks on the Perth to Mandurah railway line.

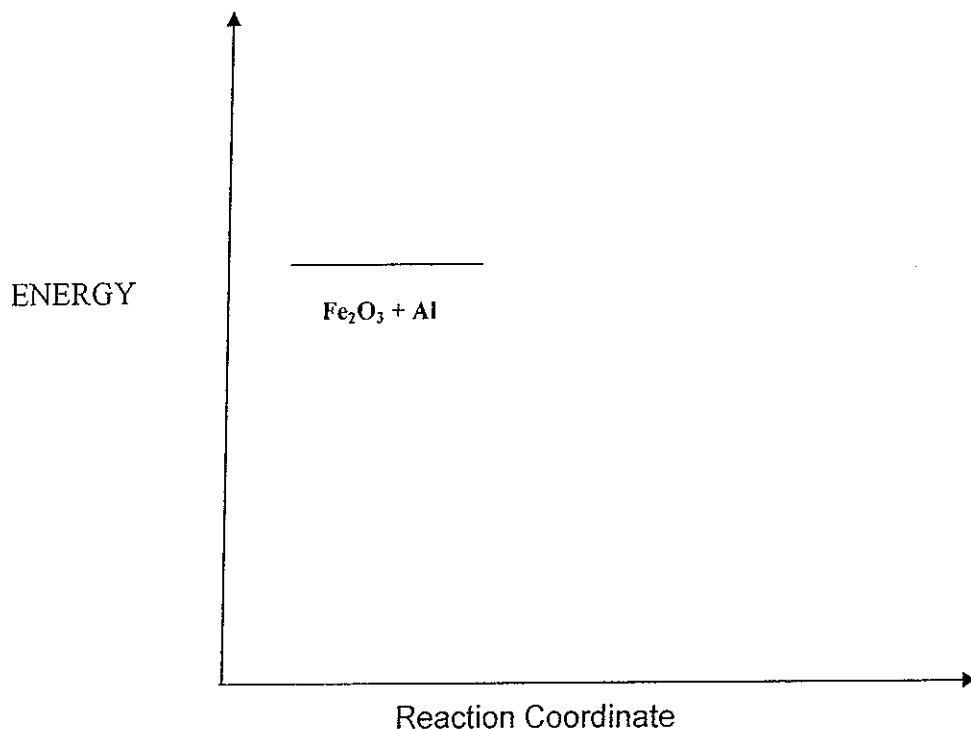


- (a) Write a balanced chemical equation for this reaction [1 mark]

ΔH for the reaction is $-851.5 \text{ kJmol}^{-1}$, however, this reaction requires a very high activation energy to start. Dropping burning magnesium ribbon into the mixture is one way, since it burns at around 2200°C .

- (b) On the following diagram, show the expected SHAPE of the reaction profile. Label the activation energy and the ΔH .

[3 marks]



(c) The Fe_2O_3 and Al must be "finely divided" and thoroughly mixed. What does "finely divided" mean and why is this important?

[2 marks]

(d) The Thermite reaction is a REDOX reaction. Identify the oxidant and reductant in the reaction:

[2 marks]

Oxidant: _____ Reductant: _____

In order for the reaction to occur efficiently, the reactants must be mixed in the correct stoichiometric proportions, so there is no wasted excess of reactants.

(e) Calculate the mass of aluminium needed to completely react with 40g of Fe_2O_3 .

[2 marks]

Question 4

[8 marks]

Draw 4 isomers for the compound C_4H_8 , including two geometric isomers and one cyclic isomer. Using IUPAC nomenclature, name each isomer.

Structure	Name

Question 5

[4 marks]

Complete the table below by either naming or drawing the organic compound - whichever is missing.

When drawing compounds, use structural formulae and show all hydrogen atoms as appropriate.

Structure	IUPAC name
(a)	Trans-2-butene
$ \begin{array}{cccc} & \text{H} & \text{H} & \text{Br} & \text{H} \\ & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{Br} \\ & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $	(b)
(c)	3-ethylcyclo-1-pentene
$ \begin{array}{cccc} & & & \text{Cl} & \text{H} \\ & & & & \\ & & & \text{C} & - \text{C} & - \text{H} \\ & & & // & \\ \text{H} & \text{H} & & & \text{H} \\ & & & & \\ \text{H} - \text{C} - \text{C} - \text{C} & & & & \\ & & \backslash & & \\ \text{H} & \text{H} & \text{Cl} & & \end{array} $	(d)

Question 6

[6 marks]

When the acid concentration of the gastric juices in a person's stomach becomes too high, pain results. Taking "antacid" medicine neutralises the acid and relieves this pain.

- (a) A person experiencing stomach pain may have gastric juice with a pH of 2.0. If the volume of gastric juice was 4.00×10^2 mL, calculate the moles of acid in the stomach.

[2 marks]

To neutralise this acid, a person dissolved some "bicarbonate of soda" (sodium hydrogen carbonate) in a glass of water and drank it.

- (b) Write the ionic equation for this neutralisation reaction:

[1 mark]

- (c) Calculate the minimum mass of sodium hydrogen carbonate which would need to be taken to ensure complete neutralisation of the stomach acid.

[3 marks]

Question 7

[9 marks]

Write balanced half equations and the full redox equation for the following reactions.

- (a) $\text{Fe}^{2+}_{(\text{aq})}$ and $\text{MnO}_4^{-}_{(\text{aq})}$ reacted together in acidic solution to form $\text{Fe}^{3+}_{(\text{aq})}$ and $\text{MnO}_{2(\text{s})}$.

(i) Oxidation half-equation:

[1 mark]

(ii) Reduction half-equation:

[1 mark]

(iii) Overall Redox Reaction:

[1 mark]

- (b) The reduction of nitrate ions in acidic solution with solid magnesium, forming Mg^{2+} ions and nitrogen II oxide (NO).

(i) Oxidation half-equation:

[1 mark]

(ii) Reduction half-equation:

[1 mark]

(iii) Overall Redox Reaction:

[1 mark]

- (c) Complete the table by identifying the oxidant in each reaction: [3 marks]

	reactions	oxidant
(i)	$\text{Ca(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	
(ii)	$\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{l}) + 3\text{CO}_2(\text{g})$	
(iii)	$2\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HNO}_2(\text{aq}) + \text{HNO}_3(\text{aq})$	

Question 8

[5 marks]

A sample of molten potassium bromide is electrolysed in an electrolytic cell.

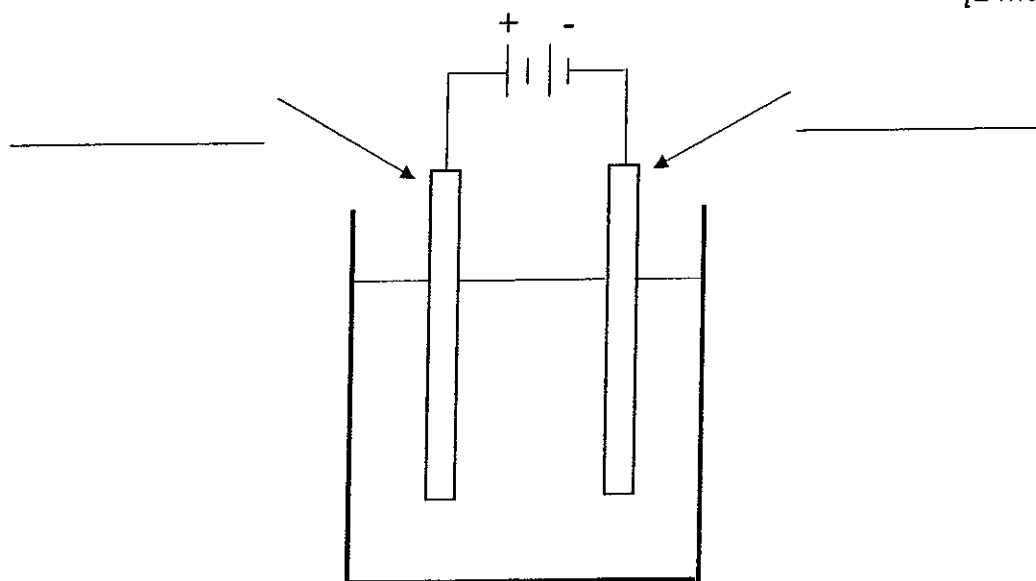
- (a) In the diagram below, label the following:

- The direction of travel of electrons in the external circuit
- The anode and cathode
- The direction of travel of the potassium and bromide ions

[3 marks]

- (b) Write the half equation for the reaction at each electrode.

[2 marks]



Equation:

Equation:

Question 9

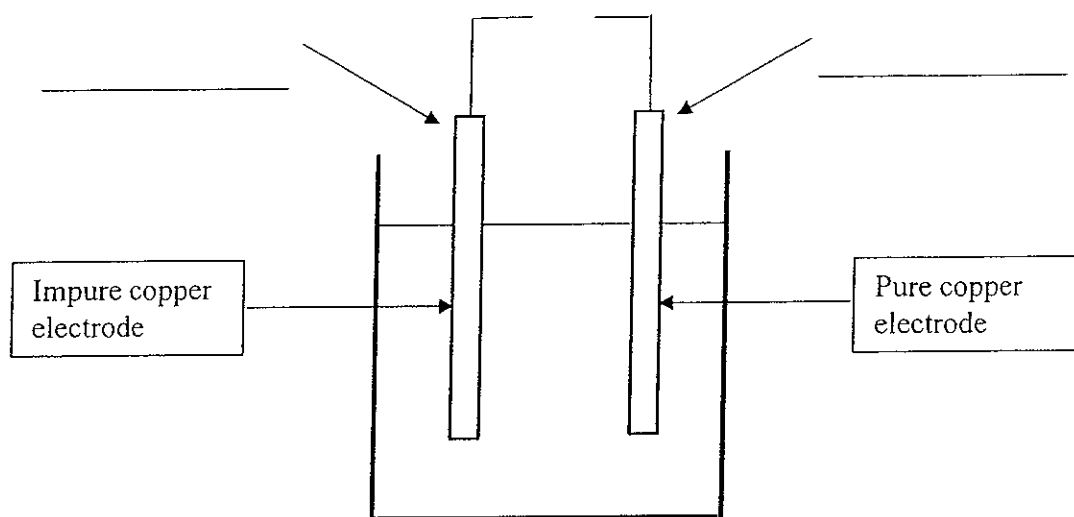
[4 marks]

In the process of electro-refining, an impure metal can be purified using electrolysis. Below is a partially completed diagram to show how copper can be electro-refined.

(a) Complete the diagram:

- (i) Show the polarity of the power supply (use + or – symbols) necessary for the cell to work properly.
- (ii) Show direction of travel of electrons in the external circuit.
- (iii) Label the anode and cathode.

[3 marks]



(b) Write the half equation for the reaction at the cathode:

[1 mark]

Further analysis of the compound determined that its molar mass was 60.1 g mol^{-1} .

(b) Determine the molecular formula of the compound.

[2 marks]

(c) The compound was found to react as a weak acid. What could be the name of this acid and write its structural formula. [2 marks]

Name: _____

Structural formula:

Question 2

[8 marks]

105 mL of a 0.500 mol L^{-1} solution of potassium iodide was added to 50.0 mL of a solution containing 0.75 mol L^{-1} of lead nitrate. A yellow precipitate results.

(a) Write a balanced ionic equation for this reaction

[1 mark]

(b) Determine the limiting reagent and hence identify the substance in excess.

[3 marks]

(c) Calculate the mass of lead iodide produced.

[2 marks]

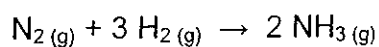
(d) Calculate the mass of the excess reagent.

[2 marks]

Question 3

[12 marks]

In the Haber process, ammonia is produced according to the reaction:



The hydrogen gas is produced in two steps:

Firstly, methane is reacted with steam (H_2O) over a catalyst of NiO to produce carbon monoxide and hydrogen. The carbon monoxide then further reacts with steam to produce carbondioxide and hydrogen.

(a) Write and balance the two equations for this process:

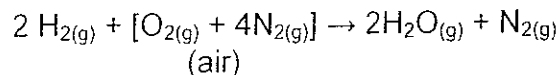
[2 marks]

(b) If 1.00×10^3 kg of methane is reacted in excess steam, calculate the **total** mass of hydrogen gas produced. (You will need to use both equations.) [3 marks]

(c) Calculate the mass of nitrogen gas required to completely react with the hydrogen gas [as calculated in (b)] to produce ammonia.

[2 marks]

The mole ratio of oxygen to nitrogen in air can be considered to be 4 to 1. When air is added to the system, the oxygen reacts with hydrogen at a high temperature leaving nitrogen gas:



(d) Calculate the mass of hydrogen gas required to produce amount of nitrogen gas as calculated in (c). *If you do not have an answer to (c), use mass = 2.00×10^3 tonne.*
[2 marks]

In practice, not all the hydrogen and nitrogen react completely. In a particular factory, a yield of only 40% is achieved.

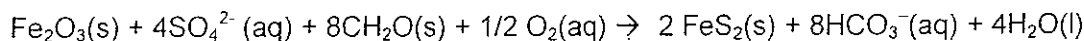
(e) Calculate the mass of ammonia produced from the quantities of nitrogen and hydrogen you have determined.

[3 marks]

Question 4 [10 marks]

The sea level rise that followed the last ice age inundated coastal bays and rivers. The sulfate in the sea water combined with organic matter and reduced iron minerals to form iron sulfide minerals (Pyrites – FeS₂).

The production of pyrite requires a supply of sulfate, easily decomposable organic matter (CH₂O), oxygen and iron rich sediments. The overall reaction for pyrite production is:



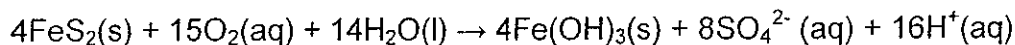
a) Identify ALL the oxidising and reducing agents in this equation

[3 marks]

b) What is unusual about this redox reaction compared to many that you may have come across in your studies?

[1 mark]

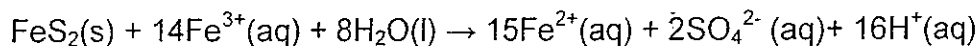
The pyrite reacts with oxygen and soil moisture to produce iron (III) hydroxide (Fe(OH)₃), sulfate ions (SO₄²⁻), and hydrogen ions (H⁺), according to the equation for the reaction:



At pH greater than 4, Fe³⁺ ion is unstable and the precipitate Fe(OH)₃ is formed. Name the acid that's going to be produced in the soil, and state its nature?

[1 mark]

If the pH is below 4, however, ferric iron remains stable and may further oxidise pyrite according to this equation:



Final Examination 2009

CHEMISTRY 2A-2B

NAME : _____

TEACHER : _____

MULTIPLE CHOICE ANSWER SHEET

- | | |
|---------------------|---------------------|
| 1. [A] [B] [C] [D] | 16. [A] [B] [C] [D] |
| 2. [A] [B] [C] [D] | 17. [A] [B] [C] [D] |
| 3. [A] [B] [C] [D] | 18. [A] [B] [C] [D] |
| 4. [A] [B] [C] [D] | 19. [A] [B] [C] [D] |
| 5. [A] [B] [C] [D] | 20. [A] [B] [C] [D] |
| 6. [A] [B] [C] [D] | 21. [A] [B] [C] [D] |
| 7. [A] [B] [C] [D] | 22. [A] [B] [C] [D] |
| 8. [A] [B] [C] [D] | 23. [A] [B] [C] [D] |
| 9. [A] [B] [C] [D] | 24. [A] [B] [C] [D] |
| 10. [A] [B] [C] [D] | 25. [A] [B] [C] [D] |
| 11. [A] [B] [C] [D] | |
| 12. [A] [B] [C] [D] | |
| 13. [A] [B] [C] [D] | |
| 14. [A] [B] [C] [D] | |
| 15. [A] [B] [C] [D] | |

(25 marks)