Name	Register No	Class

QUESTION PAPER

SINGAPORE PIAGET ACADEMY MEDAN

SINGAPORE PIAGET ACADEMY MEDAN
PRELIMINARY EXAMINATION 2008-2009

CHEMISTRY SECONDARY FOUR

PAPER 2 1 hour 30 minutes

Additional Materials: 1 x Cover Page
Answer Booklet/ 4 sheets writing paper
Electronic Calculator

INSTRUCTIONS TO CANDIDATES

Read these instructions first.

Write your Centre number, candidate number and name on the work you hand in.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **three** questions.
Write our answers on any lined pages and/or separate answer paper.
You may use a calculator.
A copy of the Periodic Table is printed on the last page.
At the end of the examination, fasten all your work securely together.
The number of marks is given in bracket [ ] at the end of each question or part question.

This document consists of 15 printed pages including this cover page

Section A (45 marks)
Answer ALL questions. Write your answers in the spaces provided.

A1 From the list below, choose the most suitable answer.

carbon dioxide
chlorine
ammonia
potassium chloride
aqueous copper(II) sulphate
carbon monoxide
nitrogen
water
sodium oxide
hydrogen
graphite
iron

Which substance

(a) when added to potassium iodide produces a black solid?

.....

(b) is formed at the cathode when an aqueous solution of dilute sulphuric acid is electrolysed?

.....

(a) is produced when aqueous sodium nitrate is warmed with aqueous sodium hydroxide and aluminium foil?

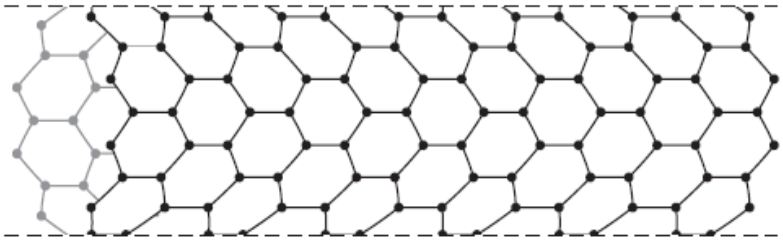
.....

(d) reacts with iron powder to give a pink-brown solid?

.....

[4]
[Total: 4]

A2 In recent years scientists have made tube-shaped structures of carbon called nanotubes.



(a) State **two** differences between the structure of a carbon nanotube and the structure of diamond.

..... [1]

(b) Carbon nanotubes are fifty times stronger than steel.
Use ideas about structure and bonding to suggest why these nanotubes are so strong.

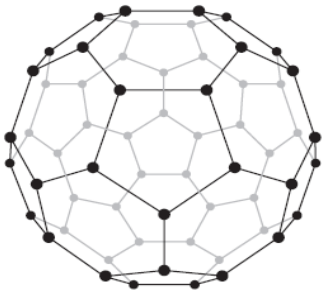
.....

.....[1]

(c) Carbon nanotubes are good electrical conductors.
(i) Carbon nanotubes conduct electricity nearly as well as copper.
Explain why copper is a good conductor of electricity.

.....[1]

(d) Another form of carbon is buckminsterfullerene.



● carbon atom

Argon can be trapped inside the cage-like structure of buckminsterfullerene.
(i) Explain why argon is unreactive.

.....[1]

(ii) One isotope of argon is $^{38}_{18}Ar$
Calculate the number of neutrons in this isotope of argon.

.....[1]

(e) Recently, chemists have been trying to attach atoms of transition elements to buckminsterfullerene to make more efficient catalysts. State **one** properties, other than catalysis, which distinguish transition elements from other metals.

.....

.....[1]
[Total: 6]

A3 A commercial agricultural fertiliser contains three compounds:

- ammonium sulphate, $(NH_4)_2SO_4$,
- iron(II) sulphate, $FeSO_4$,
- sand, SiO_2.

(a) Aqueous iron(II) ions can react with aqueous sodium hydroxide.
(i) Write the equation for the reaction between sodium hydroxide and iron (II).

..... [1]

(c) Aqueous iron(II) ions can be oxidised by reaction with acidified potassium manganate(VII), $KMnO_4$. The colour change during the reaction shows that iron(II) ions act as a reducing agent.

(i) Write the equation for the reaction between potassium manganate(VII) and iron(II).

..... [1]
(ii) In terms of oxidation numbers, explain the meaning of the term *reducing agent*.

.....

..... [1]

(d) The mass of iron(II) ions in a sample of fertiliser can be determined by the reaction between iron(II) ions and acidified potassium manganate(VII), $KMnO_4$. A student analysed a sample of the fertiliser. He dissolved the sample in 25.0 cm^3 of dilute sulphuric acid and titrated the solution formed with 0.0200 mol / dm_3 potassium manganate(VII).

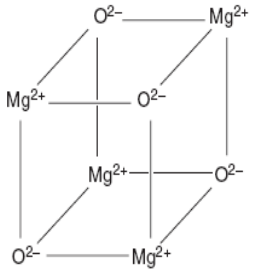
The student used 22.5 cm^3 of potassium manganate(VII) to reach the end-point.
(i) Calculate the number of moles of potassium manganate(VII) used in the titration.

..... moles [1]

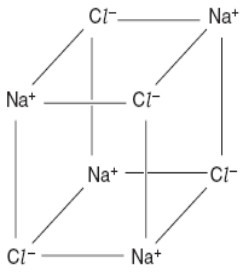
(ii) One mole of potassium manganate(VII) reacts with five moles of iron(II) ions.
Calculate the mass, in grams, of iron(II) ions in the sample analysed.

. ..... g [2]
[Total: 7]

A4 The structures of two ionic lattices are shown below.



magnesium oxide



sodium chloride

(a) Magnesium oxide, MgO, has a similar structure to sodium chloride. Suggest why the melting point of magnesium oxide is higher than that of sodium chloride.

.....

.....

..... [1]

Germanium, Ge, is an element in Group IV of the Periodic Table. Some of its chemistry resembles that of carbon.

(b) How many electrons does an atom of germanium have in its outer shell?

.

..... [1]

(c) Germanium forms a range of saturated compounds with hydrogen. These compounds resemble the alkanes.

(i) Predict the general molecular formula for these compounds.

..... [1]

(ii) Germanoethane, Ge_2H_6, has a similar structure to ethane.
Draw the full structural formula for germanoethane.

[1]

(iii) Hydrochloric acid reacts with magnesium germanide, Mg_2Ge, to form germanomethane, GeH_4, and magnesium chloride.
Write an equation for this reaction.

..... [1]

[Total: 5]

A5 Rubidium, Rb, is in Group I of the Periodic Table. It reacts with water according to the equation below.

$$2Rb(s) + 2H_2O(l) \rightarrow 2RbOH(aq) + H_2(g)$$

Predict what you would **observe** when a small piece of rubidium is added to cold water.

.....

..... [1]

Potassium,K, is also in Group I of the Periodic Table. Potassium reacts with water in a reaction similar to Rubidium. A sample of 0.195 g of potassium was added to 500 cm^3 of cold water. When the reaction was finished, 100 cm^3 of 0.100 mol/dm^3 hydrochloric acid was added to form solution **X**.

(i) Calculate the number of moles of hydroxide ions formed when the potassium was added to water.

..... [1]

(ii) Calculate the number of moles of hydrogen ions in 100 cm^3 of 0.100 mol/dm^3 hydrochloric acid.

..... [1]

(iii) Give an ionic equation to represent the neutralisation reaction.

..... [1]

(iv) Suggest a pH value for solution **X**. Explain your answer clearly.

.....

..... [1]
[Total: 5]

A6 Some redox reactions can be used to propel rockets.
The following equations represent redox reactions used to propel rockets.
Reaction **A**

$$N_2H_4(g) + 2H_2O_2(g) \rightarrow N_2(g) + 4H_2O(g)$$

Reaction **B**

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

(i) Use these equations to complete the following table.

reaction	*number of moles of reactants*	*number of moles of products*
A		
B		

[1]

(ii) Reactions used to propel rockets need to produce large volumes of gas.
Use the information in the table to suggest why reaction **A** is more likely to be used to propel rockets.

.....

..... [1]

(b) Explain why gas volumes measured at rtp. cannot be used in calculations for gases produced in rocket engines.

..... [1]

(c) In the air, sulphur dioxide reacts with nitrogen dioxide forming sulphur trioxide.
The reactions that take place are shown in the equations.
Sulphur dioxide and nitrogen dioxide react together as shown in the equation.

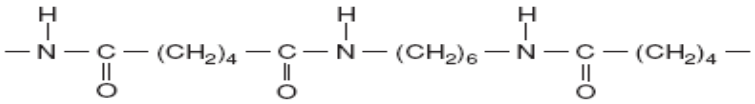
$$SO_2 + NO_2 \longrightarrow SO_3 + NO \qquad \Delta H = +43 \text{ kJ/mol}$$

Draw an energy profile diagram for this reaction.
Indicate both the enthalpy change and the activation energy on your diagram.

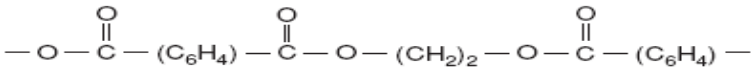
[2]
[Total: 5]

A7 These diagrams show sections of the polymer chain of two condensation polymers.

Nylon



Terylene



(a) The formulae of the two monomers used to make nylon are shown below.

Nylon monomers $HOOC(CH_2)_4COOH$ $H_2N(CH_2)_6NH_2$

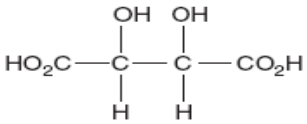
Deduce the formulae of the two monomers that are used to make *Terylene*.

***Terylene* monomers**

.....

..... [1]

Tartaric acid can be extracted from grape juice. Tartaric acid and its salts are used in food. The structure of tartaric acid is shown below.



(i) Name the <u>two</u> different functional groups in tartaric acid.

..... [1]

(ii) Write the structural formulae of the ions formed when tartaric acid dissolves in water.

..... [1]

(iii) A solution of tartaric acid was titrated with 0.100 mol/ dm^3 potassium hydroxide.

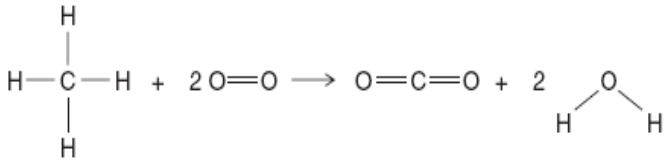
$$\underset{\text{tartaric acid}}{C_2H_2(OH)_2(CO_2H)_2} + 2KOH \rightarrow C_2H_2(OH)_2(CO_2K)_2 + 2H_2O$$

It required 6.00 cm^3 of the potassium hydroxide solution to neutralise 20.0 cm^3 of tartaric acid. Calculate the concentration, in mol/dm^3, of the tartaric acid solution.

..... mol/dm^3 [2]

[Total: 5]

A8 Methane, CH_4, and methanol, CH_3OH, will both burn in air. The reactions are described by the equations below.



$\Delta H = -890\ kJ/mol$

$2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$; ΔH = -1452kJ/mol

(i) Explain why this reaction is exothermic when methanol burnt in air in terms of the energy changes that take place during bond breaking and bond making.

.....

..... [1]

(ii) If 2 mol of methane and 2 mol of methanol are completely burnt in separate experiments, which experiment will release the most energy? Explain using calculations.

..... [1]

(iii) Draw a 'dot and cross' diagram to show the bonding in methanol. You only need to draw the outer (valence) electrons of carbon.

[1]
[Total: 3]

A9 Mercury oxide-zinc batteries are used in many low-power applications, such as watches and calculators. For the two half cells, the relevant equations from the electrochemical series are given below.

$HgO(s) + H_2O(l) + 2e^- \rightarrow Hg(l) + 2OH^-(aq)$

$Zn(OH)_2(s) + 2e^- \rightarrow Zn(s) + 2OH^-(aq)$

(i) Write the equation for the reaction occuring at the anode

..... [1]

(ii) Write the equation for the reaction occuring at the cathode

..... [1]

(iii) Write the equation for the overall cell reaction.

..... [1]

The acid salt, sodium dihydrogen phosphate, NaH_2PO_4 can be found in toilet cleaner. Sodium dihydrogen phosphate can be made by reacting sodium hydroxide with phosphoric acid, H_3PO_4.

(v) Write an equation for the formation of sodium dihydrogen phosphate.

..... [1]

(vi) Suggest the formula of **two** other salts formed from sodium hydroxide and phosphoric acid.

..... [1]

[Total: 5]

END OF SECTION A

Section B (30 marks)
Answer any three questions. Write your answers on the writing paper provided. Begin each question on a new page.

B10 Ammonia is used to manufacture nitric acid, by a two-stage process.

Stage 1: the ammonia is converted to nitrogen(II) oxide.
$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ ΔH = –950 kJ/mol

(a)(i) State and explain how the **rate** changes when the pressure is increased. Use ideas about colliding particles.

(ii) State and explain how the **yield** changes when the pressure is increased. Use ideas about reacting volumes of gases. [4]

(b) During the reaction, the ammonia and oxygen are passed through a powdered catalyst.

(i) Explain why the catalyst becomes hot during the reaction.

(ii) Explain why the catalyst is used in the form of a powder. [2]

Stage 2: the nitrogen dioxide is converted to nitric acid.
$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$

(c) Calculate the maximum mass of nitric acid which can be made from 720dm^3 of nitrogen(II) oxide, NO, at room temperature and pressure. [3]

(d) Use the two equations to construct an overall equation for the conversion of ammonia to nitric acid. [1]

[Total: 10]

B11 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulphide, NiS.

- Stage 1 – nickel(II) sulphide is heated in air to form nickel(II) oxide and sulphur dioxide.
- Stage 2 – nickel(II) oxide is heated with carbon to give impure nickel.
- Stage 3 – impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$.
- Stage 4 – nickel tetracarbonyl is decomposed to give pure nickel.

(a) (i) Construct the balanced equation for the reaction in stage 1.

(ii) Calculate the mass of sulphur dioxide that is formed when 182 kg of nickel sulphide is heated in air. [3]

(b) Nickel tetracarbonyl is a liquid with a boiling point of 43 °C.
Suggest, with a reason, the type of bonding in nickel tetracarbonyl. [2]

(c) Suggest **one** possible environmental consequence of the manufacture of nickel. [1]

(d) Give an example of the use of nickel as a catalyst. [1]

(e) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions. The results are shown in the table.

	aqueous zinc nitrate $Zn(NO_3)_2$	aqueous nickel(II) nitrate, $Ni(NO_3)_2$	aqueous copper(II) nitrate, $Cu(NO_3)_2$
zinc	no reaction	green solution went colourless and zinc coated with a silver solid	blue solution went colourless and zinc coated with a pink solid
nickel		no reaction	
copper	no reaction	no reaction	no reaction

Predict the observations when nickel is added to separate solutions of zinc nitrate and copper(II) nitrate. Write an ionic equation for **one** of the reactions that takes place. [3]

[Total: 10]

B12 The table shows the molecular formula of the first three members of the alcohol homologous series and the heat change, ΔH, of the compounds released when the compounds are completely burnt in oxygen during combustion.

Compound	***Molecular Formula***	***Boiling Point/^{o}C***	***ΔH/kJmol^{-1}***
Methanol	CH_4O	65	-700
Ethanol	C_2H_5O	78	-1350
Propanol	C_3H_8O	97	-2000

(i) State **two** evidences from the table which show that methanol, ethanol and propanol belong to the same homologous series of alcohols.

[2]

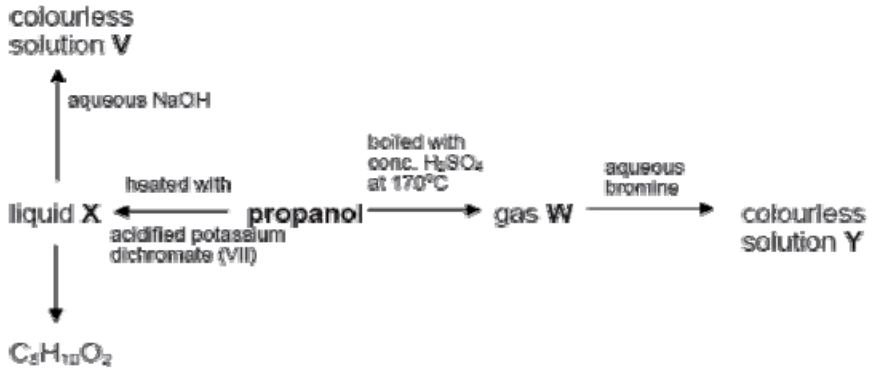
(ii) Butan-1-ol is the fourth member of the alcohol homologous series. Predict the amount of energy released when 1 mole of butan-1-ol is completely burnt.

[1]

Isomerism can be found in the fourth member of the homologous series of alcohols.

(iii) Draw and name the full structural formula of the isomer of butan-2-ol. [1]

(b) Propanol is the third member of the alcohol homologous series.
Consider the following reactions involving propanol.



(i) Draw the full structural formulae for each of the compounds **V**, **W**, **X** and **Y**. [4]

(ii) Describe how the conversion of liquid X to $C_5H_{10}O_2$ is possible. [1]

(iii) Name the other product formed when liquid **X** reacts with aqueous sodium hydroxide.[1]

[Total: 10]

B13 All members of the carboxylic acid homologous series contain the –CO_2H group.
The table shows the formula of the first three members of this homologous series.

carboxylic acid	formula
methanoic acid	HCO_2H
ethanoic acid	CH_3CO_2H
propanoic acid	$C_2H_5CO_2H$

(a) Name the unbranched carboxylic acid that has four carbon atoms per molecule. [1]

(b) Give the formula of the sixth member of the carboxylic acid homologous series. [1]

(c) Ethanol, C_2H_5OH, reacts with ethanoic acid to make ethyl ethanoate.
Draw the full structural formula of ethyl ethanoate. [1]

(d) Name a reagent that can be used to convert ethanol into ethanoic acid. [1]

(e) Magnesium reacts with ethanoic acid to make magnesium ethanoate and hydrogen.
Write the equation for this reaction. Use the equation to calculate the mass of magnesium needed to react completely with 50 cm^3 of 1.0 mol/dm^3 of ethanoic acid.
[3]

(f) Suggest why the reaction between magnesium and 1.0 mol/dm^3 ethanoic acid is much slower than the reaction between magnesium and 1.0 mol/dm^3 hydrochloric acid.
[2]

(g) Aqueous sodium hydroxide neutralises dilute ethanoic acid.
Write the ionic equation for this reaction. [1]

[Total: 10]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

*58-71 Lanthanoid series	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
†90-103 Actinoid series	232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).