Class	Register Number	Name

南洋女子中學校

NANYANG GIRLS' HIGH SCHOOL

End-of-Year Examination 2014
Secondary Three

CHEMISTRY **1 hour 45 minutes**

Paper 2 Theory Paper

Wednesday **1st October 2014** **0915-1100**

Additional materials: Writing paper

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, register number and class in the spaces at the top of this page and on any separate answer paper used.

Section A (40 marks)

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B (30 marks)

Answer **all** questions including questions **8, 9** and **10** ***Either*** or **10** ***Or***.

Write your answers on the separate writing paper provided.

At the end of the examination,

1. Fasten all your work securely together;
2. tick **10** ***Either*** (for Either) or **10** ***Or*** (for Or) next to the number 10 in the grid below to indicate which question you have answered.

INFORMATION FOR CANDIDATES

The intended number of marks is given in the brackets [ ] at the end of each question or part question. You are advised to spend no more than one hour on Section A and no longer than 45 minutes on Section B.

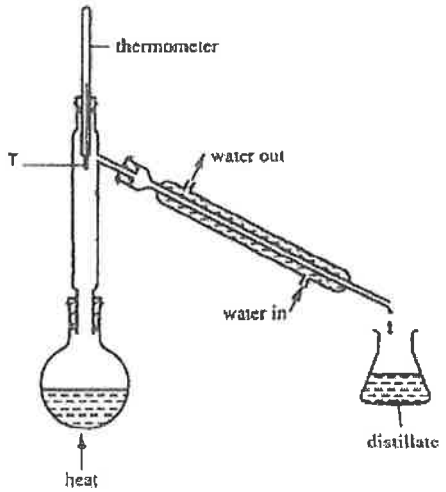
Examiner's Use	
Section A	
Section B	
8	
9	
10 *Either*	
10 *Or*	
Total	

Section A

Answer **all** questions.

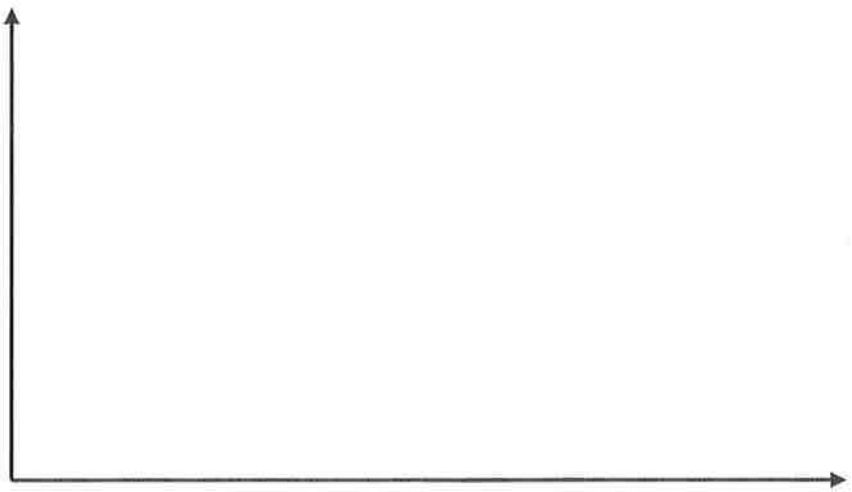
Write your answers in the spaces provided.

A1 The diagram shows the setup used to separate hexane (boiling point, 70°C) and heptane (boiling point, 98°C).



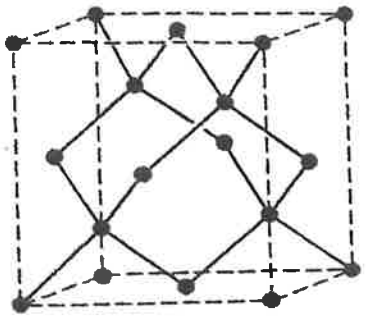
(a) Explain why the mixture needs to be separated by fractional distillation. [2]

(b) Sketch and label a graph to show the change of temperature at point **T** against the total volume of distillate collected. [2]

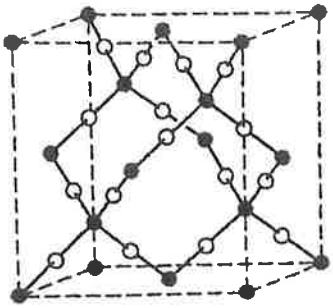


Total [4]

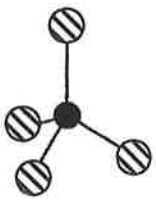
A2 The diagrams below show the structures of an element **X**, its principal oxide and its principal chloride.



● = element **X**



● = element **X**
○ = oxygen



● = element **X**
⊘ = chlorine

(a) What is the formula of the oxide of **X**? [1]

(b) Given that the percentage composition of oxygen atoms in the oxide of **X** is 53.3%, find the atomic mass of element **X**. Show your calculations in the space below to support your answer. [2]

Atomic mass of **X**: _____

Total [3]

A3 **(a)** Agricultural lime is manufactured from limestone (calcium carbonate) by first heating the rock to a high temperature in a quicklime kiln (Reaction 1).

The product is then allowed to cool and a calculated amount of water is added. A highly exothermic reaction characterised by a release of a large amount of energy takes place and a white powder called slaked lime is produced (Reaction 2).

(i) Write balanced equations for the reactions. [2]

Reaction 1: _____

Reaction 2: _____

(ii) Why is lime used in agriculture? [1]

_____

(iii) The pH of 0.100 mol/dm^3 aqueous sodium hydroxide and 0.100 mol/dm^3 aqueous ammonia are measured. Given that equal volumes of both alkalis are used, explain why aqueous sodium hydroxide has a higher pH. [1]

_____

_____

_____

(b) The mineral dolomite is a double carbonate of magnesium and calcium, with the formula $CaMg(CO_3)_2$. When 1.00 g of an impure sample of dolomite was completely dissolved in an excess of hydrochloric acid, a salt was formed and 0.450 g of carbon dioxide was given off.

(i) Write a balanced equation for the reaction. [1]

_____

(ii) Calculate the percentage purity of the dolomite. [2]

Total [7]

A4 The table below gives the boiling points of three substances.

Substance		Molar mass/ g mol^{-1}	Boiling point/ °C
J	$CH_3CH_2CH_2CH_3$	58	0
K	KSCN	97	500
L	*Al*	27	2520

(a) Name the forces of attraction that exist between molecules of **J**. [1]

(b) Explain the difference in the boiling points of substances **J** and **K**. [2]

(c) Describe the bonding present in solid **L** and explain the high boiling point of **L**. [2]

Total [5]

A5 **(a)** Sodium sulfate can be prepared from the reaction of aqueous sodium hydroxide with another reagent.

(i) Name the reagent that can be reacted with aqueous sodium hydroxide to form sodium sulfate. [1]

_____

(ii) Using the reagents from (a)(i), outline the steps needed to form a pure and dry sample of sodium sulfate. Assume that the reagents used have concentrations of 0.100 mol/dm^3.
Include the chemical equation for the reaction. [4]

_____

_____

_____

_____

_____

_____

_____

(b) Aqueous silver nitrate is treated with successive additions of the following reagents:

- an excess of aqueous calcium chloride
- an excess of aqueous potassium sulfate

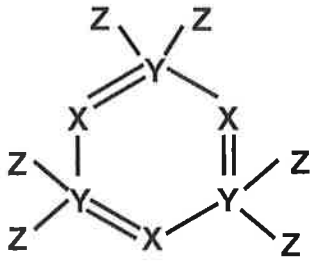
State the final observation after the addition of both reagents. [1]

_____

_____

Total [6]

A6 **(a)** A stable molecule containing atoms of the elements, **X**, **Y** and **Z** has the following structure.



Identify possible elements for **X** and **Z**. [2]

Element **X**: _____

Element **Z**: _____

(b) Phosphorus oxide, P_4O_6 dissolves in water to form an acid according to the reaction below.

$$P_4O_6\ (s) + 6H_2O\ (l) \rightarrow 4H_3PO_3(aq)$$

(i) Arsenic is an element that is in the same Group as phosphorus. Given that arsenic oxide reacts with water to form an acid, suggest a formula of the acid formed. [1]

_____

(ii) Hence, give the formula of the salt formed when the acid reacts with sodium carbonate. [1]

_____

Total [4]

A7 **(a)** Hydrogen peroxide, H_2O_2 reacts with silver oxide according to the following equation.

$$Ag_2O(s) + H_2O_2(l) \rightarrow 2Ag(s) + H_2O(l) + O_2(g)$$

Identify the oxidising agent and the reducing agent from the reaction above. [1]

Oxidising agent: _____

Reducing agent: _____

(b) In an attempt to establish the formula of an oxide of nitrogen, a known volume of the pure gas was mixed with hydrogen and passed over a catalyst at a suitable temperature. 100% conversion of the oxide to ammonia and water was shown to have taken place.

$$N_xO_y \xrightarrow[\text{catalyst}]{H_2(g)} xNH_3 + yH_2O$$

2400 cm^3 of the nitrogen oxide, measured at room temperature and pressure (r.t.p.), produced 7.20 g of water. The ammonia produced was neutralised by 200 cm^3 of 1.0 mol/dm^3 hydrochloric acid.

(i) Find the number of moles of nitrogen oxide. [1]

(ii) Find the number of moles of water and ammonia produced. [2]

(iii) Hence, find the formula of nitrogen oxide, N_xO_y. [2]

(iv) Find the oxidation number of the nitrogen in the nitrogen oxide. Show your workings. [2]

(c) Nitric acid is a strong oxidizing agent. State and explain which of the following species is **least** likely to be produced when nitric acid reacts with a strong reducing agent such as zinc metal.

N_2O, NO, NO_2, N_2O_4, N_2O_5 [3]

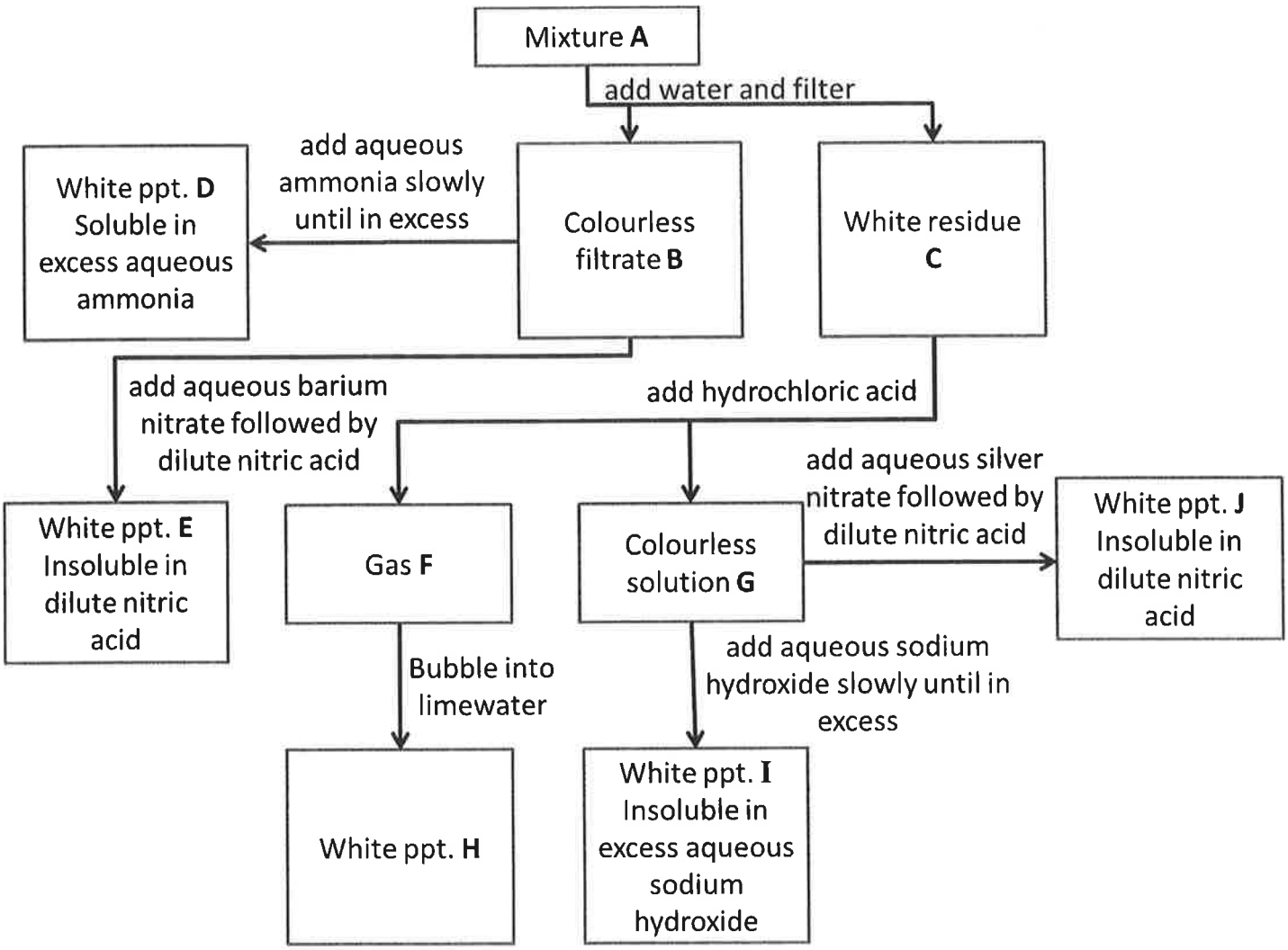
Total [11]

Section B

Answer all **three** questions from this section.

The last question is in the form of either/or and only **one** of the alternatives should be attempted. Each question carries **ten** marks.

B8 Substance A is a mixture of two white solids, one of which is soluble in water. Study the flow chart given and answer the questions that follow.



(a) Identify the compounds **D** to **J**. [4]

(b) Upon prolonged bubbling of gas **F** in limewater, gas **F** will eventually react with **H**. State and explain your observation. [2]

(c) Write a balanced equation, with state symbols for the formation of the precipitate **E** from reaction of filtrate **B** with acidified aqueous barium nitrate. [1]

(d) Calculate the number of moles of solution **G** obtained when 5.00 g of **C** is reacted with 25.0 cm^3 of 0.100 mol/dm^3 of hydrochloric acid. [3]

B9 **(a)** An analysis of 1.00 dm^3 of exhaust gases from the combustion of octane in a motor car produced the following data.

Gas	Formula	Percentage by volume
Carbon monoxide	CO	2.0
Carbon dioxide	CO_2	11.3
Oxygen	O_2	0.8
Unburnt octane	C_8H_{18}	0.05

In the following calculations, assume that all gases are ideal and that all measurements were taken at room temperature and pressure.

(i) Calculate the volume of unburnt octane in 1.00 dm^3 of exhaust gas. [1]

(ii) Hence, calculate the number of moles of unburnt octane. [1]

(iii) Calculate the total volume of carbon monoxide and carbon dioxide in 1.00 dm^3 of exhaust gas. [1]

(iv) Hence, calculate the total number of moles of carbon monoxide and carbon dioxide. [1]

(v) Therefore, calculate the number of moles of octane burnt to produce these oxides. [1]

(b) Acidified aqueous potassium dichromate(VI) and acidified aqueous potassium manganate(VII) each liberate iodine from aqueous potassium iodide.

(i) Describe the observations when aqueous potassium iodide is added to acidified aqueous potassium manganate(VII). Explain the observations in terms of change in oxidation number. [2]

(ii) 25.0 cm^3 of acidified aqueous potassium dichromate(VI) liberates the same mass of iodine as that of 25.0 cm^3, 0.0300 mol/dm^3 acidified aqueous potassium manganate(VII) from a solution of aqueous potassium iodide.

2 moles of potassium manganate(VII) produces 5 moles of iodine and 1 mole of potassium dichromate(VI) produces 3 moles of iodine.

What is the concentration in mol/dm^3 of the acidified aqueous potassium dichromate(VI)? [3]

B10 EITHER

(a) In order to determine the percentage purity of a sample of 5.00 g lithium carbonate, a student added 150 cm^3 of 1.20 mol/dm^3 excess hydrochloric acid to dissolve all the solid sample. The volume of gas produced was measured and the percentage purity of the lithium carbonate was determined to be 63.5%.

(i) Write a chemical equation for the reaction. [1]

(ii) Find the number of moles of lithium carbonate present in the sample. [1]

(iii) Find the volume of gas produced and collected by the student in the experiment. [1]

(iv) Find the number of moles of hydrochloric acid leftover in the mixture after reaction. [2]

(b) The mixture in **(a)** was topped up to 2.00 dm^3 with water and labeled **FA1**.

25.0 cm^3 of **FA1** was titrated with 29.00 cm^3 of barium hydroxide solution of unknown concentration. The solution obtained from the titration was **subjected** to crystallization.

(i) Find the new concentration of hydrochloric acid in **FA1**. [1]

(ii) Find the number of moles of acid present in 25.0 cm^3 of **FA1**. [1]

(iii) Find the concentration of the barium solution in mol/dm^3. [2]

(iv) The yield of the crystals obtained was less than 100%. Suggest a possible reason. [1]

B10 OR

(a) A student added 17.00 cm^3 of 0.380 mol/dm^3 sulfuric acid to 24.00 cm^3 of 0.275 mol/dm^3 barium hydroxide solution. The percentage yield of salt obtained in this experiment was 98.9%.

(i) Write a chemical equation for the reaction. [1]

(ii) By showing the necessary calculation, explain which is the limiting reagent in this reaction. [2]

(iii) Find the actual mass of salt obtained. [2]

(b) Another student carried out the same reaction but using reactants with different concentrations from **(a)**.

28.00 cm^3 of 0.500 mol/dm^3 sulfuric acid was reacted with 20.00 cm^3 barium hydroxide solution. In order to find the amount of acid left after the reaction, the resulting mixture was titrated with 0.160 mol/dm^3 sodium hydroxide solution. 8.00 cm^3 of sodium hydroxide was required for this titration.

(i) Find the number of moles of sulfuric acid that reacted with sodium hydroxide. [1]

(ii) Find the number of moles of sulfuric acid that reacted with barium hydroxide. [2]

(iii) Find the concentration of the barium hydroxide solution used. [1]

(iv) The accurate volume of sodium hydroxide for the titration should be 8.50 cm^3. Suggest 1 possible reason that caused the student's volume to be lower than actual. [1]

End of paper

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 sulfur 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	– Ra radium 88	– Ac actinium † 89															

Key

relative atomic mass
atomic symbol
name
atomic number

*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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).