Class	Register Number	Name

南洋女子中學校

NANYANG GIRLS' HIGH SCHOOL

End-of-Year Examination 2016
Secondary Three

CHEMISTRY **1 hour 45 minutes**

Paper 2 Theory Paper **1015 – 1200 hrs**

Wednesday **5 October 2016**

Additional materials: Writing papers

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 **7, 8** and **9 *Either*** or **9 *Or*.**
Write your answers on the separate writing paper provided.
At the end of the examination,

1. fasten all your answers to **Section B** securely together;
2. tick **9 *Either*** (for *Either*) or **9 *Or*** (for *Or*) in the grid below to indicate which question you have answered.
3. hand in **Section A** and **Section B separately**

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 longer than one hour on Section A and no longer than 45 minutes on Section B.

The use of scientific calculators is allowed.

A copy of the periodic table is found on page 13.

Examiner's Use	
Section A	
Section B	
7	
8	
9 *Either*	
9 *Or*	
Total	

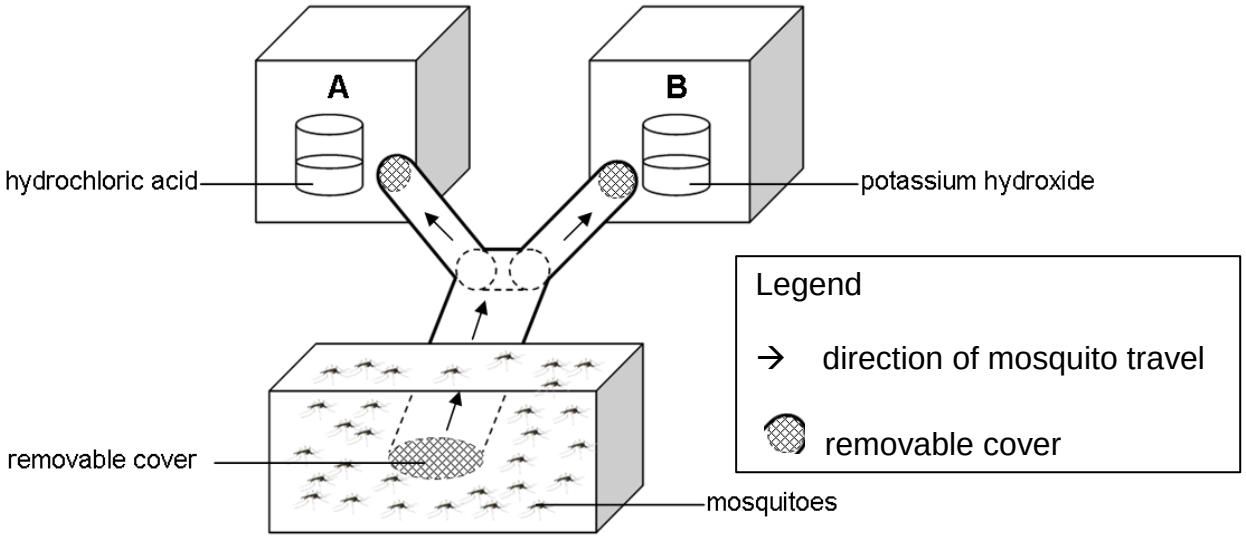
Section A

Answer **all** questions.

Write your answers in the spaces provided.

A1 Mosquitoes are attracted to humans due to the chemicals we release. Two main chemicals they respond to are carbon dioxide and ammonia.

Using the following transparent setup, James carried out an experiment to find out if mosquitoes are more attracted to carbon dioxide or ammonia.



Through chemical reactions, carbon dioxide was produced in **A** and ammonia in **B**. When the reactions are completed, he removed all removable covers simultaneously to release the gases and mosquitoes. He monitored the direction of mosquito travel.

More mosquitoes flew to **B** than to **A**, leading James to conclude that mosquitoes are more attracted to ammonia.

(a) Write the chemical formula of a substance that James could add to hydrochloric acid in **A** to produce carbon dioxide and to potassium hydroxide in **B** to produce ammonia gas. [2]

A: .....

B: .....

(b) How would James know that the reaction in **A** had completed? Suggest an observation. [1]

.....

.....

(c) James' teacher did not agree with his conclusion. She argued that more mosquitoes are attracted to **B** because they detected ammonia **faster** than they detected carbon dioxide.
Using simple calculations, justify the teacher's argument. [2]

Total [5]

A2 The table below shows the melting points of some oxides and chlorides of elements in Period 3 of the Periodic Table.

group	I	II	III	IV	V	VI
oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_6	SO_2
melting point / ^oC	920	2852	2072	1610	24	-73

chloride	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_5	SCl_2
melting point / ^oC	801	701	178	-70	162	-121

(a) Describe the trend in the melting points of the oxides based on the data given in the table. [1]

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(b) Explain, in terms of bonding and structure,

(i) the difference between the melting point of SiO_2 and P_4O_6, [2]

.....

.....

.....

(ii) the similarity in melting point of NaC*l* and $MgCl_2$. [1]

.....

.....

(c) Predict the melting point of Cl_2O. [1]

.....

Total [5]

A3 The 'Odda process' was a method for the industrial production of nitrogen fertilisers invented by Erling Johnson around 1927. The process includes the following steps:

Step 1: Phosphate rock, $Ca_3(PO_4)_2$, is reacted with nitric acid to produce phosphoric acid, H_3PO_4, and calcium nitrate.

Step 2: Cooling the resulting mixture to below 0^oC where calcium nitrate crystallises and is separated from phosphoric acid.

Step 3: Using carbon dioxide, ammonia and water, crystals of calcium nitrate are converted into aqueous ammonium nitrate and calcium carbonate.

$$CO_2 + 2NH_3 + H_2O + Ca(NO_3)_2 \rightarrow 2NH_4NO_3 + CaCO_3$$

(a) **(i)** Write a balanced chemical equation, with state symbols to illustrate the reaction in Step 1. [1]

.....

(ii) When Step 1 was carried out in the presence of Universal Indicator, there was a change in colour from red to orange. Based on the information provided, comment on the relative strengths and the extent of dissociation of phosphoric acid and nitric acid in water. [2]

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.....

.....

(b) **(i)** 246 tonnes of calcium nitrate was used in Step 3. Calculate the maximum mass, in tonnes, of ammonium nitrate that can be produced. [1 tonne = 1000 kg] [3]

(ii) Calculate the percentage yield if the actual mass of ammonium nitrate produced was 181 tonnes. [1]

Total: [7]

A4 Boron is a non-metallic element found in Group III of the Periodic Table. It can be extracted from its oxide (B_2O_3) by heating with excess powdered magnesium in the absence of air.

$$B_2O_3\ (s) + 3\ Mg\ (s) \rightarrow 2\ B\ (s) + 3\ MgO\ (s)$$

(a) After the reaction, boron is obtained from the reaction mixture by the following steps:

1. Wash with warm dilute hydrochloric acid;
2. Wash with a solution of sodium hydroxide;
3. Wash with distilled water.

Give a reason for each step. [3]

Step 1:

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Step 2:

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.....

Step 3:

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(b) Describe how you would determine the purity of the boron extracted. [1]

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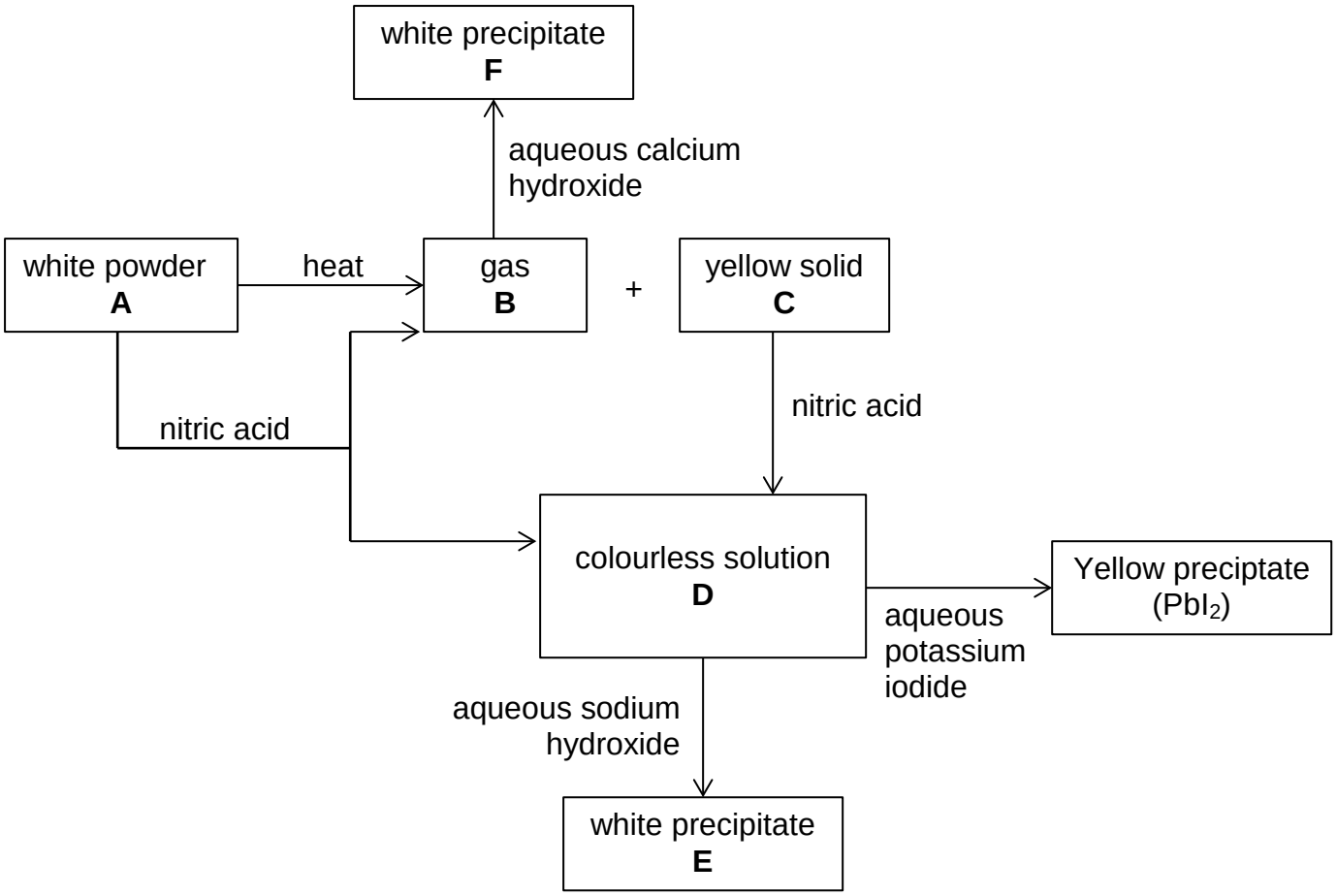
(c) Determine the mass of magnesium that was used if 22kg of boron was extracted. [3]

Total [7]

A5 The flowchart below shows a series of chemical reactions.



(a) Name the following compounds. [6]

A: ..... **D**: .....

B: ..... **E**: .....

C: ..... **F**: .....

(b) Describe what is observed when an excess of sodium hydroxide is added to white precipitate **E**. [1]

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(c) Name the products formed when white precipitate **F** is heated. [1]

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Total [8]

A6 Lumps of magnesium carbonate, of identical shapes and sizes, were treated with 100 cm^3 of dilute acid of various concentrations. The volume of carbon dioxide gas evolved after 4 minutes was measured while temperature rise was simultaneously monitored. All other conditions remain the same.

The results of the four experiments were recorded in the table below.

experiment	concentration/ $moldm^{-3}$	dilute acid used	volume of CO_2 gas/ cm^3	temperature rise /°C
1	0.10	HC*l*	11.0	0.15
2	0.20	HC*l*	22.0	0.30
3	0.40	HC*l*	44.0	0.59
4	0.20	HNO_3	22.0	?

(a) Explain why it is important that the pieces of magnesium carbonate are of the same size and shape and how the shape and size will affect the results obtained. [2]

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(b) State one trend observed when concentration of dilute acids was increased. [1]

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(c) Using ideas from the collision theory, explain the trend observed in **(b)**. [2]

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(d) **(i)** For experiments 2 and 4, the volume of carbon dioxide gas produced is the same over the 4-minute interval. Explain why this is so. [2]

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.....

.....

(ii) Hence predict the rise in temperature for experiment 4. [1]

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Total [8]

Section B

Answer **three** questions from this section on the writing papers provided.

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

B7

(a) A naturally occurring sample of potassium contains ^{39}K, ^{40}K and ^{41}K isotopes.

(i) Define the term "isotopes". [1]

(ii) List and indicate the amount of each type of subatomic particles present in each of the above-named K isotopes. Present your answers in a table format. [3]

(b) NPK fertilisers are three-component fertilisers providing the macronutrients nitrogen, phosphorus and potassium that support plant growth. The table below shows some properties of three substances ammonium chloride, urea and potassium chloride. [4]

substance	physical state at room temperature	action of heat	solubility in cold water
ammonium chloride NH_4Cl	solid	sublimes	soluble
urea $CO(NH_2)_2$	solid	no effect	insoluble
potassium chloride KCl	solid	no effect	soluble

You are given an NPK fertilizer that is a mixture of all these three substances.

Describe a procedure to obtain a pure and dry sample of potassium chloride from the mixture, stating the steps clearly.

(c) The strength of a fertiliser is determined by its percentage by composition of nitrogen. Determine if ammonium chloride or urea is a better fertiliser. [2]

Total [10]

B8

In a reaction vessel, iodine was reacted with aqueous silver nitrate in liquid pyridine (C_5H_5N) forming silver iodide and an organic substance. After removing silver iodide, the resulting solution was treated with an organic solvent to form a yellow solid. Analysis of the yellow solid showed a composition of 45.6% pyridine, 17.8% nitrate and **x**% iodine.

(a) Electrical conductivity of the reaction mixture, before and after the reaction between iodine, silver nitrate and liquid pyridine, was monitored using a electrical conductivity meter. It was observed that the electrical conductivity decreased over time.

Using your knowledge on chemical bonding and solubilities, explain the phenomenon. [3]

(b) **(i)** Determine the value of **x**. [1]

(ii) Determine the empirical formula of the yellow solid. [3]

(iii) Given that the molar mass of the yellow solid is 347 g mol^{-1}, find the molecular formula of the yellow solid in **(bii)**. [1]

(c) Another compound of iodine, potassium tetrachloroiodate, $KICl_4$ can be made by reacting potassium iodate, KIO_3 with dilute hydrochloric acid according to the following equation:

$$KIO_3 + 6HCl \rightarrow KICl_4 + 3H_2O + Cl_2$$

Given that 2.28 g of potassium tetrachloroiodate was obtained when 3.00 g of potassium iodate was used, determine the percentage yield of the experiment. [2]

Total [10]

B9
EITHER

(a) During a titration experiment, 24.0 cm^3 of **X**OH solution (an alkali) in a conical flask was found to be neutralised completely with 28.00 cm^3 of 1 mol dm^{-3} of sulfuric acid from a burette.

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

(ii) Name a suitable indicator for the titration and state the expected colour change. [2]

(iii) Calculate the concentration of this alkali in mol dm^{-3}. [2]

(b) In a separate titration experiment, the concentration of the alkali was determined to be 130.5 g dm^{-3}. Determine the identity of **X**. [2]

(c) 7.8 g of metal **X** was added to excess dilute hydrochloric acid in another experiment. Calculate the volume of hydrogen gas produced from this reaction. [3]

Total [10]

B9
OR

(a) Tartaric acid is a dibasic acid. Its formula can be written as H_2T and its molecular mass is 150. To make the salt, sodium tartrate, tartaric acid is neutralized completely with aqueous sodium hydroxide as shown in the equation below:

$$H_2T\ (aq)\ + 2NaOH\ (aq)\ \rightarrow Na_2T\ (aq) + 2H_2O\ (l)$$

(i) Define a dibasic acid with the help of an acid dissociation equation. [2]

(ii) What mass (in grams) of tartaric acid would be required to make 100 cm^3 of acid with concentration 0.100 mol dm^{-3}? [2]

(iii) If 100 cm^3 of tartaric acid with concentration 0.100 mol dm^{-3} is completely neutralized, what would be the mass of sodium tartrate produced? [3]

(iv) If 100 cm^3 of tartaric acid with concentration 0.100 mol dm^{-3} is completely neutralized by **x** cm^3 of sodium hydroxide with concentration 0.200 mol dm^{-3}, calculate the value of **x**. [2]

(b) Cream of tartar, a potassium acid salt of tartaric acid, reacts with baking soda, to create the fluffiness in breads and cakes.

Describe a laboratory test and expected observations that will confirm the identity of the gas produced in this reaction. [1]

Total [10]

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 †															

*58-71 Lanthanoid series
†90-103 Actinoid 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
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 X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and

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