Class	Register Number	Name

南洋女子中学校

NANYANG GIRLS' HIGH SCHOOL

End-of-Year Examination 2013
Secondary Three

CHEMISTRY **1 hour 45 minutes**

Paper 2 Theory Paper **0915 - 1100**

Wednesday **9th October 2013**

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 longer 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 names of some compounds are given below.

carbon monoxide	ammonium sulfate	magnesium carbonate
potassium hydroxide	lead(II) iodide	lead(II) nitrate
aluminium oxide	methane	ethanoic acid

Select from the above list, substance(s) that fit(s) the following descriptions. Each name may be used once, more than once or not at all. [4]

(a) a salt which is prepared by precipitation _____

(b) two solutions, which, when added together and warmed, will produce a gas that turns moist red litmus paper blue

_____ and _____

(c) a substance that dissolves in water, forming a solution which causes Universal Indicator to turn orange

_____

Total [4]

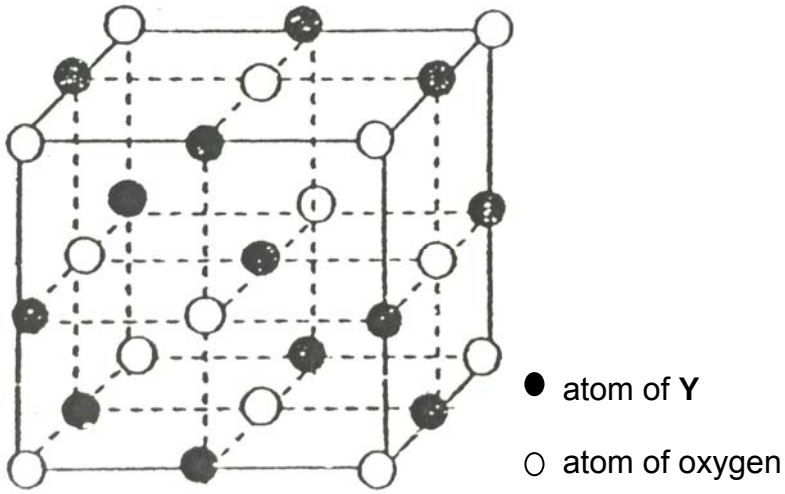
A2 Methylamine, CH_3NH_2, is a derivative of ammonia, in which one H atom in ammonia is replaced by a CH_3 group.

(a) Draw a Lewis dot diagram to show the electronic arrangement of methylamine. [1]

(b) As with ammonia, methylamine reacts with acids to form a salt only. In a reaction, it was found that 0.0250 mol of methylamine reacted completely with 20.0 cm^3 of 0.0625 mol/dm^3 of acid **Q**. Show, by calculations, the basicity of acid **Q**. [2]

Total [3]

A3 The arrangement of particles in solid **Z**, which is made of an unknown element **Y** and oxygen, is shown below.



(a) In solid **Z,** what is the ratio of oxygen atoms to atoms of element **Y**? [1]

_____

(b) Identify element **Y**, given that the percentage composition of oxygen atoms in solid **Z** is 23.9 %. Show your calculations in the space below to support your answer. [3]

Element **Y** : _____

(c) Solid **Z** would react with both dilute sulfuric acid and aqueous sodium hydroxide. State the type of oxide **Z** is, and name another example of such an oxide. [2]

_____

_____

_____

(d) Solid **Z** melts at 1975°C.

(i) In terms of its structure and bonding, explain why solid **Z** has a high melting point. [2]

_____

_____

_____

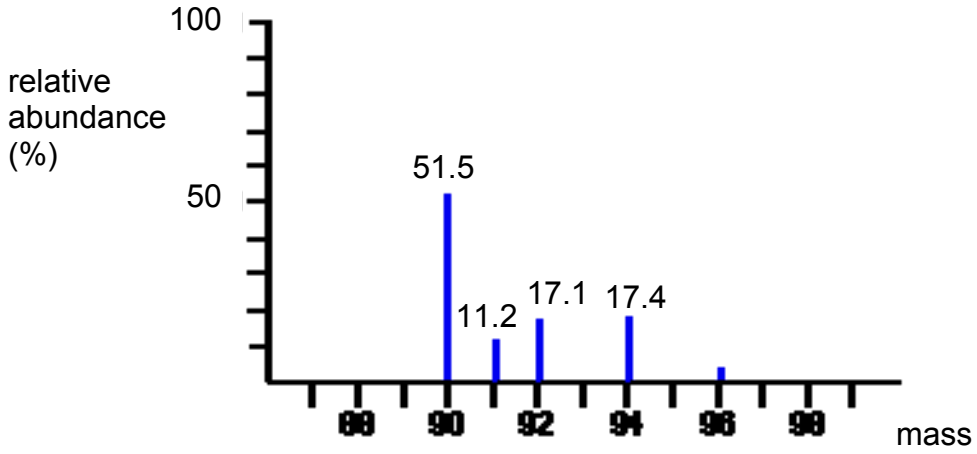
(ii) Explain another physical property solid **Z** is likely to have. [2]

_____

_____

Total [10]

A4 A gas sample of **X** was injected into the mass spectrometer and the result is shown below.



Using the mass spectrum, calculate the relative atomic mass of **X** and identify the element **X**. [2]

Element **F** : _____

Total [2]

A5 The following is an account of an experiment to determine the mass of copper(II) nitrate from a given quantity of nitric acid.

A measuring cylinder was used to transfer 250 cm^3 of 2 mol/dm^3 nitric acid to a beaker. 22.0 g of copper(II) oxide was weighed out. The acid was heated and the copper(II) oxide was added, a little at a time, with stirring, until the copper(II) oxide is present in excess. The mixture was filtered and the filtrate was heated until the volume has been reduced to about a third of its original. The solution was left to cool. The crystals that formed were filtered off and dried between pieces of filter paper.

(a) What was observed to show that copper(II) oxide was in excess? [1]

_____

(b) Explain which measurement was unnecessary. [2]

_____

_____

(c) Why did crystals of copper(II) nitrate form when the filtrate was cooled? [1]

_____

(d) Give an ionic equation, including state symbols, for the above reaction. [1]

_____

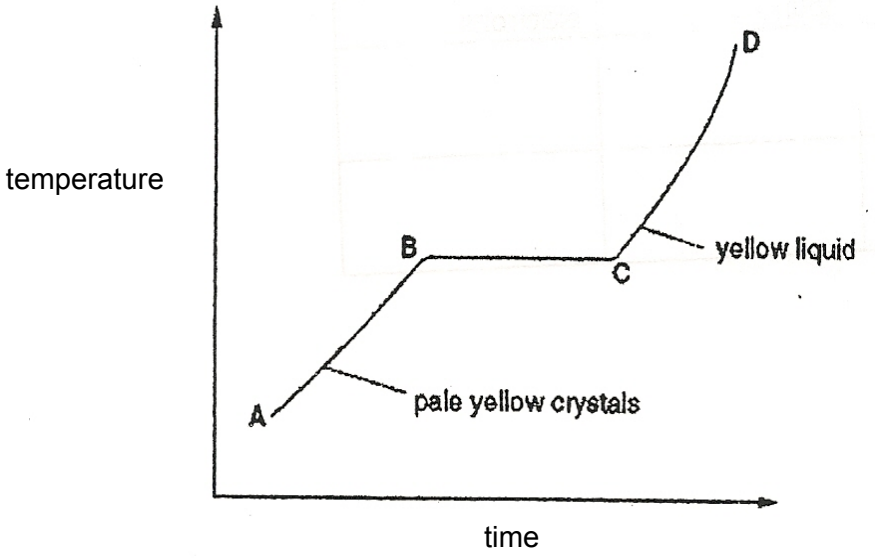
(e) Calculate the maximum mass of copper(II) nitrate formed. [3]

(f) Suggest one way to increase the yield of copper(II) nitrate crystals without changing the amount of the reactants used. [1]

_____

Total [9]

A6 Nitrogen dioxide is a dark brown gas. When 0.12 dm^3 of nitrogen dioxide at room temperature and pressure is cooled, it forms a yellow liquid and then the pale yellow crystals. The crystals are heated and the temperature is measured every minute as shown in the graph below.



(a) Calculate the number of molecules present in this sample of nitrogen dioxide. [2]

(b) (i) Describe the arrangement and movement of the molecules in the region **AB**. [2]

_____

_____

_____

(ii) Name the change that occurs in the region **BC**. [1]

_____

Total [5]

A7 Sulfurous acid, H_2SO_3, is formed when sulfur dioxide dissolves in water. Left in air, sulfurous acid then undergoes a slow reaction with oxygen to produce sulfuric acid.

(a) Write down the two chemical equations, including the state symbols, for these reactions. [2]

_____

_____

(b) Describe a test to determine if sulfur dioxide is present in a sample of air. [2]

_____

_____

(c) Describe how lead(II) sulfate could be prepared from sulfuric acid and another named compound. [3]

_____

_____

_____

_____

_____

_____

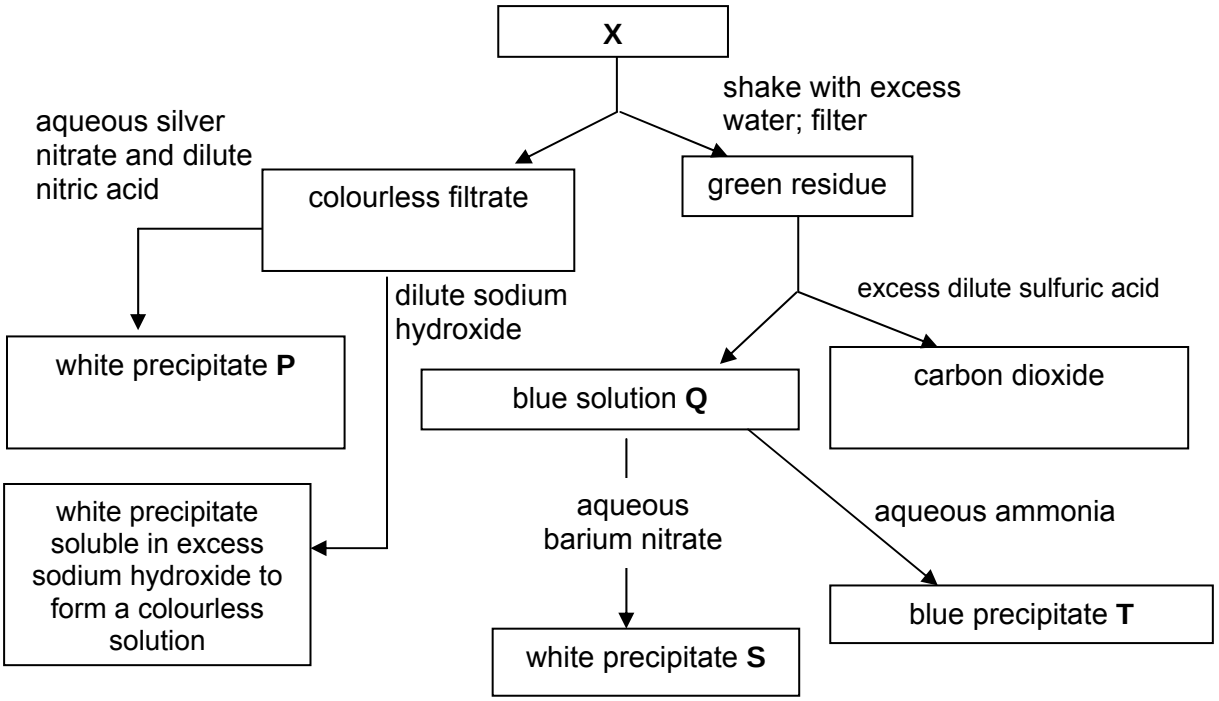
Total [7]

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 **X** is a mixture of compound **A** and compound **B**. Compound **A** is soluble in water but compound **B** is not soluble in water. The reaction scheme shows the results of some experiments on substance **X**.



(a) Describe a simple chemical test to identify carbon dioxide. [1]

(b) State the formulae of ions present in precipitate **S**. [1]

(c) Describe the observation when excess aqueous ammonia is added to **T**. [1]

(d) State the chemical formula of the solute present in solution **Q**. [1]

(e) Write the ionic equation for the formation of precipitate **P**. [1]

(f) Explain why the anion of **P** cannot be CO_3^{2-}. [1]

(g) State two possible identities of **A** and one possible identity of **B**. [3]

(h) State what could be added to a solution of **A**, that will determine the correct identity of **A**. [1]

B9 When 31.0 g of copper(II) carbonate was mixed with 0.250 mol of hydrochloric acid, 2800 cm^3 of carbon dioxide gas was produced.

(a) State the molar mass of copper(II) carbonate, with units. [1]

(b) State the volume of 1 mole of carbon dioxide gas at room temperature and pressure. [1]

(c) Calculate the number of moles of copper(II) carbonate present. [1]

(d) Write a chemical equation for the above reaction and explain which is the limiting reactant. [3]

(e) Hence, calculate the maximum volume of carbon dioxide gas produced at room temperature and pressure. [2]

(f) Calculate the percentage yield of carbon dioxide in this reaction. [1]

(g) Suggest why the percentage yield of carbon dioxide in **(f)** is less than 100%, assuming that there were no impurities in the reactants used, and there was no human error. [1]

B10 EITHER

In volumetric analysis, it is preferable to use ferrous ammonium sulfate, $(NH_4)_2SO_4.FeSO_4.6H_2O$, instead of iron(II) sulfate because the former is less easily oxidized by atmospheric oxygen. In an experiment, a standard solution of ferrous ammonium sulfate is prepared by dissolving 7.84 g of ferrous ammonium sulfate crystals in deionised water and making up the ferrous solution to 250 cm^3. 25.0 cm^3 of potassium manganate(VII) solution was then pipetted into a conical flask, acidified with 10 cm^3 of dilute sulfuric acid and then titrated against the ferrous ammonium sulfate solution. The titration was repeated and the following results were obtained.

Titration number	**1**	**2**	**3**	**4**
Final burette reading/ cm^3	26.50	26.90	27.60	26.00
Initial burette reading / cm^3	0.00	0.60	1.30	0.20
Volume of ferrous solution used /cm^3				
Best titration readings (✓)				

(a) Copy the table onto your writing space, complete the table and calculate the average volume of ferrous ammonium sulfate used. [3]

(b) State the colour of the potassium manganate(VII) solution before titration. [1]

(c) Calculate the number of moles of the ferrous ammonium sulfate which reacted with the potassium manganate(VII) solution. [2]

(d) If the concentration of the potassium manganate(VII) solution used in the titration was 0.0168 mol/dm^3, calculate the number of moles of the potassium manganate(VII) which reacted. [1]

(e) In this reaction, iron(II) ions in the ferrous ammonium sulfate are oxidized by the acidified potassium manganate(VII) solution into iron(III) ions. The ionic equation for the reaction is as follows: [3]

$$\boldsymbol{x}Fe^{2+} + \boldsymbol{y}MnO_4^- + \boldsymbol{z}H^+ \rightarrow \boldsymbol{x}Fe^{3+} + \boldsymbol{y}Mn^{2+} + \boldsymbol{(z/2)}H_2O$$

Use your answers in **(c)** and (**d)** to find the value of ***x*** and of ***y***.
Hence, or otherwise, find the value of ***z***.

B10 OR

A sample of a potassium carbonate, K_2CO_3, contains an impurity. 4.80 g of the impure sample was fully dissolved in 25.0 cm^3 of 1.25 mol/dm^3 sulfuric acid. The resulting solution was found to be acidic and 12.6 cm^3 of sodium hydroxide of concentration 0.250 mol/dm^3 were required to neutralise it.

(a) Calculate the number of moles of sulfuric acid left in excess when the potassium carbonate was dissolved in acid. [3]

(b) Calculate the number of moles of sulfuric acid that had reacted with the potassium carbonate. [2]

(c) Calculate the percentage purity of the potassium carbonate in the sample. [3]

(d) Suggest why it is unlikely that the impurity in the original sample was calcium carbonate. [2]

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.).