NAME		INDEX NO.

ST. PATRICK'S SCHOOL
PRELIMINARY EXAMINATIONS 2017

SUBJECT : CHEMISTRY 5073 Paper 1 DATE : 25 Aug 2017

LEVEL : SECONDARY 4 EXPRESS DURATION : 1 HOUR

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

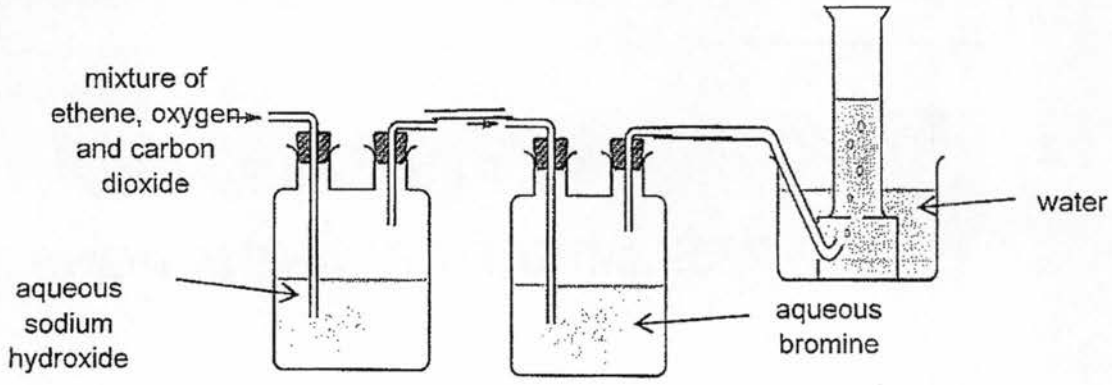
1. There are **forty** questions on this paper. Answer **all** questions.
2. For each question there are four possible answers **A**, **B**, **C** and **D**.
3. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.
4. Answer **all** questions on the **Answer sheet** provided.

INFORMATION FOR CANDIDATES:

Each correct answer will score one mark. A copy of the Periodic Table is provided.

This question paper consists of 21 printed pages including the Periodic Table

1 A gaseous mixture of ethene, oxygen and carbon dioxide is passed through the apparatus shown. Only one of the gases is collected.



What is a property of the gas collected?

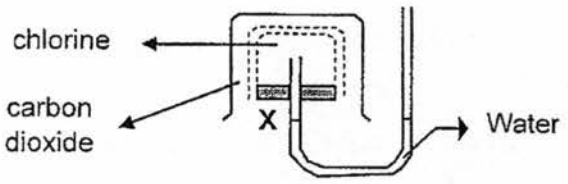
A gas extinguishes burning splint

B gas forms a white precipitate when bubbled through limewater

C gas relights a glowing splint

D gas turns acidified potassium manganate (VII) solution colourless

2 A porous pot contains chlorine gas.



What would happen to the water level at X when a beaker of carbon dioxide was inverted over the pot?

A X would fall only.

B X would rise only.

C X would fall, then rise after some time.

D X would rise, then fall after some time.

3 Deuterium is an isotope of hydrogen and has the symbol D.
Which formula is incorrect for a deuterium compound?

A $BaOD$

B CD_3CO_2D

C $C_2D_4Br_2$

D D_2O_2

4 Which one of the following represents the most likely structural formula for the covalent compound disulfur dichloride, S_2Cl_2?

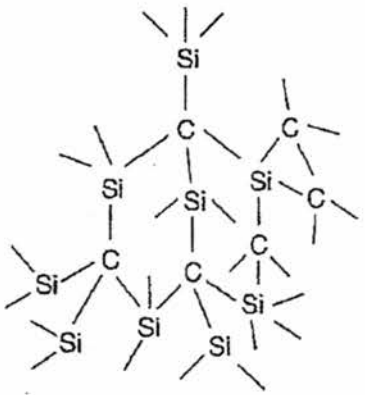
A Cl–S–S–Cl

B S–Cl–Cl–S

C S–Cl–S–Cl

D Cl=S–S=Cl

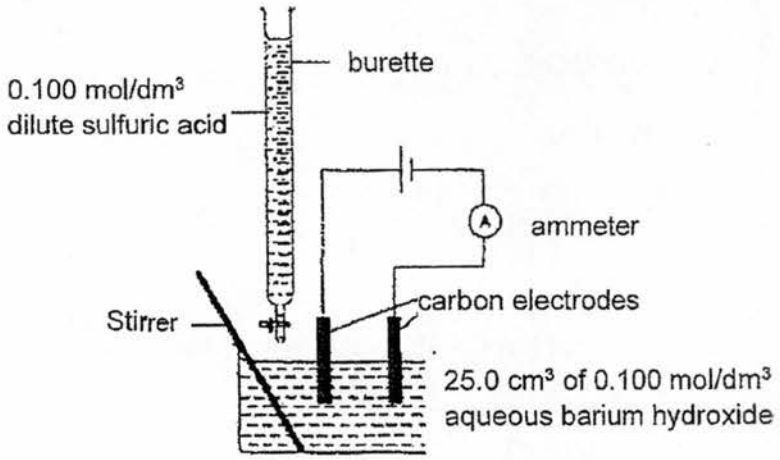
5 The diagram shows part of the structure of the compound silicon carbide.



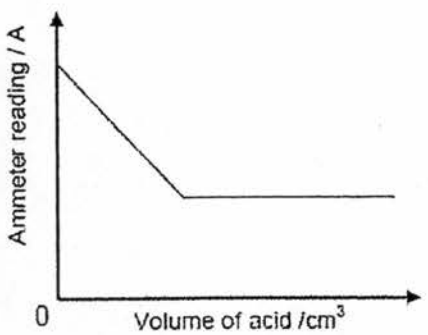
Which set of information about silicon carbide is correct?

	empirical formula	*when strongly heated in oxygen*
A	SiC	burns, giving a solid residue only
B	SiC	burns, giving a solid residue and a colourless gas
C	Si_2C	burns, leaving no solid residue
D	SiC_2	burns, giving a solid residue and a colourless gas

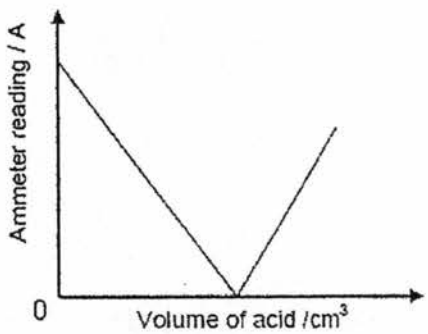
6 In an experiment, excess of 0.100 mol/dm^3 dilute sulfuric acid was added to 25.0 cm^3 of 0.100 mol/dm^3 aqueous barium hydroxide as shown in the diagram below.



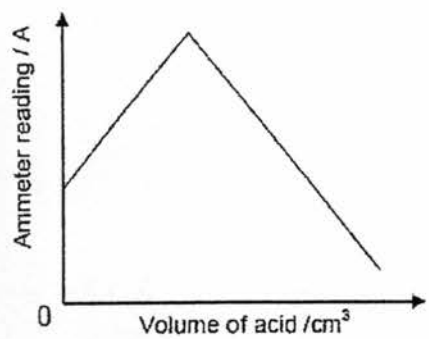
The acid was added from the burette in portions of 5 cm^3 until 40 cm^3 of the acid was added. After each addition, the solution was stirred and the ammeter reading was noted.
Which one of the following graphs correctly represents the relationship between the ammeter reading and the volume of acid added?



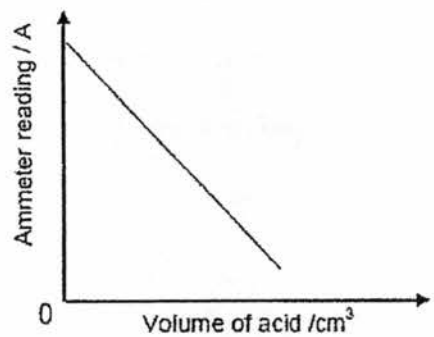
A



B



C



D

7 Naturally occurring iridium has a relative atomic mass of 192.2 and consists of two isotopes, $^{191}_{77}Ir$ and $^{193}_{77}Ir$. The percentage of the lighter isotope is

A 80%

B 60%

C 40%

D 20%

8 1 mole of an organic compound requires 3 moles of oxygen gas for complete combustion to form carbon dioxide and water.

What could be the formula of the compound?

A CH_3CHO

B CH_3CH_2OH

C CH_3CH_3

D CH_3CO_2H

9 20 cm^3 of an aqueous 1.0 mol/dm^3 solution of the hydroxide of metal X, exactly neutralises 40 cm^3 of aqueous 0.5 mol/dm^3 sulfuric acid.

What is the formula for the sulfate of X?

A X_2SO_4

B XSO_4

C $X_2(SO_4)_3$

D $X(SO_4)_2$

10 Zinc oxide is produced by heating zinc carbonate.

$$ZnCO_3 \rightarrow ZnO + CO_2$$

What is the percentage yield of zinc oxide if 125 g of zinc carbonate on heating produces 75 g of zinc oxide?

A $125 \times \frac{81}{75} \times 100$

B $125 \times \frac{75}{81} \times 100$

C $\frac{81}{75} \times 100$

D $\frac{75}{81} \times 100$

11 Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement about rubidium is likely to be correct?

A It forms a dichromate(VI) $Rb_2Cr_2O_7$.

B It forms an insoluble hydroxide.

C It is produced during the electrolysis of aqueous rubidium chloride.

D It reacts slowly with cold water.

12 When solid Y was added to dilute sulfuric acid, effervescence was observed and a colourless solution was obtained. When solid Y was warmed with aqueous sodium hydroxide and potassium nitrate, a pungent gas which turned damp red litmus blue was evolved. What could Y be?

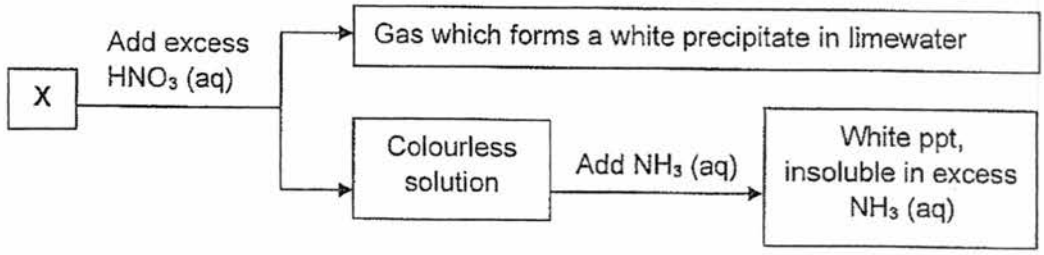
A Copper

B Zinc

C Aluminum

D Aluminium carbonate

13 The flow chart below shows the reaction of compound **X.**



What can compound **X** possibly be?

A aluminium carbonate

B calcium carbonate

C lead (II) sulfate

D zinc carbonate

14 Zinc is heated in oxygen. The product obtained is yellow when hot and white when cold.
Which of the following will neutralise the product?

I aqueous sodium hydroxide

II dilute hydrochloric acid

III dilute sulfuric acid

A I only

B II only

C II and III only

D I, II and III

15 A salt has the chemical formula $(NH_4)_2Fe(SO_4)_2.12H_2O$. Excess aqueous sodium hydroxide was added slowly, with shaking, to a hot aqueous solution of the salt in a boiling tube until there is no further reaction. The boiling tube was then left to stand for some time.

Which observation will **not** be observed?

A A green precipitate was produced.

B A precipitate formed which dissolved in excess aqueous sodium hydroxide.

C A strong smelling gas was produced which turned damp red litmus paper blue.

D The precipitate slowly turned brown.

16 The mass of an iron strip decreased from 10 g to 8 g after being placed in a beaker of solution X for some time. The mass of an identical iron strip remained the same after being placed in a beaker of solution Y for the same amount of time. Predict the identity of the solutions X and Y.

	X	Y
A	Copper(II) sulfate	Lead (II) nitrate
B	Calcium chloride	Zinc sulfate
C	Silver nitrate	Magnesium sulfate
D	Sodium chloride	Copper(II) chloride

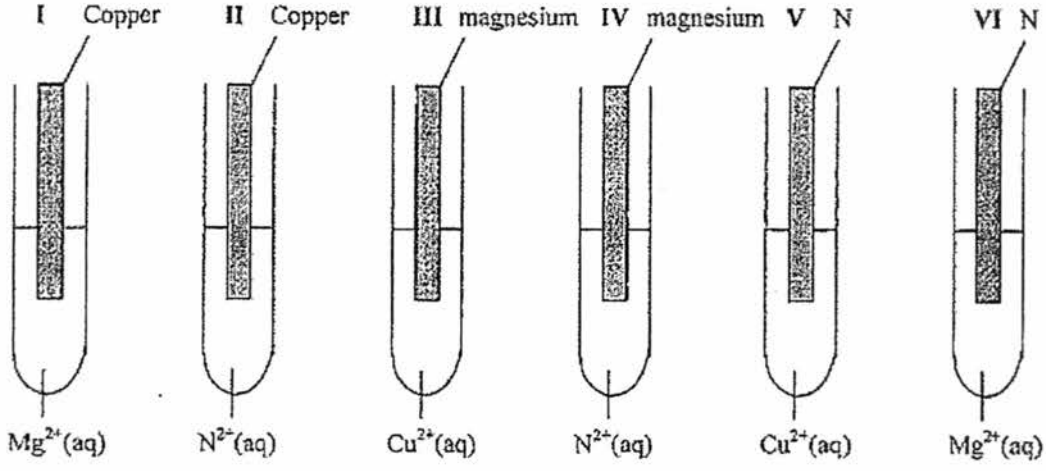
17 N is an unknown metal.

A student did the following experiments to compare the reactivity of magnesium, copper and metal N.

Six tubes were arranged as shown in the diagrams below. Each tube contained a piece of metal half immersed in an aqueous solution containing ions of one of the other two metals. The following observation were made:

There was a deposit seen in only three tubes including tube V.

There was no deposit in tube VI.



Which of the two tubes, besides tube V contain a deposit?

A I and II

B II and III

C II and IV

D III and IV

18 Which of following reactions does **not** occur in a blast furnace in the extraction of iron?

A $CaO + CO_2 \rightarrow CaCO_3$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $CO_2 + C \rightarrow 2CO$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

19 Which of the following metals requires the **least** energy to be extracted from its ore?

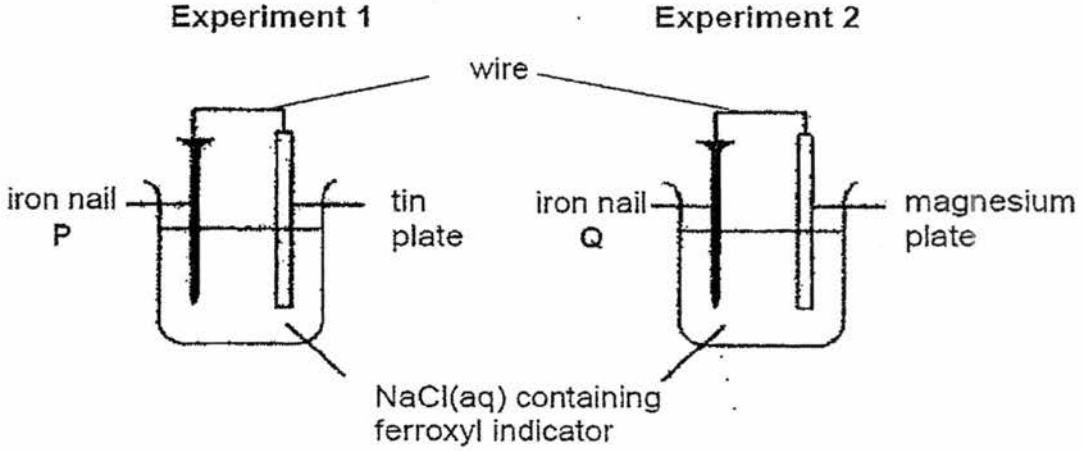
A copper

B iron

C lead

D zinc

20 A student carried out two experiments to investigate the rusting of iron. Ferroxyl indicator turns blue when Fe^{2+} ions are present.



After a short while, what would be observed?

A Blue colour does not appear at both **P** and **Q**.

B Blue colour appears around **Q** but not around **P**.

C Blue colour appears at both **P** and **Q**.

D Blue colour appears around **P** but not around **Q**.

21 Which one of the following changes is endothermic?

A $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

B $HCl + NaOH \rightarrow NaCl + H_2O$

C $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$

D $2H \rightarrow H_2$

22 Hydrogen reacts with chlorine according to the equation below.

$$H_2 + Cl_2 \rightarrow 2HCl \qquad \Delta H = -184 \text{ kJ/mol}$$

The H-H bond energy is 436 kJ/mol and the Cl-Cl bond energy is 242 kJ/mol.

What is the H-Cl bond energy?

A 862 kJ/mol

B 678 kJ/mol

C 431 kJ/mol

D 247 kJ/mol

23 In which reaction is the pressure **least** likely to affect the rate of the reaction?

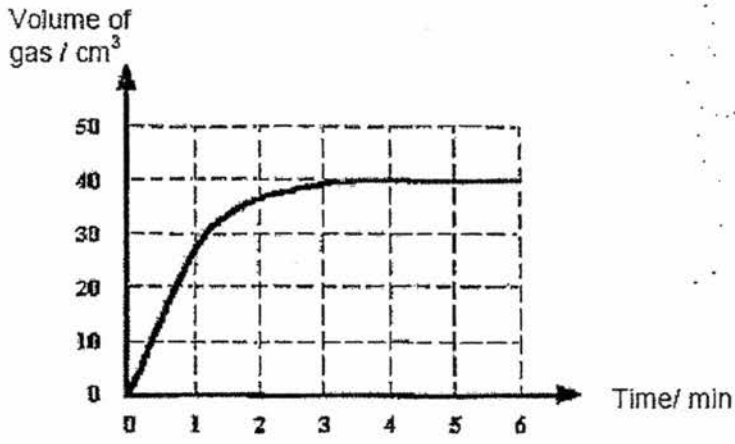
A $C(s) + CO_2(g) \rightarrow 2CO(g)$

B $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

C $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

D $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

24 The rate of reaction between pieces of zinc and 1.0 mol/dm^3 hydrochloric acid was investigated. The total volume of gas produced every minute was recorded over a period of time. The zinc had completely reacted in the reaction and the results are shown in the graph below.



What would be expected if the experiment was repeated using the same mass of zinc and the same volume of 2.0 mol/dm^3 hydrochloric acid?

	Maximum volume of gas produced	**Time at which maximum volume is obtained**
A	40 cm^3	less than 4 minutes
B	40 cm^3	longer than 4 minutes
C	80 cm^3	less than 4 minutes
D	80 cm^3	longer than 4 minutes

25 The reaction represented by the equation below occurs by collisions between X_2 and Y_2 molecules.

$$X_2\,(g) + Y_2\,(g) \rightarrow 2XY\,(g)$$

Which of the following statement(s) is/are correct about this reaction?

I: All collisions between X_2 and Y_2 molecules produce XY molecules.

II: The frequency of collisions is increased by raising the concentration of X_2 and Y_2 molecules in the reaction mixture.

III: The frequency of collisions is unaffected by raising the pressure exerted on the reaction mixture.

IV: The frequency of collisions is increased markedly by even a small rise in the temperature of the reaction mixture.

A **IV** only

B **II** and **IV** only

C **I** and **III** only

D **I**, **II** and **III** only

26 Which statement best explain why coal dust forms an explosive mixture with air?

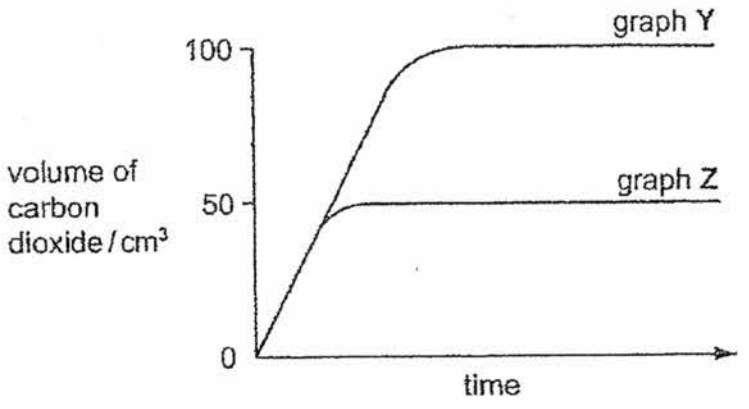
A Coal dust catalyse the explosion.

B Crushing coal breaks chemical bonds.

C Coal dust have a large surface area.

D Crushing coal releases hydrogen from compounds in coal.

27 Some crystals of sodium carbonate were added to an excess of sulfuric acid at room temperature. The volume of carbon dioxide produced was measured over a period of time. The results are shown in graph **Y**. The experiment was repeated and graph **Z** was obtained.



Which one of the following changes was made to obtain the results shown in graph **Z**?

A Acid of half the original concentration was used.

B A lower temperature was used.

C Half the amount of sodium carbonate was used.

D Larger crystals of sodium carbonate were used.

28 Which of the following pairs of compounds react together to produce ammonia?

1. solid calcium nitrate, solid lead(II) hydroxide and aluminium foil
2. solid calcium nitrate, aqueous sodium hydroxide and aluminium foil
3. solid ammonium sulfate and aqueous calcium hydroxide
4. solid ammonium sulfate and aqueous calcium nitrate

A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

29 Which reaction does not involve oxidation and/or reduction?

A $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

B $Ag^+ + Cl^- \rightarrow AgCl$

C $Mg + 2HCl \rightarrow MgCl_2 + H_2$

D $2Na + Cl_2 \rightarrow 2NaCl$

30 A portion of acidified potassium manganate (VII) solution was added to a sample of solution X.

Solution X decolourised the potassium manganate(VII) solution. The resulting solution Y was brown. When starch solution is added to a sample of solution Y, the solution turned dark blue.

What conclusion can be drawn about solution **X**?

A It is a reducing agent and it contains bromide ions.

B It is a reducing agent and it contains iodide ions.

C It is an oxidising agent and it contains bromide ions.

D It is an oxidising agent and it contains iodide ions.

31 When dilute aqueous sodium chloride is electrolysed between platinum electrodes,

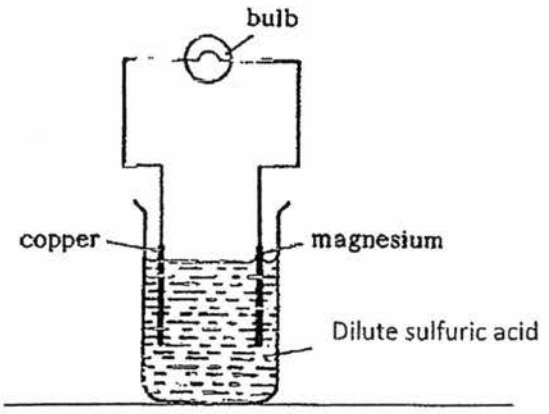
A sodium is produced at the cathode.

B the mass of the anode decreases.

C the concentration of sodium chloride increases.

D the pH of the electrolyte decreases.

32 The apparatus shown in the diagram below was set up:



Which one of the following represents the correct half equation taking place at the positive and negative electrode respectively for the above set up?

	Positive Electrode	Negative Electrode
A	$2H^+ + 2e \rightarrow H_2$	$Mg \rightarrow Mg^{2+} + 2e$
B	$Cu^{2+} + 2e \rightarrow Cu$	$Mg \rightarrow Mg^{2+} + 2e$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e$	$Mg^{2+} + 2e \rightarrow Mg$
D	$Cu \rightarrow Cu^{2+} + 2e$	$2H^+ + 2e \rightarrow H_2$

33 The following quantities of ions were discharged during electrolysis. Which of the following options required the passage of the largest quantity of electricity?

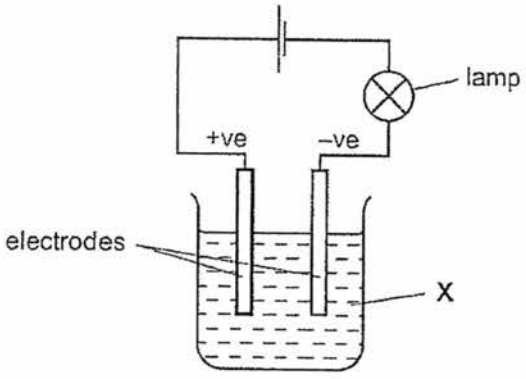
A 1 mole of Cu^{2+} ions

B 2 moles of Al^{3+} ions

C 2 moles of Br^- ions

D 4 moles of OH^- ions

34 In the following experimental set up, the lamp lights up, but there are no decomposition products at the electrodes.



What is **X**?

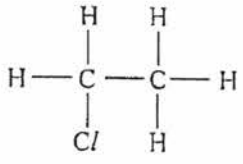
A aqueous sodium chloride

B bromine

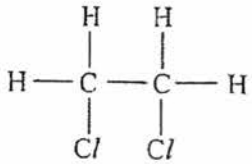
C molten sodium chloride

D mercury

35 The structures of three compounds are shown below.



1



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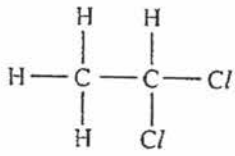


3

Which compound(s) can be product(s) of addition reaction of ethene with chlorine?

A 1 only

B 2 only

C 2 and 3 only

D 1, 2 and 3

36 The general formula for alkene is C_nH_{2n}.

Which physical property does **not** increase as n increases?

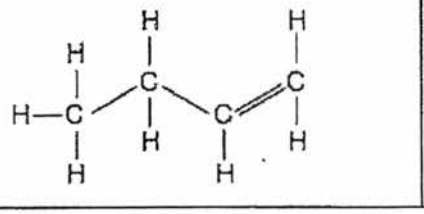
A boiling point

B density

C percentage of carbon by mass

D viscosity

37 The diagram below shows how the structural formula of butene can be simplified:

Usual structural formula of butene	Simplified version
	

The simplified structural formula of benzene is shown below:

What is the empirical formula of benzene?

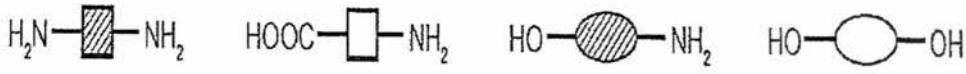
A CH

B CH_2

C CH_3

D CH_4

38 The diagrams show four monomers.



How many of the monomers above would react with the molecule below to form a polymer?

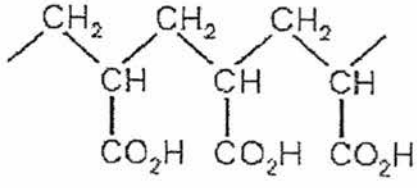
A 1

B 2

C 3

D 4

39 The absorbent material in babies' disposable nappies is made from the polymer shown.



From which monomer could this polymer be obtained?

A $H_2C{=}CHCO_2H$

B $HO_2CCH{=}CHCO_2H$

C $HOCH_2CH_2CO_2H$

D $CH_3CH_2CH_2CO_2H$

40 A food chemist wants to create the fragrance of pineapples for a product. An ester with this fragrance has the formula $C_3H_7CO_2C_2H_5$.

Which pair of reactants would produce this ester?

A propanoic acid and propanol

B ethanoic acid and butanol

C propanoic acid and ethanol

D butanoic acid and ethanol

-----end of paper-----

The Periodic Table of the Elements

Group																	
										III	IV	V	VI	VII	0
								1 H hydrogen 1							4 He helium 2
										11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
										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
	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
	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
	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

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

NAME	CLASS	INDEX NO.

ST. PATRICK'S SCHOOL
PRELIMINARY EXAMINATIONS 2017

SUBJECT : CHEMISTRY 5073 Paper 2 DATE : 21 Aug 2017

LEVEL : SECONDARY 4 EXPRESS DURATION : 1 HOUR 45 MIN

INSTRUCTIONS TO CANDIDATES:

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

1. This paper consists of **Two Sections**: **Section A and Section B.**
2. Answer **all** questions in **Section A** in the spaces provided.
3. Answer all **three** questions in **Section B, the last question is in the form either/or.** Answer **all** questions in **Section B** in the spaces provided.

INFORMATION FOR CANDIDATES:

The number of marks is given in brackets [ ] at the end of each question or part question. A copy of the Periodic Table is provided.

FOR MARKER'S USE ONLY:

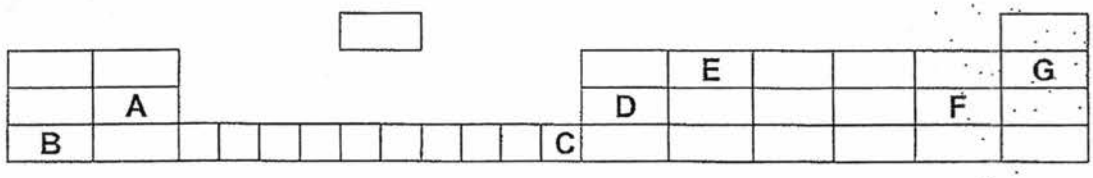
For Examiner's Use Only						
Paper 1 (40 m)	A (50 m)	B (30 m)	Total (120 m)	Percentage	Grade	Target Grade
Teacher's Comments, if any:						
						Parent's Signature

This question paper consists of 21 printed pages including the Periodic Table.

Section A [50 marks]

Answer all questions in the spaces provided.

A1 The positions of six elements, represented by letters, **A**, **B**, **C**, **D**, **E**, **F** and **G** are shown in the Periodic Table below. These letters **A**, **B**, **C**, **D**, **E**, **F** and **G** **are not** symbols of elements in the Periodic Table.



Use the letters **A**, **B**, **C**, **D**, **E**, **F** and **G** to answer the following questions. You may use each letter once, more than once or none at all.

(a) An element which combines with **F** to form a very volatile compound. [1]

_____

(b) An element which has an insoluble hydroxide that is soluble in excess sodium hydroxide to form a colourless solution. [1]

_____

(c) An element which is the strongest reducing agent. [1]

_____

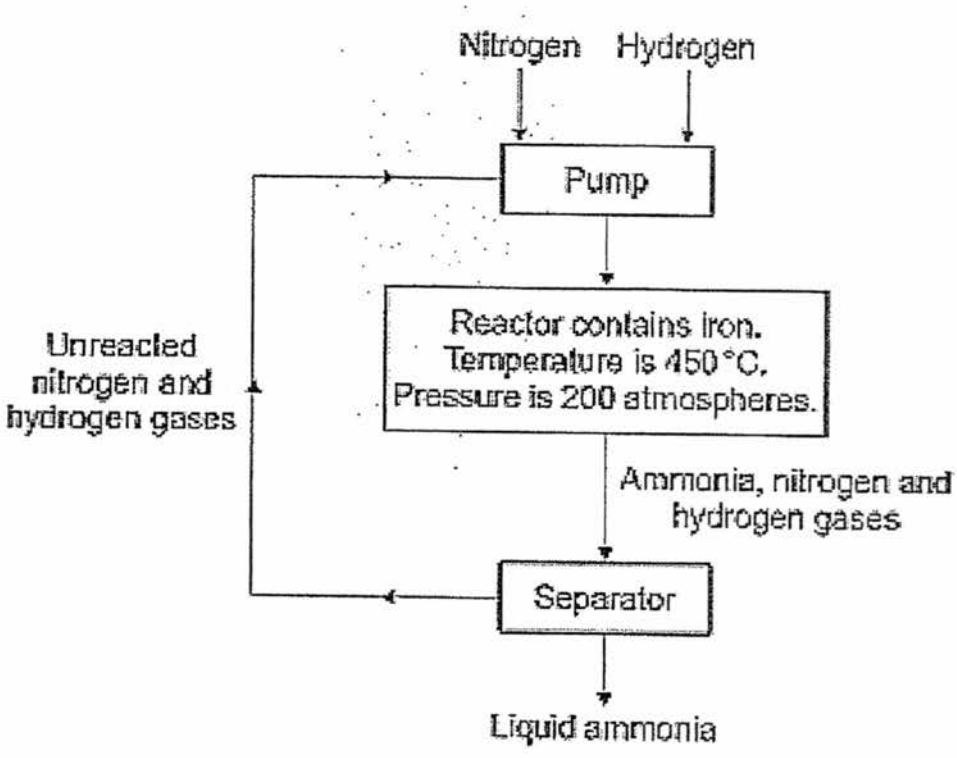
(d) An element which is chemically unreactive. [1]

_____

(e) An element that can be obtained by heating its oxide with coke. [1]

_____

A2 The figure below shows how ammonia is manufactured by the Haber process.



(a) Complete the table below about the gases used in the Haber Process. [2]

Gas	source	obtained by
nitrogen		fractional distillation
hydrogen	crude oil	

(b) Ammonia is used to produce nitrogenous fertilisers such as ammonium nitrate which is a source of nitrogen needed by the crops. Fertilisers like ammonium nitrate are added to the soil to increase crop yield.

Read the information given below on how to increase the crop yield with respect to using ammonium nitrate.

- Calcium carbonate may be added to reduce the acidity of a fertilised soil.
- Avoid adding calcium hydroxide to recently fertilised soil.

Explain why calcium carbonate may be added to fertilised soil to reduce the soil's acidity but adding calcium hydroxide to recently fertilised soil to reduce the soil's acidity should be avoided. [2]

_____

_____

_____

A3 The reactivity of metals can be compared by their reactions with water, steam and displacement reactions. Some data of the experiments are recorded in table below.

metals	displacement reactions	reaction with water and steam	observations during reaction with steam
mercury	mercury does not displace any of the other metals	has no reaction with steam	silvery metal remains unchanged
magnesium	$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$	reacts slowly with cold water but burns in steam	grey solid turns white
nickel	$Ni + Hg(NO_3)_2 \rightarrow Ni(NO_3)_2 + Hg$	has no reaction with water, reacts slowly with steam	silvery solid turns green
zinc	$Zn + Ni(NO_3)_2 \rightarrow Zn(NO_3)_2 + Ni$	has no reaction with water, reacts slowly with steam	grey solid turns yellow when hot

(a) From table above, arrange the metals in ascending order of their chemical reactivity. [1]

_____

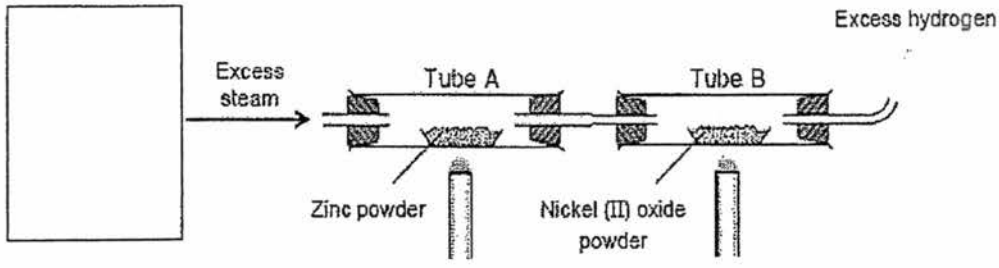
(b) **(i)** Solutions containing nickel(II) ions are usually green. What would you expect to see if magnesium is added to nickel(II) nitrate solution? [1]

_____

(ii) Write an ionic equation, with state symbols, for the reaction in **(b)(i)**. [2]

_____

(c) The figure below shows an apparatus set up where steam was first passed into tube A and zinc and the nickel(II) oxide were then heated.



(i) Write a balanced chemical equation with state symbols, for the reaction that occurs in tube **A**. [2]

_____

(ii) Nickel lies in between iron and lead in the reactivity series. What would you observe in tube **B**? Explain your answer. [2]

_____

_____

_____

A4 Haematite is an iron ore which is mainly made up of iron(III) oxide. The process of extracting iron from haematite occurs in a blast furnace.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(a) 2000 g of haematite was used to produce 1300 g of iron. Find the percentage purity of iron(III) oxide in haematite. [2]

(b) There are a number of reactions occuring in the blast furnace. Write a balanced chemical equation with state symbols, for the reaction which is a thermal decomposition reaction. [2]

_____

(c) State the **chemical name** of the main molten waste product from the extraction of iron from haematite. [1]

_____

A5 A toilet detergent contains the acid salt - sodium dihydrogen phosphate, NaH_2PO_4. Sodium dihydrogen phosphate can be made by reacting sodium hydroxide solution with dilute phosphoric acid, H_3PO_4.

(a) Explain why sodium dihydrogen phosphate is both an 'acid' and a salt. [2]

(b) Suggest the chemical formula of another possible salt formed from sodium hydroxide solution and dilute phosphoric acid. [1]

A6 A student found a solid sample of ammonium carbonate in a laboratory. The following steps were carried out. Record the observations in the table below including the test for gas (if any). [5]

Step	Observations and test for gas (if any)
1. Aluminium foil and aqueous sodium hydroxide were added to an aqueous solution of the solid sample and warmed.	
2a. Excess hydrochloric acid was added to the solid sample to form solution G.	
2b. Silver nitrate solution was added to a portion of solution G.	

A7 A student carried out an experiment to investigate the relationship between the mass of zinc used in a reaction and the volume of hydrogen gas liberated.
In the experiment he added pieces of zinc to 50 cm^3 of hydrochloric acid and recorded the volume of the gas collected. The table shows the student's results.

mass of zinc /g	volume of hydrogen collected / cm^3
0.1	33
0.2	66
0.3	99
0.4	132
0.5	165
0.6	198
0.7	225
0.8	225

The reaction of zinc and hydrochloric acid is

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(a) **(i)** Using the equation, calculate the theoretical volume of hydrogen liberated when 0.5 g of zinc was used. [2]

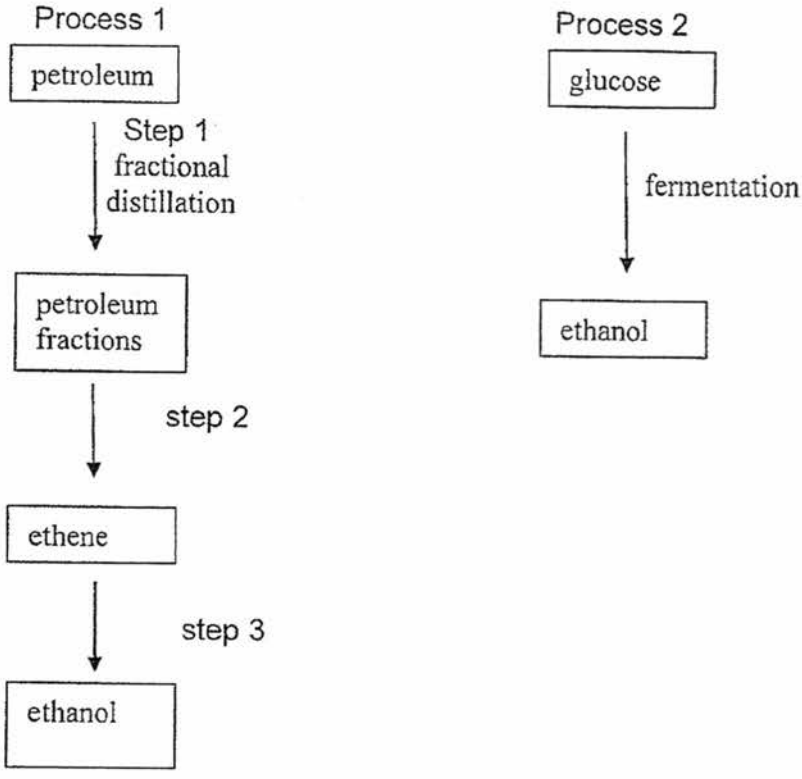
(ii) Using information from the table, suggest why the answer in **a (i)** is different from the one obtained in the experiment assuming that there is no loss in gas collected. [1]

(b) Suggest why the volume of the hydrogen collected is different for 0.1 g to 0.6 g of zinc but remains the same for 0.7 g and 0.8 g. [2]

(c) Using information from the table, calculate the concentration of the acid used in this experiment. [3]

(d) The experiment was repeated using hydrochloric acid which was warmed to 60°C. Using the collision theory explain why a shorter time was observed to collect the hydrogen gas. [2]

A8 Ethanol can be manufactured by two processes. The flowcharts outline the sequence of steps for producing ethanol.



(a) Name the process in step 2 [1]

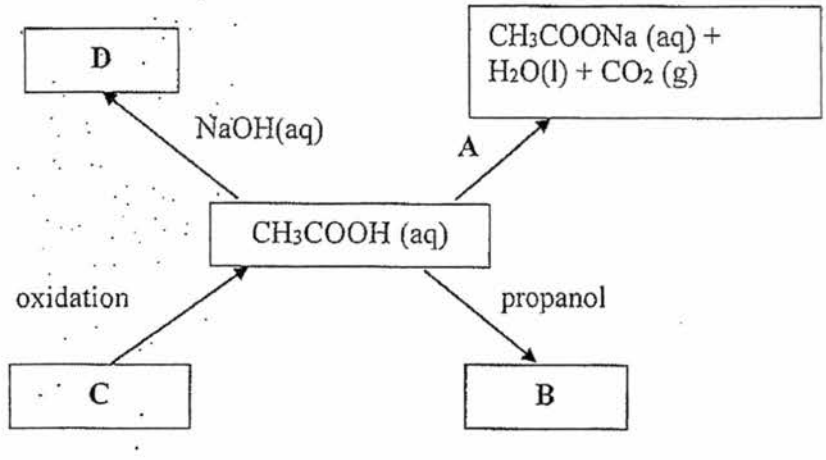
_____

(b) State 2 conditions for step 3. [2]

_____

_____

A9 Four reactions of ethanoic acid CH_3COOH, are shown below.



(a) Name substance **A** that is added to ethanoic acid. [1]

_____

(b) Name substance **B** and the catalyst in the spaces below. [2]

Substance B _____

Catalyst _____

(c) Name substance **C**, and state the reagents and/or condition(s) for the oxidation reaction that **C** undergoes in the laboratory to form ethanoic acid. [2]

_____

_____

(d) Write the balanced chemical equation, including state symbols, for the formation of substance **D**. [2]

_____

End of Section A

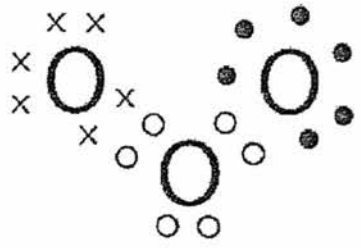
Section B (30 marks)

Answer **ALL 3** questions from this section.

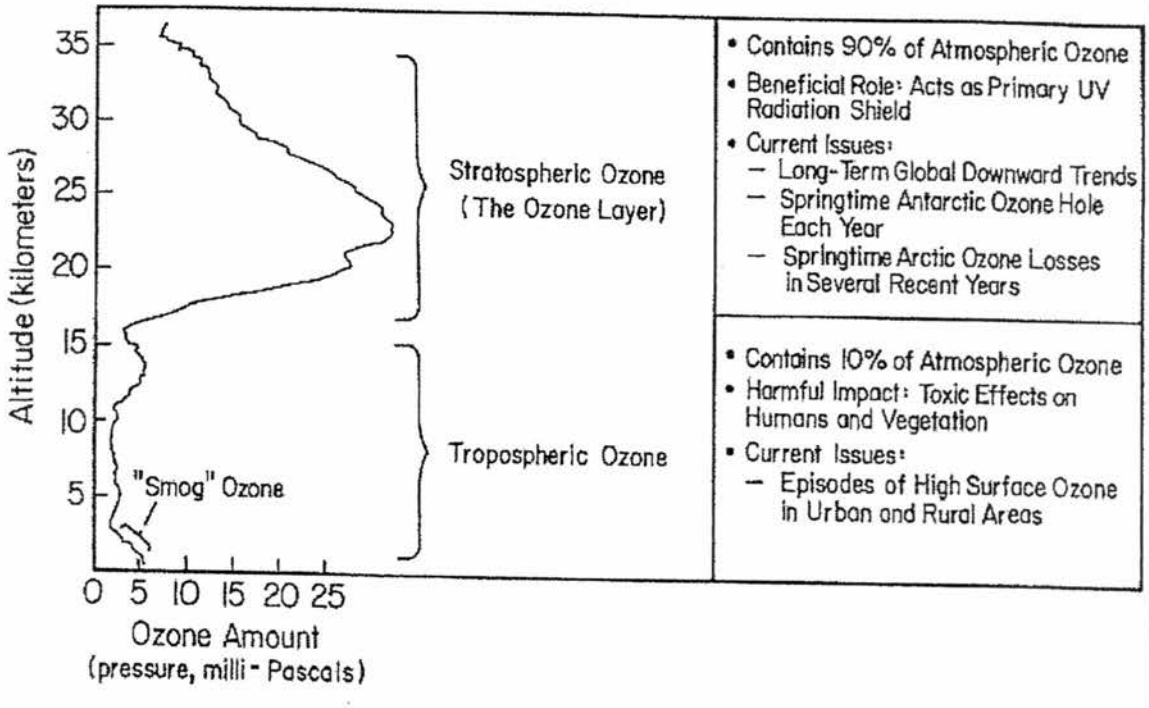
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B10 Ozone, O_3 is a much less stable triatomic form of oxygen.

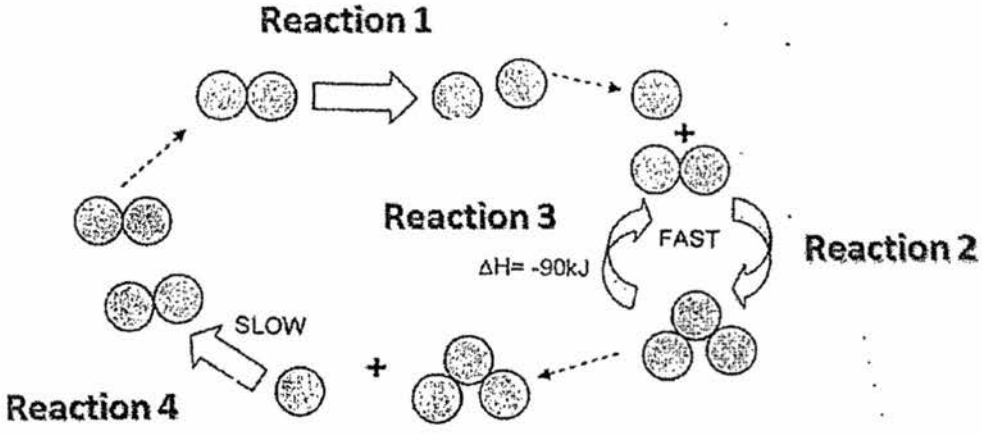
The diagram below shows the bonding in ozone molecules.



It is a pale blue gas present at low concentrations throughout the atmosphere (around 0.375 parts per million for O_3 compared to 21% for O_2).
In the troposphere, ozone is an air pollutant which can damage the respiratory systems of humans and other animals. The ozone in the stratosphere however is beneficial.
The diagram below shows how the concentration of ozone varies in the troposphere and stratosphere.



Ozone is formed as part of a natural cycle similar to nitrogen and carbon cycle. The first step in the formation of ozone is the decomposition of an oxygen molecule into two atoms by low energy ultraviolet (UV) light (reaction 1). The higher the altitude, the faster is this reaction. Each of these oxygen atoms can combine with another oxygen molecule to form an ozone molecule (reaction 2). The rate of reaction 2 is faster where the pressure is higher. The ozone molecule formed absorbs UV radiation and splits to form an oxygen atom and oxygen molecule which produces a lot of heat (reaction 3). For every mole of ozone that splits up, 90 kJ of energy is given off. Reactions 2 and 3 rapidly interconvert oxygen atoms and ozone. There is another slow reaction, though, which is known to destroy both oxygen atoms and ozone (reaction 4).
Reactions 1 to 4 are summarised in the figure below.

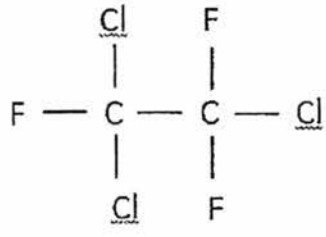


dotted arrow ------> indicates a molecule or an atom from one reaction goes on to take part in another reaction
solid arrow ⟹ indicates reactions
● - indicate one oxygen atom

Chlorofluorocarbons, CFCs, destroy ozone in the upper atmosphere. Once the CFC vapour reaches the upper atmosphere the following reactions occur in order.

Reaction 5: CFC + UV light → CFC fragment + Cl
Reaction 6: $Cl + O_3 \rightarrow ClO + O_2$
Reaction 7: $ClO + O \rightarrow Cl + O_2$

One example of CFC is the compound CFC 113. CFC 113 is an inert, synthetic compound used in the electronics industry. The figure shows the structure of CFC 113 below.



Some data about the bond strength in these molecules are given below.

Bond	bond strength/ kJ per mole
C – Cl	330
C – C	346
C – F	450
C – H	412

(a) Calculate the percentage of ozone in the atmosphere. [1]

(b) At which altitude is the rate of ozone formation maximum? [1]

(c) With the help of information provided, suggest why the stratosphere is a warmer layer than the troposphere. [2]

(d) Which two reactions, 5, 6 or 7, when taken together are equivalent to reaction 4 which destroys the ozone and oxygen atoms? [1]

(e) The energy of the UV light is equivalent to 400 kJ per mole.

(i) When CFC 113 is decomposed by UV light, are chlorine atoms or fluorine atoms formed? Explain. [2]

(ii) Suggest a further bond change you would expect to occur in CFC 113 molecule. [1]

_____

_____

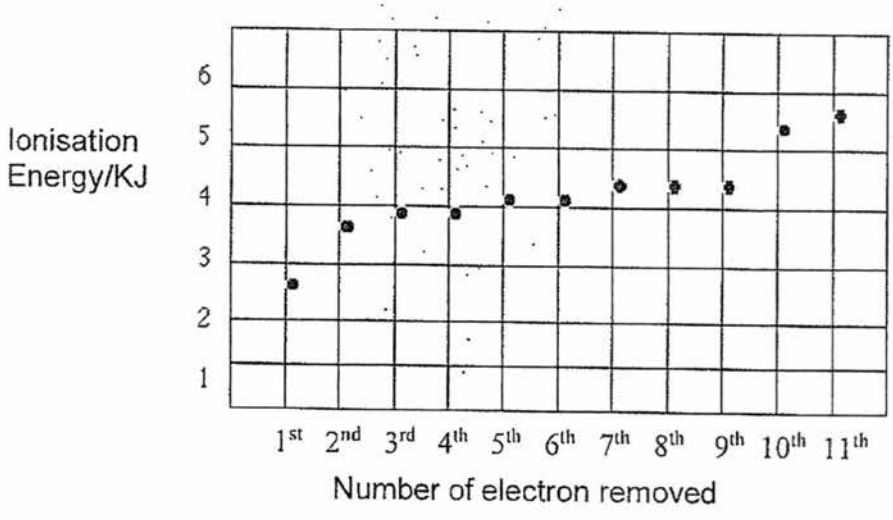
(f) The formation of ozone in the upper atmosphere can be represented by a single equation shown below. [1]

$$3O_2\,(g) \rightarrow 2O_3\,(g)$$

What is the value for enthalpy change for the reaction shown?

(g) Draw the full structural formula for ozone molecule. [1]

B11 **(a)** The ionization energy of an atom describes the minimum amount of energy required to remove an electron (to infinity) from an atom.
The data below shows a plot of ionisation energy against the number of the electron removed for sodium.



Use the information above to explain the trend in ionisation energy for sodium with reference to its electronic structure. [3]

(b) The table below shows the first ionization energy (energy required to remove the first electron from the atom) of elements in Period 3.

element	Na	Mg	Al	Si	P	S	Cl	Ar
first ionisation energy/ kJ /mol	496	738	577	786	1060	1000	1256	1520
formula of the hydride of the element	NaH	MgH_2	AlH_3			H_2S	HCl	

(i) Complete the table above by filling in the formulae of the 2 hydrides. [1]

(ii) Explain why there is a great difference in the first ionization energy of sodium and argon. [2]

(iii) Draw a 'dot and cross' diagram to show the bonding in sodium hydride. You need to show **all** the electrons. [2]

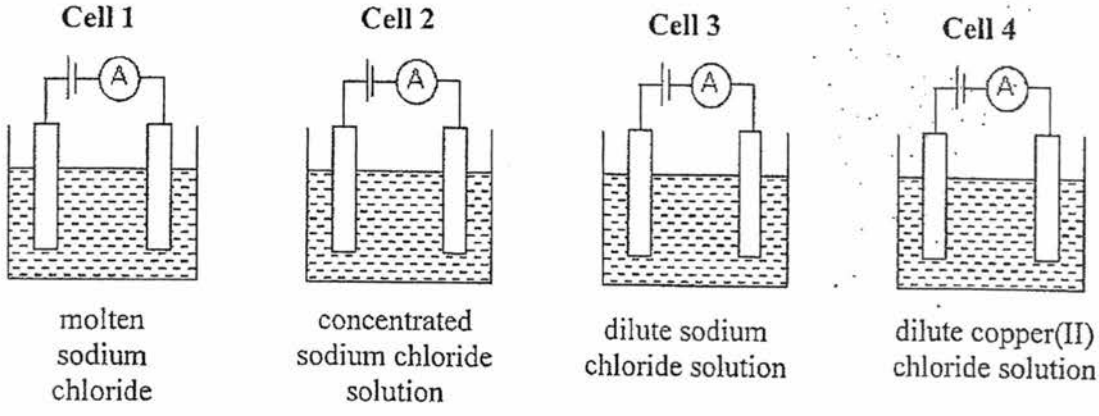
(iv) Suggest one similarity and one difference in physical property between sodium hydride and hydrogen chloride. [2]

Similarity:

Difference:

EITHER

B12 The diagrams show the electrolysis of four different electrolytes, using graphite electrodes.



(a) Explain why sodium metal can be extracted from molten sodium chloride solution using **Cell 1**. [1]

(b) The gases produced at the electrodes in **Cell 2** and **Cell 3** are collected and their volumes are measured.

(i) Name the gas formed at the anode of **Cell 3** and describe a test to identify the gas. [1]

(ii) Explain why the gases collected at the anode in **Cells 2** and **Cell 3** are different. [2]

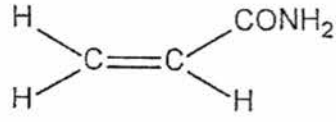
(iii) The volume of gas collected at the cathode in **Cell 3** is twice the volume of gas collected at the anode. By giving equations for the reactions that take place at the two electrodes, explain why this is so. [2]

(c) (i) Explain what happens to the ions as they arrive at the cathode in **Cell 4**. [2]

(ii) Explain why the reading of the current meter in **Cell 4** decreases when a few drops of lead (II) nitrate solution were added to the electrolyte. [2]

OR

B12 In 2002, Swedish scientists found high levels of acrylamide in starchy foods that had been cooked above 120 °C. Acrylamide, which is thought to be toxic to human health, has the following structure as shown in the figure below.



(a) Acrylamide polymerises to polyacrylamide. Interestingly, polyacrylamide is non-toxic and is used as an ingredient in a variety of cosmetic and beauty products, including skin cleansers, moisturisers, lotions and creams. Small polyacrylamide beads may also be used in skin cleansing products as an abrasive.

(i) Draw the structure of polyacrylamide. [1]

(ii) What type of polymerisation is this? [1]

_____

(iii) Calculate the maximum mass of polyacrylamide that can be made from 13 000 moles of acrylamide. [2]

(iv) A student comments that the percentage by mass of nitrogen in acrylamide is the same as that in polyacrylamide. [2]
Explain why the student is correct.

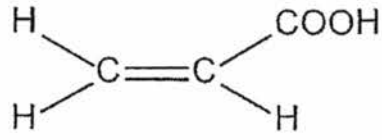
_____

_____

_____

_____

(b) Acrylamide reacts with water to form acrylic acid and ammonium ions. The structural formula of acrylic acid is shown in the figure below. It forms compounds called acrylates.



(i) Acrylic acid is a weak acid. [1]
How can Universal Indicator show that acrylic acid is a weak acid?

_____

_____

(ii) Acrylic acid reacts with ethanol to make an ester. [1]
Draw the structure of this ester.

(iii) Deduce the name of this ester. [1]

_____

(iv) Acrylic acid reacts with aqueous bromine. [1]
Draw the structural formula of the product of this reaction.

End of Section B

-----END OF PAPER-----

The Periodic Table of the Elements

Group I	Group II											Group III	
							1 H hydrogen 1						
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	6
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	1
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	ge 3
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	5
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	8
– 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	h 67
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	ein 99

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

ST. PATRICK'S SCHOOL
PRELIM EXAMINATIONS 2017

SUBJECT : CHEMISTRY DATE :

LEVEL : SECONDARY 4 EXPRESS DURATION :

PAPER 1

1	2	3	4	5	6	7	8	9	10
C	C	A	A	B	B	C	B	B	D

11	12	13	14	15	16	17	18	19	20
A	C	A	D	B	C	D	A	A	D

21	22	23	24	25	26	27	28	29	30
A	C	D	A	B	C	C	C	B	B

31	32	33	34	35	36	37	38	39	40
C	A	B	D	B	C	A	C	A	D

(deduct ½ for wrong unit / not in 3 sig fig – deduct only once per part of a question)

PAPER 2 Section A

					ttl
A1	a		E	1	5
	b		C OR D	1	
	c		B	1	
	d		G	1	
	e		C	1	

A2	a		gas	Source	obtained by	2	4
			Nitrogen	(liquid) air [1]	fractional distillation		
			Hydrogen	crude oil	Cracking [1]		

	b		Calcium carbonate does not react with ammonium nitrate. [1] Calcium hydroxide reacts with ammonium nitrate to produce ammonia which results in the loss of nitrogen. [1]	2	

A3	a		Mercury, nickel, zinc, magnesium	1	8
	b	i	Green solution turns colourless OR Silvery solid forms OR Grey magnesium dissolves	1	
		ii	$Mg\ (s) + Ni^{2+}\ (aq) \rightarrow Mg^{2+}\ (aq) + Ni\ (s)$	2	
	c	i	$Zn(s) + H_2O\ (g) \rightarrow ZnO\ (s) + H_2\ (g)$	2	
		ii	Silvery solid coated on green solid [1] Green nickel (II) oxide has been reduced by hydrogen to form silvery nickel metal. [1]	2	

A4	a		No of moles of Fe produced: 1300/56 = 23.2 mol moles of Fe : moles of Fe_2O_3 2 : 1 No of moles of Fe_2O_3= 23.2/2 = 11.6mol [1] % purity of Fe_2O_3=[(56 x 2 + 16 x 3) x 11.6]/2000 x 100% = 1856/2000 = 92.8% [1]	2	5
	b		$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$	2	
	c		Calcium silicate *(NOT: slag)*	1	

A5	a		It is an acid as it can produce hydrogen ion, H^+, when dissolved in water [1] It is a salt as it is a compound formed from the reaction of an acid and a base [1].	2	3
	b		Na_2HPO_4 or Na_3PO_4	1	

A6	Step	Observations and test for gas (if any)	5	5
	1. Aluminium foil and aqueous sodium hydroxide were added to an aqueous solution of the solid sample and warmed.	Effervescence/bubbles[0.5] Gas turned damp [0.5]red litmus blue [0.5]		
	2a. Excess hydrochloric acid was added to the solid sample to form solution G	Effervescence/bubbles[0.5] Gas pass through limewater [1] White ppt [1]		
	2b. Silver nitrate solution was added to a portion of solution G.	White ppt [1]		

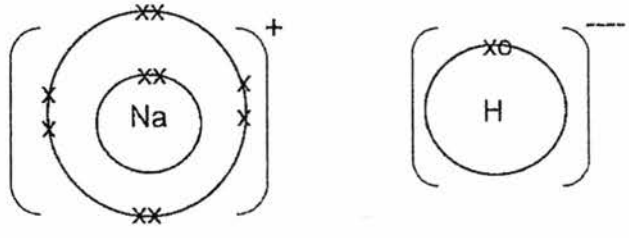
A7	a	i	Moles of 0.5 g of zinc $= \frac{0.5}{65}$ $= 0.007692$ Mole ratio: 1mole Zn:1 mole H_2 Moles of H_2 = 0.007692 [1] Volume of H_2 = 0.007692 x 24000 = 184.6 cm^3 = 185 cm^3[1] or 0.185 dm^3 (3 sf)	2	10
		ii	The zinc samples are impure.	1	
	b		In the experiments when 0.1 g to 0.6 g of zinc were used , zinc is the limiting reagent. Or HCL is in excess[1] From 0.7 g of zinc, HCl is the limiting reagent. Or zinc is in excess [1]	2	
	c		Moles of $H_2 = \frac{225}{24000}$ = 0.009375 [1] Moles of HCl = 0.009375 x 2 = 0.01875 [1] Concentration of HCl $= \frac{1000}{50}$ x 0.01875 = 0.375 mol/dm^3 [1]	3	
	d		increase in frequency of effective collisions [1] increase in kinetic energy/move faster/ more particles that possess the minimum activation energy[1]	2	

A8	a		cracking	1	3
	b		heat, 60 atmospheric pressure and phosphoric (V) acid any 2 (1m each)	2	

A9	a		sodium carbonate/sodium hydrogencarbonate	1	7
	b		propyl ethanoate [1] concentrated sulfuric acid [1]	2	
	c		Ethanol [1] add acidified potassium manganate(VII) [0.5] reflux/heating [0.5]	2	
	d		$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$	2	

PAPER 2 Section B

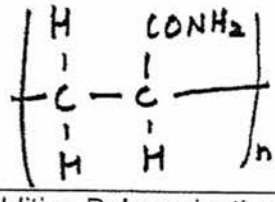
B10	a		0.375 / 1000 000 x 100 % = 0.0000375 %	1	**10**
	b		23 km (accept 22 to 24)	1	
	c		Energy produced by splitting of ozone [1] Comparison of stratosphere and troposphere – higher conc of ozone, UV shield, faster reaction 3 as pressure lower at higher altitude [1]	2	
	d		Reactions 6 and 7 (both correct)	1	
	e	i	Chlorine atoms [1] The UV light has sufficient energy to break the C-Cl bond(330 kJ/mol) but not able to break the C-F bond (450 kJ/mol) [1]	2	
		ii	The C – C bond will also break.	1	
	f		2 x 90 kJ/ mol = +180 kJ/mol	1	
	g		O = O – O	1	

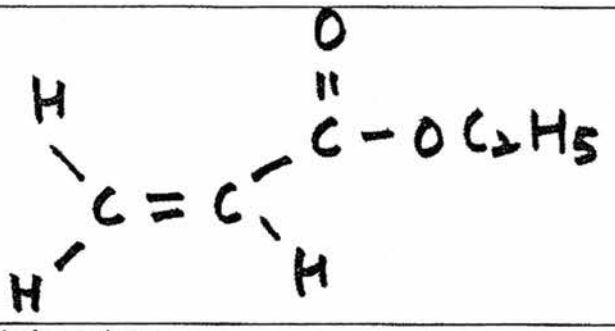
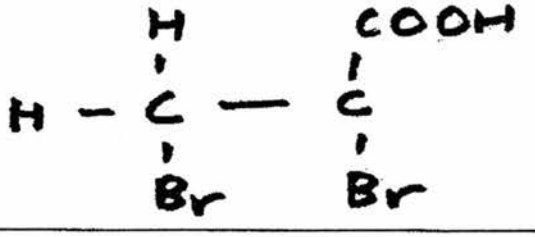
B11	a		Increase in ionisation energy [1] Decreasing Distance/shell [1] Increasing charge [1]	3	**10**
	b	i	Formula of the hydride of the element: SiH_4 PH_3 ---- 0.5 mark each	1	
		ii	3rd shell same [0.5]; decreasing atomic radius [0.5]; closer nucleus and electron [0.5]; stronger electrostatic force of attraction for argon [0.5]	2	
		iii	 sodium hydride	2	
		iv	Similarity: NaH and HCl are both soluble in water.c [1] Difference: NaH has high melting point and boiling point/solid HCl has low melting and boiling point/gas [1] Must have correct comparison to earn the mark	2	

EITHER

B12	a		The molten sodium chloride contains **Na^+ ions** [½],which are the only cations present, and will **accept electrons/be discharged**[½] at the cathode of Cell 1.	1	10
	b	i	Oxygen gas [½]. It relights a glowing splint [½].	1	
		ii	Cell 2 contains concentrated sodium chloride. The **chloride ions will be preferentially discharged** [½] as **chlorine gas** [½], instead of the hydroxide ions. Cell 3 contains dilute sodium chloride and the **hydroxide ions are preferentially discharged** [½] instead, forming **oxygen gas** [½].	2	
		iii	Cathode: $2H^+(aq) + 2e \rightarrow H_2(g)$ or $4H^+(aq) + 4e \rightarrow 2H_2(g)$ [½] Anode $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$ [½] For the same number of electrons [½], the volume of hydrogen gas produced is twice the volume of oxygen gas produced. [½]	2	
	c	i	**H^+ and Cu^{2+} ions** [½] both arrive at the cathode in Cell 4. Since **copper is less reactive than hydrogen in the reactivity series** [½], it will be **preferentially discharged** [½] instead at the cathode, forming **copper metal** [½].	2	
		ii	An insoluble salt of $PbCl_2$ [1] is formed It does not contain delocalised ions [1] to conduct electricity. OR it removes Cl^- ions [1]	2	

OR

B12	a	I		1	10
		ii	Addition Polymerisation	1	
		iii	Mr of acrylamide = 12x3 + 5x1 + 16 +14 = 71 [1] Mass of 13 000 moles of acrylamide = maximum mass of polyacrylamide that can be formed = 13 000 x 71 = 923 000 g [1]	2	

		iv	The calculation for both the monomer and polymer is based on the formula of the monomer, same empirical formula [1] There are no other molecules being eliminated or produced OR All the elements in the monomers become the polymer product. [1]	2	
	b	i	When it shows colours of yellow and orange	1	
		ii		1	
		iii	Ethyl acrylate	1	
		iv		1	