ZHONGHUA SECONDARY SCHOOL

Preliminary I Examination 2017

CANDIDATE NAME		( )
CLASS		

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **15 September, 2017**

Secondary 4 Express **1 hr**

Set by: Ms Ong Lay Hong

Vetted by: Mrs Maybrie Ang and Mr Ong Kai Kun

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, index number and class on the OTAS Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer all questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the one you consider correct and record your choice in soft pencil on the separate OTAS Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

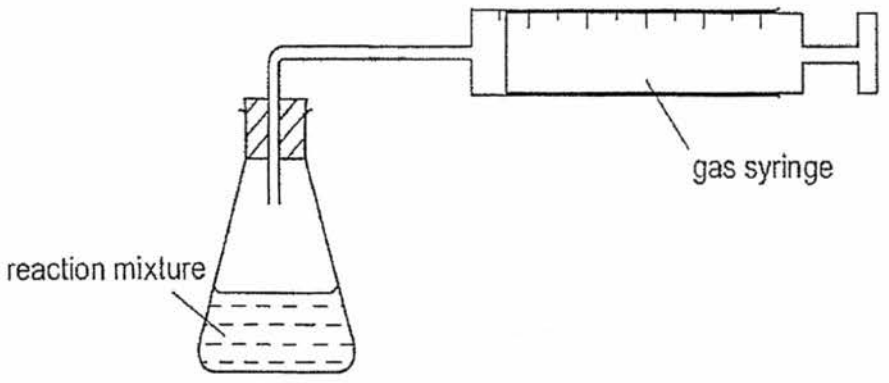
Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 17.

This document consists of **17** printed pages, including this cover page.

[Turn over

1 The apparatus shown can be used to measure the rate of some chemical reactions.



For which two reactions would this apparatus be suitable?

reaction **1** $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

reaction **2** $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

reaction **3** $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$

reaction **4** $ZnCO_3(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + CO_2(g) + H_2O(l)$

A 1 and 2 **B** 1 and 3

C 2 and 4 **D** 3 and 4

2 Camphor is a white solid isolated from camphor tree and has medicinal properties. It has a penetrating smell and has to be kept in closed containers in a cool place to prevent the crystals from "disappearing". It is sparingly soluble in water but readily dissolves in ether, an organic solvent.

Glauber's salt is isolated from mineral ore and consists of hydrated sodium sulfate. ($Na_2SO_4.10\ H_2O$).

A sample of camphor was found to be mixed with sand and Glauber's salt.

How may the components in the sample be separated and recovered?

A heating → dissolving in water → filtration → crystallisation of filtrate

B dissolving in ether → filtration → crystallisation of filtrate and heating of residue

C dissolving in a mixture of ether and water → using of separating funnel → crystallisation

D dissolving in ether → filtration → crystallisation of filtrate

3 Liquid nitrogen, with a boiling point of -196°C, is often used as a coolant. It is observed that ice forms at the opening of a tank of liquid nitrogen after it is opened.

Which of the following is the best explanation for this observation?

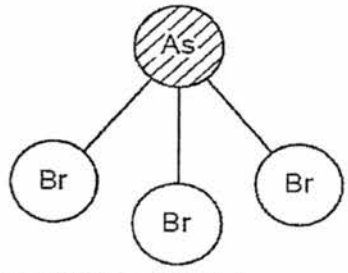
A Water trapped in the liquid nitrogen escapes and freezes.

B Water vapour at 0°C is colder than liquid nitrogen and so it freezes.

C The nitrogen boils in contact with air and then condenses to form a solid.

D Water vapour in the air surrounding the opening of the liquid nitrogen freezes.

4 A molecule of arsenic bromide, $AsBr_3$, has the structure shown.



Which properties could be correct for arsenic bromide?

	melting point / °C	electrical conductivity at room temperature
A	31	does not conduct
B	39	conducts
C	650	conducts
D	755	does not conduct

5 What do the ions $^{36}S^{2-}$ and $^{37}Cl^-$ have in common?

A Both ions contain the same number of nucleons in their nuclei.

B Both ions have the same number of protons.

C Both ions have more electrons than neutrons

D Both ions have 20 neutrons,

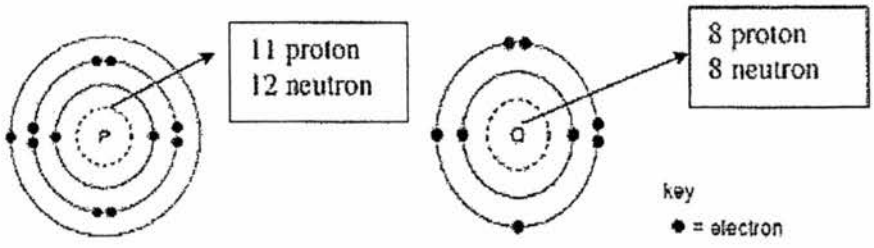
6 Shakudo is a Japanese alloy of copper and gold. The information in the table was obtained by mass spectrometry of a sample of shakudo.

mass number	63	65	197
% abundance	65	29	6

What is the average relative atomic mass of copper?

A 59.8 B 63.5 C 63.6 D 71.6

7 The atomic structures of atoms **P** and **Q** are as shown in the diagram below.



P and **Q** react to form a compound. Which of the following gives the correct type of bonding, molecular formula and the mass of one mole when **P** and **Q** combine to produce a compound?

	type of bonding	molecular formula of compound
A	covalent	P_2Q
B	covalent	PQ_2
C	ionic	P_2Q
D	ionic	PQ_2

8 A mass of 10.4 g of magnesium nitrate is completely thermally decomposed. The products are magnesium oxide and a mixture of two gases.
One gas is acidic while the other gas is neutral. The equation below shows the reaction.

$$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$$

What is the mass of the neutral gas formed?

A 1.12 g B 1.93 g C 2.24 g D 6.45 g

9 An element forms a diatomic molecule, P, which has a relative molecular mass, **x**. The Avogadro constant is ***L***.

How many atoms are present in 1.0 g of P?

A $\frac{L}{x}$ B $\frac{2L}{x}$

C $\frac{L}{2x}$ D $2Lx$

10 Ammonia and carbon dioxide can react to form urea, CON_2H_4 in the reaction as follows:

$$2NH_3 + CO_2 \rightarrow CON_2H_4 + H_2O$$

Urea is a useful compound as it can be used to provide nitrogen in fertilisers for plants.

What is the volume of carbon dioxide required to produce 120 g of urea given that the process is only 80% efficient at room temperature and pressure? (Mr CON_2H_4 = 60)

A 38 dm^3 B 48 dm^3

C 60 dm^3 D 150 dm^3

11 0.5 mol/dm^3 dilute sulfuric acid is added gradually to a flask containing 20 cm^3 of 2 mol/dm^3 sodium hydroxide solution.

What is the total volume, in cm^3, of the mixture in the flask when the solution reaches pH 7?

A 30 B 40 C 60 D 100

12 Methylamine is a gas with the formula CH_3NH_2. It undergoes the following reaction in water:

$$CH_3NH_2 + H_2O \rightarrow CH_3NH_3^+ + OH^-$$

Which of the following is/are true about aqueous methylamine?

1 It turns litmus paper blue.
2 It consists of $CH_3NH_3^+$ and OH^- ions only.
3 It forms a blue precipitate with copper(II) sulfate.

A 1 only B 1 and 2 only

C 1 and 3 only D 2 and 3 only

13 An unknown solid **X** has the following properties.

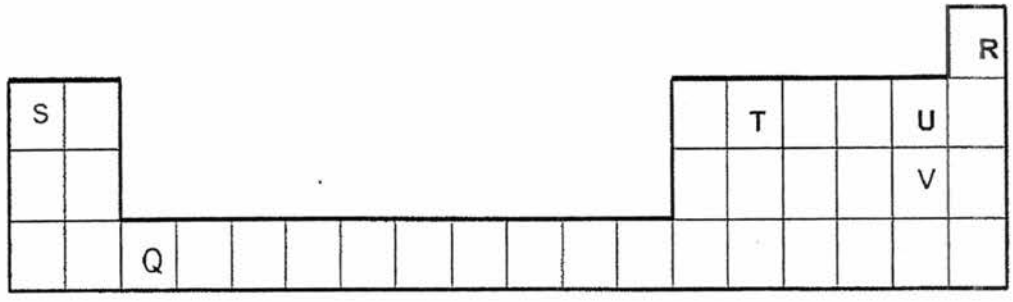
- **X** is stable to heat.
- When dilute acid is added to **X**, effervescence of a colourless gas is observed.
- **X** dissolves in water to form a colourless solution.
- When aqueous sodium hydroxide is added until in excess to the solution, no visible reaction is observed.

What is **X** likely to be?

A calcium metal **B** sodium carbonate

C zinc metal **D** zinc carbonate

14 The diagram shows the positions of elements Q, R ,S, T, U and V in the Periodic Table



Which of the following statements is correct?

A The valence shell of an atom of R has an octet structure.

B The metallic character of the Period 2 elements increases from S to U.

C T forms an ionic compound with U.

D U is a stronger oxidising agent than V.

15 Which of the following statements correctly shows the general trend of the oxides of Period 3 elements from sodium to chlorine?

A The melting points of the oxides increase.

B The electrical conductivities of the molten oxides increase.

C The bonds of the oxides show a trend from ionic to covalent.

D The oxides show a trend from acidic to amphoteric and then to basic.

16 A Group I metal, francium is below caesium in the Periodic Table.

What is a likely property of francium?

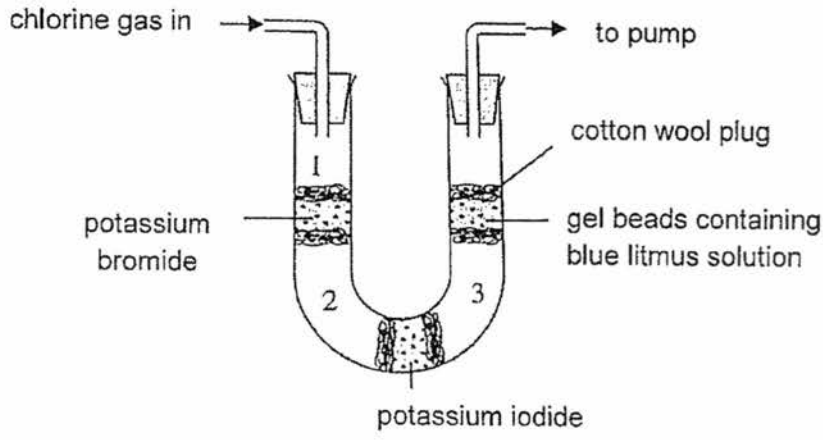
A It does not conduct electricity.

B It has a higher density than iron.

C It is more reactive than the rest of the Group I metals in the Periodic Table.

D It has the highest melting point than the rest of the Group I metals in the Periodic Table.

17 Gaseous chlorine was passed through the following apparatus. The apparatus was continuously heated and the observations were recorded below.



Which of the following observations would be made at regions 1, 2 and 3?

	region 1	region 2	region 3
A	red-brown gas	black solid	violet gas
B	red-brown gas	violet gas	black solid
C	yellow-green gas	red-brown gas	violet gas
D	yellow-green gas	violet gas	brown gas

18 Which three salts are all prepared by precipitation?

A barium sulfate, calcium nitrate, lead(II) sulfate

B barium sulfate, calcium nitrate, silver chloride

C barium sulfate, lead(II) sulfate, silver chloride

D calcium nitrate, lead(II) sulfate, silver chloride

19 In which reaction does the oxidation state of iron remain unchanged?

A $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$

B $FeCl_2 + Mg \rightarrow MgCl_2 + Fe$

C $Fe + 2FeCl_3 \rightarrow 3\ FeCl_2$

D $Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

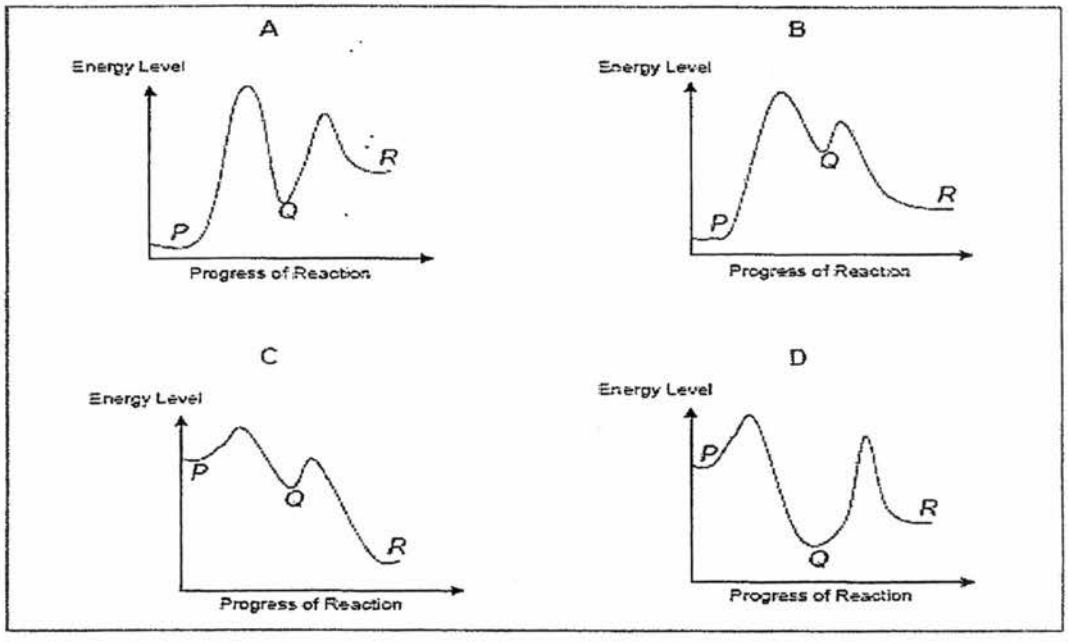
20 Compound **R** can be produced from Compound **P**, via a 2-stage reaction.

The following stages were involved.

stage 1: **P** → **Q**; ΔH, negative

stage 2: **Q** → **R**; ΔH, positive

Which reaction profile fits these data?



Refer to the following table to answer questions 21 and 22.

formula	fuel	molar mass/g	density kg/ litre	enthalpy change of combustion / kJ/ mol
CH_4	methane	16	6.4×10^{-4}	– 891
C_2H_5OH	ethanol	46	0.79	– 1360
H_2	hydrogen	2	8.4×10^{-5}	– 285
C_8H_{18}	petrol	114	0.69	– 5460

21 Which of the following shows the correct order of fuels which produce decreasing amounts of carbon dioxide per mole of fuel?

A petrol, methane, ethanol, hydrogen

B petrol, ethanol, methane, hydrogen

C methane, ethanol, petrol, hydrogen

D ethanol. petrol, methane , hydrogen

22 Methane in the form of compressed natural gas (CNG) is being used as a fuel for cars. Which of the following show the advantages of using methane as a car fuel compared to petrol?

1 Produces more heat per unit mass

2 Enables car to travel longer distance for each tank of fuel

3 Produces lower level of carbon dioxide per unit of energy released

A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

23 Which statements about the production of iron from iron(III) oxide in the blast furnace is correct?

A The reaction between iron(III) oxide and carbon monoxide liberates carbon dioxide.

B The iron is obtained using carbon monoxide as an oxidising agent.

C Molten iron floats on slag at the base of the furnace.

D The iron(III) oxide is reduced by carbon dioxide.

24 Element **X** displaces element **Y** from the aqueous chloride of **Y**.
Element **Z** reacts with cold water to give hydrogen.
Element **X** gives off hydrogen only when heated with steam.

What could elements **X**, **Y** and **Z** be?

	X	Y	Z
A	copper	zinc	sodium
B	calcium	copper	silver
C	copper	silver	calcium
D	zinc	copper	calcium

25 Ammonia gas is produced industrially by the Haber process.
Which of the following statements is not true with regard to the Haber process?

A Nitrogen is obtained from the air.

B A catalyst is added to increase the yield of ammonia.

C High pressure is applied to increase the yield of ammonia.

D High temperature is applied to overcome the activation energy.

26 Some properties of four elements **P**, **Q**, **R** and **S** are listed.

- **P** is the most abundant elements on earth and forms an acidic oxide PO_2.
- **Q** has a high density and is easily drawn into wire.
- **R** acts as a catalyst and its oxide reacts with acids.
- **S** is a red brown solid used to form alloys.

Which of the elements are metals?

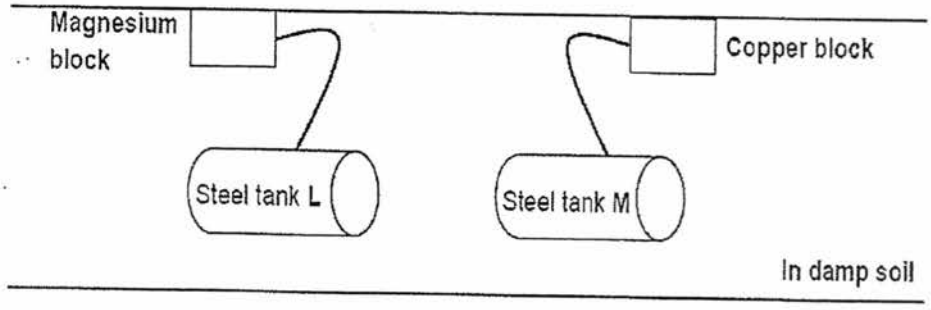
A **P** and **R** only

B **Q** and **R** only

C **Q** and **S** only

D **Q**, **R** and **S**

27 A block of magnesium and a block of copper are attached to underground steel tanks, **L** and **M**, as shown in the diagram below.



Which of the following statements is not true?

A The magnesium block will need to be replaced more regularly than the copper block.

B Steel tank M will rust faster than steel tank L.

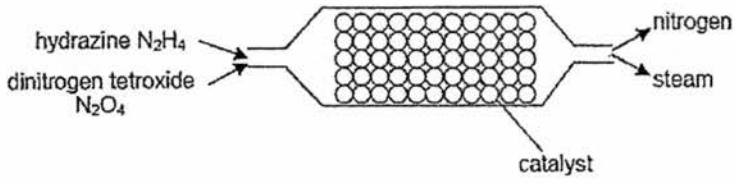
C Both the magnesium and copper block will be oxidised.

D The magnesium block will be oxidised by losing electrons to steel tank L.

28 In what way do methane, nitrogen dioxide and chlorofluorocarbons affect the atmosphere and the environment?

	methane	nitrogen dioxide	chlorofluorocarbons
A	depletion of ozone layer	greenhouse gas	acid rain
B	acid rain	global warming	depletion of ozone layer
C	greenhouse gas	acid rain	depletion of ozone layer
D	depletion of ozone layer	acid rain	global warming

29 A rocket can be fuelled by hydrazine burning with dinitrogen tetroxide. The reaction in the rocket engine is shown in the following diagram.



Which of the following take(s) place in the rocket engine?

1 The oxidation state of nitrogen increased from -2 in hydrazine to 0 in nitrogen.

2 3.5 moles of gaseous products were produced when 1 mole of hydrazine is used.

3 Endothermic reaction occurs.

A 2 only

B 1 and 2 only

C 2 and 3 only

D 1, 2 and 3

30 Two experiments were carried out in which dilute hydrochloric acid was added to excess calcium carbonate.

experiment **1**: 100 cm^3 of 5.00 mol/dm^3 dilute hydrochloric acid was used

experiment **2**: 400 cm^3 of 1.25 mol/dm^3 dilute hydrochloric acid was used

The initial rate of production of carbon dioxide and the total volume of carbon dioxide were measured in each experiment.

How do the results in Experiment **1** compare with those in Experiment **2** when all other conditions are identical?

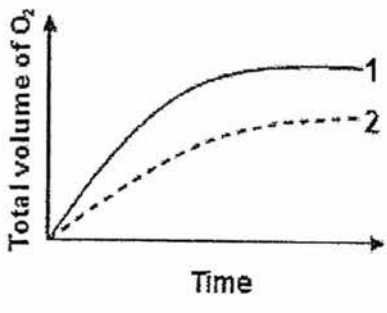
	rate of production of carbon dioxide	total volume of carbon dioxide
A	faster in **1**	greater in **1**
B	faster in **1**	same in both
C	slower in **1**	greater in **1**
D	slower in **1**	same in both

31 Aqueous hydrogen peroxide decomposes to form water and oxygen gas. Two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide.

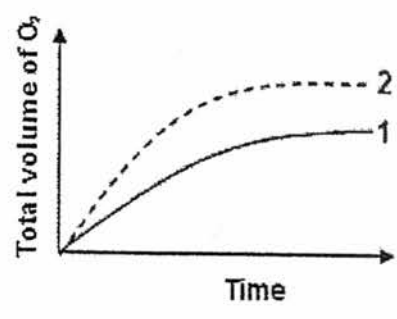
Which graph shows how the how the volume of oxygen gas varies with time in each experiment?

experiment	reagent used
1	400 cm^3 of 0.2 mol/dm^3 hydrogen peroxide
2	100 cm^3 of 1.0 mol/dm^3 of hydrogen peroxide

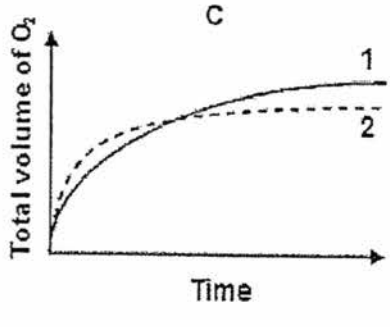
A



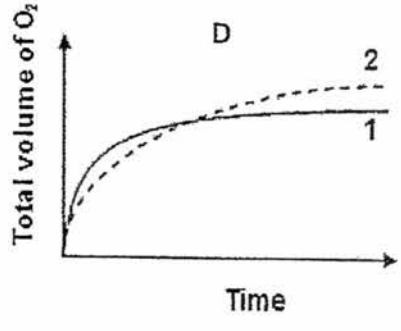
B



C



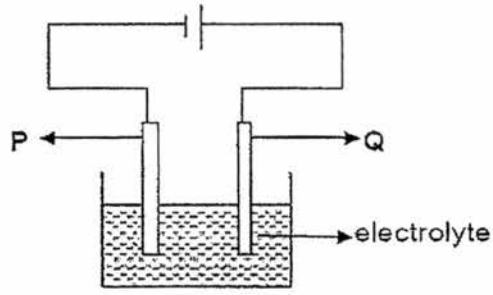
D



32 Metal X forms a chloride XCl_2. X is between copper and silver in the reactivity series. If a concentrated aqueous solution of XCl_2 is electrolysed, which reactions will occur at the cathode and anode?

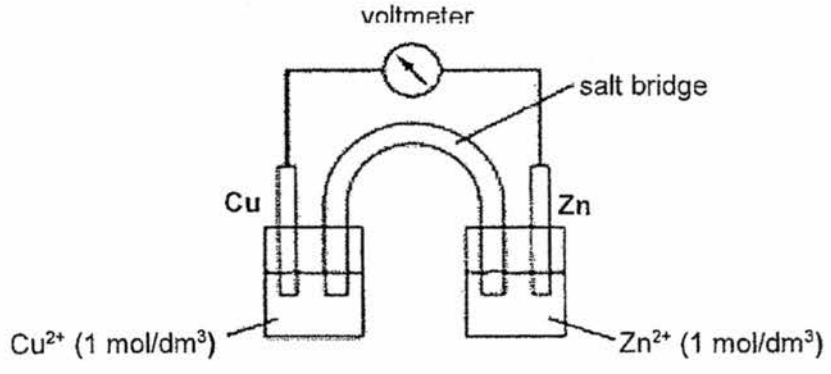
	cathode	anode
A	$X^+ + e \rightarrow X$	$2Cl^- - 2e \rightarrow Cl_2$
B	$X^+ + e \rightarrow X$	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$
C	$X^{2+} + 2e \rightarrow X$	$2Cl^- - 2e \rightarrow Cl_2$
D	$X^{2+} + 2e \rightarrow X$	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$

33 An experiment is set up as shown in the diagram below. Both electrodes **P** and **Q** are made of graphite.
Which of the following gives the correct results as electrolysis proceeds?



	electrolytes	mass of **P**	mass of **Q**
A	aqueous sodium chloride	remains unchanged	increase
B	aqueous potassium chloride	increase	remains unchanged
C	aqueous copper (II) sulfate	remains unchanged	increase
D	aqueous silver nitrate	increase	remains unchanged

34 The figure below shows a galvanic cell in which the particles being oxidised is in one part of the cell; that being reduced is in the other.



Which of the following is true?

A Electrons flow through the voltmeter from Cu to Zn.

B The reaction is $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}.(aq)$

C Zn is reduced.

D Cu is the anode.

35 The reaction of different vegetable oils with hydrogen was investigated.

100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst. The volume of hydrogen gas that remained after each reaction was recorded in the table below.

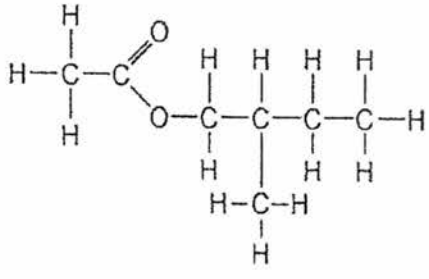
vegetable oil	volume of hydrogen gas that remained after the reaction / cm^3
P	100
Q	87
R	63
S	0

Which vegetable oil(s) is/ are unsaturated?

A P only **B** Q, R and S

C P, Q and R **D** S only

36 Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone. When disturbed, individual bees on guard will raise their abdomen and emit the alarm pheromone, fanning their wings to aid its dispersal



2-methylbutyl ethanoate

Which starting materials would be required to form 2-methylbutyl ethanoate?

A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

37 The compound C_6H_{10} is a member of a hydrocarbon homologous series. What can be the first possible member of this series with the smallest relative molecular mass?

A C_2H_2 **B** C_2H_3 **C** C_2H_4 **D** C_2H_6

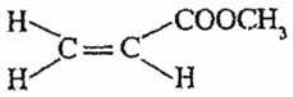
38 In which of the following processes will carbon dioxide be produced?

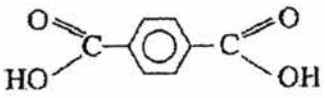
1 fermentation of glucose solution
2 formation of ethanoic acid from ethanol
3 photosynthesis by green plants
4 treatment of car exhaust gases in catalytic converter

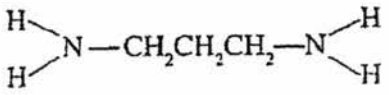
A 1 and 2 B 1 and 4

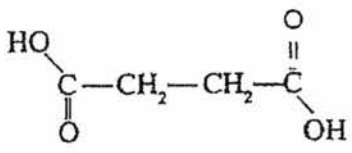
C 1, 3 and 4 D 4 only

39 Which of the following monomers can be used to produce condensation polymers?

1 

2 

3 

4 

A 1 and 3 B 2 and 4

C 1, 2 and 4 D 2, 3 and 4

40 0.1 mole of a polyunsaturated hydrocarbon reacts with 9.6 dm^3 of hydrogen gas. If the compound has 21 carbon atoms in its structure.

What is the chemical formula of the hydrocarbon?

A $C_{21}H_{36}$ B $C_{21}H_{40}$

C $C_{21}H_{42}$ D $C_{21}H_{44}$

********* **end of paper** **********

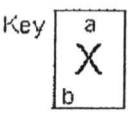
Group														
I	II											III	IV	
							1 H hydrogen 1							
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbo 6	
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silico 14	
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 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 germar 32	
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	
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	
– 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 holmiu 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	– Es einsteini 99	

Key



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 pressure (r.t.p.).

ZHONGHUA SECONDARY SCHOOL
Preliminary Examination 2017

CANDIDATE NAME		( )
CLASS	4 E	

CHEMISTRY **5073/02**

Paper 2 Theory **11 September, 2017**

Secondary 4 Express **1 hour 45 minutes**

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Vetted by: Mrs Maybrie Ang & Ms Ong Lay Hong

READ THESE INSTRUCTIONS FIRST

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

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions in the spaces provided.

Section B

Answer all **three** questions, the last question is in the form either/or.

You are advised to spend no longer than one hour on **Section A** and no longer than 45 minutes on **Section B**.

The number of marks is given in brackets [ ] at the end of each question or part question.

All essential working must be shown clearly.

A copy of the Periodic Table is printed on page 19.

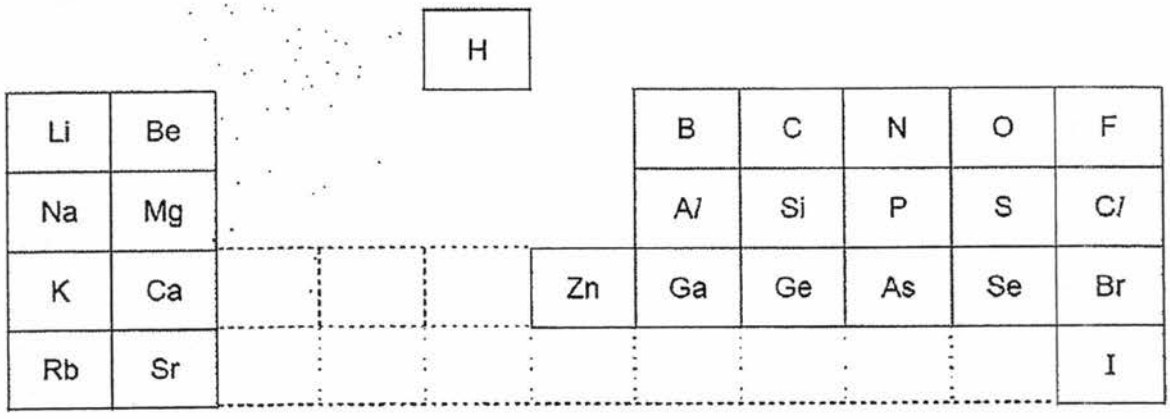
For Examiner's Use	
Section A	50
B 8	10
B 9	10
B 10	10
Total	

This document consists of **19** printed pages, including this cover page.

Section A (50 MARKS)

Answer **all** the questions.
Write your answers in the spaces provided on the question paper.

A1 The diagram below shows part of the Periodic Table.



Answer these questions using only the elements shown in the diagram. Each element can be used once, more than once or not at all.

(a) Which two elements form the gas released when aqueous sodium nitrate is warmed with aqueous sodium hydroxide and aluminium foil?

..... [1]

(b) Which two elements in Period 3 form an ionic compound with the formula of the type Y_2Z?

..... [1]

(c) Which two elements form the compound with a giant molecular structure?

..... [1]

(d) Which element can be used as a reducing agent in the extraction of iron from iron(III) oxide?

..... [1]

(e) Which two elements form a solution used to test for an oxidising agent?

..... [1]

[Total: 5]

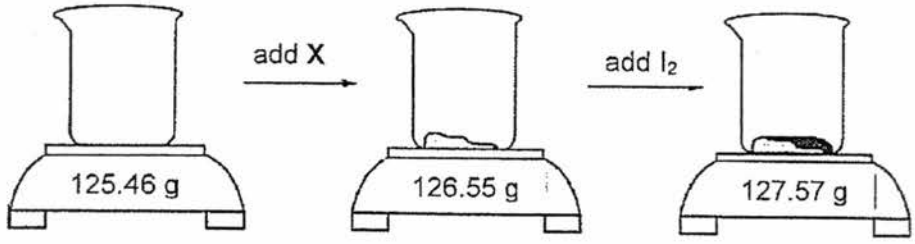
Total marks:	

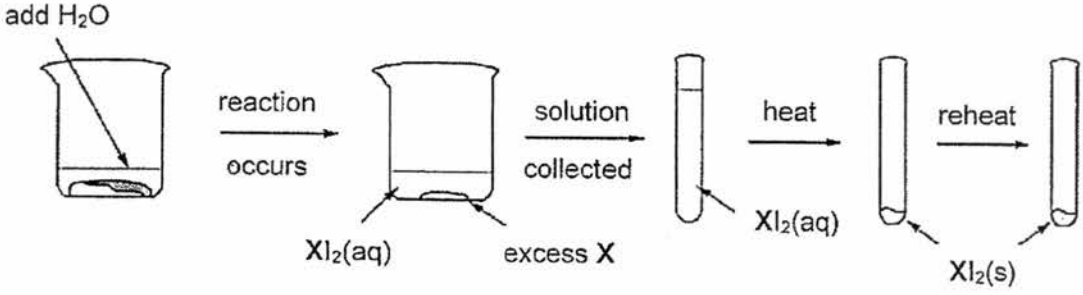
A2 A student conducted an experiment to determine the molar mass of an unknown metal, **X**. The student reacts iodine with an **excess** of the metal to form a water-soluble compound, XI_2.

The equation can be represented below:

$$X + I_2 \rightarrow XI_2$$

The reaction proceeds until all of the iodine is used up. The XI_2 solution is collected and heated to remove the water and the product is dried and weighed to a constant mass. The experimental steps are represented and the results are tabulated below.





mass of beaker / g	125.46
mass of beaker + metal **X** / g	126.55
mass of beaker + metal **X** + I_2 / g	127.57
mass of XI_2 (first weighing) / g	1.28
mass of XI_2 (second weighing) / g	1.28

(a) Calculate the number of moles of I_2 used.

[2]

Total marks:	

(b) Calculate the molar mass of the unknown metal, **X**. Identify metal **X**.

Metal **X** is _____ [3]

(c) The student hypothesized that

"the compound formed in the synthesis reaction is ionic"

Propose an experimental test the student could perform in the laboratory to test the hypothesis. Explain how the results of the test would support the hypothesis if the compound is ionic.

_____

_____

_____

_____

_____ [2]

(d) The student also hypothesizes that chlorine gas will react with metal **X** more vigorously than solid iodine at room temperature.

Explain, in terms of structure and bonding, why iodine is a solid at room temperature while chlorine is a gas.

_____

_____

_____

_____

_____

_____ [3]

[Total: 10]

Total marks:	

A3 A group of students were investigating the effects of 'acid rain'.
They decided to look at the effect of acid on metals used as building materials.
Lead and copper are used as materials for roofing and iron and aluminium can be used for window frames.

They learnt that the order of the reactivity of the metals as:

aluminium > iron > lead > copper

The students went on to test on the metals by adding dilute sulfuric acid to pieces of each metal to simulate the effects of 'acid rain' on the metals. It is found that only the iron seemed to give a reaction.

(a) Explain why the students deduce that aluminium did not react with the acid, even when aluminium is known to be more reactive than iron.

.....

.....

..... [1]

(b) As the reaction was carried out with sulfuric acid, there were no reactions for both lead and copper. It did not prove that lead was more reactive than copper.

(i) Explain why the students cannot prove the reactivity of lead and copper using sulfuric acid.

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..... [2]

(ii) Briefly describe an experiment the students can carry out to show that lead is more reactive than copper. Explain how the above experiment can prove that lead is more reactive than copper.

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..... [3]

[Total: 6]

Total marks:	

A4 Three experiments were carried out to study the speed of reaction between dilute acid and granulated zinc.

The table below shows the amount of acid, mass of zinc used, drops of copper(II) sulfate used and the time taken to collect 50 cm^3 of hydrogen gas for each experiment.

experiment	amount of dilute acid used	mass of granulated zinc used /g	drops of aqueous copper (II) sulfate used	time taken /s
I	25.0 cm^3, 1.0 mol/dm^3 sulfuric acid	2.5	0	28.0
II	25.0 cm^3, 1.0 mol/dm^3 hydrochloric acid	2.5	0	52.0
III	25.0 cm^3, 1.0 mol/dm^3 sulfuric acid	2.5	5	17.0

(a) Explain, in terms of collision theory, why the time taken for Experiment **I** is shorter than Experiment **II**.

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..... [4]

(b) Using the information from the table, explain the role of aqueous copper (II) sulfate in Experiment **III**.

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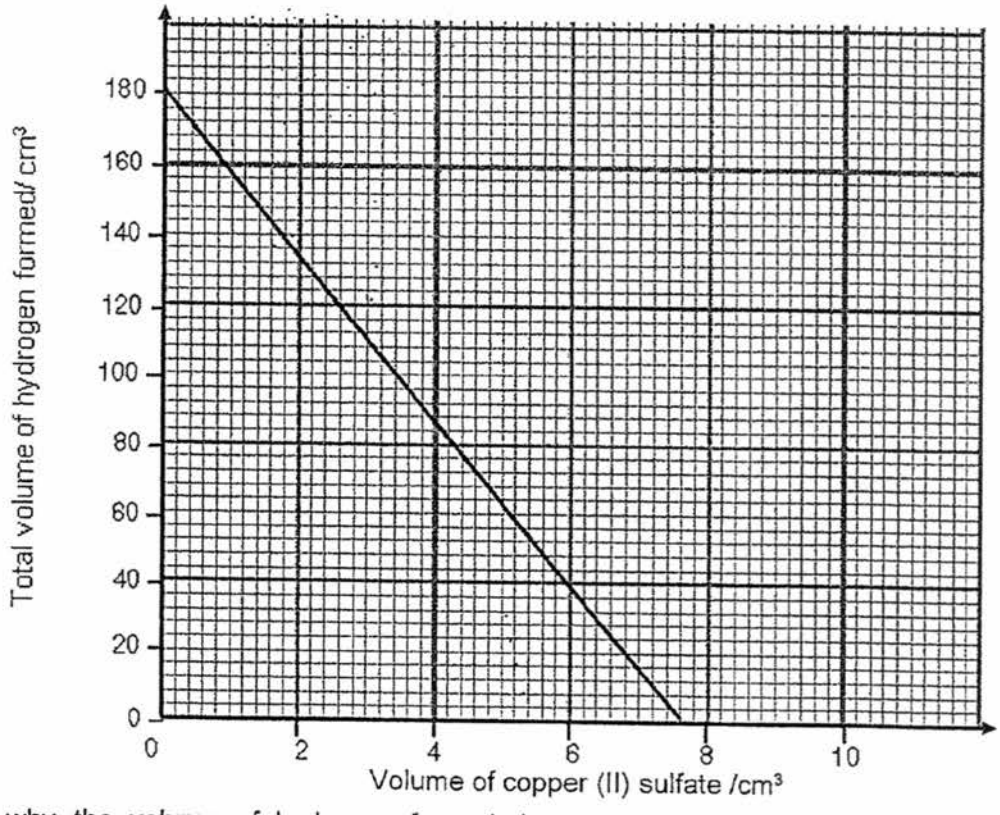
..... [2]

Further experiments of the reaction between zinc and sulfuric acid were carried out. In

Total marks:	

these experiments, various volumes of aqueous copper(II) sulfate were added to the sulfuric acid.

The graph below shows the volume of hydrogen gas collected when various volumes of aqueous copper (II) sulfate (1.0 mol/dm^3) were added to excess sulfuric acid and a fixed mass of zinc. The volume of hydrogen was measured at room temperature and pressure.



(c) Explain why the volume of hydrogen formed decreases as the volume of aqueous copper(II) sulfate added increases.

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..... [2]

(d) Predict the change in the volume of hydrogen gas produced when aqueous magnesium sulfate is used in place of aqueous copper (II) sulfate. Explain your answer.

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..... [2]

[Total: 10]

Total marks:	

A5 Methanol, CH_3OH, is manufactured from carbon dioxide and hydrogen.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \qquad \Delta H = -49 \text{ kJ}$$

The reaction is carried out in the presence of a catalyst containing copper. The conditions used are 70 atmospheres pressure and a temperature of 250 °C.

(a) Explain, using collision theory, what happens to the speed of the reaction if the temperature of the reaction mixture is increased to 400 °C,

.....

.....

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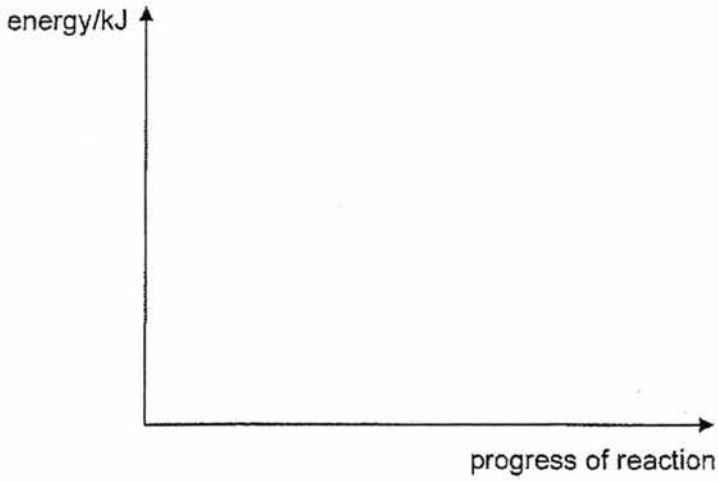
..... [2]

(b) In the reaction when 3.0 moles of hydrogen gas react, 49 kJ of heat energy is released. Calculate how much heat energy is released when 500 kg of hydrogen gas react.

[2]

(c) Complete the energy profile diagram using the given axes to show the production of methanol. The diagram should show:

- the activation energy, E_a;
- the energy change for the reaction, ΔH;
- the reaction pathway for the reaction



[2]

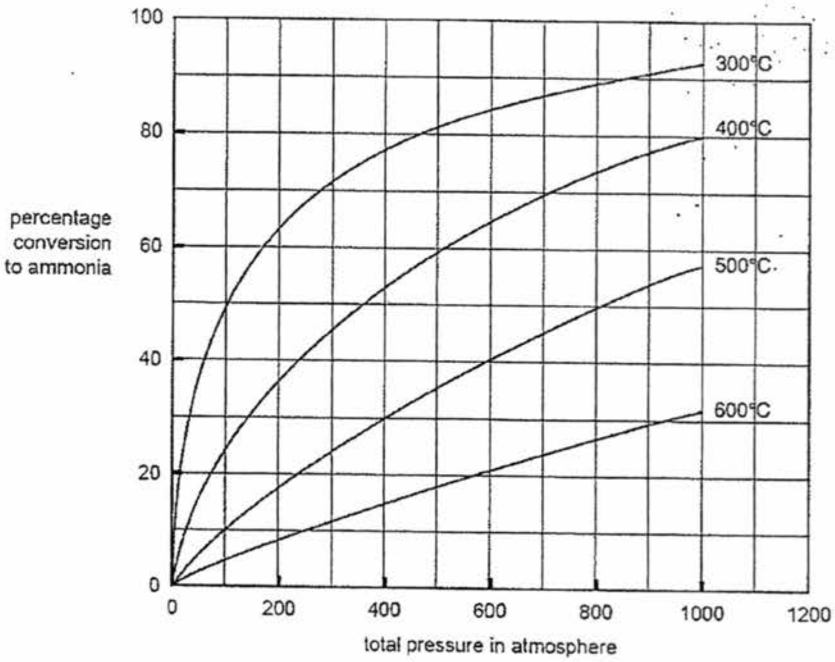
[Total: 6]

Total marks:	

A6 Ammonia is prepared industrially from hydrogen and nitrogen in the presence of a suitable catalyst according to the equation below.

$$N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$$

The graph below shows the variation of the equilibrium yield of ammonia with pressure at different temperatures.



(a) A particular industrial plant uses a pressure of 400 atm and a temperature of 500°C. From the graph, determine the percentage yield of ammonia under these conditions.

.... [1]

(b) Deduce from the graph whether the production of ammonia from hydrogen and nitrogen is an exothermic or an endothermic reaction. Explain your reasoning.

....

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.... [2]

(c) Temperatures less than 400°C are not used for this industrial reaction even though such temperatures give a greater equilibrium yield of ammonia. Give a possible reason why this is so.

....

.... [1]

[Total: 4]

Total marks:	

A7 A chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(a) Draw the full structural formulae of the monomer and the polymer, poly(propene).

monomer	polymer

[2]

(b) Suggest whether the monomer or the polymer will react with aqueous bromine. Describe what you would see and explain your observations with the help of a full structural equation.

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..... [4]

(c) To show that the polymer, poly(propene), contains silver the following test was carried out.

The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered to get the filtrate. The filtrate contains silver nitrate.

(i) The above test is incomplete. Using the test above, briefly describe the steps you will take to show that the polymer contains silver. State the reagent(s) you would use to help you identify the presence of silver ions.

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..... [2]

(ii) Write an ionic equation with state symbols described in **(c)(i)** for the above test to identify the presence of silver ions.

..... [1]

Total marks:	

[Total: 9]

Section B (30 MARKS)

Answer all **three** questions, the last question is in the form either/or.
Write your answers on the separate answer papers provided

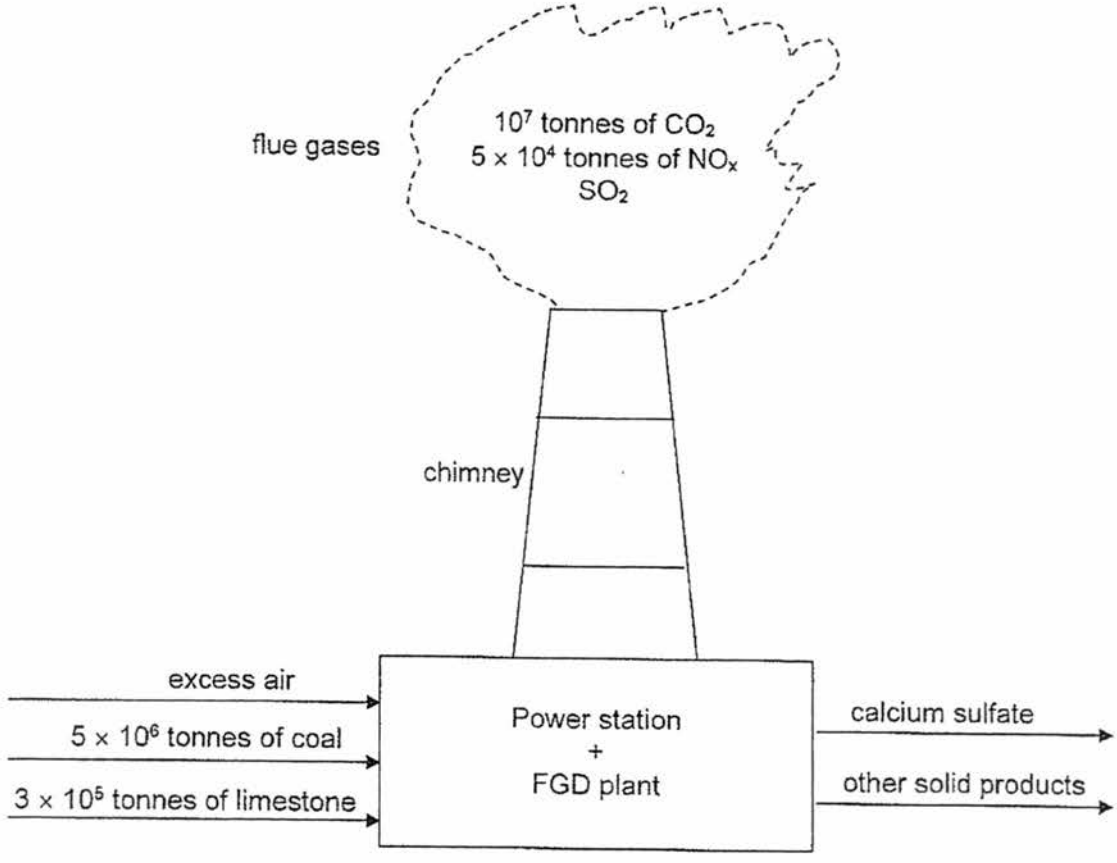
B8 **Part 1**

A coal-fired power station is fitted with a Flue Gas Desulphurisation (FGD) plant, which removes sulfur dioxide from the waste gases. In the FGD plant, the waste gases are treated with powdered limestone ($CaCO_3$). The limestone reacts with sulfur dioxide producing calcium sulfite ($CaSO_3$) and carbon dioxide.

$$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$$

The calcium sulfite is then oxidised by air to form solid calcium sulfate.

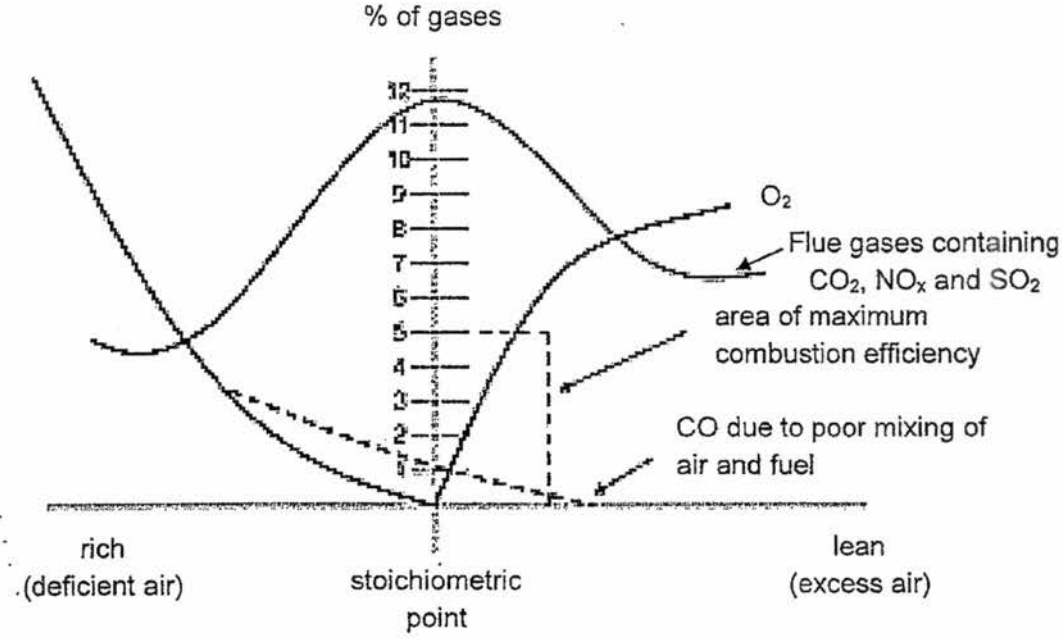
The diagram below shows the masses of substances used, and produced, by such a coal-fired power station with an FGD plant in one year.



Total marks:	

Part 2

FGD plant operators have used combustion flue gas analysis for decades as a method of optimizing boiler combustion fuel/air ratios. By measuring the amount of excess oxygen and/or carbon monoxide (CO) in the flue gases, the plant can be tuned to operate at the best heat rate and lowest oxides of nitrogen levels. Operation at best efficiency also inherently produces the least amount of carbon dioxide.



Combustion at stoichiometric point as seen in the graph above occurs when all of the fuel is reacted with just the right amount of oxygen in the combustion air so that no fuel is left unburned and no oxygen remains in the flue gas. Any air that is not used to combust the fuel is called "excess air".

(a) Using the information given in **Part 1**, calculate the maximum mass of sulfur dioxide which could be removed by the given amount of limestone in the FGD plant.

[3]

(b) Using the information given in **Part 1**, briefly describe the reaction that provides the energy used in the power station.

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Total marks:	

[1]

(c) Using the information given in **Part 2**, describe and explain the percentage of carbon monoxide and oxygen at stoichiometric point.

[3]

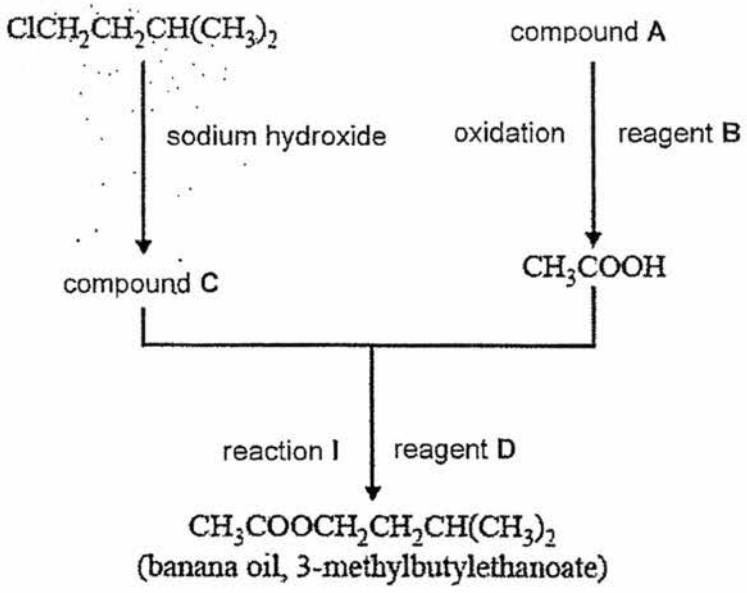
(d) Explain why the percentage of flue gases are at their maximum at stoichiometric point.

[3]

[Total: 10]

Total marks:	

B9 Banana oil, 3-methylbutylethanoate, $CH_3COOCH_2CH_2CH(CH_3)_2$, is a sweet smelling liquid that gives bananas their characteristic odour.
A chemist working for Wow Bananas Pte Ltd has proposed the following reaction pathway for the synthesis of banana oil.



(a) Name compound **A** and reagent **B**. Describe what you see when reagent **B** is used.

compound **A**: ..... reagent **B**: .....

.....

.....

..... [3]

(b) Draw the full structural formula of compound **C**.

[1]

(c) Identify reagent **D** and name the process in reaction **I**.

reagent **D**: .....

name of process: ..... [2]

Total marks:	

(d) The chemist decided to separate the final product from the reaction mixture.

State the separation technique he can use to obtain a pure product and explain how it can be separated using this technique.

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..... [2]

(e) Give two uses of the pure product obtained in **part (d)**.

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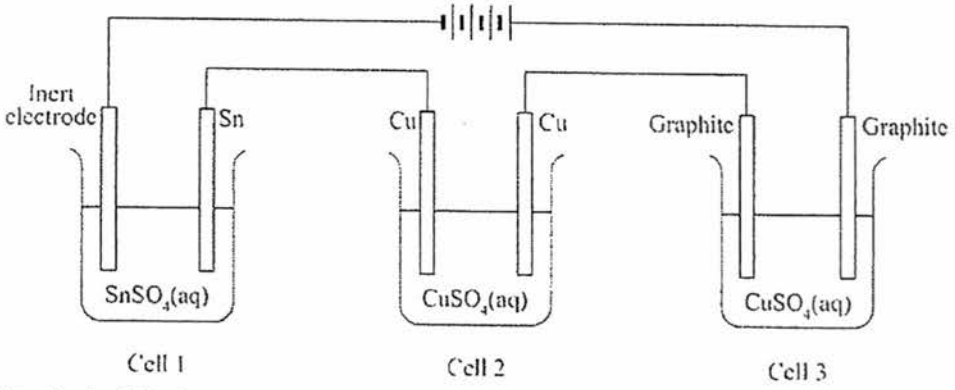
..... [2]

[Total: 10]

EITHER

B10 Three electrolytic cells are set up in series as shown below.
All of the electrolytes have a concentration of 1.00 mol/dm^3.



(a) Write the half ionic equations with state symbols in the table below to show the reactions that happen in Cells 2 and 3.

cell	electrode	half ionic equation
2	copper anode	
	copper cathode	
3	graphite anode	
	graphite cathode	

Total marks:	

[4]

(b) Calculate the mass of copper produced at one of the electrodes in cell 2 if the tin electrode in cell 1 decreased in mass by 0.034 g.

[2]

(c) Describe the colour and the pH of the solutions in cells 2 and 3 after the electrolysis set-up has been running for some time Explain your answers.

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.....

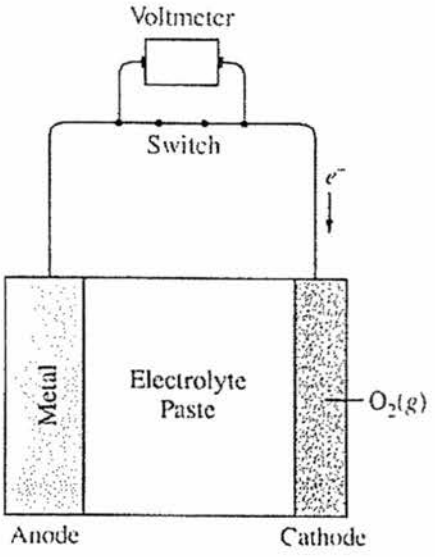
..... [4]

[Total: 10]

Total marks:	

OR

B10 Metal-air cells are a relatively new type of portable energy source consisting of a metal anode, an alkaline electrolyte paste that contains water, and a porous cathode membrane that lets in oxygen from the air.



A schematic of the cell is shown above. The half ionic equations that take place at the cathode and at the three possible metal anodes are given in the table below.

electrode	half ionic equation
cathode	O_2 (g) + $2H_2O$ (l) + $4e^-$ → $4OH^-$ (aq)
zinc anode	Zn (s) + $2OH^-$ (aq) → ZnO (s) + H_2O (l) + $2e^-$
sodium anode	2Na (s) + $2OH^-$ (aq) → Na_2O (s) + H_2O (l) + $2e^-$
calcium anode	Ca (s) + $2OH^-$ (aq) → CaO (s) + H_2O (l) + $2e^-$

(a) Early forms of metal-air cells used zinc as the anode. Zinc oxide is produced as the cell operates.

Using the half ionic equations from the table above, write the overall equation that takes place in zinc-air cells.

.....[1]

(b) The electrolyte paste contains OH^- ions. On the diagram of the cell above, draw an arrow to indicate the direction of migration of OH^- ions through the electrolyte as the cell operates.

[1]

Total marks:	

(c) Metal-air cells need to be lightweight for many applications. A fresh zinc-air cell is weighed on an analytical balance before being placed in a hearing aid for use.

(i) As the cell operates, does the mass of the cell increase, decrease, or remain the same? Using the overall equation in **(a)**, explain your answer.

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..... [2]

(ii) In order to transfer more electrons with a smaller mass, sodium and calcium metals are investigated as potential anodes.

Which of these 2 metals would transfer more electrons if 1 g of metal anode is used? Justify your answer with calculations.

[4]

(e) Draw the 'dot and cross' diagram of sodium oxide formed when sodium anode is used in metal-air cells. Include all the electrons.

[2]

[Total: 10]

END-OF-PAPER

Total marks:	

"The difference between a successful person and others is.not a lack of strength, not a lack of knowledge, but rather a lack in will."
— Vince Lombardi Jr.

Total marks:	

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 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

†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 (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 pressure (r.t.p.).

2017 Sec 4E Chemistry PRELIMINARY EXAMINATIONS
5073 Paper 2 Answer Scheme

SECTION A

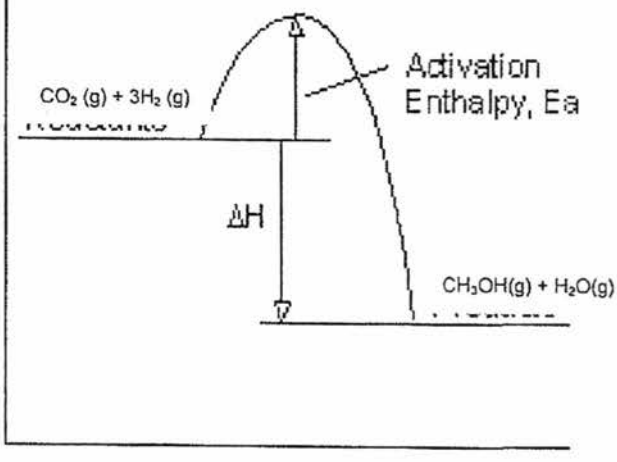
A1	(a)	**N & H**	[1]
	(b)	**Na & S**	[1]
	(c)	**Si & C or Si & O**	[1]
	(d)	**C**	[1]
	(e)	**K & I or Cl or Br or H & O**	[1]
			[Total: 5 marks]

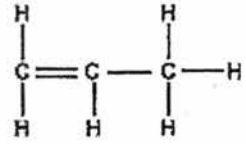
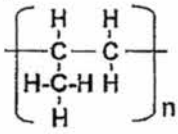
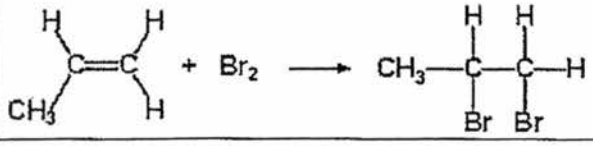
A2	(a)	Mass of I_2 = 127.57 – 126.55 = **1.02 g**	[1]
		Number of moles of I_2 = 1.02/ 2(127) = **0.00402** (3 s.f) *(no mark given if answer is 0.004)*	[1]
	(b)	Number of moles of I_2 = number of moles of X	
		Mass of X = 1.28 – 1.02 = **0.26 g**	[1]
		0.00402 mol of X → 0.26 g 1 mole of X → 0.26/ 0.00402 = **64.7 g** (3.s.f)	[1]
		Therefore, Ar of X is 65. Identity of metal X is **zinc**	[1]
	(c)	(1) The student could **dissolve the compound in water** and **test electrical conductivity** of the solution formed.	[1]
		If it conducts electricity, the compound has **mobile ions in aqueous state**, thus the compound is likely to be ionic.	[1]
	(d)	Both iodine and chlorine are **simple molecules**.	[1]
		Iodine molecules are **larger in molecular sizes** compared to chlorine molecules.	[1]
		Iodine molecules have **greater intermolecular forces of attraction** than chlorine molecules. More energy is required to overcome the forces of attraction.	[1]
			[Total: 10 marks]

A3	(a)		aluminium forms a **protective (insoluble) oxide layer** which react with the acid to form salt and water only. Hence no effervescence seen.	[1]
	(b)	(i)	Lead reacts with sulfuric acid to form an **insoluble lead(II) sulfate coating** around lead. This forms a physical barrier **prevent further reaction** between the acid and lead. Copper is an **unreactive metal**. It does not react with acid to form salt and hydrogen gas.	[1] [1]
		(ii)	Conducts a **metal displacement reaction** by **dipping a piece of lead metal and a piece of copper metal in separate solutions of copper(II) nitrate.** Lead metal in copper(II) nitrate: **blue copper (II) nitrate solution turns colourless/ reddish brown deposits** This shows that lead is a more reactive metal than copper and lead can **displace the less reactive metal (copper) from its solution.**	[1] [1] [1]
				[Total: 6 marks]

A4	(a)	Sulfuric acid used in Experiment I is dibasic. **Every mole of sulfuric acid ionise completely to form 2 moles of hydrogen ions.** Hydrochloric acid in Experiment II is monobasic. **Every mole of hydrochloric acid ionize completely to form 1 mole of hydrogen ions.** In Experiment I, there is **a twice the concentration of hydrogen ions per unit volume than in Experiment II.** Hence, there is a **higher frequency of effective collision** in Experiment I than in Experiment II. As a result, there is a **higher rate of reaction** in Experiment I than in Experiment II.	[1] [1] [1] [1]
	(b)	**Copper(II) sulfate acts as a catalyst** It **increases the speed of reaction** by **reducing the time taken to collect 50 cm^3 of hydrogen gas. Experiment I takes 28s while experiment III takes only 17s.** *(must support with data readings)*	[1] [1]
	(c)	When aqueous copper (II) sulfate is added, a side reaction occurs. **Zinc displaces copper from copper (II) sulfate** **Less zinc is available to reacts with sulfuric acid to produce less hydrogen.** Hence, the greater the volume of aqueous copper (II) sulfate added, the lower the volume of hydrogen produced.	[1] [1]

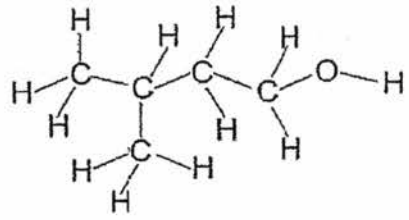
	(d)	No (no marks) **Zinc, being less reactive than magnesium is unable to displace magnesium from magnesium sulfate.** Hence, **mass of zinc reacting with sulfuric acid remains the same.**	[1] [1]
			[Total: 10 marks]

A5	(a)	The speed of reaction increases **More** reacting particles gain energy, move faster and will **attain energy equal or more than the activation energy** **Higher frequency of effective collisions** of the reacting particles	[1] [1]
	(b)	Number of moles of hydrogen gas = 500 x 10^3 / 2(1) = **250 x 10^3** Energy released = (250 x 10^3 / 3) x 49 = **4.08 x 10^6 kJ**	[1] [1]
	(c)	energy/kJ  	[2]
			[Total: 6 marks]
A6	(a)	30%	[1]
	(b)	**Exothermic reaction** The **percentage yield of ammonia increases with lower applied temperature**. The lower applied temperature favors the forward reaction of ammonia production.	[1] [1]
	(c)	Slows down the rate of production of ammonia	[1]
			[Total: 4 marks]

A7	(a)	Propene 	Poly(propene) 	[2]
	(b)	The **monomer** will react with aqueous bromine.		[1]
		Reddish brown bromine solution will decolourise when added to monomer.		[1]
		Monomer (propene) has a **C=C bond** (OR is **unsaturated**) which can **undergo addition reaction** with aqueous bromine to form 1,2 dibromopropane.		[1]
				[1]
	(c)	(i) Add **sodium chloride** (or any suitable chloride solution) to the filtrate.		[1]
		A **white precipitate**, **AgCl** is formed. *(must identify the white precipitate)* Since a white ppt is formed, this shows that the polymer contains silver.		[1]
		(ii) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$		[1]
				[Total: 9 marks]

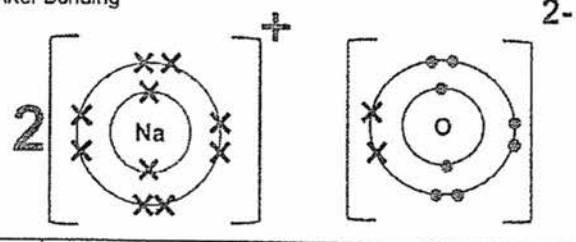
SECTION B

B8	(a)	No. of moles of $CaCO_3 = \frac{3\times10^5\times10^6}{100} = 3\times10^9$ From the given equation, 1 mole of $CaCO_3$ removes 1 mole of SO_2 No. of moles of SO_2 removed = **3×10^9** Max. mass of SO_2 removed = $3 \times 10^9 \times 64$ = **1.92×10^5 tonnes**	[1] [1] [1]
	(b)	The **combustion of coal** (or fuel) is exothermic which produces the energy needed in the power station.	[1]
	(c)	Carbon monoxide – 1% (from graph) Poor mixing of oxygen in air and coal (fuel) caused **incomplete combustion of coal**, hence producing traces of carbon monoxide Oxygen – 0% (from graph) **All the coal (fuel) has reacted with the oxygen** so that no fuel is left unburned and no oxygen remains in the flue gas 1 mark for quoting the right % values of carbon monoxide & oxygen	[1] [1] [1]
	(d)	**Carbon dioxide** All the coal (fuel) is combusted completely to form high amount of carbon dioxide gas **Sulfur dioxide** Coal contains **sulfur as an impurity**. When coal burns completely, a high amount of sulfur dioxide is produced. **Oxides of nitrogen** The furnace in FGD plant is at **high temperature, nitrogen and oxygen** from the air will react/ combined to form oxides of nitrogen	[1] [1] [1]
			[Total: 10 marks]
B9	(a)	Compound A – ethanol Reagent B – acidified potassium manganate (VII)/ acidified potassium dichromate (VI) In acidified potassium manganate (VII), purple solution decolourised/ in acidified potassium dichromate (VI), orange solution turns green.	[2] [1]

	(b)		[1]
	(c)	Concentrated sulfuric acid Esterification	[1] [1]
	(d)	**Fractional distillation** **Heat** the mixture to vaporize the fractions The **final product will be distilled as it has different boiling point with lower boiling point will be collected as distillate first.** Followed by the fraction with higher boiling point	[1] [1]
	(e)	The two uses of esters are: Food flavourings/ Solvents used in perfumes/ manufacture of soaps *(choose any 2)*	[2]
		[Total: 10 marks]	

EITHER					
B10	(a)	cell	electrode	half ionic equation	[4]
		2	copper anode	$Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2e$	
			copper cathode	$Cu^{2+}\ (aq) + 2e \rightarrow Cu\ (s)$	
		3	graphite anode	$4OH^{-}\ (l) \rightarrow O_2\ (g) + 2H_2O\ (l) + 4e$	
			graphite cathode	$Cu^{2+}\ (aq) + 2e \rightarrow Cu\ (s)$	
	(b)	$Sn\ (s) \rightarrow Sn^{2+}\ (aq) + 2e$ Number of moles of Sn = 0.034/ 119 = **0.00028571** Every 2 moles of electrons, 1 mole of Sn is oxidised and 1 moles of Cu is formed. Mass of Cu = 0.00028571 x 64 = **0.0183 g**			[1] [1]

	(c)	The electrolyte remains blue in cell 2 and the blue colour fades in cell 3;	[1]
		positive Cu electrode (anode) is oxidized to replace the Cu^{2+} ions in the electrolyte in cell 2	[1]
		pH does not change in cell 2 and decreases in cell 3;	[1]
		solution becomes acidic as hydroxide ions are preferentially discharged at the anode, leaving behind H+ ions in the electrolyte.	[1]
		[Total: 10 marks]	

OR			
B10	(a)	$2Zn\ (s) + O_2\ (g) \rightarrow 2ZnO\ (s)$	[1]
	(b)	Arrow should point left in the electrolyte	[1]
	(c)	Mass decreases	[1]
		Oxygen in the air reacts with zinc in the cell to form zinc oxide which weighs more than the original mass of zinc	[1]
	(d)	For Na:	
		Number of moles of Na = 1 / 23 = **0.0434**	[1]
		Number of moles of electrons = **0.0434**	[1]
		For Ca:	
		Number of moles of Ca = 1 / 40 = **0.025**	
		Number of moles of electrons = 2 x 0.025 = **0.05**	[1]
		The cell with **calcium anode will transfer more electrons**	[1]
	(e)	After Bonding 	[2]
		[Total: 10 marks]	