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Candidate Name: _____	Class	Index No.



FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2017

4E

[illegible]

CHEMISTRY

5073/01

Paper 1 Multiple Choice

28 August 2017

0750 - 0850

1 hour

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Write your name and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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 Answer Sheet provided.

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 14.

The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE	FOR EXAMINER'S USE
	/40

Setter: Mdm Hia Soo Ching

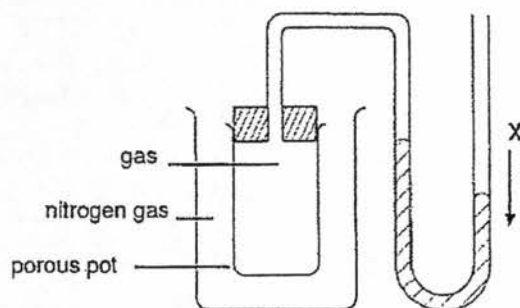
Vetter: Mr Elton Tan

This question paper consists of 14 printed pages including this page.

Multiple Choice Questions [40 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

- 1 The following apparatus can be used to show the diffusion of gases.



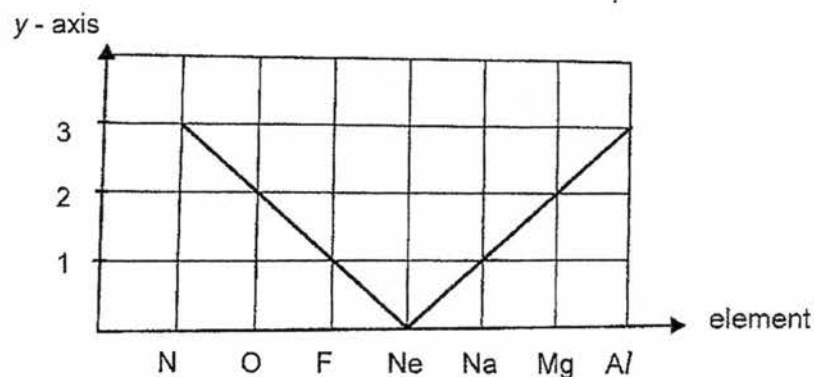
Which of the following gases will cause the liquid level in column X to fall as shown above?

- A ammonia
 - B chlorine
 - C hydrogen chloride
 - D sulfur dioxide
- 2 Some information on three solids is given below.

solid	solubility in water	solubility in ethanol	action of heat
X	soluble	insoluble	no effect
Y	insoluble	soluble	no effect
Z	soluble	soluble	sublimes

Which of the following procedures could be carried out to obtain a pure sample of Z from a mixture of the three solids?

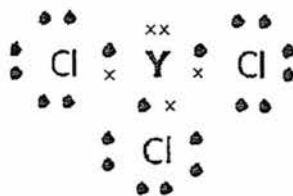
- A Add ethanol to the mixture, filter and collect the residue.
 - B Add water to the mixture and filter to collect the residue.
 - C Add ethanol to the mixture, filter and evaporate the filtrate.
 - D Heat the mixture and condense the gases.
- 3 The graph below shows information of seven elements in the Periodic Table.



What could the y-axis represent?

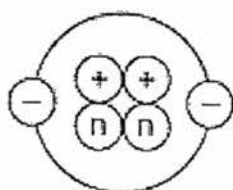
- A atomic number
- B number of electron shells
- C number of valence electrons
- D valency of element

- 4 The electronic structure of a compound formed between an element Y and chlorine is shown below (only valence electrons are shown).



What is the chemical formula when sodium combines with element Y?

- A Na_2Y
 B NaY_2
 C Na_3Y
 D Na_5Y
- 5 An element Z has the electronic structure 2,4.
 Z combines with chlorine to form a compound that is most likely a
- A good conductor of electricity in liquid.
 B liquid with a simple molecular structure.
 C solid that dissolves in water.
 D solid with a giant ionic crystal lattice structure.
- 6 The diagram shows the structure of an atom.

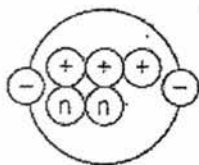


key

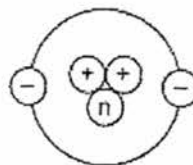
- $\oplus$ = proton
 n = neutron
 $\ominus$ = electron

Which diagram shows the structure of an isotope of this atom?

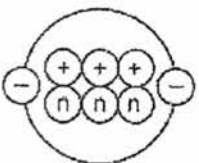
A



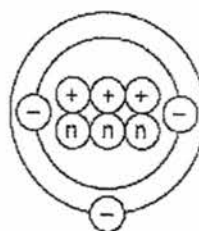
B



C



D



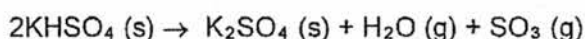
- 7 Which substance has metallic bonding?

substance	electrical conductivity		nature of product formed by reaction between substance and oxygen
	when solid	when liquid	
A	x	✓	no reaction
B	x	x	reacts with alkali
C	✓	✓	reacts with both alkali and acid
D	✓	✓	does not react with alkali nor acid

- 8 The compound S_2O_7 reacts with water to produce sulfuric acid and oxygen only. What volume of oxygen, measured at room temperature and pressure, is evolved when 0.704 g of S_2O_7 is reacted?

A 48 cm³ B 96 cm³ C 192 cm³ D 384 cm³

- 9 When solid potassium hydrogen sulfate ($KHSO_4$) is heated strongly, the following reaction occurs:



What is the loss in mass when 20.4 g of solid potassium hydrogen sulfate is heated?

A 1.35 g B 6.00 g C 7.35 g D 13.10 g

- 10 Farmers and gardeners often treat soil with ammonium sulfate to increase the nitrogen content in soil. Calcium hydroxide is also often added to soil. Given that a farmer added both chemicals to soil together, which of the statements below is true?

- A Ammonium sulfate increases the pH of soil.
- B The calcium hydroxide decreases the pH of the soil.
- C Sulfur dioxide is produced in the reaction between ammonium sulfate and calcium hydroxide.
- D Ammonium sulfate can react with calcium hydroxide and the nitrogen content of soil does not improve.

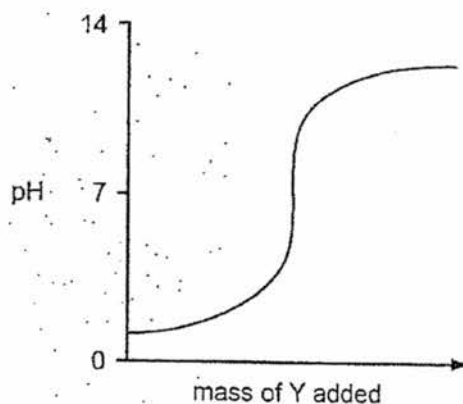
- 11 The following are some statements on hydroxide, OH^- ions.

- It reacts with hydrogen ions to form water.
- It reacts with aqueous iron(III) sulfate to form a green precipitate.
- It migrates to the cathode in electrolysis of an aqueous solution.
- Its solution gives an alkaline gas when warmed with aqueous ammonium chloride.

How many statements are correct?

A 1 B 2 C 3 D 4

- 12 Solid Y was added bit by bit with stirring to an aqueous solution of Z. The changes in pH of the mixture are shown in the graph.



Identify Y and Z.

	Y	Z
A	soluble metal oxide	hydrochloric acid
B	soluble metal oxide	sodium hydroxide
C	insoluble metal oxide	nitric acid
D	insoluble metal oxide	aqueous ammonia

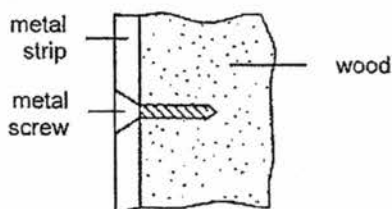
- 13 What will be the best method for making a sample of lead(II) chloride?
- A Add lead(II) sulfate to dilute hydrochloric acid, and filter.
 B Add dilute hydrochloric acid to aqueous lead(II) nitrate, and filter.
 C Heat powdered lead with aqueous sodium chloride, cool, and filter.
 D Pass hot chlorine gas over a heated lump of lead, and cool.
- 14 The table shows the results of tests carried out to examine the air in an industrial area.

tests carried out with	observations
aqueous calcium hydroxide	white precipitate formed
anhydrous copper(II) sulfate	white solid turned blue
acidified potassium manganate(VII)	purple solution decolourised

Which of the following sets of gases was present in the sample of air?

- A CO_2 , H_2O , SO_2
 B CO_2 , H_2O , NO_2
 C CO_2 , H_2 , SO_2
 D CO_2 , H_2 , NO_2
- 15 Which of the following reactions is neither a reduction nor oxidation reaction?
- A Aqueous silver nitrate is added to hydrochloric acid.
 B Discharge of hydrogen ions at the cathode.
 C Silver chloride is exposed to light.
 D Wine turns sour.

- 16 Alloys are usually harder than the metals from which they are made.
Which difference between the metals explains the greater hardness of alloys?
- A densities
B atomic radii
C electrical conductivities
D relative atomic masses
- 17 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.
After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.

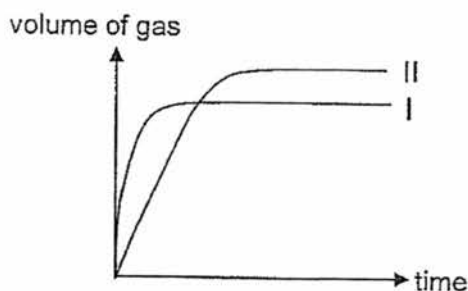


Which two metals would give this result?

	screw	strip
A	copper	steel
B	copper	zinc
C	steel	copper
D	steel	magnesium

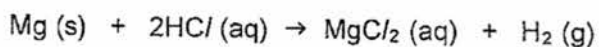
- 18 When zinc foil is placed in an aqueous solution containing both magnesium chloride and copper(II) sulfate, which element is displaced?
- A chlorine
B copper
C hydrogen
D magnesium
- 19 Chlorine and iodine are both in Group VII of the Periodic Table.
Which statement about these elements is correct?
- A Chlorine is less reactive than iodine.
B Chlorine has a lower melting point than iodine.
C Chlorine and iodine are diatomic gases at room temperature.
D Iodine will react with a solution of sodium chloride.
- 20 Which statement about alkali metals is true?
- A They form metal oxides with water.
B They form covalent bonds with halogens.
C Their reducing powers increase down the group.
D Their melting and boiling points increase down the group.

- 21 In the graph, curve I represents the result of a reaction between 1.0 g of calcium granules and excess water at 25 °C.



Which alteration to the conditions would produce curve II?

- A 1.0 g of calcium powder with excess water at 25 °C.
 - B 1.0 g of calcium powder with excess water at 50 °C.
 - C 1.15 g of calcium granules with excess water at 15 °C.
 - D 1.15 g of calcium granules with excess water at 50 °C.
- 22 Excess magnesium was reacted with dilute hydrochloric acid at room temperature.

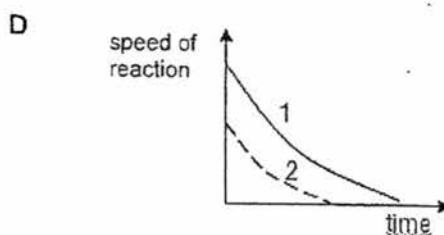
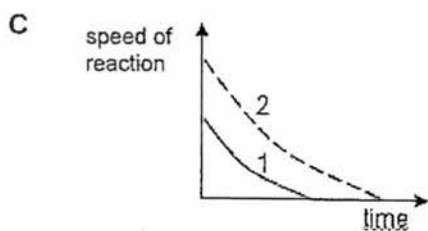
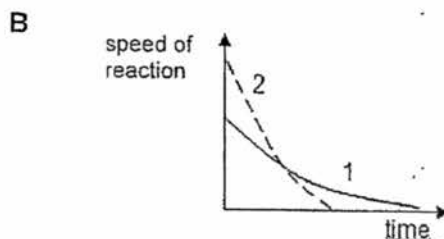
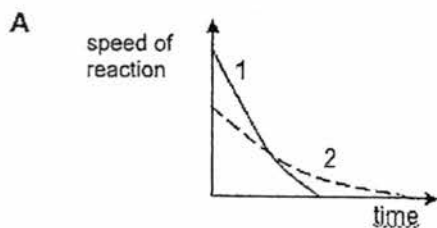


Two experiments were carried out.

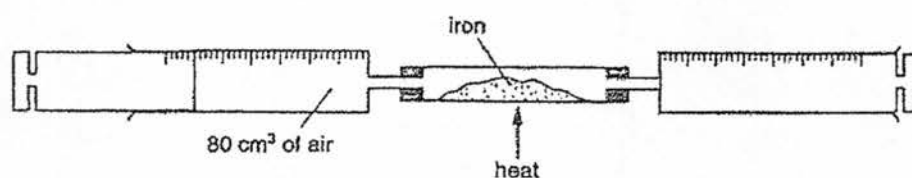
Experiment 1: 40 cm³ of 1 mol/dm³ hydrochloric acid

Experiment 2: 15 cm³ of 2 mol/dm³ hydrochloric acid

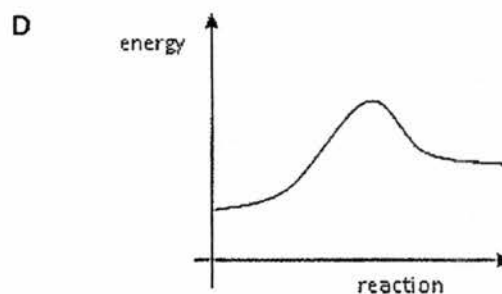
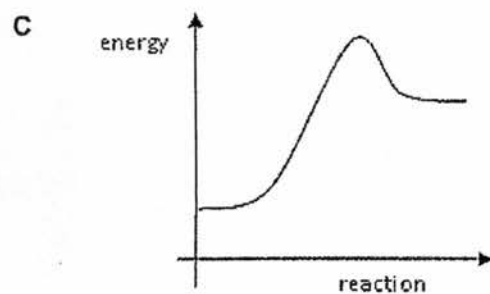
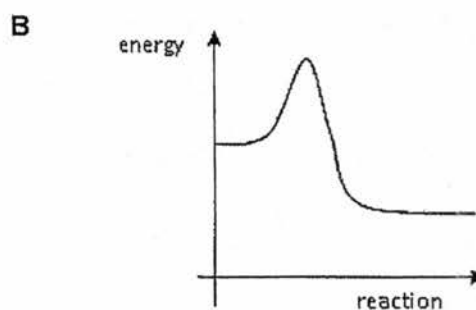
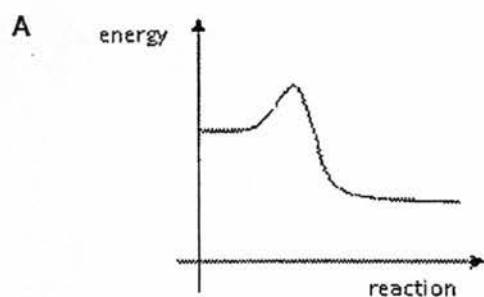
Which graph shows how the speed of reaction varied with time in each experiment?



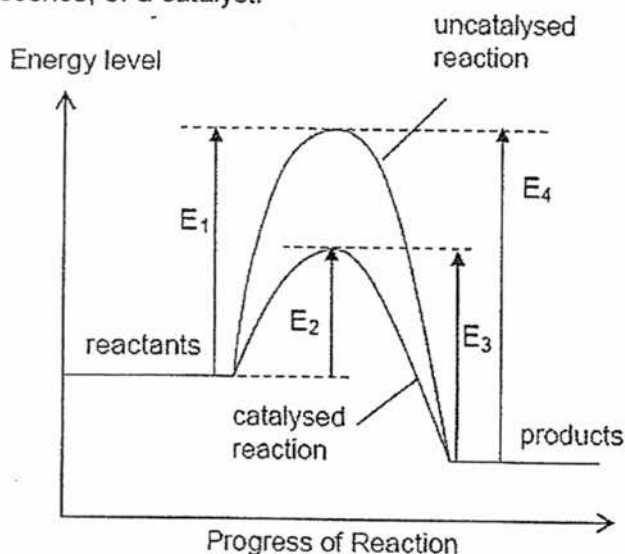
- 23 An 80 cm^3 sample of air is trapped in a syringe. The air is slowly passed over heated iron in a tube until there is no further decrease in volume. When cooled to the original temperature, which volume of gas remains?



- A 16 cm^3
 B 24 cm^3
 C 63 cm^3
 D 80 cm^3
- 24 Four different chemical reactions are represented in the following energy profile diagrams. Which diagram shows the slowest endothermic reaction?

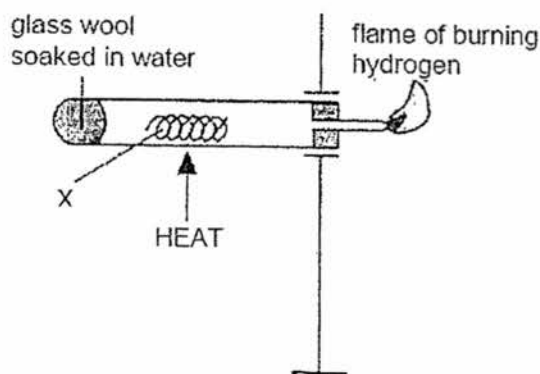


- 25 The energy profile diagram shows the same reaction that occurred in the absence, and in the presence, of a catalyst.



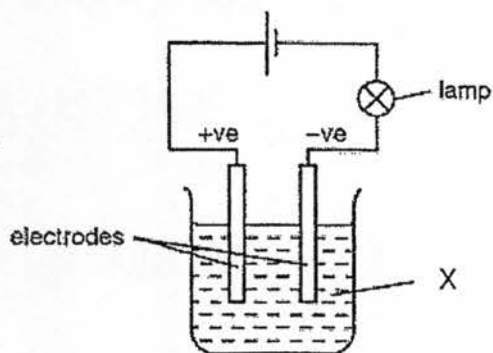
Which of the following statements is correct when describing the energy changes involved in the reaction?

- A The forward catalysed reaction is endothermic.
 - B $(E_4 - E_1)$ is the enthalpy change of the reverse reaction.
 - C E_2 is the activation energy for the reverse catalysed reaction.
 - D The enthalpy change of the reaction is decreased by using a catalyst.
- 26 Based on the setup as shown in the diagram below, what is substance X most likely to be?



- A X is a metal below hydrogen in the reactivity series.
- B X is a metal above hydrogen in the reactivity series.
- C X is an oxide of a metal that is below hydrogen in the reactivity series.
- D X is an oxide of a metal that is above hydrogen in the reactivity series.

- 27 When the circuit in the set-up below is closed, the bulb is lighted up, but X is not decomposed.

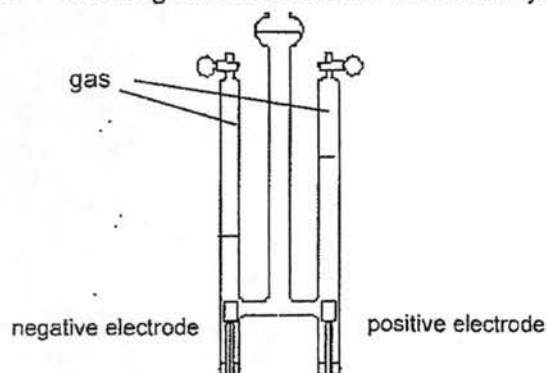


X is likely to be

- A mercury
 - B lead(II) iodide
 - C aqueous silver nitrate
 - D concentrated potassium nitrate solution
- 28 An article to be gold plated is made the cathode (negative electrode) of a cell. What would be suitable materials for the anode and the electrolyte?

	anode	electrolyte
A	carbon	aqueous gold(II) chloride
B	carbon	dilute hydrochloric acid
C	gold	aqueous gold(II) chloride
D	gold	dilute hydrochloric acid

- 29 The diagram below shows the electrolysis of a substance after a few hours.



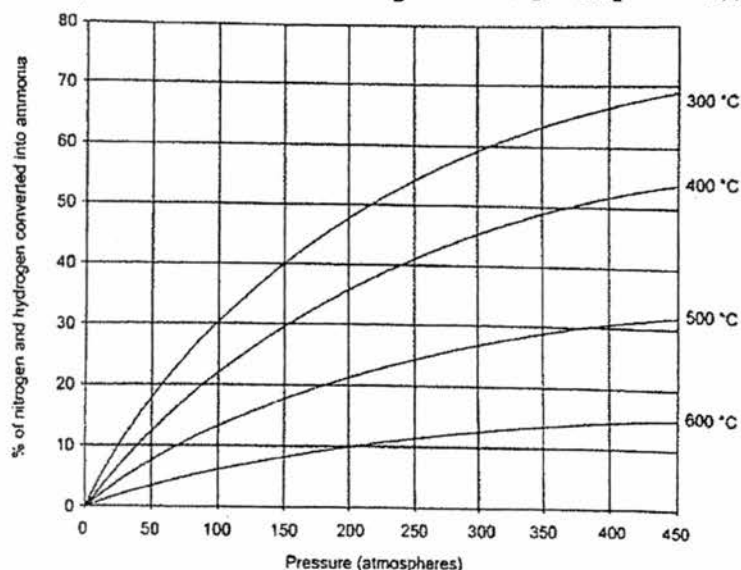
The substance is

- A copper(II) sulfate solution
- B concentrated hydrochloric acid
- C silver nitrate solution
- D sodium chloride solution

- 30 Which one of the following chemical equations shows the removal of one or more exhaust gases in a catalytic converter?
- A $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$
 B $2\text{CO} + \text{SO}_2 \rightarrow 2\text{CO}_2 + \text{S}$
 C $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$
 D $\text{N}_2 + 2\text{O}_2 \rightarrow 2\text{NO}_2$
- 31 In an experiment, 2 moles of aluminium ions, Al^{3+} were discharged in the electrolysis of molten aluminium oxide.
 Which amount of metal ions would be discharged by an equal amount of electricity in the following experiments?
- A 2 mol of Cu^{2+} , in the electrolysis of aqueous copper(II) nitrate
 B 3 mol of Pb^{2+} , in the electrolysis of molten lead(II) bromide
 C 3 mol of Ag^+ , in the electrolysis of aqueous silver nitrate
 D 6 mol of Zn^{2+} , in the electrolysis of aqueous zinc sulfate

- 32 The graph below gives the percentage conversion of nitrogen and hydrogen under different conditions.

The equation for the reaction is given as: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ $\Delta H = -92\text{kJ}$



Which of the following statements is correct?

- A The yield of ammonia increases with increasing pressure.
 B Finely divided nickel is used to catalyse the reaction.
 C The yield of ammonia increases with increasing temperature.
 D The forward reaction for production of ammonia is an endothermic process.
- 33 Two compounds are thought to be isomers.
 Possible similarities and differences are listed below. Which combination would confirm isomerism?

	similarity	difference
A	molecular mass	molecular structure
B	molecular structure	molecular mass
C	chemical properties	physical properties
D	physical properties	chemical properties

- 34 The following data gives the concentration in parts per billion parts of air, in four industrialised cities.

In which city would limestone buildings be under the greatest threat from pollution?

city	carbon monoxide	nitrogen dioxides	ozone
A	0.01	45	21
B	0.03	17	23
C	0.20	38	11
D	3.00	32	30

- 35 5 g of vegetable oil ($M_r = 800$) reacted completely with 900 cm^3 of hydrogen gas (measured at room temperature and pressure) to form margarine which is a saturated fat. How many C=C bonds are there in one molecule of the oil?

A 3 B 4 C 5 D 6

- 36 An alcohol, X, was fully oxidised to a carboxylic acid. Neutralisation of the acid with aluminium oxide gives a salt with the formula $(\text{CH}_3\text{CO}_2)_3\text{Al}$.

What was alcohol X?

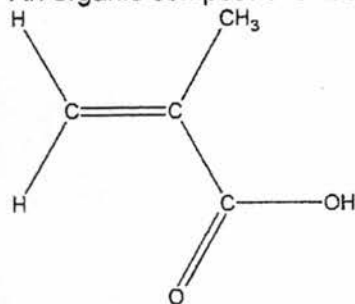
- A CH_3OH
 B $\text{CH}_3\text{CH}_2\text{OH}$
 C $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

- 37 Ethanol can be manufactured from carbohydrates as well as ethene. The table gives statements about the processes involved.

In which row are both statements **incorrect**?

	process using carbohydrates	process using ethene
A	conversion to ethanol gives a low yield	conversion to ethanol gives a high yield
B	conversion to ethanol uses yeast as a catalyst	conversion to ethanol carried out at less than 100 atm.
C	conversion carried out with the reactants in gaseous state	conversion carried out in aqueous state
D	conversion to ethanol carried out at less than 100 atm.	ethene obtained from fractional distillation of hydrocarbons

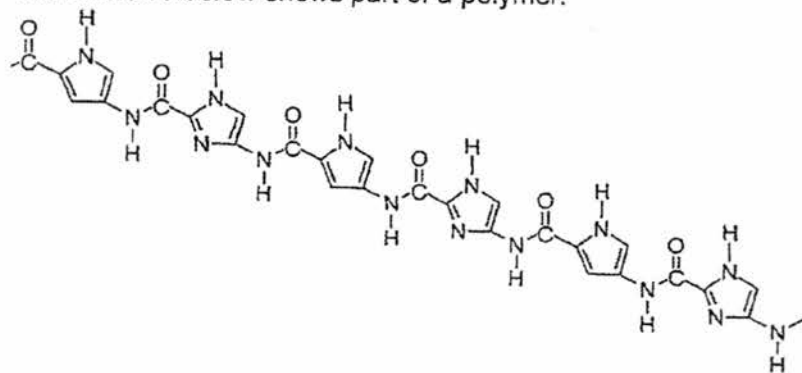
- 38 An organic compound E has the following structural formula:



Which of the following statements about compound E is true?

- A Compound E cannot be polymerised.
 B No change in the colour of aqueous bromine when it is added to compound E.
 C An aqueous solution of compound E reacts with copper to give hydrogen gas.
 D Compound E reacts with ethanol to give a compound with relative molecular mass of 114.

- 39 The structure below shows part of a polymer.



- It is a polyamide.
- It is formed in an addition polymerisation reaction.
- The partial structure is that of nylon.
- It is formed from two different types of monomers.
- Each monomer has two different functional groups.

How many statements are correct?

- A 2 B 3 C 4 D 5
- 40 The following reactions are carried out.

reaction	result
ethanoic acid is added to magnesium	gas X given off
ammonium ethanoate is warmed with aqueous sodium hydroxide	salt Y formed
ethanoic acid is added to aqueous ammonia	salt Z formed

What are X, Y and Z?

	X	Y	Z
A	ammonia	ammonium hydroxide	water
B	ammonia	sodium ethanoate	ammonium ethanoate
C	hydrogen	ammonium hydroxide	water
D	hydrogen	sodium ethanoate	ammonium ethanoate

*****End of Paper*****

The Periodic Table of Elements

Group																	
I	II													III			
3 7 Li Lithium	4 9 Be Beryllium	1 H Hydrogen												5 11 B Boron	13 27 Al Aluminum	31 70 Ga Gallium	49 115 In Indium
11 23 Na Sodium	12 24 Mg Magnesium													19 39 K Potassium	20 40 Ca Calcium	30 64 Zn Zinc	48 112 Cd Cadmium
37 85 Rb Rubidium	38 86 Sr Strontium	45 89 Y Yttrium	46 91 Zr Zirconium	47 93 Nb Niobium	48 95 Mo Molybdenum	49 101 Ru Ruthenium	50 103 Rh Rhodium	51 106 Pd Palladium	52 108 Ag Silver	53 110 Cu Copper	54 112 Zn Zinc	55 114 Sn Tin	56 116 Pb Lead	57 137 La Lanthanum	58 139 Ce Cerium	59 141 Pr Praseodymium	60 143 Nd Neodymium
55 133 Cs Cesium	56 137 Ba Barium	57 138 La Lanthanum	58 140 Ce Cerium	59 142 Pr Praseodymium	60 144 Nd Neodymium	61 146 Pm Promethium	62 150 Sm Samarium	63 152 Eu Europium	64 154 Gd Gadolinium	65 156 Tb Terbium	66 158 Dy Dysprosium	67 160 Ho Holmium	68 162 Er Erbium	69 164 Tm Thulium	70 166 Yb Ytterbium	71 168 Lu Lutetium	72 170 Hf Hafnium
87 223 Fr Francium	88 226 Ra Radium	89 227 Ac Actinium	90 232 Th Thorium	91 231 Pa Protactinium	92 238 U Uranium	93 237 Np Neptunium	94 244 Pu Plutonium	95 243 Am Americium	96 247 Cm Curium	97 247 Bk Berkelium	98 251 Cf Californium	99 252 Es Einsteinium	100 253 Fm Fermium	101 254 Md Mendelevium	102 255 No Nobelium	103 256 Lr Lawrencium	104 257 Rf Rutherfordium

* 58-71 Lanthanoid series
† 90-103 Actinoid series

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

Key

The volume of one mole of any gas is 24dm³ at room temperature and pressure

Candidate Name: _____ Class _____ Index No. _____



FUHUA SECONDARY SCHOOL

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Preliminary Examinations 2017

4E

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CHEMISTRY

5073/02

Paper 2

18 August 2017

1045 – 1230

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

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

Section A (50 marks)

Answer **all** questions.

Write your answers in the spaces provided.

Section B (30 marks)

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

Write your answers in the spaces provided.

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

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

The use of an approved scientific calculator is expected, where appropriate.

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	Total
/50	/30	/80

Setter: Mdm Hia Soo Ching

Vetter: Mr Elton Tan

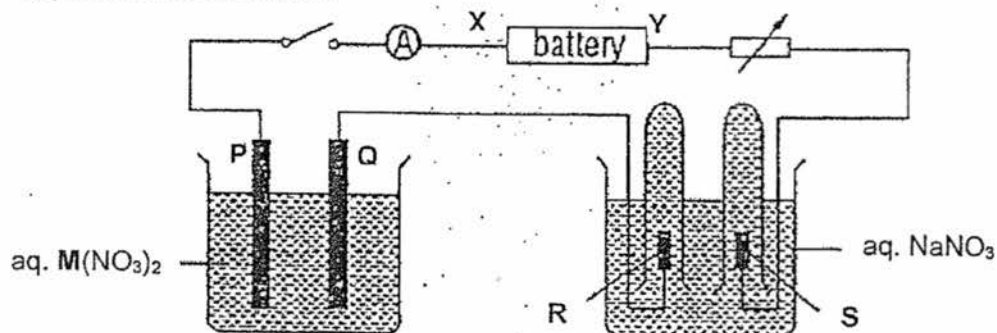
This question paper consists of 19 printed pages including this page.

- A2 The following experiment was set up for the electrolysis of aqueous $M(NO_3)_2$ and aqueous sodium nitrate. Electrode Q is made up of metal M.

Electrodes P, R and S are made of platinum.

X and Y are terminals of the battery.

When the switch was closed, metal M began to deposit at electrode P, and gas bubbles appeared above R and S.



- (a) Deduce the polarity (positive or negative) of the terminals X and Y of the battery.

X: _____

Y: _____ [1]

- (b) Write an ionic equation for the reaction occurring at electrode P. Include state symbols.

_____ [1]

- (c) After the electrolysis has been carried out for 30 minutes, 200 cm^3 of gas, measured at room temperature and pressure, was collected in the test tube at electrode R.

- (i) Name the gas collected in the test tube at electrode R.

_____ [1]

- (ii) Estimate the volume of gas collected in the test tube at electrode S.

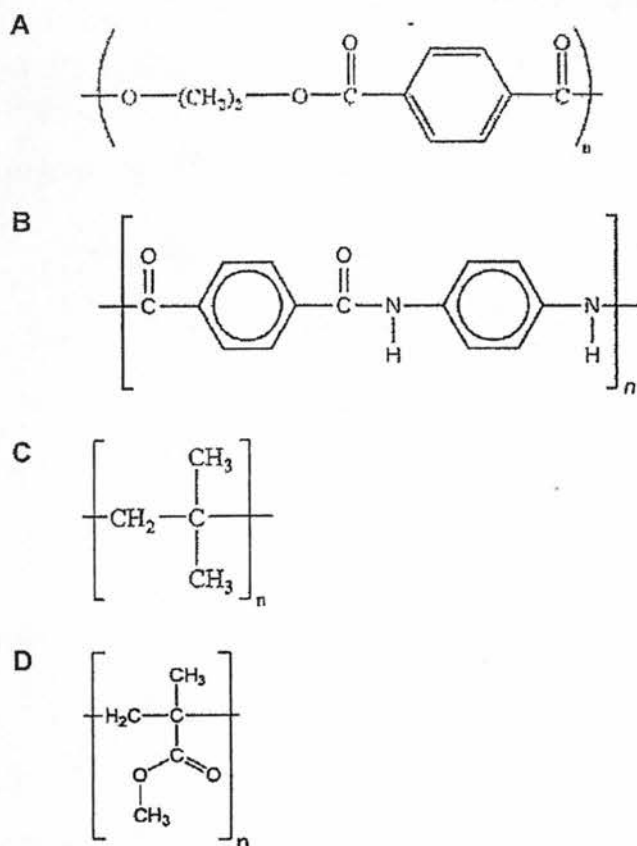
_____ [1]

- (iii) If the relative atomic mass of metal M is 64, calculate the gain in mass of electrode P.

[3]

[Total: 7]

A3 The diagram below shows the structure of some polymers A, B, C and D.



- (a) A sample of **C** contain molecules with an average relative molecular mass of 14 000. How many carbon atoms are there in an average molecule of the polymer?

[1]

- (b) Which of the statements would you predict to be true and which to be false?
Put a tick (✓) in one box in each row.

	true	false
D is a polyester.		
Water is formed as a by-product when monomers react to form A and B .		
The empirical formula of C is the same as its monomer.		
One of the monomers that react to form B is an alcohol.		

[2]

- (c) Draw the displayed formulae of the monomers that react to form **A**.

[2]

- (d) (i) Draw the structural formula of the monomer that react to form D.

[1]

- (ii) The monomer in (d)(i) can be formed by reacting an acid and an alcohol under suitable conditions.
Draw the structural formulae of the acid and alcohol.

[2]

- (iii) State the conditions required for the reaction in (d)(ii).

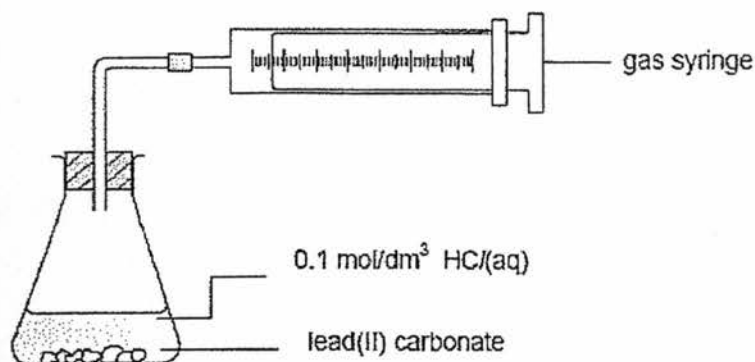
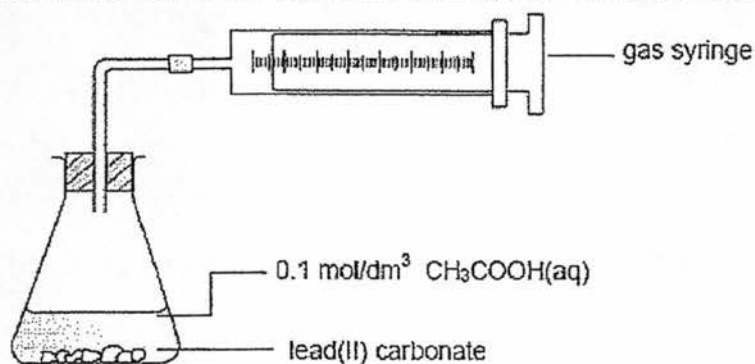
[1]

- (e) A, B, C and D are non-biodegradable.
Explain why being non-biodegradable is both an advantage and a disadvantage.

[2]

[Total: 11]

- A4 A student conducted an experiment using hydrochloric acid and ethanoic acid to prepare two different salts. The experimental setup used is shown below.



- (a) Hydrochloric acid is a strong acid, ethanoic acid is a weak acid.
Describe a **simple** test to show which is the strong acid and which is the weak acid.

[2]

- (b) State the chemical formulae of the **two** salts formed from the above experiment

[2]

- (c) The student recorded down the following observations.

"Slower effervescence is observed with ethanoic acid at the beginning of the experiment but the gas syringe is pushed further away from its initial position at the end of the experiment."

Explain the above observations made.

[4]

- (d) An exothermic change occurred in both reactions mentioned above.
Define *exothermic change*.

[1]

[Total: 9]

- A5 Copper can be extracted by two different extraction processes involving low grade ore, chalcopyrite, CuFeS_2 . The ore is first crushed in huge cylindrical ball mills.

The following show information about these processes.

process	roasting & smelting	leaching
main process	The concentrated ore is then heated in the furnace to about 700°C in the presence of oxygen according to the following equation: $2\text{CuFeS}_2(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{FeO}(\text{s}) + 2\text{CuS}(\text{s}) + 2\text{SO}_2(\text{g})$ The iron(II) oxide impurities are then removed by heating to over 1200°C silica.	The ore is treated with dilute sulfuric acid and converts insoluble chalcopyrite into a solution containing Cu^{2+}, Fe^{2+}, Fe^{3+} and SO_4^{2-} ions.
conversion	Copper(II) sulfide is reduced to copper by further heating with oxygen.	Copper can also be extracted from solutions of copper(II) salts using scrap iron.

- (a) Suggest **two** environmental reasons and why the extraction of copper by leaching is preferable to the roasting and smelting process.

[2]

- (b) The leaching process uses lesser energy than the roasting and smelting process. Use the information in the table to explain why.

[2]

- (c) (i) Give the ionic equation for the reaction involved in the recovery of solid copper from an aqueous solution using scrap iron.

[1]

- (ii) Can zinc or magnesium be used in place of iron?
Explain why.

[2]

- (d) The copper obtained from these two processes is only 95% pure. This impure copper has to be further refined by electrolysis to obtain copper of 99% purity for use in electrical wiring.

Draw and label an electrolytic cell diagram to demonstrate the electrolytic refining of copper.

[2]

[Total: 9]

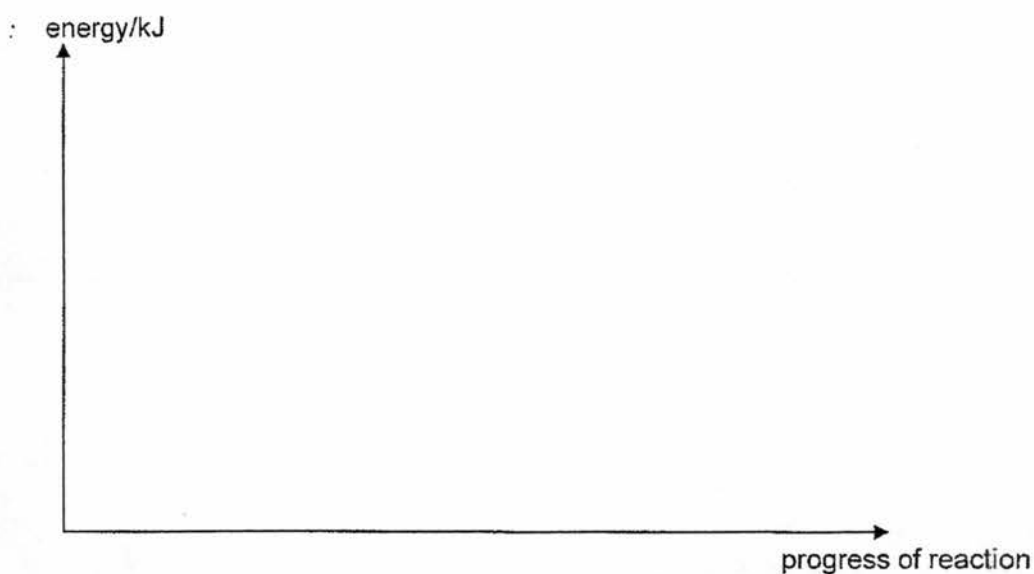
- A6 When zinc is added to a solution of copper(II) sulfate, a displacement reaction takes place. The equation for this reaction is given below:



- (a) Complete the energy profile diagram.

Your diagram should include

- formulae of reactants and products
- enthalpy change of reaction
- activation energy



[2]

- (b) In an experiment, 20 cm^3 of copper(II) sulfate solution is reacted with excess zinc powder. The amount of heat evolved is found to be 1.76 kJ .

Calculate the concentration, in mol/dm^3 , of the copper(II) sulfate solution used.

[2]

[Total: 4]

A7 Some physical properties of chlorides of carbon and lead are shown in the table below.

chloride	melting point/ $^{\circ}\text{C}$	electrical conductivity
tetrachloromethane, CCl_4	-23	does not conduct in any state
lead(II) chloride, PbCl_2	498	good conductor in molten state but non-conductor in aqueous solution

- (a) Draw a 'dot and cross' diagram to show the bonding in tetrachloromethane. Show outer electrons only.

[1]

- (b) Explain why tetrachloromethane and lead(II) chloride have different properties.

[4]

[Total: 5]

Section B: Free Response Questions [30 marks]

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

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

B8 Read the information about the oxides of elements in Period 3 of the Periodic Table.

The formulae and the chemical properties of the oxides and chlorides of the elements change across Period 3.

element	metal/non-metal	formula of main oxide	bonding in oxide	formula in chloride	bonding in chloride
Na	metal	Na ₂ O	ionic	NaCl	ionic
Mg	metal	MgO	ionic	MgCl ₂	ionic
Al	metal	Al ₂ O ₃	ionic	AlCl ₃	covalent
Si	non-metal	SiO ₂	covalent	SiCl ₄	covalent
P	non-metal	P ₄ O ₁₀	covalent	PCl ₃	covalent
S	non-metal	SO ₃	covalent	S ₂ Cl ₂	covalent
Cl	non-metal	Cl ₂ O ₇	covalent	Cl ₂	covalent

Electronegativity refers to the tendency of an atom to attract electrons to itself. Metals tend to have low electronegativities while non-metals have high electronegativities. The electronegativity values of Period 3 elements are shown in the table below.

element	electronegativity of each element
Na	0.9
Mg	1.2
Al	1.6
Si	1.8
P	2.1
S	2.5
Cl	3.0

Oxygen has electronegativity of 3.5.

The difference in the electronegativities between each element and oxygen can be calculated. Some examples are shown the table below.

formula of oxides	difference in electronegativities between each element and oxygen
Na ₂ O	2.6
MgO	2.3
Al ₂ O ₃	2.1

- (a) Describe the pattern for the difference in electronegativities between each element and oxygen across Period 3.

[2]

- (b) With reference to atomic structure, give reason(s) why the electronegativity of oxygen is higher than that of any element in Period 3.

[2]

- (c) A student wrote the following conclusion by studying the results.

"The bonds in the oxides and chlorides are covalent when the difference in electronegativities is less than 2.0."

Do you agree with this conclusion?
Use the results to explain your reasoning.

[4]

- (d) The electronegativity of beryllium is 1.57. Predict the bonding in beryllium chloride and beryllium oxide.
Explain your answer.

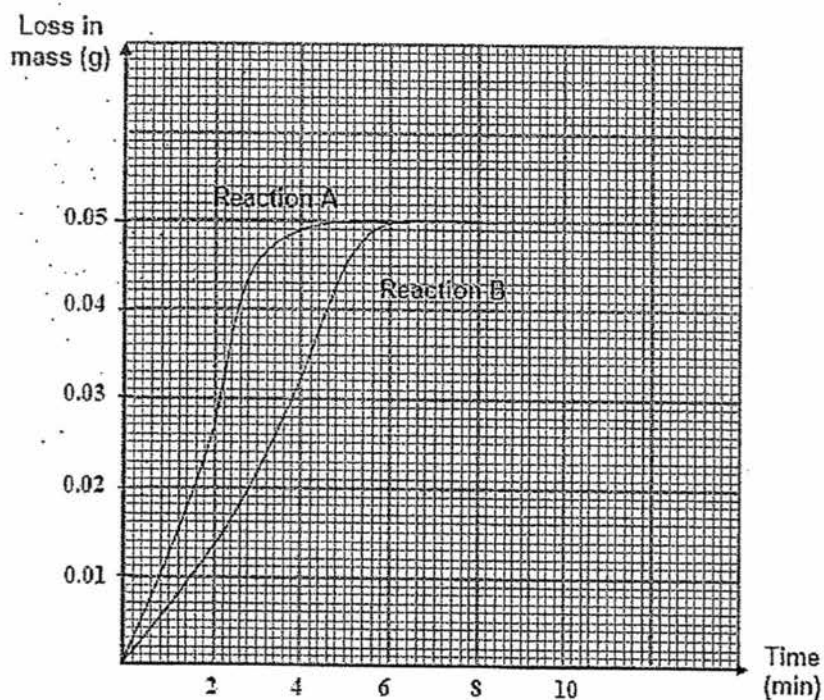
[2]

- (e) Suggest, with reason(s), an electronegative value for argon.

[2]

[Total:12]

- B9 The graphs below show the reaction of zinc with dilute nitric acid in two different reactions. The beaker and its contents were weighed every two minutes and the loss in mass was recorded.



- (a) (i) In Reaction A, 1.625 g of large lumps of zinc was added to 250 cm³ of dilute nitric acid of 0.500 mol/dm³ in a beaker. Explain the cause of the loss in mass.

[1]

- (ii) Determine the limiting reactant. Show your working clearly.

[2]

- (b) In Reaction B, the reaction was repeated using 1.625 g of large lumps of zinc added to 250 cm³ of dilute nitric acid of 0.500 mol/dm³ in a beaker at a lower temperature.
All other conditions of the reaction remained the same.

Explain the difference in initial speed of reaction for reaction B.

[2]

- (c) A third reaction, Reaction C, is repeated with the addition of 50 cm³ of aqueous copper(II) sulfate.

Two students predict the results of this experiment.

Student 1: 'The initial rate of reaction is **slower** as the aqueous copper(II) sulfate is an impurity.'

Student 2: 'The loss in mass is **lesser** as the aqueous copper(II) sulfate reacts with one of the reactants.'

Do you agree with the students?

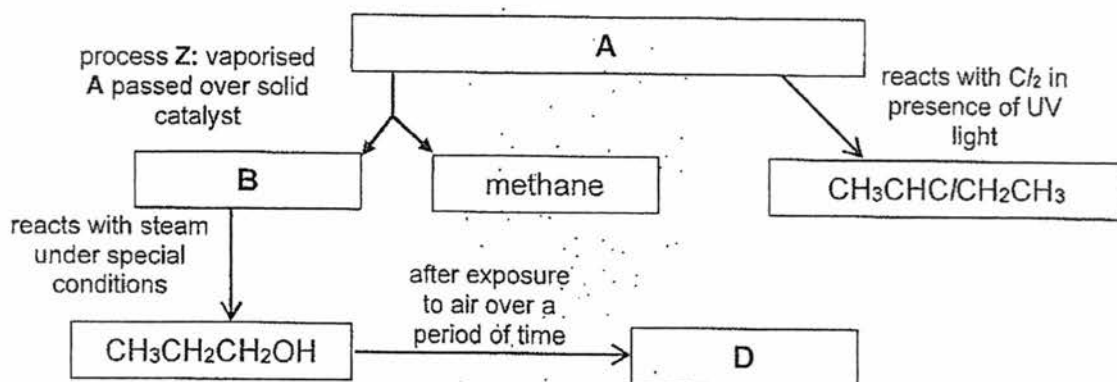
Explain your reasoning.

[3]

[Total: 8]

B10 Either

The reaction scheme of organic compound **A** is shown below.



- (a) (i) Name the process **Z** and state the solid catalyst used.

_____ [2]

- (ii) Describe a test to differentiate compound **A** from **B**.

 _____ [2]

- (iii) Construct a balanced chemical equation for process **Z**.

_____ [1]

- (b) Describe a test to prove that $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ has been completely converted to **D**.

 _____ [2]

- (c) (i) Molecules of **B** can undergo addition polymerisation to form a polymer with a relative molecular mass of 33600. How many monomers of **B** are required to form this polymer?

[1]

- (ii) With reference to their structures, state one similarity and one difference between monomer B and its polymer,

[2]

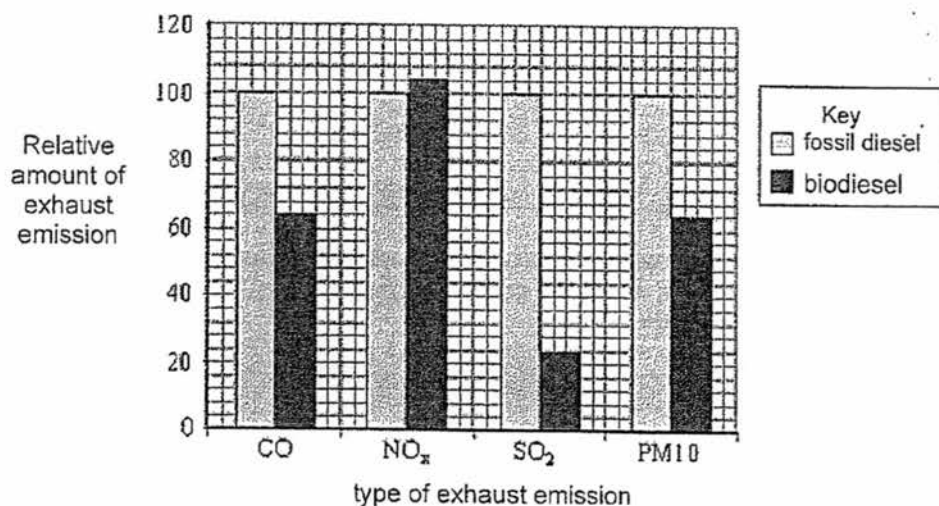
[Total: 10]

B10 OR

Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.

Tiny particles of solids are produced when the fuel does not burn completely. This increases the level of particulates (PM10) in the atmosphere. These particles are small enough to pass through the throat and nose and enter the lungs.

One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels. Some of the relative amounts of these exhaust emissions are shown in the bar chart.



- (a) (i) Using the data given, compare the exhaust emission between fossil diesel and biodiesel.

[2]

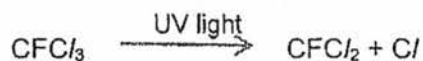
- (ii) Exhaust emissions from fossil diesel cause more harm to human health than those from biodiesel. Explain why.

[2]

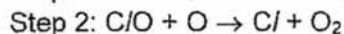
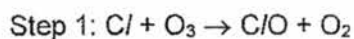
- (b) Some scientists suggest that biodiesel is **carbon neutral**. Explain why.

[2]

- (c) Refrigerants are substances used to cool refrigerators and freezers. Until recently, many of the compounds used as refrigerants were chlorofluorocarbons (CFCs), but these are now known to form chlorine radicals. One such compound is CFCI_3 .



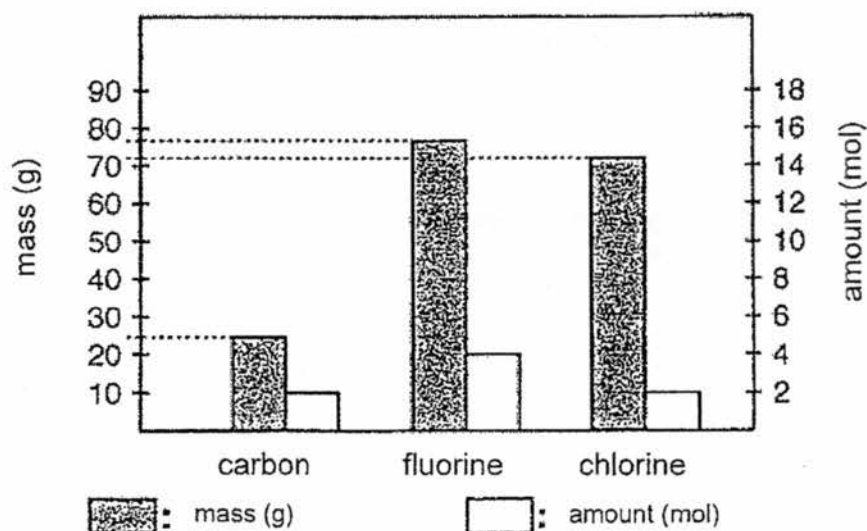
The $\text{Cl}\cdot$ atom reacts with ozone in a two-step reaction.



- (i) One molecule of CFCI_3 can destroy thousands of ozone molecules. Explain why.

[2]

- (ii) The graph below shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a certain compound of CFCs found in the aerosol can of hairspray.



Using the above information, determine the molecular formula of this CFCs compound.

[2]

[Total: 10]

*****End of Paper*****

The Periodic Table of Elements

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66 Dy Dysprosium 66				67 Ho Holmium 67 68 Er Erbium 68				69 Tm Thulium 69 70 Yb Ytterbium 70				71 Lu Lutetium 71 72 Hf Hafnium 72				73 Ta Tantalum 73 74 W Tungsten 74				75 Re Rhenium 75 76 Os Osmium 76				77 Ir Iridium 77 78 Pt Platinum 78				79 Au Gold 79 80 Hg Mercury 80				81 Tl Thallium 81 82 Pb Lead 82				83 Bi Bismuth 83 84 Po Polonium 84				85 At Astatine 85 86 Rn Radon 86				87 Fr Francium 87 88 Ra Radium 88				89 Ac Actinium 89 90 Th Thorium 90				91 Pa Protactinium 91 92 U Uranium 92				93 Np Neptunium 93 94 Pu Plutonium 94				95 Am Americium 95 96 Cm Curium 96				97 Bk Berkelium 97 98 Cf Californium 98				99 Es Einsteinium 99 100 Fm Fermium 100				101 Mn Mendelevium 101 102 Nr Nobelium 102				103 Lr Lutetium 103 104 Uu Ununquadium 104				105 Uub Ununbium 105 106 Uuh Ununhexium 106				107 Uus Ununseptium 107 108 Uuo Ununoctium 108				109 Uuh Ununhennium 109 110 Uuo Ununnilium 110				111 Uuh Ununhennium 111 112 Uuo Ununnilium 112				113 Uuh Ununhennium 113 114 Uuo 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Ununnilium 274				275 Uuh Ununhennium 275 276 Uuo Ununnilium 276			

* 58-71 Lanthanoid series
† 90-103 Actinoid series

Key

a	X
b	

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

The volume of one mole of any gas is 24dm³ at room temperature and pressure (r.t.p.)

Paper 1 (Multiple choice questions)

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

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

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

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

Paper 2 (Structured and Free Response)

- A1**
- (a) B [1]
 - (b) J [1]
 - (c) K [1]
 - (d) D [1]
 - (e) HJ_3 [1]
- A2**
- (a) X: negative Y: positive [1]
 - (b) $\text{M}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{M}(\text{s})$ [1]
 - (c) (i) hydrogen [1]
 - (ii) 100 cm^3 [1]
 - (iii) $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$ [3]
 - No. of moles of hydrogen gas = $200/24000 = 0.0083333$ [1]
 - No. of moles of electrons = 0.01667 [1]
 - No. of moles of M = $0.01667 / 2 = 0.0083333$
 - Mass of M = $0.0083333 \times 64 = 0.533 \text{ g}$ [1]

A3 (a) 1000 [1]

[1]

(b)

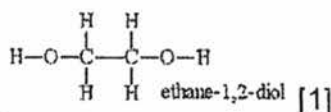
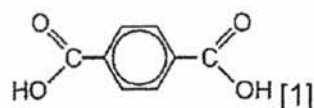
	true	false
D is a polyester..		✓
Water is formed as a by-product when monomers react to form A and B.	✓	
The empirical formula of C is the same as its monomer.	✓	
One of the monomers that react to form B is an alcohol.		✓

4 ✓ : [2]

1-3 ✓ : [1]

[2]

(c)

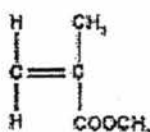


ethane-1,2-diol [1]

[2]

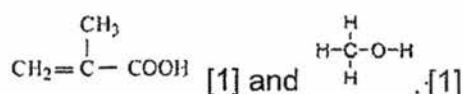
need to show all bonds, including -O-H bond

(d) (i)



[1]

(ii)



[1] and [1]

[2]

(iii) Warming/heating with concentrated sulfuric acid [1]

[1]

(e) Disadvantage: Polymer can only be disposed off by burying in landfills which will lead to land or air pollution. [1]

Advantage: Polymer is durable and resistant to corrosion. [1]

[2]

A4

(a) Measure pH of the acid samples with a pH meter, [1]

[2]

if the acid gives a lower pH reading such as 1 or 2, it is a strong acid while acid that gives a higher pH reading such as 3 or 4 is a weak acid. [1]

OR

Add two or three drops of Universal indicator into each acid sample separately. If the UI produced a red colour, the acid is a strong acid. If the UI produced a yellow or orange colour, the acid is a weak acid.

(b) $(\text{CH}_3\text{COO})_2\text{Pb}$ [1] PbC_2 [1]

- (c) Ethanoic acid dissociate partially in aqueous solution to produce H^+ ions [1]
Ethanoic acid produces a lower initial concentration of H^+ ions in aqueous solution than hydrochloric acid [1]
Hence produces a slower initial rate of reaction.
[Accept RA for hydrochloric acid]

Lead(II) carbonate reacts with hydrochloric acid to form **insoluble** lead(II) chloride [1]
which coats around lead(II) carbonate and prevents it from further reaction with acid. [1]
gives a low yield of carbon dioxide gas.
[Accept RA for ethanoic acid] [4]

- (d) An exothermic change refers to a chemical reaction in which energy is given out to the surroundings [1]

- A5 (a) Lesser fossil fuels burnt (reduced energy requirements in leaching process) hence reducing CO_2 produced, a greenhouse gas which leads to reduced effect on global warming OR
conserves resources/fossil fuels [1]

No SO_2 gas produced, an air pollutant which causes acid rain [1] [2]

- (b) The roasting and smelting required high energy demands such as
heating to a high temperature of $700^\circ C$ during the roasting of the ores, $1200^\circ C$ for the removal of iron(II) oxide impurities and additional heating of copper(II) oxide and oxygen during conversion (list any two) [1]

as compared to leaching where no heating is required. [1] [2]

- (c) (i) $Cu^{2+}(aq) + Fe(s) \rightarrow Fe^{2+}(aq) + Cu(s)$ [1] [1]

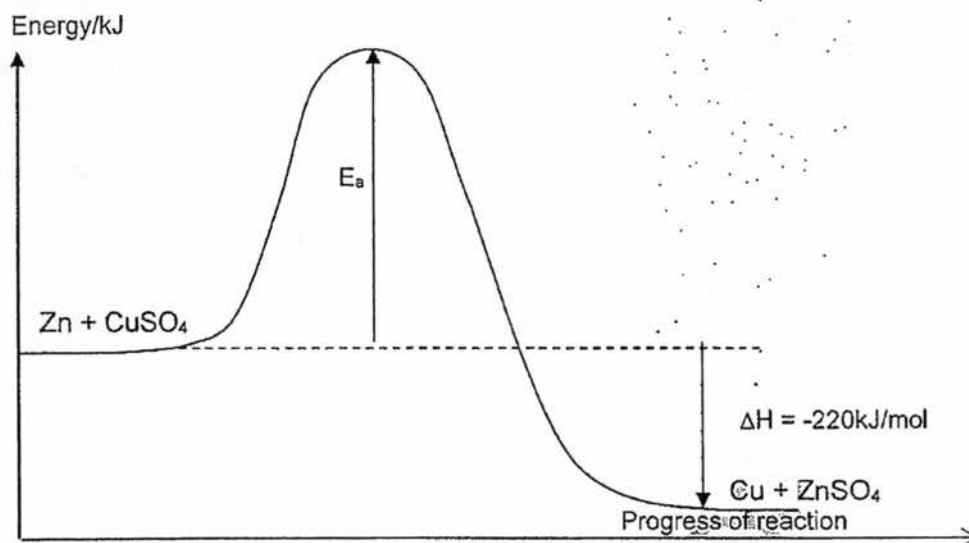
- (ii) No. Magnesium and zinc is more reactive than iron [1] [2]
and will displace iron from the aqueous solution as well. [1]
Copper obtained would be contaminated with iron.

- (d) Electrolyte: any aqueous copper(II) solution[;]
Anode: impure copper[;]
Cathode: pure copper[;]
Battery and wires [;] [2]

4; - [2]

A6 (a)

[2]



E_a (arrow head upwards) ;
 ΔH (arrow head downwards) ;
 Label reactants & products ;
 3; - [2]
 1-2; [1]

- (b) No. of moles of $\text{CuSO}_4 = 1.76/220 = 0.008$ [1]
 Concentration of CuSO_4 used = $0.008/(20/1000) = 0.400 \text{ mol/dm}^3$ [1] [2]

A7 (a) Non bonded electrons [;]
 Bonded electrons [;] [1]

- (b) Electrical conductivity:
 Tetrachloromethane molecules are electrically neutral. There are no mobile ions and electrons to conduct electricity. [1] [4]

Whereas lead(II) chloride is insoluble in water and hence ions are held in fixed position and are not mobile [;]
 Pb^{2+} and Cl^- ions are mobile in aqueous solution that can act as charged carriers. [;]
 2; - 1

Melting point:
 Tetrachloromethane has a simple molecular structure consisting of molecules held by weak intermolecular forces of attraction. [;]
 Lead (II) chloride has a giant ionic lattice structure consisting of oppositely charged ions held by strong electrostatic forces of attraction. [;]
 A larger amount of energy is required to overcome the forces in lead (II) chloride. [;]
 3; [2]

B8

- (a) The difference in electronegativity between each element and oxygen decreases from 2.6 for Na to 0.5 for Cl across the period. [2]

Trend [1], quote data [1]

- (b) Oxygen atom has one lesser electron shell (2 electron shells) than each element in Period 3 [1] [2]

Hence there is a stronger electrostatic attraction between the positively charged nucleus and the valence electrons [1]

- (c) The student's conclusion is true for oxides.
The difference in electronegativities between Si, P and Cl and O is less than 2.0 and bond character is covalent. [1] [3]

His conclusion does not apply for chlorides.

The difference in electronegativities between Mg and Cl is less than 2.0 at 1.8 and the bond is ionic. [1]

Data cited for both statements [1]

- (d) Bond nature in beryllium chloride is covalent and that in beryllium oxide is ionic. [1] [2]

Since the electronegativity of beryllium is approximately same as aluminium. [1]

- (e) 0.0 [1] [2]
Argon is unreactive as it has a stable complete electronic configuration and
Hence unlikely to attract electrons to itself. [1]

B9

- (a) (i) Hydrogen gas produced escapes from the reaction mixture. [1]

- (ii) Loss in mass = mass of hydrogen = 0.05 g
No. of moles of hydrogen = $0.05/2 = 0.025$
No. of moles of Zn required = 0.025
Actual no. of moles of Zn provided = $1.625/65 = 0.025$
OR
No. of moles of acid used = $0.025 \times 2 = 0.05$
Actual no. of moles of acid = $250/1000 \times 0.500 = 0.125$

[1] for working

The limiting reactant is Zn. [1] [2]

- (b) As the temperature of the water decreases,
Nitric acid and Zn particles lose energy and move slower [;]
lesser reacting particles have energy equal or more than the activation energy [;]
1; to get first mark

leading to lowered frequency of effective collision between Zn and nitric acid. [1] [2]

- (c) I disagree with student 1.
The initial rate of reaction is slower because adding 50 cm³ of aqueous solution **decreases the concentration of H⁺ ions in the solution** [1] thereby decreasing the rate of reaction.

I agree with student 2.

Zinc displaces copper from aqueous copper (II) sulfate. [:]

Lesser no. of moles of Zn is available for reaction with nitric acid.[:]

2; -[1]

Hence lesser volume of hydrogen gas produced.[1]

[3]

B10 Either

- (a) (i) Cracking [1]
Mixture of aluminium oxide and silicon(IV) oxide catalyst [1] [2]
- (ii) Add samples of A and B to aqueous bromine. [:]
If reddish brown aq. bromine decolourises rapidly, sample is A;
If aq. bromine remains reddish brown, sample is B.

3; [2]
1-2; [1] [2]
- (iii) $C_4H_{10} \rightarrow CH_4 + C_3H_6$ [1] [1]
- (b) Add acidified potassium manganate(VII) and warm the mixture [1]
If acidified potassium manganate(VII) remains purple, C is 100% converted to D [1] [2]
- (c) (i) M_r of B(propene) = 42

Number of monomers = $33600/42 = 800$ [1]
- (ii) Similarity:
Same empirical formula as the monomer. [1]
Difference:
Monomer is unsaturated while polymer is saturated[1] [2]

B100R

- (a) (i) The amounts of CO, SO₂ and PM10 emissions are lower when using biodiesel than fossil diesel. [1] On the contrary, the amount of NO_x exhaust emission is higher when burning biodiesel than fossil diesel. [1] [2]
- (ii) There is more amount of CO produced. CO is a pollutant which binds irreversibly with haemoglobin in red blood cell to form carboxyhaemoglobin, impairing its ability to transport oxygen causing breathing difficulties and death. [1]

There is more SO₂ produced. SO₂ irritate the eyes and lungs and causes breathing difficulties [1] [2]

- (b) Burning of biodiesel releases CO₂ to the atmosphere. [;]
Biodiesel is formed from plants which absorb CO₂ in the atmosphere during photosynthesis. [;]
Hence there is no net increase of CO₂ in the atmosphere. [;]

3;[2]

1-2; [1]

- (c) (i) One molecule of CFC₃ produces a Cl atom under UV light which reacts with one molecule of O₃ to form one molecule of C/O [1]
Another Cl atom is regenerated when one molecule of C/O reacts with an O atom. [1] [2]
- (ii) From graph,

	C	F	Cl
moles	2	4	2
simplest ratio	1	2	1

The empirical formula is CF₂Cl. [1]

From graph,

	C	F	Cl
Mass of 1 mole of compound/g	24	76	71

Mr of CFCs = 171

$n = 2$

Molecular formula is C₂F₄Cl₂ [1]