# ZHONGHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY 4E

| Candidate's Name | Class | Register Number |
|---|---|---|
| | | |

## CHEMISTRY 6092/01

**23 September 2019**
**1 hour**

Additional Materials: OTAS

**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 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.

**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.

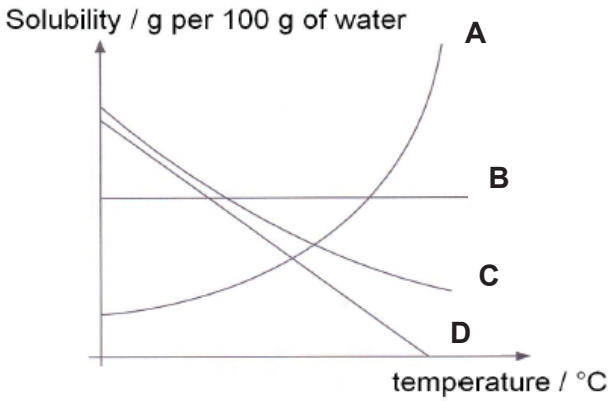
Setter: Ms Ong Lay Hong
Vetter: Mrs Maybrie Ang and Ms Julia Yeo



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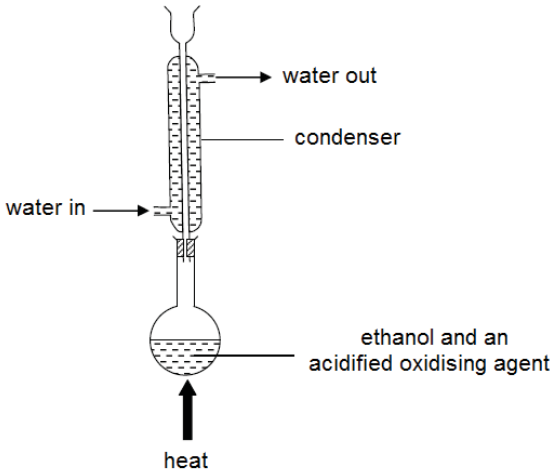
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**1** The solubility curves of four different substances **A** to **D** in water are shown below.
The solubility of a substance refers to the mass of substance that can dissolve completely in 100 g of water at a specific temperature to form a saturated solution.




Which substance is the most suitable to be collected by crystallisation from cooling its hot saturated aqueous solution?

**2** The following apparatus is commonly used to oxidise ethanol to ethanoic acid




What is the purpose of the condenser?

**A** prevent air from oxidizing ethanoic acid formed

**B** prevent ethanoic acid from reforming back to ethanol

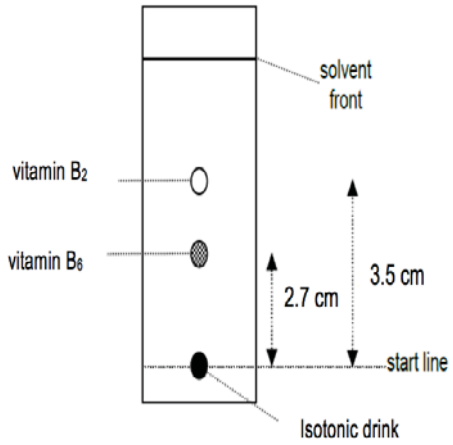
**C** prevent ethanol from being converted to ethene

**D** prevent the escape of any unreacted ethanol.

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**3** A sample of isotonic drink containing two water soluble vitamins was analysed using the method of chromatography with water as a solvent. The following chromatogram (*not drawn to* scale) was obtained.




Given that the $R_f$ value of vitamin $B_2$ is 0.35, which of the following statements can be deduced from the chromatogram?

1 Isotonic drink is a mixture.
2 The solvent front is at 10 cm from the start line.
3 The $R_f$ value of vitamin $B_6$ is 0.27
4 Vitamin $B_6$ is more soluble in ethanol than vitamin $B_2$.

**A** 1 and 2
**B** 2 and 3
**C** 1, 2 and 3
**D** 2, 3 and 4

**4** Two elements, **X** and **Y**, have the electronic configurations 2.8.2 and 2.8.7 respectively. Which of the following statements describe the compound formed by **X** and **Y**?

1 It is soluble in water.
2 It has high melting and boiling point.
3 It has a crystal lattice structure similar to that of sodium chloride.
4 The elements in it can be separated by electrolysis of the aqueous mixture.

**A** 1 and 2
**B** 3 and 4
**C** 2, 3 and 4
**D** 1, 2, 3 and 4

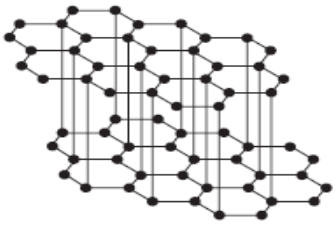


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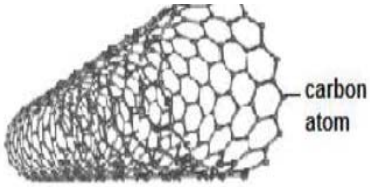
**5** Element **A** forms an acidic, covalent oxide
Which row shows the possible number of electrons that could be present in the outer shell of an atom of **A**?

| | 1 | 2 | 6 | 7 |
|---|---|---|---|---|
| **A** | √ | √ | x | x |
| **B** | √ | x | √ | x |
| **C** | x | x | √ | √ |
| **D** | x | √ | x | √ |

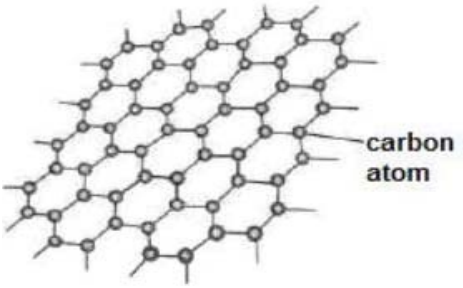
**6** Carbon can form different structures as shown in the diagram below. Which of these structures are able to conduct electricity?



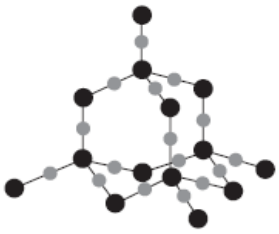
1




2




3



4

**A** 1 and 4 **B** 2 and 3

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

**7** The formation of metallic chlorides involves the transfer of electrons from a metal atom to chlorine atoms.
Which of the metal atom in the metallic chloride below do not transfer exactly two moles of electrons to form the metallic chloride?

**A** barium chloride **B** iron (II) chloride

**C** magnesium chloride **D** sodium chloride

**[Turn over**

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**8** Hardness in tap water can be determined by titrating a sample of water against a reagent which reacts with dissolved metals ions. The indicator for this titration requires the pH to be maintained at about 10.

Which substances, in aqueous solution, could be used to maintain the pH at about 10?

**A** ammonia and ammonium chloride

**B** ammonia and sodium hydroxide

**C** sodium hydroxide and sodium ethanoate

**D** sodium hydroxide only

**9** Gas **Y** is soluble in water. Its solution turns red litmus paper blue.

Which statement is not correct?

**A** A green precipitate is obtained when an aqueous solution of **Y** is added one drop at a time to aqueous iron(III) nitrate.

**B** A white precipitate is produced, which is soluble when an aqueous solution of **Y** is added one drop at a time to aqueous zinc nitrate.

**C** Gas **Y** could be made by warming ammonium nitrate with aqueous sodium hydroxide.

**D** Gas **Y** could be made by warming calcium nitrate with aqueous sodium hydroxide and powdered aluminium.

**10** Barium sulfate which is used as a medical tracer is prepared by mixing two substances, **X** and **Y.**

Which row shows the best way to prepare pure barium sulfate?

| | substance **X** | substance **Y** |
|---|---|---|
| **A** | aqueous barium nitrate | lead(II) sulfate |
| **B** | aqueous barium chloride | aqueous sodium sulfate |
| **C** | barium carbonate | dilute sulfuric acid |
| **D** | barium oxide | dilute sulfuric acid |

**11** A student added 12.5 $cm^3$ of 0.0500 $mol/dm^3$ sodium hydroxide to 25.0 $cm^3$ of 0.100 $mol/dm^3$ hydrochloric acid.

What is the concentration of hydrochloric acid remaining in the reaction mixture?

**A** 0.0333 $mol/dm^3$ **B** 0.0500 $mol/dm^3$

**C** 0.0667 $mol/dm^3$ **D** 0.0750 $mol/dm^3$



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**12** Iron(II) sulfate is a common nutritional supplement used in treating patient with iron-deficiency anaemia. The percentage of iron(II) sulfate present in one tablet of this supplement can be determined by dissolving 5.00 g tablet containing iron(II) sulfate in water with excess barium chloride solution.

After mixing, 2.89 g of barium sulfate is precipitated out, what is the percentage of iron(II) sulfate in the tablet?

**A** 18.9 %
**B** 37.7 %
**C** 42.2 %
**D** 57.8 %

**13** In an experiment, 8.0 $cm^3$ of 1.0 $mol/dm^3$ aqueous copper(II) sulfate and 4.0 $cm^3$ of 1.0 $mol/dm^3$ aqueous sodium carbonate are mixed.

What does the reaction vessel contain once the reaction is completed?

**A** a colourless solution only
**B** a green precipitate and a blue solution
**C** a green precipitate and a colourless solution
**D** a white precipitate and a colourless solution

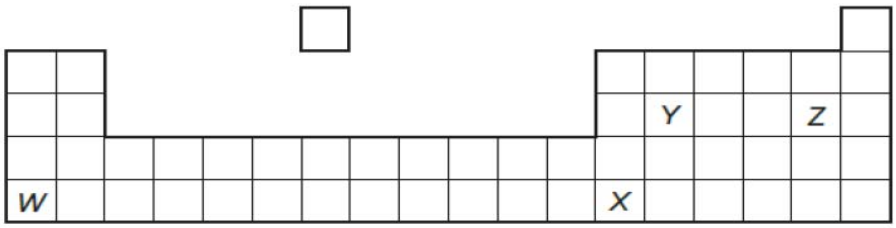
**14** Metal **R** is more reactive than metal **S** which is more reactive than metal **T**.
The sulfates of **R** and **T** are colourless; the sulfate of **S** is blue.
Which observation is correct when a metal is added to a solution of sulfate?

| | metal added | solution of sulfate | colour change |
|---|---|---|---|
| **A** | **R** | **S** | blue to colourless |
| **B** | **S** | **R** | colourless to blue |
| **C** | **S** | **T** | blue to colourless |
| **D** | **T** | **S** | blue to colourless |

**[Turn over**

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**15** The diagram shows the positions of elements **W**, **X**, **Y** and **Z** in the Periodic Table.
These letters are not the chemical symbols of the elements.




Which statement is not correct?

**A** **W** and **Z** could react together and form a compound, **WZ**

**B** **W** has a melting point that is lower than that of **Z**.

**C** **X** could form an oxide, $\mathbf{X_2O_3}$

**D** **Y** could form an oxide, $\mathbf{YO_2}$.

**16** Which statement about metals and their compounds is not correct?

**A** Unreactive metals are likely to be found as elements in soil or rocks.

**B** Metals low in the reactivity series are generally extracted from their oxides by heating with carbon.

**C** Heating magnesium with iron(III) oxide produces iron and a white ash containing magnesium oxide.

**D** Higher temperature are needed to reduce copper(II) oxide to copper than are needed to reduce zinc oxide to zinc by hydrogen.

**17** An underground water tank made of iron is joined to a copper pipe.
Which of the following will occur?

**A** The corrosion of copper is faster.

**B** Electrons will flow from the iron to copper.

**C** Copper atoms will be oxidised to form copper(II) ions.

**D** A chemical cell will be formed with the copper pipe acting as the negative terminal.



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**18** **P**, **Q** and **R** are elements found in Group VII of the Periodic Table. Three experiments were carried out to determine the reactivity of **P**, **Q** and **R**.
The three reactions are represented by the three equations shown below.

1 $\mathbf{R}^-(aq) + \mathbf{Q}_2(aq) \rightarrow$ no reaction
2 $\mathbf{P}^-(aq) + \mathbf{R}_2(aq) \rightarrow$ no reaction
3 $2\mathbf{Q}^-(aq) + \mathbf{P}_2(aq) \rightarrow \mathbf{Q}_2(aq) + 2\mathbf{P}^-(aq)$

Which statement about **P**, **Q** and **R** is correct?

**A** $\mathbf{P}_2$ is a solid at room temperature.

**B** $\mathbf{R}_2$ is a stronger oxidising agent than $\mathbf{Q}_2$.

**C** Aqueous H**Q** turns red litmus paper blue.

**D** $\mathbf{P_2}$ is a reducing agent for reaction 3.

**19** In which equation(s) is nitrogen being reduced?

1 $HNO_3\ (aq) + NH_4OH\ (aq) \rightarrow NH_4NO_3\ (aq) + H_2O\ (l)$
2 $4NO_3^-\ (aq) + 5CH_2O\ (l) + 4H^+\ (aq) \rightarrow 2N_2\ (g) + 5CO_2\ (g) + 7H_2O\ (l)$
3 $2NO_3^-\ (aq) + 4H^+\ (aq) + Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2NO\ (g) + 2H_2O\ (l)$

**A** 3 only
**B** 1 and 2
**C** 2 and 3
**D** 1, 2 and 3

**20** In which reactions are reduction taking place?

1 the formation of iron from hematite in the blast furnace
2 the manufacture of ammonium sulfate from aqueous ammonia and sulfuric acid.
3 the manufacture of margarine from vegetable oil
4 a reaction of acidified potassium dichromate(vi) in which colour changes from orange to green

**A** 1 and 3
**B** 1 and 2
**C** 1, 3 and 4
**D** 2, 3 and 4



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**21** Bismuth(III) oxychloride is dissolved in concentrated hydrochloric acid to give a colourless solution of bismuth(III) chloride.

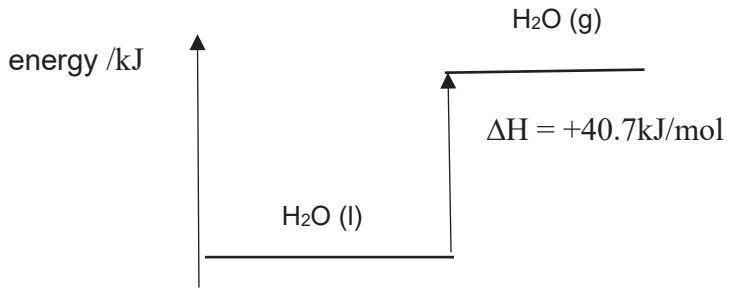
$BiOCl(s) + 2HCl(aq) \rightarrow BiCl_3(aq) + H_2O(l)$; $\Delta H = -132$ kJ/mol
The activation energy for the forward reaction is 45 kJ/mol.

Addition of water re-forms the bismuth(III) oxychloride as a white precipitate.
What is the activation energy for the reverse reaction?

**A** -45 kJ/ mol **B** 87 kJ/ mol

**C** -87 kJ/mol **D** 177 kJ/mol

**22** The following diagram shows the energy changes associated with one stage of the heating of water under atmospheric pressure.




Which of the following statements about this system are correct?

1 The conversion $H_2O(l)$ to $H_2O(g)$ is exothermic.
2 When 18 g of steam at 100°C condense to water at 100°C, 40.7 kJ of energy is given out.
3 Water at 100°C has particles further apart than steam at 100°C.
4 Steam at 100°C contains more energy than the same mass of water at 100°C.

**A** 1 and 2 **B** 2 and 4

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

**23** When aqueous potassium iodide is added to hydrogen peroxide, the following reactions are observed.

$H_2O_2(aq) + I^-(aq) \rightarrow IO^-(aq) + H_2O(l)$

$H_2O_2(aq) + IO^-(aq) \rightarrow I^-(aq) + H_2O(l) + O_2(g)$

There is a vigorous reaction and energy is liberated very rapidly, leading to a rise in temperature of the reaction mixture.

What is the role of aqueous potassium iodide in the overall reaction?

**A** as a base **B** as a catalyst

**C** as a reducing agent **D** as an oxidising agent

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**24** Aqueous hydrogen peroxide decomposes according to the following equation.

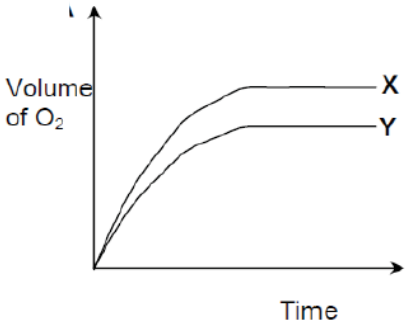
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide. The results are given below.

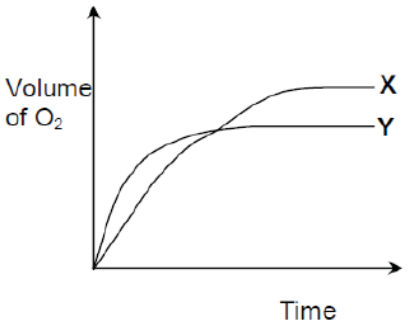
| experiment | solution used |
|---|---|
| X | 100 $cm^3$ of 2 $mol/dm^3$ $H_2O_2$ |
| Y | mixture of 100 $cm^3$ of 2 $mol/dm^3$ of $H_2O_2$ and 50 $cm^3$ of 0.5 $mol/dm^3$ $H_2O_2$ |

Which graph best shows the results of the two experiments?

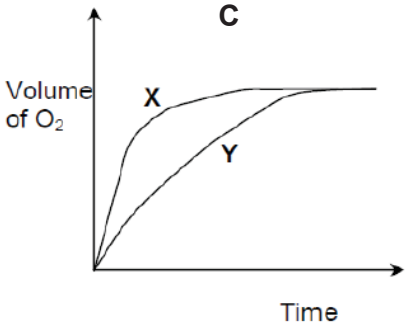
**A**



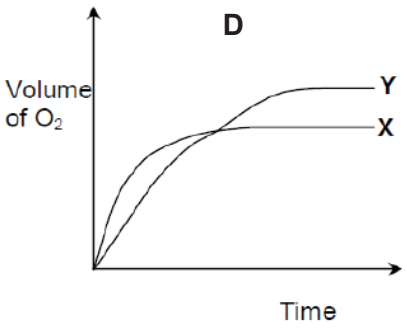

**B**




**C**




**D**




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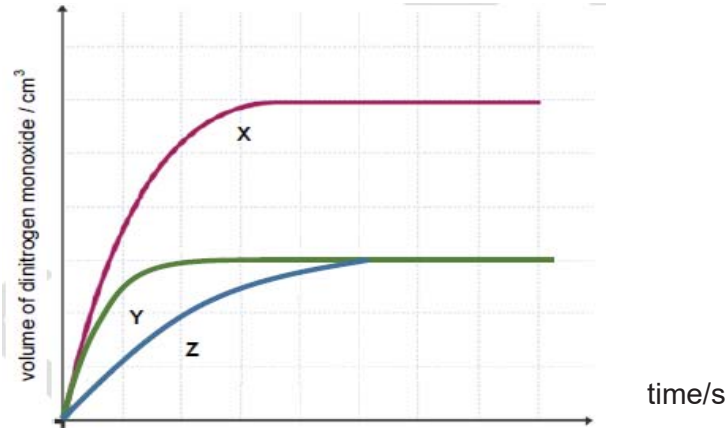
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**25** Sulfamic acid, $H_2NSO_3H$, is used as an acidic cleaning agent. It reacts with dilute nitric acid to produce the gas dinitrogen monoxide, $N_2O$.

$$H_2NSO_3H + HNO_3 \rightarrow N_2O + H_2O + H_2SO_4$$

Three experiments were performed using a fixed concentration and volume of sulfamic acid but with varying concentrations and volumes of dilute nitric acid. The total volume of the dinitrogen monoxide evolved was recorded against time.

| experiment | concentration of $HNO_3$/ $mol/dm^3$ | volume of $HNO_3$ /$cm^3$ |
|---|---|---|
| 1 | 2.0 | 50 |
| 2 | 1.0 | 100 |
| 3 | 2.0 | 100 |




Assuming that sulfamic acid is in excess, which of the curves **X**, **Y** and **Z** in the graph above relate to experiment 1, 2, and 3?

| | **1** | **2** | **3** |
|---|---|---|---|
| **A** | **X** | **Y** | **Z** |
| **B** | **X** | **Z** | **Y** |
| **C** | **Z** | **X** | **Y** |
| **D** | **Y** | **Z** | **X** |

**[Turn over**

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**26** 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

**27** Metal **P** can be obtained from its oxide by heating with carbon, and from its aqueous chloride by electrolysis.

Which metal is **P**?

**A** lead **B** copper

**C** silver **D** sodium

**28** Three electrolytic cells are set up using inert electrodes.
The electrolytes used are listed below.

cell 1: concentrated aqueous potassium chloride
cell 2: dilute sulfuric acid
cell 3: molten magnesium oxide

In which of these cell(s) is/are gases formed at both electrodes?

**A** 2 only **B** 3 only

**C** 1 and 2 **D** 2 and 3

**29** During the electrolysis of an aqueous solution of a molybdenum salt, 24 g of molybdenum (Ar of Mo = 96) is deposited at the cathode by 1.5 moles of electrons.

What is the formula of the molybdenum ion?

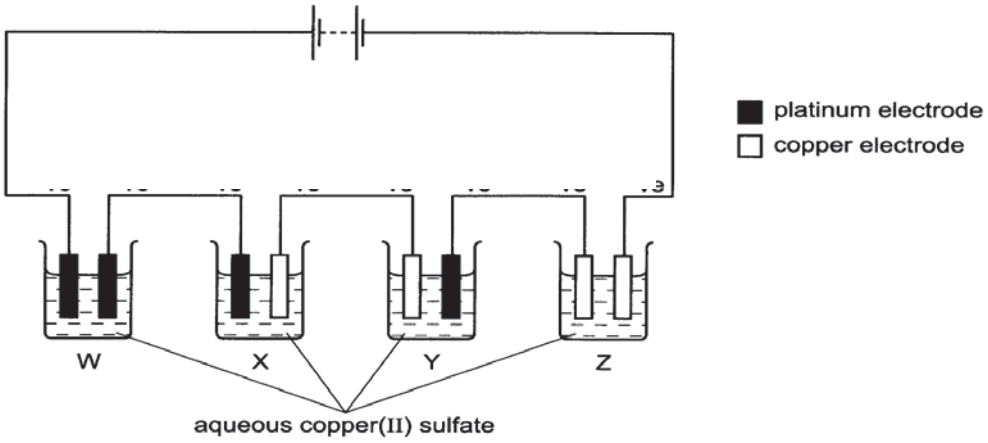
**A** $Mo^{+}$ **B** $Mo^{3+}$

**C** $Mo^{4+}$ **D** $Mo^{6+}$

**[Turn over**

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**30** The circuit shown is set up and an electric current is passed through the four cells in series.
In which cells are the intensity of the blue colouration of the solution unchanged?




**A** W and Z
**B** X and Y
**C** X and Z
**D** Y and Z

**31** Which of the following reaction(s) produces greenhouse gases?

1 Cracking of $C_9H_{20}$ to form 4 moles of ethene and another organic compound.
2 Heating potassium carbonate over a strong flame.
3 Passing of unburnt hydrocarbons through the catalytic converters.

**A** 2 only
**B** 1 and 3
**C** 2 and 3
**D** 1, 2 and 3

**32** A car burning lead-free fuel has a catalytic converter fitted to its exhaust. On analysis, its exhaust gases are shown to contain small quantities of nitrogen oxides.
What modifications would results in lower exhaust concentrations of nitrogen oxides?

1 An increase in the surface area of the catalyst in the converter.
2 An increase in the air-fuel ratio through the engine of the car.
3 A much higher temperature of combustion in the engine.

**A** 1 only
**B** 2 and 3
**C** 1 and 2
**D** 1, 2 and 3

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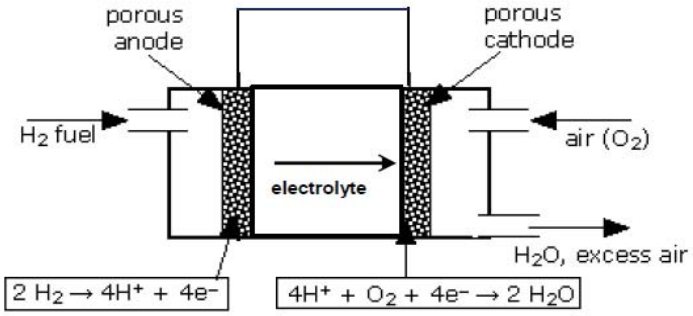
**33** Which of the following are true of the Haber Process?

1 Nitrogen is oxidised to form ammonia
2 The hydrogen is obtained from cracking of petroleum fractions.
3 Ammonia formed is condensed and obtained as liquid.
4 A high temperature will increase the yield of ammonia.

**A** 1 and 2 **B** 1 and 4

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

**34** A diagram of the hydrogen-oxygen fuel cell is shown below.



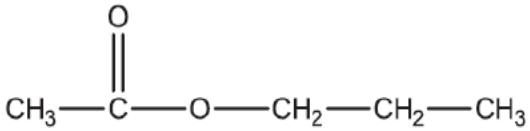

Which of the following are correct statements about the fuel cell?

1 Electricity is used to generate hydrogen and oxygen.
2 Electrons flow from the anode to the cathode in the electrolyte.
3 Hydrogen and oxygen undergo redox reactions to generate electricity.
4 The anode and cathode are the negative and positive electrodes respectively

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

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

**35** Esters are sweet smelling substances found in fruits and flowers.
The following is the ester from pear.




Which of the following react together to form the above ester?

**A** methanol and butanoic acid **B** propanoic acid and ethanol

**C** ethanoic acid and propanol **D** methanoic acid and butanol

**[Turn over**

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**36** When iodine, $I_2$, reacts with an unsaturated compound, one molecule of iodine adds across each double bond.
Unsaturated fatty acids react similarly with iodine. 0.150 mol of a particular fatty acid reacts with exactly 0.300 mol of $I_2$.
What could the fatty acid be?

| | | |
|---|---|---|
| **A** | lauric acid | $CH_3(CH_2)_{10}COOH$ |
| **B** | linoleic acid | $CH_3(CH_2CH{=}CH)_2(CH_2)_{10}COOH$ |
| **C** | palmitoleic acid | $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$ |
| **D** | arachidonic acid | $CH_3(CH_2CH{=}CH)_4(CH_2)_6COOH$ |

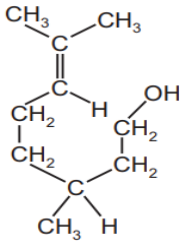
**37** The chemical formulae of four organic compounds are listed below.

1 $H_2C{=}CH(COOCH_3)$
2 $HOOC(CH_2)_3COOH$
3 $NH_2CH_2CH_2CH_2COOH$
4 $H_2NCHClCHClNH_2$

Which two compounds can undergo self-polymerisation to form a polymer?

| | | | |
|---|---|---|---|
| **A** | 1 and 2 | **B** | 1 and 3 |
| **C** | 2 and 4 | **D** | 3 and 4 |

**38** A student carried out some test on citronella, a compound which is found in rose oil.
The structure formula of citronella is shown below.




Which of the following statements about citronella are correct?

1 Aqueous bromine was decolourised when citronella was added to it.
2 Effervescence observed when sodium carbonate was reacted with citronella.
3 Citronella turns aqueous acidified potassium manganate(VII) from purple to colourless.
4 A sweet smelling smell was detected when citronella was heated with a mixture of methanoic acid and concentrated sulfuric acid.

| | | | |
|---|---|---|---|
| **A** | 1 and 2 | **B** | 2 and 3 |
| **C** | 1, 3 and 4 | **D** | 2, 3 and 4 |



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**39** Petroleum can be separated into fractions by fractional distillation.
Which statement about this process is not correct?

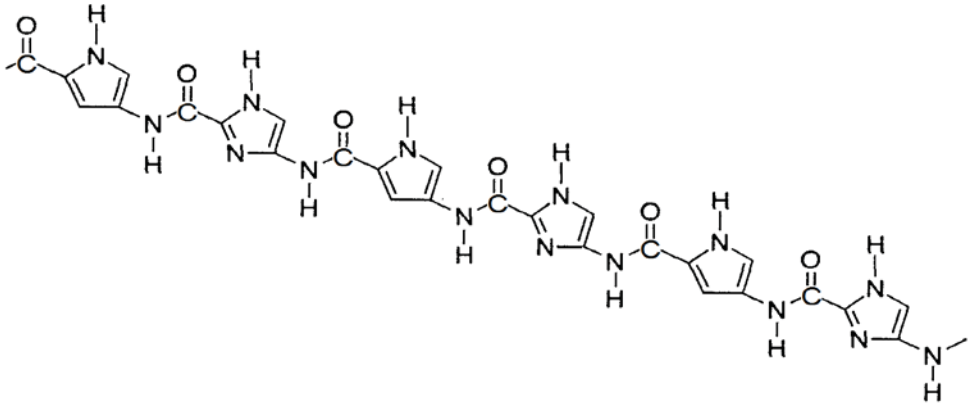
**A** The lubricating oil fraction is a source of polishes and waxes.

**B** The fraction obtained at the top of the fractionating column has the highest boiling point.

**C** In a fractionating column, the bitumen fraction is obtained below the kerosene fraction.

**D** The molecules reaching the top of the column have the smallest relative molecular mass.

**40** The structure below shows part of a polymer.
Which one of the following show the correct monomers?



**A**



**B**



**C**



**D**



***end of paper***

**[Turn over**

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# The Periodic Table of Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium - | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57 – 71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89 – 103 actinoids | 104 Rf Rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

proton (atomic) number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium – | 62 Sm samarium 150 | 63 Eu europium 152 | 64 Gd gadolinium 157 | 65 Tb terbium 159 | 66 Dy dysprosium 163 | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 |
| actinoids | 89 Ac actinium – | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium – | 94 Pu plutonium – | 95 Am americium – | 96 Cm curium – | 97 Bk berkelium – | 98 Cf californium – | 99 Es einsteinium – | 100 Fm fermium – | 101 Md mendelevium – | 102 No nobelium – | 103 Lr lawrencium – |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).



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# ZHONGHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY 4E

| Candidate's Name | Class | Register Number |
|---|---|---|
| | | |

## CHEMISTRY 6092 /02

16 September 2019
1 hour 45 minutes

Additional Materials: NIL

### 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.

Write your answers in the spaces provided on the question paper

**Section B**

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

Write your answers in the spaces provided.

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

At the end of the examination, fasten all your work securely together.

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 22.

| For Examiner's Use | |
|---|---|
| Section A | /50 |
| B8 | /10 |
| B9 | /10 |
| B10 | /10 |
| Total | /80 |

Setter: Ms Julia Yeo
Vetter: Ms Ong Lay Hong & Mrs Maybrie Ang

This document consists of **22** printed pages, including this cover page.

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## Section A

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

The total marks for this section is 50.

**A1** Choose from the following solutions to answer the questions below.

| | | | |
|---|---|---|---|
| $CuSO_4$ | KCl | $K_2Cr_2O_7$ | KI |
| $KMnO_4$ | $MgSO_4$ | $NH_3$ | $ZnSO_4$ |
| $Al(NO_3)_3$ | $AgNO_3$ | $NH_4NO_3$ | $NaNO_3$ |

Each solution can be used once, more than once, or not at all.

Write the formula for a solution which

**(a)** reacts with an acid to produce a fertiliser.

..... [1]

**(b)** turns colourless when sulfur dioxide is bubbled through it.

..... [1]

**(c)** is used to test for an oxidising agent.

..... [1]

**(d)** reacts with magnesium strips to give a pink-brown solid.

..... [1]

**(e)** gives a white precipitate that dissolves in excess of sodium hydroxide and aqueous ammonia.

..... [1]

**(f)** reacts with lead(II) nitrate to give a bright yellow precipitate.

..... [1]

[Total: 6]

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**A2** Ammonia, $NH_3$, is a colourless, pungent-smelling gas which has been known to man from the beginning of record time. It is given off from urine such as that on a wet soiled nappy used by a baby.

The nitrogen-containing substance in urine is urea, $CO(NH_2)_2$ which reacts with water and decomposes by hydrolysis into ammonia and another colourless gas.

**(a)** Construct a balanced chemical equation for the hydrolysis of aqueous urea.

.....[1]

**(b)** Ammonia burns in pure oxygen to produce nitrogen and steam.

$4\ NH_3(g) + 3\ O_2(g) \rightarrow 2\ N_2(g) + 6\ H_2O(g)$

Explain in terms of oxidation state, whether the reaction is a redox reaction.

.....

.....

.....[2]

**(c)** The Haber process makes use of hydrogen and nitrogen to manufacture large scale amount of ammonia, $NH_3$ in the industry. Calculate the maximum mass of ammonia formed when 6 $dm^3$ of hydrogen reacts with 10 $dm^3$ of nitrogen if the percentage yield is 88%.

mass of ammonia = .....[3]

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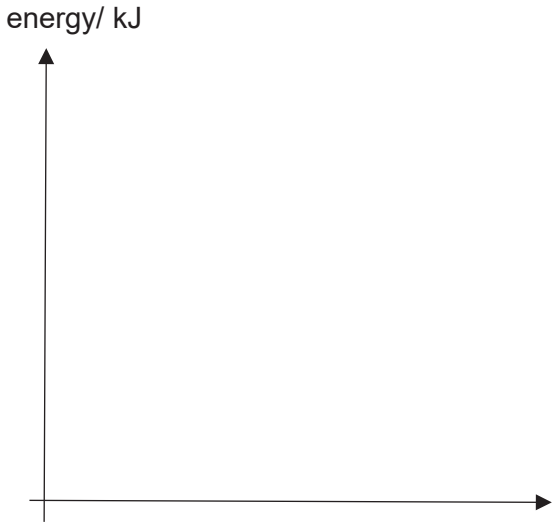
**(d)** When ammonia dissolves in water, the water feels cold.

$NH_3(g) + H_2O(aq) \rightleftharpoons NH_4OH\ (aq)$

Complete the energy profile diagram for this reaction.

Your diagram should include:

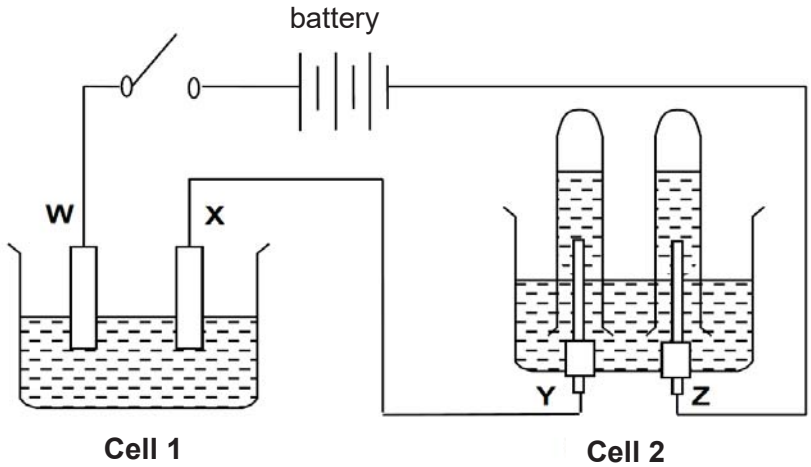
**(i)** the formulae of reactants and products.
**(ii)** labels to show activation energy and enthalpy change of the reaction.




[3]

[Total: 9]

**A3** An experiment is carried out to electrolyse copper(II) sulfate solution and concentrated potassium chloride solution at the same time using inert electrodes.




**Cell 1**

copper(II) sulfate solution

**Cell 2**

concentrated potassium chloride solution + universal indicator

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**(a)** State one visible change that can be observed on electrode **X**.

.....[1]

**(b)** Student **A** commented that the colour intensity of the blue copper(II) sulfate solution will start to fade away throughout the experiment in **Cell 1**.

Student **B** commented that there will be no changes in the colour intensity of the blue copper(II) sulfate solution throughout the experiment in **Cell 1**.

Which student is correct? Explain with the help of ionic half equations to support your answer.

.....

.....

.....

.....[3]

**(c)** **(i)** Describe the colour change of the Universal Indicator during electrolysis of the concentrated potassium chloride solution in **Cell 2**.

.....[1]

**(ii)** Explain your observation in **(c)(i)**.

.....

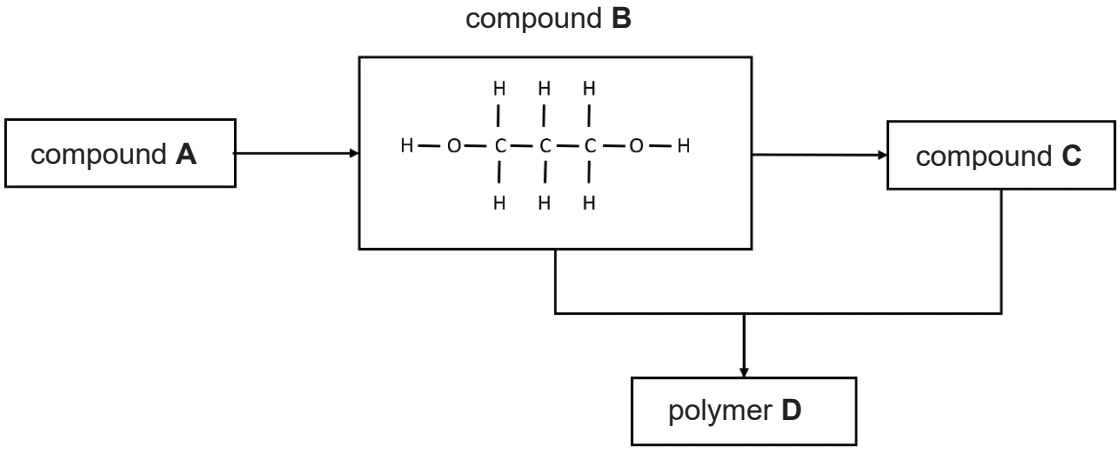
.....

.....[2]

[Total: 7]

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**A4** The reaction scheme below shows compound **A** converted into compound **B**.




**(a)** One mole of compound **A** reacts with one mole of steam to form compound **B** at high temperature and pressure in the presence of a catalyst.

Draw the full structural formula of compound **A**.

[1]

**(b)** Compound **A** is an unsaturated organic compound. Describe a chemical test to show that it is unsaturated.

.....

.....

[1]

**(c)** Compound **A** can form an addition polymer. Draw two repeat units of this addition polymer.

[1]

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**(d)** Compound **B** can be oxidised by acidified aqueous potassium manganate(VII) to form compound **C**. Draw the full structural formula of compound **C**.

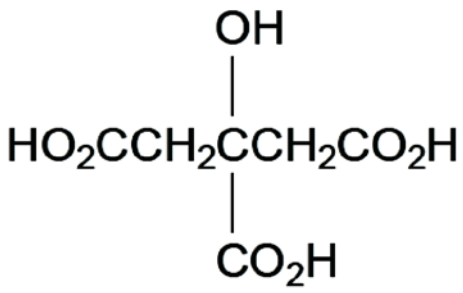
[1]

**(e)** Compound **B** and compound **C** can undergo condensation polymerisation to form polymer **D**. Draw a repeat unit of polymer **D**.

[1]

[Total: 5]

**A5** **(a)** Unripe fruit often contains polycarboxylic acids, that is acids with more than one carboxylic acid functional group in their molecule. A citric acid organic molecule is shown below.




Draw the full structural formula of the organic compound produced when citric acid is reacted with an excess of $Na_2CO_3$.

[1]

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**(b)** Another polycarboxylic acid present in unripe fruit is a colourless crystalline solid, **W**, which has the following composition by mass:

C, 40.7%; H, 5.1%; O, 54.2%.

**(i)** Show that the empirical formula of **W** is $C_2H_3O_2$. Present your working clearly in a table.

[3]

**(ii)** A sample of a compound **W** of mass 1.73 g and relative molecular mass of 118 was dissolved in water and the resulting solution was titrated with 1.00 mol/dm$^3$ NaOH. 29.40 cm$^3$ of NaOH was required for complete neutralisation.

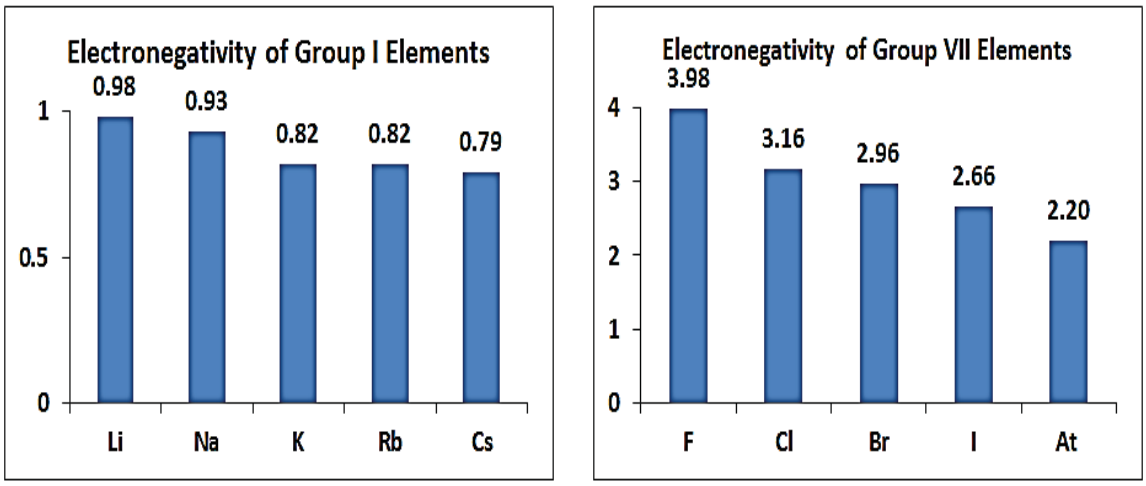
Deduce the number of carboxyl functional groups that are present in one molecule of compound **W**. Show your working clearly.

[2]

[Total: 6]

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**A6** Electronegativity refers to the ability of an atom to attract electrons and is otherwise known as 'electron attracting' power. The greater the electronegativity value of an atom, the greater is its ability to attract electrons and vice versa.
The diagram below shows the electronegativity of Group I and VII elements.




**(a)** Suggest why the electronegativity of fluorine is the highest among Group VII elements?

.....

.....

..... [2]

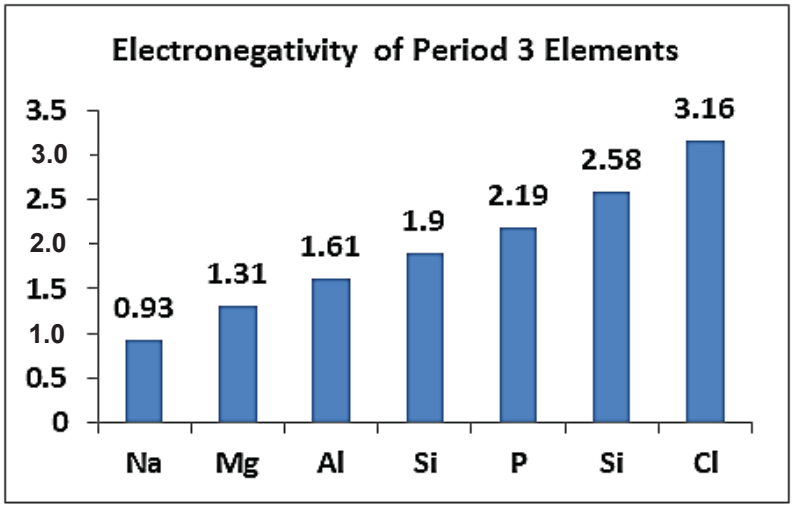
**(b)** Suggest why the electronegativity of Group I elements are very low.

.....

..... [1]

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**(c)** The diagram below shows the electronegativity across Period 3 elements with argon (Ar) being excluded. In addition, it is observed that the electronegativity increases across the period.




Explain why argon is excluded in illustrating the electronegativity across Period 3.

.....

..... [2]

**(d)** With reference to all the diagrams above and the Periodic Table, state an element other than the noble gases, that is most likely to have the lowest electronegativity. Predict the value of electronegativity for the element that you have stated.

..... [2]

[Total: 7]

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**A7** In a series of experiments, different types of acid were added to powdered sodium carbonate. The acids added were hydrochloric acid (HCl), sulfuric acid ($H_2SO_4$) and phosphoric acid ($H_3PO_4$).

**(a)** Phosphoric acid is a weak acid. Define '*weak acid*'.

.....

..... [1]

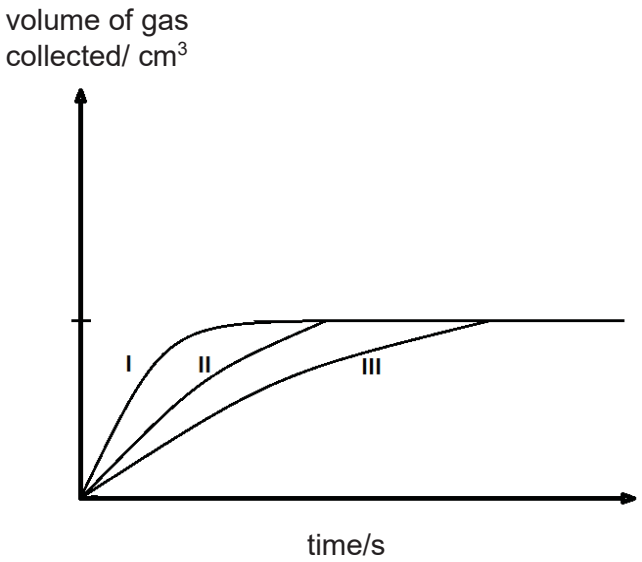
**(b)** Phosphoric acid is a weak tribasic acid. Write an ionic equation to show the ionisation of phosphoric acid.

..... [1]

**(c)** Different sodium salts can be formed by reacting sodium carbonate and phosphoric acid. Other than $Na_3PO_4$, suggest the chemical formula of two other salts formed from phosphoric acid and sodium carbonate.

..... [1]

**(d)** The graph below shows the volume of gas collected over a fixed period of time when the three different acids were added to powdered sodium carbonate. In all the experiments, three different acids of the same concentration and volume were added in excess to the same mass of sodium carbonate.




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**(i)** In the table below, match the acids used to the curves labelled **I**, **II** and **III** obtained in the graph.

| acid used | curve |
|---|---|
| HCl | |
| $H_2SO_4$ | |
| $H_3PO_4$ | |

[1]

**(ii)** Using the collision theory, explain how the types of acid chosen in **(d)(i)** affect the rate of reaction as seen in the different curves.

.....

.....

.....

.....

.....

.....

..... [3]

**(e)** On the graph shown on the previous page, sketch the curve obtained when

**(i)** the mass of sodium carbonate added to sulfuric acid is doubled but in lump form. Label this curve as **IV**. [1]

**(ii)** sodium carbonate added to sulfuric acid is replaced with calcium carbonate of the same mass. Label this curve as **V**. [1]

**(f)** Describe briefly another method that can be used to monitor the rate of reaction.

.....

..... [1]

[Total: 10]

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## Section B

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

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

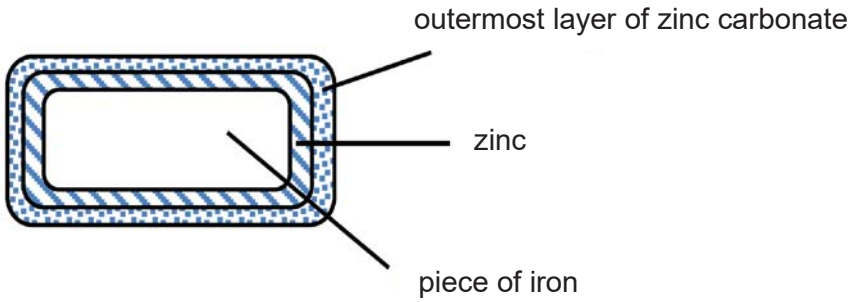
**B8** Galvanisation is the process of coating the entire surface of a piece of iron with zinc to prevent it from rusting. The information below shows two common ways of galvanising iron. Either through hot-dip galvanisation or electro-galvanisation (electroplating an object with zinc).

**Hot-dip galvanisation**

The piece of iron to be galvanised is dipped into a molten bath of zinc at a temperature of around 460°C. The piece of iron is then cooled and exposed to the air. The outermost layer of zinc then reacts with oxygen and carbon dioxide in air as follows:

**Reaction 1:** Zinc reacts with oxygen to form zinc oxide
**Reaction 2:** Zinc oxide reacts with carbon dioxide to form zinc carbonate

The resulting iron piece looks like this:




**Electro-galvanisation (electroplating an object with zinc)**

The piece of iron to be galvanised and a piece of zinc are used as electrodes and dipped into an electrolyte containing a mixture of aqueous zinc cyanide [$Zn(CN)_2$] and aqueous sodium hydroxide at room temperature and pressure. An external electrical power supply is used. Zinc ions are discharged to form zinc atoms, which are coated onto the piece of iron.

**Other facts about both types of galvanisation**

| **Hot-dip galvanised iron** | **Electro-galvanised iron** |
|---|---|
| Layer of zinc is coarse and thick. | Layer of zinc is smooth and thin. |
| Used to make alloy sheets for roofs. | Used to make bolts and nuts. |

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**(a)** A student made the following comment on galvanisation:

"Galvanising a piece of iron is more effective in preventing it from rusting than painting or greasing it." Use the information given and your knowledge to explain whether this comment is true.

.....

.....

.....

..... [2]

**(b) In hot-dip galvanisation,**

**(i)** use the information given to write balanced chemical equations for reaction **1** and reaction **2.**

.....

..... [2]

**(ii)** if 12.5 g of zinc carbonate were found on a piece of galvanised iron, calculate the mass of zinc which reacted to form this mass of zinc carbonate.

[2]

**(c) In electro-galvanisation,**

**(i)** use the information given to draw a clearly-labelled diagram of the experimental setup. In your diagram, label the piece of iron, the piece of zinc and the electrolyte.

[1]

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**(ii)** some older processes of electro-galvanisation employ the use of dilute acids in the electrolyte instead of aqueous sodium hydroxide.

Explain what problem this could pose.

.....

..... [1]

**(d)** From the information given, suggest one advantage and one disadvantage that hot-dip galvanisation has over electro-galvanisation.

.....

.....

.....

..... [2]

[Total: 10]

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**B9** Read the following article on using artificial leaves to make hydrogen.

Gasoline comes mostly from fossil fuels which cause air pollution when they are processed.

Scientists are trying to find an alternative to gasoline that is cost-efficient and sustainable. Materials that work like leaves, called synthetic leaves, could be such an alternative. Plant leaves use sunlight to make their own food, which is glucose, a type of carbohydrate.

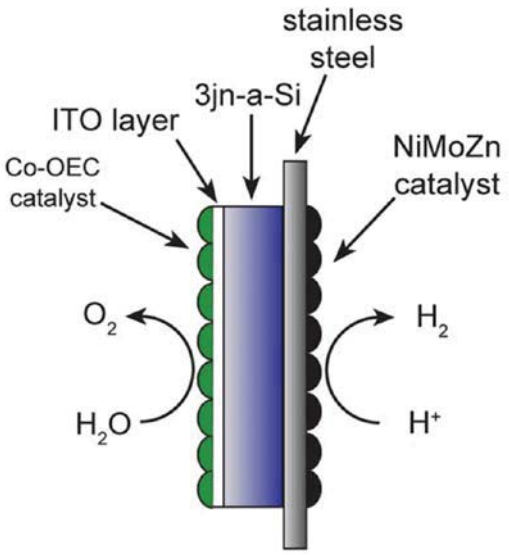
An artificial leaf would also use sunlight and water to create hydrogen and oxygen. The hydrogen created through this process could serve as a source of energy that would ultimately replace gasoline. When used as a car fuel, hydrogen combines with the oxygen in the air and releases energy along with water. The reaction is more exothermic compared to burning gasoline.

The artificial leaf below that Nate Lewis, a chemist at California Institute of Technology in Pasadena, and colleagues have developed consists of a membrane that produces hydrogen in two steps.

**Step 1:** Catalysts in the membrane help to form oxygen from water, releasing hydrogen ions and electrons.

**Step 2:** The electrons combine with hydrogen ions to form hydrogen gas as shown in the diagram below.

Artificial Leaf




The artificial leaf produced in Lewis' laboratory looks more like a small spherical structure than a leaf. Such small structures look like bubble wrap on the rooftop of a house.

The artificial leaf absorbs sunlight and water from the air. This material would generate hydrogen that could be collected into a tank and converted later into a fuel.

*~ Sherry Karabin*

*Adapted and modified from ChemMatters, December 2012*

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**(a)** Processing crude oil often releases methane into the environment. State two effects that methane has on the environment.

.....

.....

..... [2]

**(b)** Describe with the help of a balanced chemical equation, how plant leaves make food for themselves.

chemical equation: .....

.....

..... [2]

**(c)** Artificial leaves can be used to produce hydrogen gas for hydrogen fuel cell in the future. Describe how the current source of hydrogen gas is obtained and explain why it is unsustainable.

.....

..... [2]

**(d)** Suggest two other advantages, other than cost, of using hydrogen as a fuel instead of gasoline.

.....

.....

..... [2]

**(e)** The artificial leaf functions as an electrolytic cell. Using information given, write the anode half equation and the overall cell equation.

anode half equation: .....

overall cell equation: ..... [2]

[Total: 10]

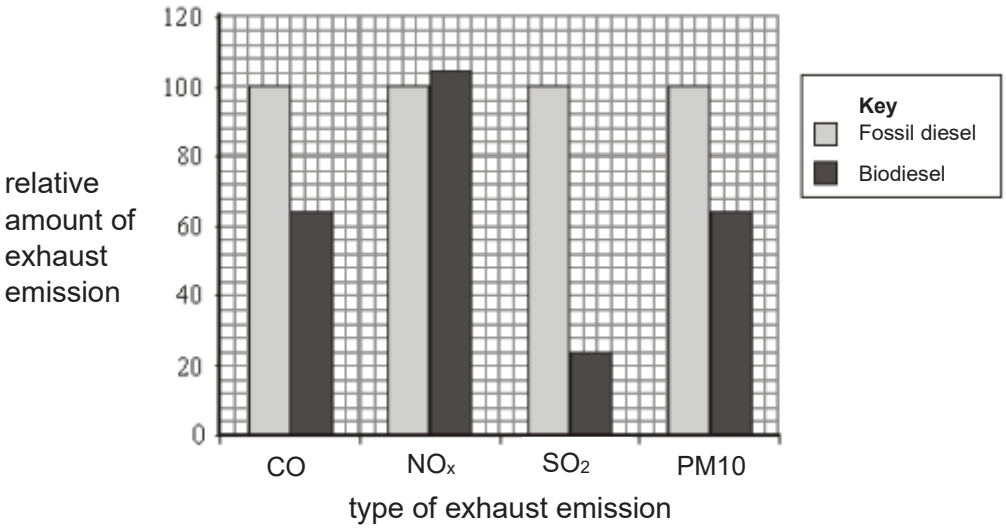
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**Either**

**B10 (a)** 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.




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

.....

.....

..... [2]

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

.....

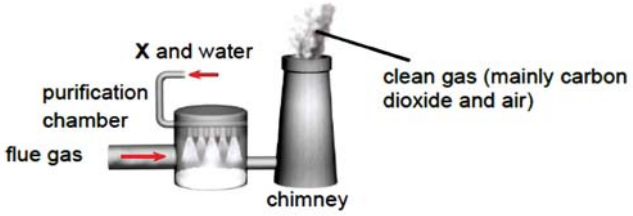
.....

..... [2]

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**(b)** Coal-burning power stations generate large amount of heat from the combustion of coal to convert water into steam which in turn drives turbine generators to produce electricity. Flue gas that is produced contains sulfur dioxide and oxides of nitrogen. These two gases cause acid rain.

Sulfur dioxide can be removed from the flue gases by several methods. One method uses a 'scrubber' that contains wet compound **X**.




**(i)** Identify compound **X** that is added to the purification chamber to remove sulfur dioxide. Write a balanced chemical equation to show how compound **X** removes sulfur dioxide.

.....[2]

**(ii)** Oxides of nitrogen generally consist of a mixture of nitrogen monoxide and nitrogen dioxide. In flue gas, nitrogen monoxide is the main component in the oxides of nitrogen produced. Explain how nitrogen monoxide cause acid rain even though it is a neutral oxide.

.....

.....

.....[2]

**(iii)** Acid rain impacts farming greatly as it often causes the soil to be overly acidic and results in the leaching of nutrients. In order to alleviate the effects of acid rain, a farmer has been advised to treat the soil to reduce the acidity.
The table below gives the solubility of some calcium compounds.

| | **calcium hydroxide** | **calcium oxide** | **calcium carbonate** |
|---|---|---|---|
| **Solubility in water (g per 100ml of water)** | **0.173** | immediately reacts with water on contact to form an alkaline solution | **$6.17 \times 10^{-4}$** |

Using the information given in the table, suggest and explain why calcium carbonate is less effective at reducing acidity than calcium hydroxide and calcium oxide.

.....

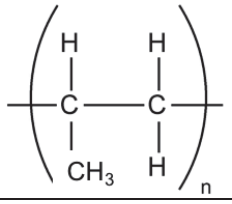
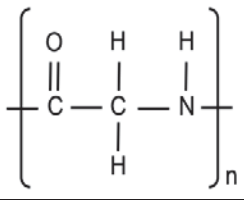
.....[2]

[Total: 10]

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**OR**

**B10 (a)** Polymers have several uses, and can be found almost everywhere. Some information about two polymers are shown below.

| **name of polymer** | **polypropene** | **polyglycine** |
|---|---|---|
| structural formula |  |  |
| name of monomer | propene | glycine |
| average $M_r$ | 2000 – 4000 | 2000 - 5000 |

**(i)** Polyglycine is a polyamide, which is made by the condensation polymerization of the amino acid monomer, glycine. Draw the full structural formula of the monomer, glycine.

[1]

**(ii)** Describe one similarity and one difference between the structures of the addition polymer, polypropene, and the condensation polymer, polyglycine.

.....

.....

.....

..... [2]

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**(iii)** The condensation polymerisation of glycine to produce one molecule of polyglycine eliminates 990 g of water.

Calculate the relative molecular mass of this molecule of polyglycine, showing all your working ($M_r$ of glycine is 75).

[2]

**(b)** When compound **A** ($C_2H_6O$), an alcohol, was heated with acidified potassium manganate (VII), an organic compound **B** was formed. When a mixture of **A** and **B** was heated in the presence of a catalyst, a sweet smelling liquid **C** was obtained.

**(i)** Draw the full structural equation for the reaction that occurs between **A** and **B**. Identify compound **A**, **B** and **C** and write their respective names next to their structural formula in the equation.

[3]

**(ii)** Compound **A** can be used as a car fuel. In some countries it is produced from the sugars in sugar cane.

An environmentalist makes a comment about using compound **A** as a fuel.

> Compound **A** as a fuel is 'carbon neutral' because using it does not add to the amount of carbon dioxide in the atmosphere.

Do you agree with the comment? Explain your reasoning.

.....

.....

[2]

[Total: 10]

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# The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | 0 |
| | | | | | | | 1<br>H<br>hydrogen<br>1 | | | | | | | | | | 2<br>He<br>helium<br>4 |
| 3<br>Li<br>lithium<br>7 | 4<br>Be<br>beryllium<br>9 | | **Key**<br>proton (atomic) number<br>atomic symbol<br>name<br>relative atomic mass | | | | | | | | | 5<br>B<br>boron<br>11 | 6<br>C<br>carbon<br>12 | 7<br>N<br>nitrogen<br>14 | 8<br>O<br>oxygen<br>16 | 9<br>F<br>fluorine<br>19 | 10<br>Ne<br>neon<br>20 |
| 11<br>Na<br>sodium<br>23 | 12<br>Mg<br>magnesium<br>24 | | | | | | | | | | | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28 | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32 | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40 |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40 | 21<br>Sc<br>scandium<br>45 | 22<br>Ti<br>titanium<br>48 | 23<br>V<br>vanadium<br>51 | 24<br>Cr<br>chromium<br>52 | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56 | 27<br>Co<br>cobalt<br>59 | 28<br>Ni<br>nickel<br>59 | 29<br>Cu<br>copper<br>64 | 30<br>Zn<br>zinc<br>65 | 31<br>Ga<br>gallium<br>70 | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75 | 34<br>Se<br>selenium<br>79 | 35<br>Br<br>bromine<br>80 | 36<br>Kr<br>krypton<br>84 |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89 | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93 | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>- | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103 | 46<br>Pd<br>palladium<br>106 | 47<br>Ag<br>silver<br>108 | 48<br>Cd<br>cadmium<br>112 | 49<br>In<br>indium<br>115 | 50<br>Sn<br>tin<br>119 | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128 | 53<br>I<br>iodine<br>127 | 54<br>Xe<br>xenon<br>131 |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137 | 57 – 71<br>lanthanoids | 72<br>Hf<br>hafnium<br>178 | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184 | 75<br>Re<br>rhenium<br>186 | 76<br>Os<br>osmium<br>190 | 77<br>Ir<br>iridium<br>192 | 78<br>Pt<br>platinum<br>195 | 79<br>Au<br>gold<br>197 | 80<br>Hg<br>mercury<br>201 | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207 | 83<br>Bi<br>bismuth<br>209 | 84<br>Po<br>polonium<br>– | 85<br>At<br>astatine<br>– | 86<br>Rn<br>radon<br>– |
| 87<br>Fr<br>francium<br>– | 88<br>Ra<br>radium<br>– | 89 – 103<br>actinoids | 104<br>Rf<br>Rutherfordium<br>– | 105<br>Db<br>dubnium<br>– | 106<br>Sg<br>seaborgium<br>– | 107<br>Bh<br>bohrium<br>– | 108<br>Hs<br>hassium<br>– | 109<br>Mt<br>meitnerium<br>– | 110<br>Ds<br>darmstadtium<br>– | 111<br>Rg<br>roentgenium<br>– | 112<br>Cn<br>copernicium<br>– | | 114<br>Fl<br>flerovium<br>– | | 116<br>Lv<br>livermorium<br>– | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 57<br>La<br>lanthanum<br>139 | 58<br>Ce<br>cerium<br>140 | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144 | 61<br>Pm<br>promethium<br>– | 62<br>Sm<br>samarium<br>150 | 63<br>Eu<br>europium<br>152 | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159 | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165 | 68<br>Er<br>erbium<br>167 | 69<br>Tm<br>thulium<br>169 | 70<br>Yb<br>ytterbium<br>173 | 71<br>Lu<br>lutetium<br>175 |
| actinoids | 89<br>Ac<br>actinium<br>– | 90<br>Th<br>thorium<br>232 | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238 | 93<br>Np<br>neptunium<br>– | 94<br>Pu<br>plutonium<br>– | 95<br>Am<br>americium<br>– | 96<br>Cm<br>curium<br>– | 97<br>Bk<br>berkelium<br>– | 98<br>Cf<br>californium<br>– | 99<br>Es<br>einsteinium<br>– | 100<br>Fm<br>fermium<br>– | 101<br>Md<br>mendelevium<br>– | 102<br>No<br>nobelium<br>– | 103<br>Lr<br>lawrencium<br>– |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).



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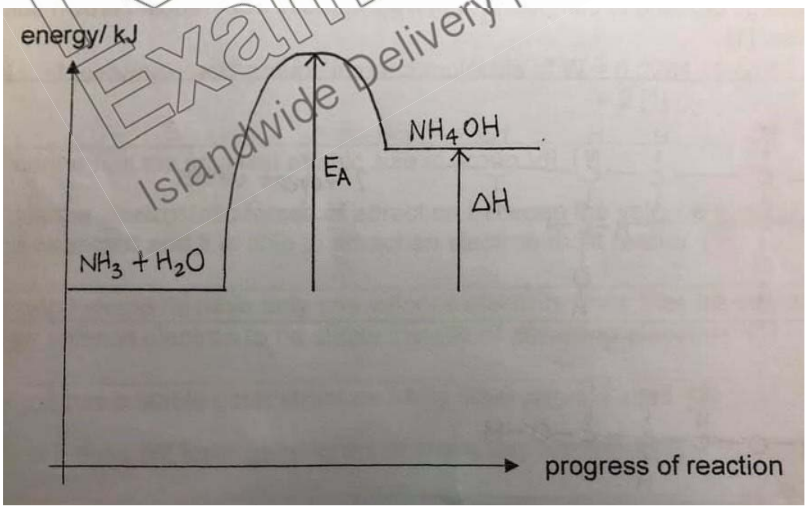
***Zhonghua Secondary School***

***2019 Prelim 6092 Examination- Chemistry***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | **A** | 21 | **D** | | | | |
| 2 | **D** | 22 | **B** | | | | |
| 3 | **C** | 23 | **B** | | | | |
| 4 | **A** | 24 | **D** | | | | |
| 5 | **C** | 25 | **D** | | | | |
| 6 | **D** | 26 | **B** | | | | |
| 7 | **D** | 27 | **B** | | | | |
| 8 | **A** | 28 | **C** | | | | |
| 9 | **A** | 29 | **D** | | | | |
| 10 | **B** | 30 | **D** | | | | |
| 11 | **B** | 31 | **B** | | | | |
| 12 | **B** | 32 | **A** | | | | |
| 13 | **B** | 33 | **C** | | | | |
| 14 | **A** | 34 | **D** | | | | |
| 15 | **B** | 35 | **C** | | | | |
| 16 | **D** | 36 | **B** | | | | |
| 17 | **B** | 37 | **B** | | | | |
| 18 | **B** | 38 | **C** | | | | |
| 19 | **C** | 39 | **B** | | | | |
| 20 | **C** | 40 | **A** | | | | |

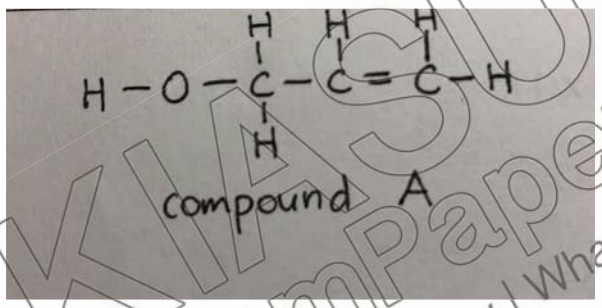
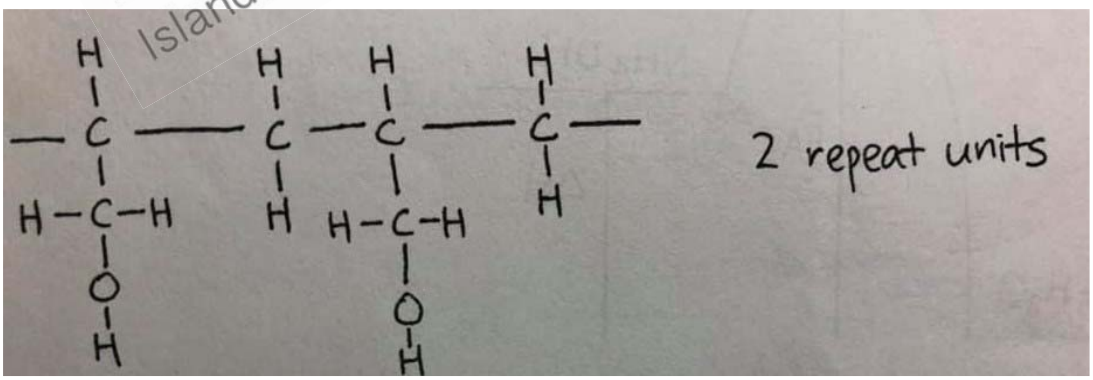
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| | |
|---|---|
| **A1**(a) | $NH_3$ [1] |
| (b) | $KMnO_4$ [1] |
| (c) | KI [1] |
| (d) | $CuSO_4$ [1] |
| (e) | $ZnSO_4$ [1] |
| (f) | KI [1] |
| | |
| **A2** (a) | $CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2$ [1] |
| (b) | Ammonia is oxidized to form nitrogen gas. Oxidation state of nitrogen increases from -3 in $NH_3$ to 0 in $N_2$. [1]<br><br>Oxygen gas is reduced to form steam. Oxidation state of oxygen decreases from 0 in $O_2$ to -2 in $H_2O$. [1]<br><br>Since oxidation and reduction take place, it is a redox reaction. |
| (c) | $N_2 + 3H_2 \rightleftharpoons 2NH_3$<br><br>No of moles of $N_2$: $H_2$<br>1 : 3<br>2 : 6<br>Nitrogen is in excess, hydrogen is the limiting reactant. [1]<br><br>Theoretical mass of ammonia = 6/24 x 2/3 x 17<br>= 2.83 g [1]<br><br>Maximum mass of ammonia = 2.83 x 88%<br>= 2.49 g [1] (3sf) |
| (d) | <br><br>[1] for $E_A$<br>[1] for $\Delta H$<br>[1] for reactants and products |

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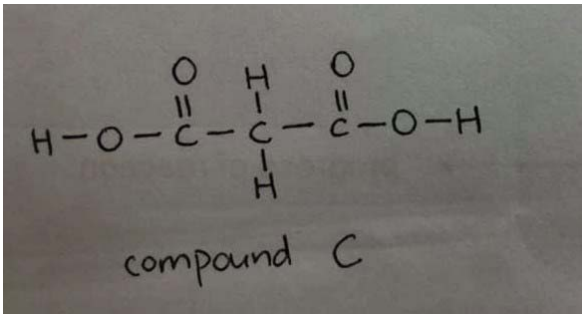
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| | |
|---|---|
| **A3**(a) | Reddish brown solid will be formed on X. [1] |
| (b) | Student A is correct.<br><br>$Cu^{2+}$ ions will be <u>preferentially discharged</u> at the cathode and reduced to form Cu. [1]<br><br>$Cu^{2+}$ (aq) + 2e → Cu(s) [1]<br><br>Blue colour intensity fades away due to $Cu^{2+}$ ions being removed from the electrolyte. [1] |
| (c)(i) | Green to violet/blue [1] |
| (ii) | Initially concentrated potassium chloride solution is neutral and universal indicator is green. <u>Hydrogen ions</u> will be <u>preferentially discharged</u> at the cathode to form hydrogen gas. <u>Chloride ions</u> will be <u>preferentially discharged</u> at the anode to form chlorine gas. [1]<br><br>Thus the remaining electrolyte is potassium hydroxide, which is alkaline. Universal indicatior turns violet in the presence of an alkaline solution. [1] |
| **A4**(a) |  |
| (b) | Add <u>aqueous bromine</u> to compound **A**. It decolourises from <u>reddish brown</u> solution to <u>colourless</u>. [1] |
| (c) |  |

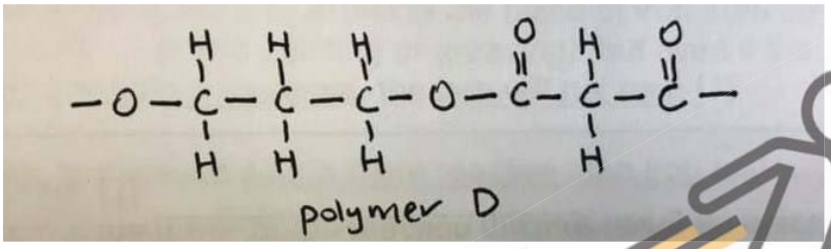
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(d)

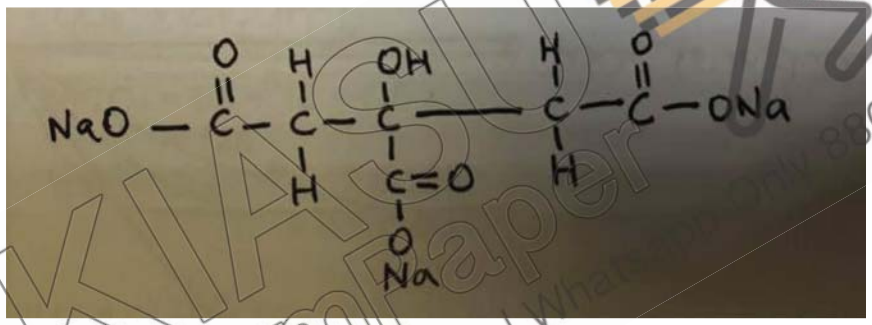



(e)




**A5**

(a)



(b)(i)

| **Element** | C | H | O |
|---|---|---|---|
| **Percentage** | 40.7 | 5.1 | 54.2 |
| **No. of moles** | 40.7/12 = 3.39 | 5.1/1 =5.1 | 54.2/16 = 3.39 |
| **Simplest ratio** | 3.39/3.39 =1 | 5.1/3.39 =1.5 | 3.39/3.39 =1 |
| | 2 | 3 | 2 |

Correct table with values [2] marks

Empirical formula is $C_2H_3O_2$. [1]

(ii)

No. of moles of NaOH = 1 x (29.40/1000)
= 0.0294 mol
No. of moles of **W** reacted = 1.73/118
= 0.0146 mol [1]

No. of carboxylic acid groups in each molecule of **W** = 0.0294 / 0.0146
= 2 [1]

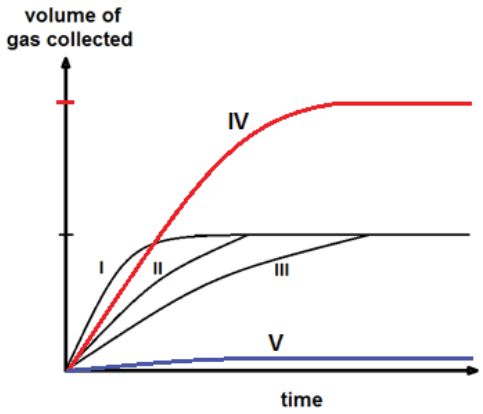
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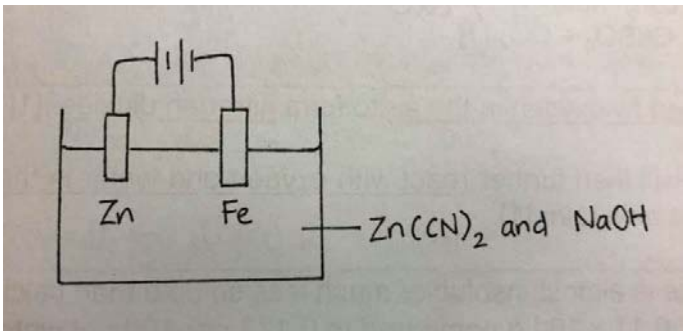
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<table>
<tr><td>A6<br>(a)</td><td>Fluorine has the smallest atomic size in group VII. [1]<br><br>Thus the electrostatic forces of attraction between the valence electron and nucleus is the strongest and it is able to attract an electron most readily. [1]</td></tr>
<tr><td>(b)</td><td>Group I elements have only one valence electron. Thus they have tendency to lose their valence electron to be stable instead of attracting electrons. [1]</td></tr>
<tr><td>(c)</td><td>Argon has a stable octet structure / fully filled valence shell. [1]<br><br>Thus it does not lose, gain/attract or share any electrons.[1]</td></tr>
<tr><td>(d)</td><td>Francium [1]<br><br>Range of value = 0.50 – 0.79 [1]</td></tr>
<tr><td>A7<br>(a)</td><td>Weak acids partially ionize to produce lower concentration of $H^+$ ions. [1]</td></tr>
<tr><td>(b)</td><td>$H_3PO_4$ (aq) ⇌ $3H^+$ (aq) + $PO_4^{3-}$ (aq) /<br>$H_3PO_4$ (aq) ⇌ $2H^+$ (aq) + $HPO_4^{2-}$ (aq)/<br>$H_3PO_4$ (aq) ⇌ $H^+$ (aq) + $H_2PO_4^-$ (aq) [1]</td></tr>
<tr><td>(c)</td><td>$NaH_2PO_4$ and $Na_2HPO_4$ [1]</td></tr>
<tr><td>(d)(i)</td><td>
<table>
<tr><th>Acid used</th><th>Curve</th></tr>
<tr><td>HCl</td><td>II</td></tr>
<tr><td>$H_2SO_4$</td><td>I</td></tr>
<tr><td>$H_3PO_4$</td><td>III</td></tr>
</table>
All correct for [1] mark</td></tr>
<tr><td>(ii)</td><td>Both sulfuric acid and hydrochloric acid are strong acids. Sulfuric acid is a dibasic acid while hydrochloric acid is a monobasic acid. Thus, the experiment using sulfuric acid has a faster rate of reaction as compared to hydrochloric acid since the concentration of hydrogen ions is doubled compared to hydrochloric acid. [1]<br><br>The experiment using phosphoric acid will have the lowest rate of reaction because the concentration of hydrogen ions in phosphoric acid is lowest among the three acids. [1]<br><br>The higher the concentration of hydrogen ions per unit volume, the higher the frequency of effective collisions and the faster the rate of reaction. [1]</td></tr>
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| | |
|---|---|
| (e) |  |
| (f) | Measure the mass of the reaction mixture using an electronic balance at fixed time intervals. [1] |

| | |
|---|---|
| **B8** (a) | Galvanising not only protects the piece of iron from coming into contact with oxygen or water (just like painting or greasing), but even if the surface is scratched and the iron beneath is exposed, the iron will not rust. [1]<br><br>This is because zinc is more reactive than iron and will corrode in place of iron. [1] |
| (b)(i) | $2Zn + O_2 \rightarrow 2ZnO$ [1]<br>$ZnO + CO_2 \rightarrow ZnCO_3$ [1] |
| (ii) | Mr of $ZnCO_3$ = 65 + 12 + (16 x 3)<br>= 125<br>No. of mol of $ZnCO_3$ = 12.5/125<br>= 0.1 mol [1]<br><br>No. of mol of ZnO = 0.1 x 1<br>= 0.1 mol<br>Mass of Zn = 0.1 x 65<br>= 6.5 g [1] |
| (c)(i) |  |

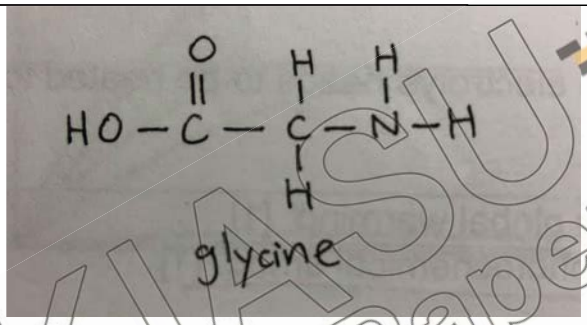
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| | |
|---|---|
| (ii) | The acids in the electrolyte may react with the iron and zinc electrodes. /<br>$H^+$ ions from the electrolyte can be preferentially discharged to form $H_2$ gas. [1] |
| (d) | A piece of iron galvanised by hot-dip galvanisation is more durable / less likely to rust, as the layer of zinc is thicker. [1]<br><br>However, it is more expensive/ more energy is needed as the electrolyte needs to be heated to 460°C to carry out galvanisation. [1] |
| **B9** (a) | Methane is a greenhouse gas. It causes global warming. [1]<br>Methane also leads to the formation of photochemical smog. [1] |
| (b) | $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ [1]<br>Plants take in carbon dioxide and water in the presence of sunlight to manufacture glucose. [1] |
| (c) | Hydrogen is currently obtained from cracking of petroleum. [1]<br>Petroleum is a non-renewable source / depleting finite resource. [1] |
| (d) | Any 2 answers:<br><br>Burning hydrogen does not produce any pollutants, it produces only water. [1]<br><br>The reaction between hydrogen and oxygen is more exothermic, thus producing more energy than that of gasoline. [1]<br><br>Hydrogen is a renewable resource. [1] |
| (e) | Anode equation: $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ [1]<br>Overall equation: $2H_2O(l) \rightarrow O_2(g) + 2H_2(g)$ [1] |
| **B10**(a)(i) Either | The amounts of CO, $SO_2$ and PM10 emissions are lower when using biodiesel than fossil diesel. [1]<br><br>On the contrary, the amount of $NO_x$ exhaust emission is higher when burning biodiesel than fossil diesel. [1] |
| (ii) | There is more amount of CO produced. CO is a pollutant which binds with haemoglobin in red blood cells, reducing its ability to transport oxygen. This causes breathing difficulties and may even result in death. [1]<br><br>There is more $SO_2$ produced. $SO_2$ irritate the eyes and lungs and causes breathing difficulties [1] |

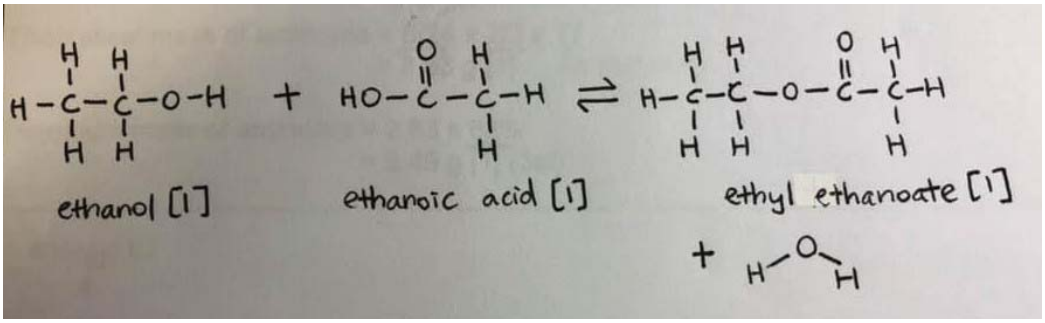
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| | |
|---|---|
| (b)(i) | CaO/ calcium oxide [1]<br>$CaO + SO_2 \rightarrow CaSO_3$ [1]<br><br>OR<br><br>$CaCO_3$/ calcium carbonate [1]<br>$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$ [1] |
| (ii) | NO will be <u>oxidised by oxygen in the air</u> to form <u>nitrogen dioxide</u>. [1]<br><br>Nitrogen dioxide will then further <u>react with oxygen and water in the air</u> to form nitric acid which causes acid rain. [1] |
| (iii) | Calcium carbonate is almost insoluble/ much less soluble than calcium hydroxide, with a solubility of $6.17 \times 10^{-4}$ g compared to 0.173 per 100g of water. [1]<br><br>Thus $CaCO_3$ reacts <u>slowly</u> with acid/effective only in reducing acidity on the surface of the soil/ cannot penetrate the soil to neutralise acid deeper down. [1] |
| **B10**<br>(a)(i)<br>Or | <br> |
| (ii) | Similarity: Both polymers only require one type of monomer / both polymers have giant molecular structures. [1]<br><br>Difference: Polypropene is a hydrocarbon while polyglycine is a non-hydrocarbon / polyglycine has amide linkage while polypropene is held together by C-C single bonds. [1] |
| (iii) | No of monomers = 990/18<br>= 55 [1]<br>Mr of polyglycine = 55 x [75 – 16 – 2(1)]<br>= 3135 [1] |

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| | |
|---|---|
| (b)(i) | Compound A is ethanol, B is ethanoic acid and C is ethyl ethanoate.<br><br> |
| (ii) | The amount of carbon dioxide emitted during the combustion of ethanol [1] is balanced by the taking in of carbon dioxide by sugar cane during photosynthesis [1].<br><br>As there is no net gain in carbon dioxide, the environmentalist is correct. |

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