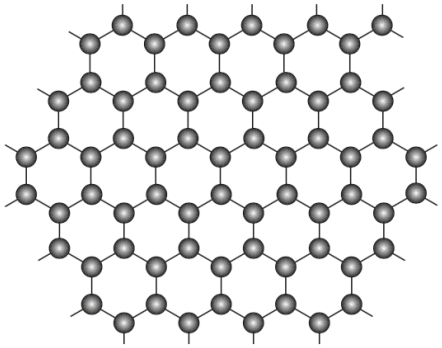
Section A (70 marks)
Answer **all** the questions in this section in the spaces provided.

A1 Carbon is an element with chemical symbol C and atomic number 6. Many substances are made from carbon atoms.

(a) Graphene is a new 2-dimensional material made of carbon atoms. Graphene can be described as a 'one-atom-thick' layer of graphite.



Using your understanding of bonding and structure, predict which of these statements would be true and which would be false.

	true	false
Graphene is slippery.		
Graphene is soluble in organic solvent.		
Graphene conducts in solid state.		
Graphene is a gas at room temperature.		

[2]

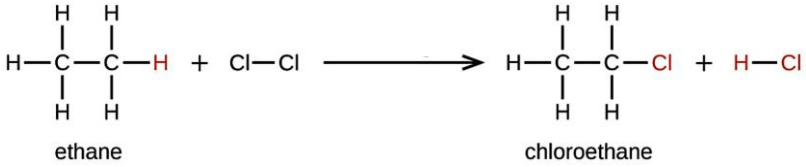
(b) Carbon disulfide, CS_2, is a compound of carbon used in the manufacture of fibres and polymers.

Draw a 'dot-and-cross' diagram using the outer electrons to show the bonding in carbon disulfide.

[2]

A2 Ethane reacts with chlorine in the presence of sunlight.

The equation for this reaction is:



Some bond energies are given in the table.

Bond	Bond energy in kJ per mole
C−C	607
C−H	413
C−Cl	327
Cl−Cl	243
H−Cl	432

(a) Show that the enthalpy change, ΔH, for this reaction is −103 kJ.

[2]

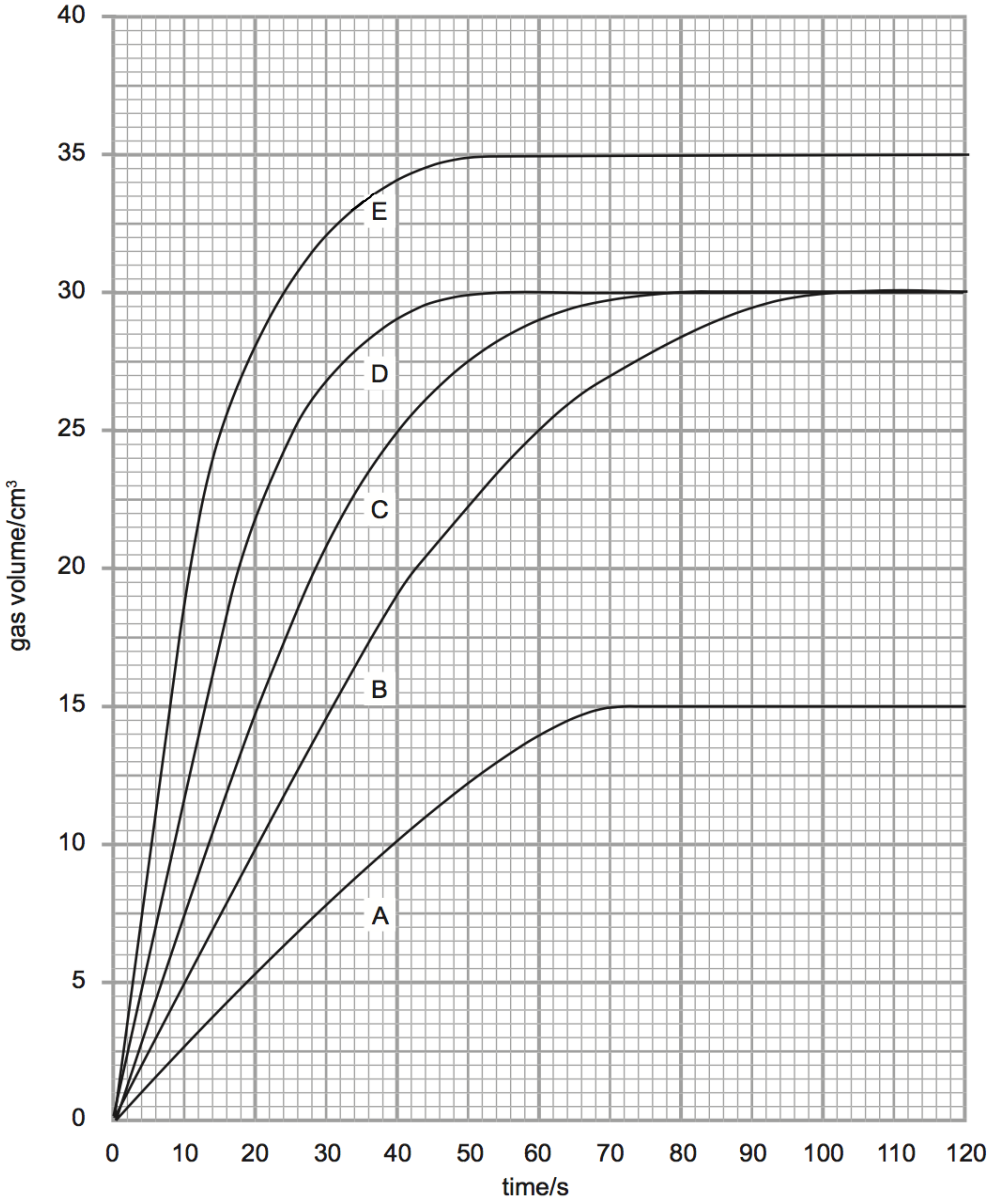
(b) Draw a labelled energy profile diagram for the reaction of ethane with chlorine, including **activation energy** and **enthalpy change**.

[2]

A3 0.03 g of magnesium ribbon reacted with excess dilute hydrochloric acid at room temperature. The volume of gas produced was recorded every 20 seconds.

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

The results obtained in the experiment, using 0.03 g of magnesium ribbon and excess dilute hydrochloric acid, are shown as line **C** on the graph, shown.



The experiment was repeated under different conditions and the results obtained plotted as lines **A**, **B**, **D** and **E** on the graph.

(a) State which line, **A**, **B**, **D** or **E**, was obtained when 0.03 g of magnesium ribbon reacted with excess dilute hydrochloric acid at a temperature below room temperature.

[1]

.....

(b) State which line, **A**, **B**, **D** or **E**, was obtained when 0.015 g of magnesium ribbon reacted with excess dilute hydrochloric acid at room temperature.

[1]

.....

(c) **(i)** State which line, **A**, **B**, **D** or **E**, was obtained when 0.03 g of magnesium ribbon were replaced by 0.03 g of magnesium powder.

[1]

.....

(ii) Explain your answer based on the shape of the line chosen in comparison to line **C**.

.....

[1]

.....

(d) State and explain, in terms of Collision Theory, the effect of increasing the concentration of the acid on the rate of the reaction between hydrochloric acid and magnesium.

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.....

.....

[2]

.....

(e) Calculate the mass of magnesium ribbon used to react with excess dilute hydrochloric acid at room temperature to produce 20 cm^3 of hydrogen gas.

[1]

A4 In 2008, many people in Zimbabwe died because of a cholera epidemic caused largely by drinking untreated water. It is possible to stop the spread of diseases like cholera by treating water with chlorine. Chlorine forms chloric(I) acid which kills the harmful bacteria found in the water.

(a) A student decides to analyse some swimming pool water to determine the concentration of chlorine it contains.

The student takes 250 cm^3 sample of water and treats it with an excess of potassium iodide solution. Equation **1** represents the reaction of chlorine with potassium iodide solution.

Equation **1** $2I^-(aq) + Cl_2(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$

(i) Equation **2** represents the reaction of sodium thiosulfate solution and iodine. The student titrates the 250 cm^3 treated sample with sodium thiosulfate solution, $Na_2S_2O_3$, to find out how much iodine has formed.

Equation **2** $2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$

The titration requires 12.30 cm^3 of 0.10 mol/dm^3 sodium thiosulfate solution.

Calculate the number of moles of thiosulfate ion, $S_2O_3^{2-}$, used.

[1]

(ii) Using the answer in **(i)** and Equation **2**, calculate the number of moles of iodine, I_2, in the 250 cm^3 sample of treated water.

[1]

(iii) Using the answer in **(ii)** and Equation **1**, calculate the concentration of the chlorine, Cl_2, in the original swimming pool water, in mol/dm^3.

[1]

(b) Chloric(I) acid, HClO, can also be produced by adding water to either solid calcium chlorate(I), which is a salt of chloric(I) acid or chlorine dioxide gas, ClO_2.

(i) Write the chemical formula of calcium chlorate(I).

[1]

.....

(ii) State one reason why it may be preferable to use calcium chlorate(I) rather than chlorine dioxide for treating drinking water.

.....

[1]

.....

(iii) Chlorine dioxide reacts with water in a disproportionation reaction.

Disproportionation happens when the oxidation state of the same element both increases and decreases in the reaction.

$$4ClO_2 + 2H_2O \rightarrow HClO + 3HClO_3$$

The oxidation state of chlorine in chlorine dioxide is +4.

Explain why the reaction of chlorine dioxide with water is a disproportionation reaction.

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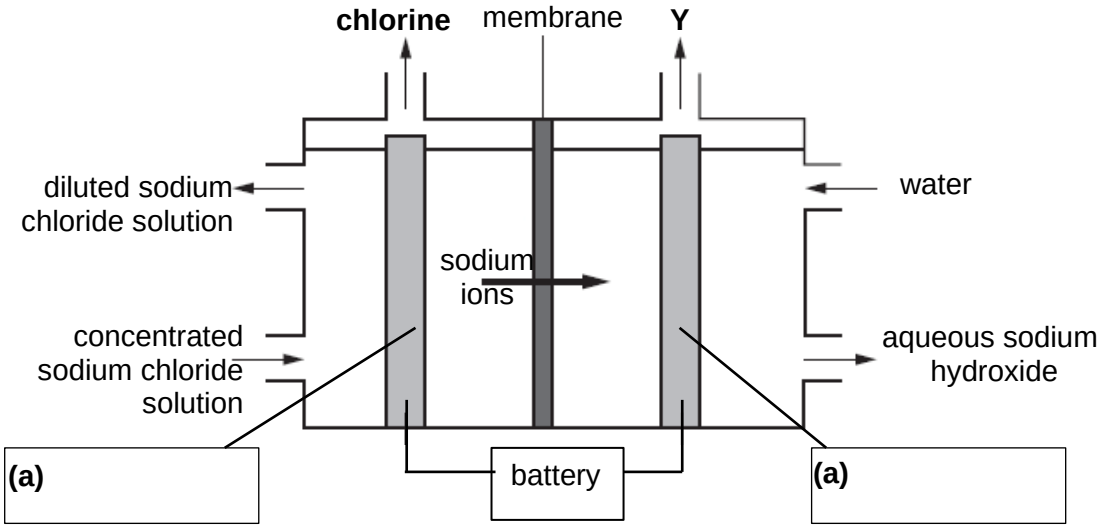
.....

[2]

.....

A5 Sodium hydroxide is a very useful industrial chemical. The diagram shows a set-up used to produce aqueous sodium hydroxide from concentrated sodium chloride solution.



(a) Label on the diagram the anode and the cathode. [1]

(b) Identify **Y** and explain your answer.

.....

[2]

.....

(c) Explain how aqueous sodium hydroxide is formed as a product.

.....

[1]

.....

(d) Describe a simple test for the presence of chlorine gas.

.....

[1]

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(e) The membrane used in the set-up is porous. A porous membrane has pores of a specific size so that only particles with sizes smaller than the pores can pass through the membrane.

The porous membrane is necessary for aqueous sodium hydroxide to be collected as the only product without any contamination from the chloride ions in the set-up.

Explain why the porous membrane prevents contamination from chloride ion.

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[1]

.....

(f) If dilute sodium chloride solution is used in the set-up instead of concentrated sodium chloride solution, the results would be different.

Describe and explain two differences in the results.

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[3]

.....

A6 Most vehicles have diesel engines. In recent years, biodiesel is used as an alternative for diesel. Biodiesel is made from a vegetable oil while diesel is obtained from fractional distillation of crude oil.

(a) Biodiesel and diesel have different effects on the environment when used as fuels.

Suggest the effect of using these two fuels on the percentage of carbon dioxide in the environment.

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[3]

(b) Cars are the most common form of transportation in Singapore.

The following message was displayed on the side of a bus in Singapore.

> This bus is more environmentally friendly than a car.
>
> 40 cars = 230,000 kg of CO_2 per year
>
> This bus = 3,200 kg of CO_2 per year

Using the information given, state and explain how the environmental problem caused by carbon dioxide can be reduced if people take public transport like the bus.

.....

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[2]

(c) Carbon dioxide formed in the atmosphere dissolves in the ocean. The dissolving process can be described by the following chemical equation:

$$CO_2(aq) + H_2O(l) \rightarrow H^+(aq) + HCO_3^-(aq)$$

Use this information to explain the likely effect of the atmospheric carbon dioxide on the pH of seawater at the ocean surface.

.....

[1]

.....

A7 Ethers are a group of compounds containing carbon, hydrogen and oxygen.

Name	Molecular formula	Boiling point / °C
methoxyethane	$CH_3–O–CH_2CH_3$	7
ethoxyethane	$CH_3CH_2–O–CH_2CH_3$	35
P	$CH_3–O–CH_2CH_2CH_3$	39
propoxybutane	$CH_3CH_2CH_2–O–CH_2CH_2CH_2CH_3$	117

(a) Name ether **P**.

[1]

.....

(b) With reference to the information in the table, state and explain the trend observed in the boiling points of ether.

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.....

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[2]

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(c) Simple ethers are prepared commercially by the dehydration of alcohols using concentrated sulfuric acid.

Alcohol **Q** is used to prepare ethoxyethane, $C_2H_5–O–C_2H_5$, according to the following equation.

$$2\mathbf{Q} \xrightarrow{\text{conc. } H_2SO_4} C_2H_5–O–C_2H_5 + H_2O$$

(i) Name alcohol **Q** used in the reaction.

[1]

.....

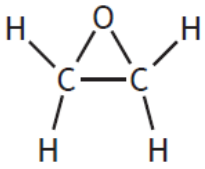
(ii) Alcohol **Q** reacted with an organic compound **P** (with a molecular formula of CH_2O_2) to form a sweet smelling liquid, **R**.

Complete the following table by giving the name and chemical formula for **R**.

Name	
Chemical Formula	

[2]

(d) Epoxides are a family of cyclic ethers.
The full structural formula for the first member (C_2H_4O) of this family is shown.



The first member has three atoms in a ring, one of which is oxygen.

(i) Epoxides can be produced by reacting an alkene with oxygen.

Name the alkene which would be used to produce the first member (C_2H_4O).

[1]

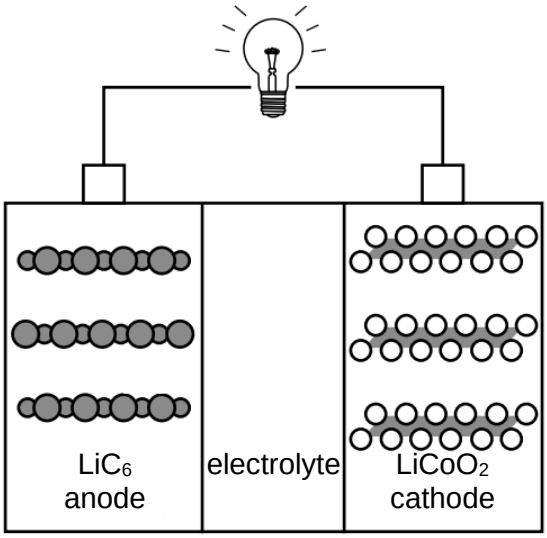
.....

(ii) The second member of epoxides has a chemical formula of C_3H_6O and four atoms in a ring, one of which is oxygen.

Draw a full structural formula for this epoxide with the chemical formula of C_3H_6O.

[1]

A8 The lithium-ion battery is rechargable and is now widely used in portable electronic devices. In these batteries, lithium ions, Li^+, move through a special non-aqueous electrolyte between the two electrodes. Both electrodes are made up of materials that allow the lithium ions to move into and out of their structures.The electrodes are housed in sealed containers to ensure that no moisture can enter them.



A lithium-ion battery

The anode consists of LiC_6, where lithium is embedded in the graphite structure. Lithium cobalt oxide,$LiCoO_2$, is commonly used as the material in the cathode.

When the lithium-ion battery discharges to create the flow of electrons in the circuit, lithium ions move out of the anode and enter the cathode.

During battery **discharges**, the half-equation at the anode is as follows:

$$LiC_6 \rightarrow Li^+ + e^- + C_6$$

During battery **recharges**, the following equations represent a simplified description of the reactions that occur at the electrodes.

Positive electrode $LiCoO_2 \rightarrow CoO_2 + Li^+ + e^-$

Negative electrode $6C + Li^+ + e^- \rightarrow LiC_6$

(a) On the diagram, use arrows to indicate the direction of movement of electrons through the light bulb as the lithium ion cell is **discharged**.

[1]

(b) Based on the information given in the passage, identify one important design feature of the lithium-ion battery that enables it to be recharged.

.....

[1]

.....

(c) In a lithium-ion battery, lithium metal must **not** be in contact with water.

Explain why and justify your answer with the use of an appropriate equation.

.....

.....

[2]

.....

(d) Suggest an advantage of using a lithium-ion battery compared to using a fuel cell as an energy source.

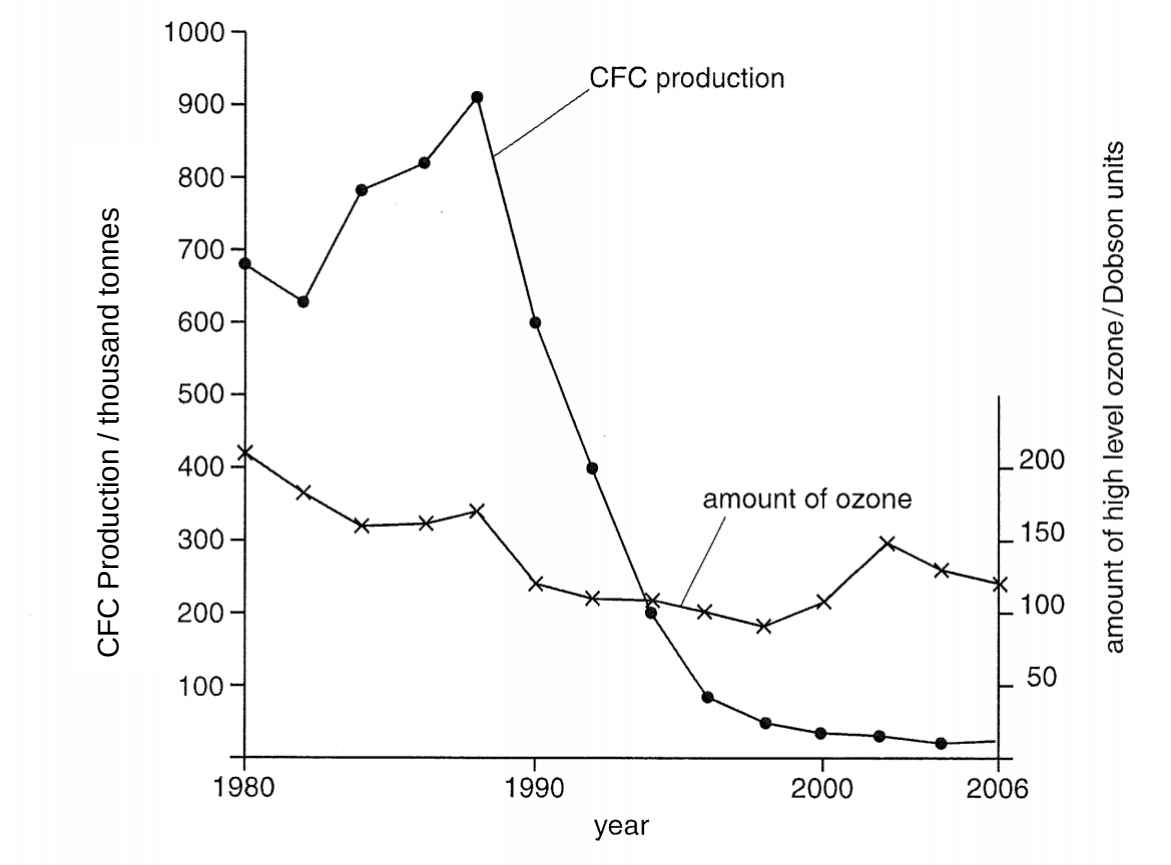
.....

[1]

.....

A9 Chlorofluorcarbons (CFCs) are organic compounds of carbon, fluorine and chlorine, which have been used in large quantities as solvents and aerosol propellants.

The graphs show how both the world CFC production and the amount of high level ozone at the South Pole have changed during 1980 to 2006.



CFCs are chemically inert and do not react with air or water. When CFC molecules diffuse high up into the atmosphere, they can destroy the ozone molecules which are present in a layer about 30 kilometres above the Earth.

Other than CFCs that destroy the ozone molecules, there are also hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and fluorocarbons (FCs) found in the atmosphere.

The abbreviations to the name tell us the elements present in the compounds as shown in the table.

Abbreviations	***Elements Present***
FC	Carbon, Fluorine
CFC	Carbon, Fluorine, Chlorine
HFC	Hydrogen, Carbon, Fluorine
HCFC	Hydrogen, Carbon, Fluorine, Chlorine

(a) Explain why the ozone layer is important in terms of human health.

.....

[1]

.....

(b) From the graph, describe how the world production of CFCs has changed over the period of 1980 to 2006.

.....

.....

[2]

.....

(c) With evidence from the graph, if any, indicate whether there is a link between the world CFC production and the amount of high-level ozone in the atmosphere at the South Pole.

Explain your answer.

.....

.....

.....

[2]

.....

(d) Given that FC is a saturated molecule, draw the structure of a FC molecule with two carbon atoms.

[1]

(e) A student comments that HFCs are safe alternatives to CFCs as HFCs do not harm the environment like CFCs do.

Explain why the student is correct.

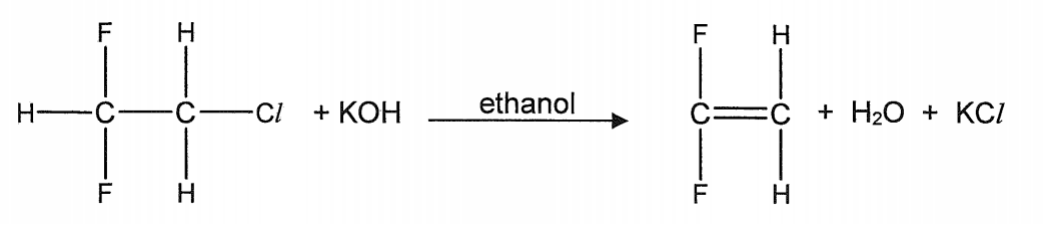
.....

[1]

.....

(f) Although most of these substances are harmful to the ozone layer, they can also be used to make polymers by first converting them into alkenes. For example, HCFCs react with potassium hydroxide dissolved in ethanol (solvent) to give an alkene, potassium chloride and water.

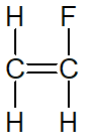
An example of the chemical reaction is shown:



The alkene produced from the reaction can be used to make useful polymers.

A scientist wants to use a similar chemical reaction to produce the polymer, polyvinyl fluoride, using HCFCs.

(i) Using a suitable HCFC, write a similar chemical reaction to show the production of the monomer, vinyl fluoride, with the structural formula of



[2]

(ii) Hence, draw the full structural formula of the polymer, polyvinyl fluoride, showing 3 repeating units.

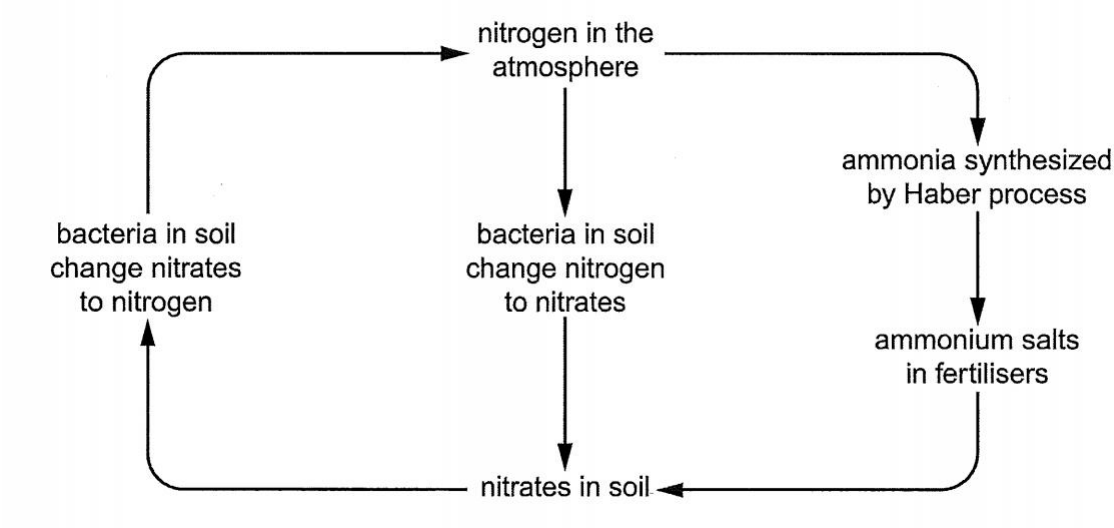
[1]

(iii) Samples of the polyvinyl fluoride polymer produced were analysed and found to have a maximum relative molecular mass of 12000.

What is the maximum number of repeating units for this polymer?

[2]

A10 A simplified diagram of the nitrogen cycle is shown.



(a) Although certain bacteria in the soil convert nitrogen gas into nitrates, other bacteria convert nitrogen into ammonium salts. The ionic equation for this second reaction is as follows:

$$N_2 + 8H^+ + 6e^- \rightarrow 2NH_4^+$$

Explain why this is a reduction reaction.

.....

[1]

.....

(b) A different type of bacterium converts nitrate ions and hydrogen ions into nitrogen gas and water.

Balance the ionic equation for this reaction.

_____ NO_3^- + _____ H^+ + _____ e^- ⟶ _____ N_2 + _____ H_2O [1]

(c) Fertilizers are added to the soil to improve crop yields.

A farmer has the choice of two fertilizers, ammonium nitrate, NH_4NO_3, or diammonium hydrogen phosphate, $(NH_4)_2HPO_4$.

Show by calculation, which of these fertilizers contains the greater percentage of nitrogen by mass.

[3]

(d) Ammonia is formed from the Haber process.

$$N_2 + 3H_2 \rightleftharpoons^{Fe\ catalyst} 2NH_3$$

(i) Suggest a source of hydrogen needed for the Haber process.

.....

[1]

.....

(ii) State two reasons why the use of a catalyst in the Haber process has an economic advantage.

.....

[2]

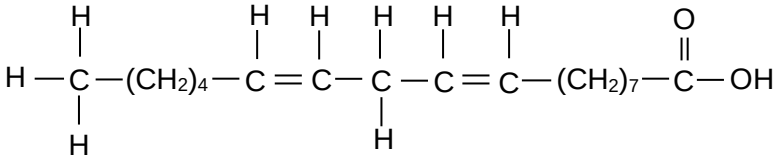
.....

Name : _____	Class	Index Number

Section B (10 marks)

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

B11 **(a)** Linoleic acid is an unsaturated carboxylic acid used to make fats. Under suitable conditions, linoleic acid can be converted to stearic acid. The structural formula of linoleic acid is shown.



(i) Circle the functional groups present in linoleic acid. [2]

(ii) Linoleic acid undergoes addition of hydrogen (hydrogenation) to form stearic acid.

State the conditions of hydrogenation.

[1]

.....

(iii) Describe a chemical test to distinguish between linoleic acid and stearic acid, stating what you would observe in each case.

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[2]

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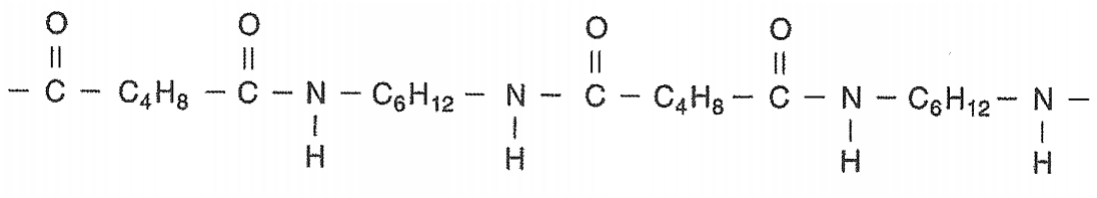
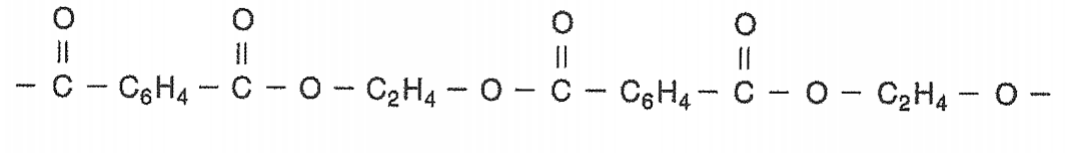
(b) The diagrams show the structures of two synthetic polymers.



Polymer A



Polymer B

(i) Construct a table to show the following information about these two polymers.

- The full structural formula and name of the type of linkages present in each type of polymer.
- The structures of the monomers that react to form each polymer.

[4]

(ii) Both **polymers A and B** are used to make tents for camping. One reason that they are suitable for this purpose is that they are non-biodegradable.

Explain why being non-biodegradable is an advantage.

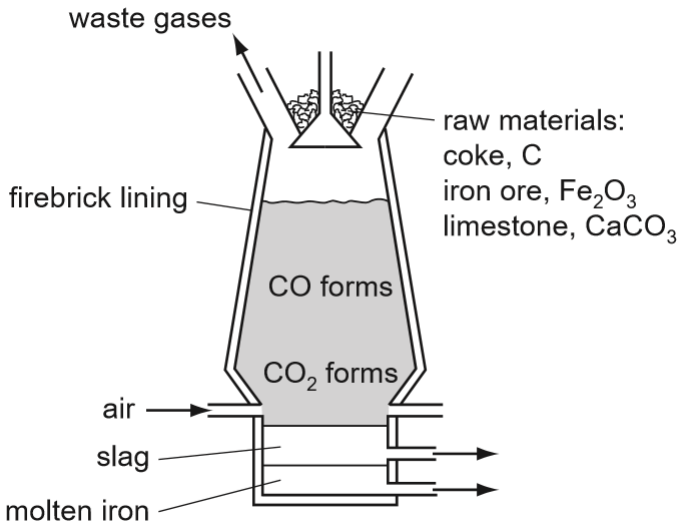
.....

.....

[1]

B12 Iron is an important transition metal used in everyday lives.

(a) Iron is extracted from the ore, hematite, in the blast furnace.



The coke reacts with the oxygen in the air to form carbon dioxide.

$$C + O_2 \rightarrow CO_2$$

(i) Explain why carbon monoxide is formed higher in the blast furnace.

.....

[1]

(ii) Explain why the molten iron does not react with air.

.....

[1]

(iii) The molten iron from the blast furnace is impure. One of the impurities is silicon. It is removed by blowing oxygen through the molten iron and adding calcium oxide.

Explain how the addition of oxygen and calcium oxide removes silicon.

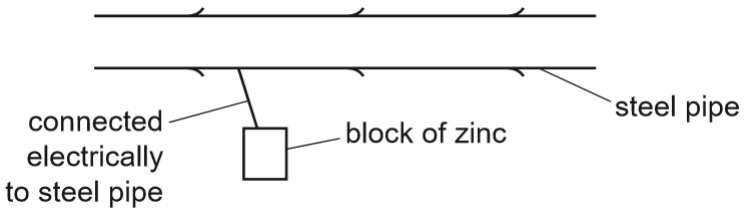
.....

.....

.....

[2]

(b) Iron and steel rust. One method of rust prevention is sacrificial protection.



Explain why the steel pipe does not rust.

.....

.....

[2]

.....

(c) Iron, (Fe), is an element while iron(III) oxide, (Fe_2O_3), is a compound.

Construct a table to show the following comparison of Fe and Fe_2O_3.
Your answer should include a discussion of the differences in their

- electrical conductivity
- chemical reaction with hydrochloric acid

Your answers should include explanations or equations to support your discussion.

[4]

End of Paper

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

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

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

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

METHODIST GIRLS' SCHOOL
SEC 4 CHEMISTRY PRELIM EXAM 2017

Answer Scheme
Section A

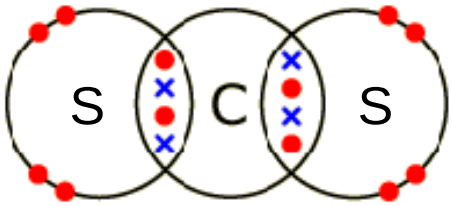
A1 (a)

	true	false
Graphene is slippery.		
Graphene is soluble in organic solvent.		
Graphene conducts electricity in solid state.		
Graphene is a gas at room temperature.		

2

Any 2 correct answer is 1 mark.

(b) 2

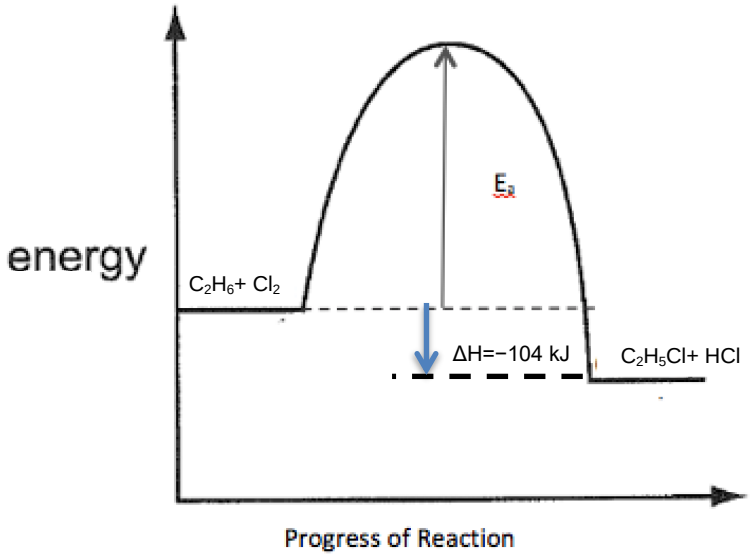


1m for correct sharing of electrons for carbon atom.
1m for correct sharing of electrons for sulfur atom.

A2 (a) Energy change in bond breaking =+(607+6x413 + 243)= +3328 kJ 1
Energy change in bond making =-(607+ 5x413 + 327+432)= -3431 kJ
Heat Change = +3328 -3431 = -103 kJ 1

1m for correct value of energy change in bond breaking and energy change in bond making.
1m for the deriving the heat change.

A2(b) 2



1m for Ea and ΔH with value and unit
1m for the shape with chemical representation of reactants and products

A3 **(a)** **B** 1

(b) **A** 1

(c)(i) **D** 1

(c)(ii) The gradient is steeper than C/rate of gas volume obtained is higher and the volume of the gas formed is the same as C. 1

(must mention both points to award 1 mark0

(d) The higher the concentration of the acid, the faster the rate of reaction. 1

The concentration of hydrogen ions/no. of hydrogen ions per unit volume increased as the concentration of the acid increases, this lead to increased in frequency of effective collision, faster rate of reaction. 1

(e) Mass of magnesium= $\frac{20}{24000}$ x 24 =0.02 g 1

A4 **(a)(i)** No of moles of thiosulfate ion= $\frac{12.3}{1000}$ x 0.1 =1.23x10^{-3} 1

(a)(ii) No of moles of iodine (I_2) in 250 cm^3= $\frac{1}{2}$ x 1.23x10^{-3} =6.15x10^{-4} 1

(a)(iii) No of moles of chlorine (Cl_2) in 250 cm^3 = 6.15x10^{-4} 1

Concentration of chlorine = $\frac{6.15x10^{-4}}{0.25}$ =2.46 x10^{-3} mol/dm^3

A4 **(b)(i)** $Ca(ClO)_2$ 1

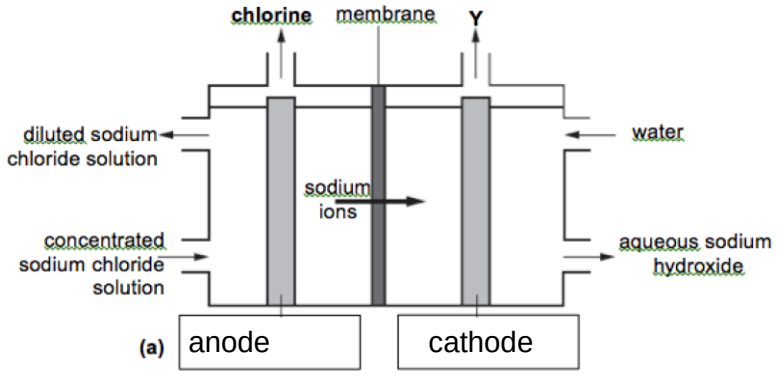
(b)(ii) When calcium chlorate(I) is added to water, <u>calcium chlorate(I)</u> which is a <u>solid will not escape to the surrounding air like chlorine gas</u>. 1

Calcium chlorate(I) is more soluble in water than chlorine gas.

Calcium chlorate is a solid so easier to store/transport compared to chlorine gas.

(b)(iiii) The oxidation state of chlorine decrease from +4 in ClO_2 to +1 in HClO. 1
The oxidation state of chlorine increase from +4 in ClO_2 to +5 in $HClO_3$. 1

A5 **(a)** 1



(b) **Y** is hydrogen 1
<u>hydrogen ion will be preferentially discharged/reduced/gain electron</u> to form hydrogen gas 1

(c) <u>As sodium ions and hydroxide ions are not discharged</u>, they remained in the solution to form sodium hydroxide. 1
OR
<u>As hydrogen ions and chloride ions are discharged</u>, <u>sodium ions and hydroxide ions remained in the solution formed sodium hydroxide</u>.

(d) Place a damp blue litmus paper near the gas, chlorine gas turned damp blue litmus paper red and bleached it. 1

(e) The size of the pore is not big enough chloride ions to pass through. Hence, chloride ion cannot pass through the membrane and chloride ion is separated from hydroxide ion and sodium hydroxide is collected as a product. 1

(f) Oxygen gas instead of chlorine gas will form at the positive electrode/anode. Hydroxide ion is preferentially discharged/oxidised/lost electrons to form oxygen gas. 3

Sodium chloride solution becomes more concentrated as water is decomposed/sodium ions and chloride ions are not discharged

1m for stating the difference: oxygen gas and remaining solution is concentrated sodium chloride solution.
1m for each explanation for each difference.

A6 **(a)** Combustion of diesel only increase the percentage of carbon dioxide in the environment. 1

Vegetable/plant will absorb the same number of moles/volume/amount of carbon dioxide released through combustion of biodiesel during photosynthesis, hence 1
the percentage of carbon dioxide does not increase. 1

OR
Biodiesel is a carbon neutral fuel so 1
the percentage of carbon dioxide does not increase. 1

1m for combustion of diesel increase the percentage of carbon dioxide.
1m for combustion of biodiesel does not increase the percentage of carbon dioxide and reason for that is 1m

(b) By taking public bus instead of having 40 cars, the mass of carbon dioxide produced by the bus is 72 times lower than 40 cars. 1
As a result, the volume of green house gas in the air is reduced to a great extent and this greatly reduced the global warming. 1

OR 1
The mass of carbon dioxide produced by one car is 5750 kg while The mass of carbon dioxide produced by one bus is 3200 kg, the mass of carbon dioxide produced by the bus is 2 times lower than one car. 1
As a result, the volume of green house gas in the air is reduced to a great extent and this greatly reduced the global warming.

(c) As the concentration of carbon dioxide increases, the concentration of hydrogen ions in the ocean increase, the pH of the ocean will decrease from 8. 1

A7 **(a)** methoxypropane 1

(b) Trend is
The boiling point increase with increase in number of carbon atom/molecular size/ relative molecular mass. 1

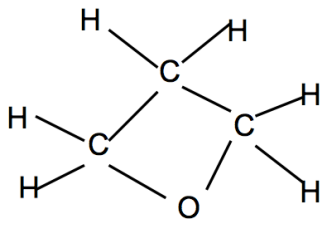
As the number of carbon atoms increase, the molecule is getting bigger/relative molecular mass increases so more heat energy is absorbed to overcome the stronger intermolecular forces of attraction. 1

(c)(i) Ethanol 1

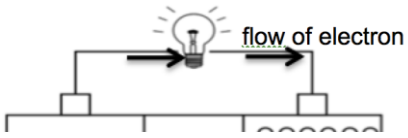
(c)(ii) Name: ethyl methanoate 1
Chemical formula: $HCOOC_2H_5$ or $HCO_2C_2H_5$ or C_2H_5OOCH 1

(d)(i) Ethene 1

(d)(ii) 1



A8 **(a)** 1



Electrons flow from anode to cathode

(b) Movement of lithium ions in and out of electrodes. 1

(c) Lithium reacts vigorously/quickly with water. 1

$2Li + 2H_2O \rightarrow 2LiOH + H_2$ 1

(d) Possible answer (any one) 1
Lithium ion battery is more convenient since it does not need a continuous external supply of reactants.
Lithium ion battery can be recharged (electrically), whereas a fuel cell continuously needs fresh reactants.
Lithium ion battery is usually cheaper than fuel cells.
Lithium ion battery is more portable than fuel cells.
Lithium ion battery is more suitable for most of today's electronic devices.

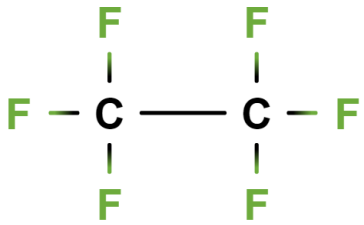
A9 **(a)** Ozone <u>absorbs / traps</u> harmful <u>ultra violet radiation</u> / it absorbs harmful UV light 1
Or: blocks UV rays
UV radiation causes <u>skin cancer / skin burns/ cataracts</u>

(b) rose from early 1980's to 1988 / just before 1990; 1
Or: rose to 1987 OR 1989 / rose to just before 1990
Or: there was an increase in CFCs in the 1980's
Or: rose to a peak in 1988
Reject: increased until 1990

then declined / lowers OR decreases after 1987 or 1988 or 1989 / from the end of the 1980's 1

(c) Any 2 contrasting evidence to show no link 1
e.g: • relates drop in amount of ozone between 1980 and 1988 to increase in CFC production;
• level of ozone from 1998 to 2002 has slightly increased when CFC production had remained low or decreased
• CFC production dropped significantly from 1988 to 1998 but so did the amount of ozone;
• level of ozone from 1998 to 2006 has been very variable and no definite correlation with decrease CFC production 1
(-1m if no conclusion)

(d) 1

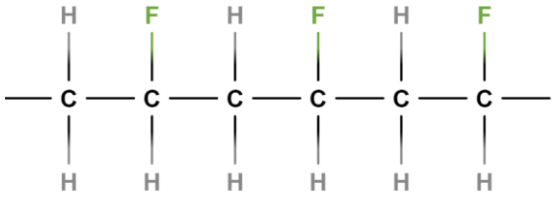


(e) HFCs do not contain <u>chlorine atoms</u>, which <u>deplete the ozone layer.</u> 1

(f)(i) Chemical equation 1

1

(ii) 1



(iii) Molar mass of monomer / repeat unit = 12 x 2 + 19 + 3 = 46 1

No. of repeat units = 12000 / 46 = 260 (round down) 1

A10 **(a)** Nitrogen has gained electrons / oxidation number of nitrogen has decreased. 1
Or: Reduction is the addition of electrons
Or: Oxidation state of nitrogen decreased from 0 to -3
Reject: removal of oxygen/ addition of hydrogen

(b) $2NO_3^- + 12H^+ + 10e^- \longrightarrow N_2 + 6H_2O$ 1

(c) % of nitrogen by mass in ammonium nitrate, NH_4NO_3 = 28 / 80 X 100% = 35% 1

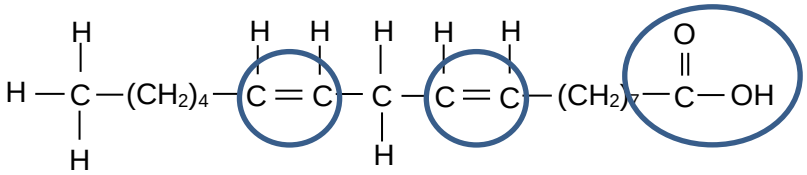
% of nitrogen by mass in diammonium hydrogen phosphate, $(NH_4)_2HPO_4$ = 28 / 132 X 100% = 21.2% 1

ammonium nitrate has the greater percentage by mass of nitrogen. 1

(d)(i) Hydrogen from cracking of hydrocarbons / petroleum 1
Or: hydrogen from methane / natural gas / water

(d)(ii) The catalyst <u>speeds up the rate of reaction</u> by lowering the Ea energy. This helps to <u>increase productivity.</u> 1
The iron catalyst can be <u>reused.</u> 1

11 (a)(i)



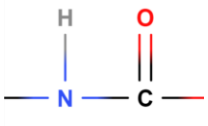
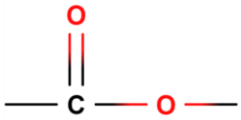
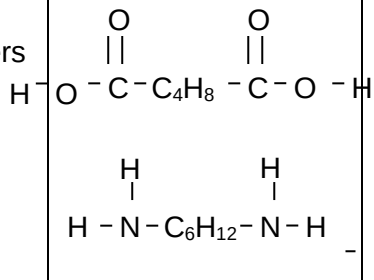
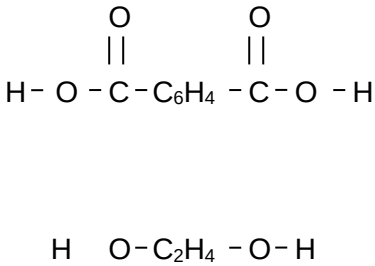
2

1 mark for either alkene and 1 mark carboxylic acid functional groups.

(ii) 200°C, nickel catalyst 1

(iii) Add a solution of bromine into the unknown solution and shake. 1
If linoleic acid is present, reddish-brown colour of bromine quickly disappears / reddish brown bromine decolourised 1
If stearic acid is present, reddish – brown bromine remains reddish brown. / no visible change

(b)(i)

	Polymer A	Polymer B
Full formula and type of linkages present	Amide linkage present: 	Ester linkage present: 
Structures of monomers		

1
1
1
1

(ii) The advantage of being non-biodegradable is that the material is long-lasting as it does not decompose by action of bacteria in the soil. 1

12 **(a)(i)** Insufficient / limited oxygen 1
Or: Coke / carbon reacts with CO_2 to form CO.

(ii) No oxygen in contact with iron. 1
Or: Layer of slag prevents iron from reacting with air
Or: All oxygen reacted with carbon

(iii) Forms silicon(IV) oxide or silicon oxide or silica / $Si + O_2 \rightarrow SiO_2$ 1
CaO reacts with SiO_2 to form slag or calcium silicate 1

(b) Zinc is more reactive than iron/ steel. 1
Zinc loses electrons more easily than iron / zinc corrodes instead of iron / zinc is oxidised / electrons move from zinc to iron. 1

(c)

	Fe	Fe_2O_3
Electrical conductivity	Can conduct in solid (presence of mobile electrons) 1m	Cannot conduct in solid state (no mobile ions) 1m
Chemical reaction with HCl	$Fe + 2HCl \rightarrow FeCl_2 + H_2$ 1m	$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$ 1m