Lisachem Materials

Chemistry Physics Biology
Psychology

VCE CHEMISTRY 2007
INDUSTRIAL TEST
UNIT 3

Time allowed: 50 minutes
Total marks: 40

SECTION A
Contains 12 multiple choice questions

SECTION B
4 Extended response questions

A data sheet and multiple choice answer sheet are provided. Answer extended response questions in the space provided. Use the marks and time allowed as a guide to how much time you should spend answering each question.

Lisachem Materials
PO Box 721 Bacchus Marsh Victoria 3340
Tel: (03) 5367 3641 Fax: (03) 5367 7383
Email: Lisachem@bigpond.net.au

relative atomic number symbol name relative atomic mass	1 H Hydrogen 1.0

																	2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulfur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 44.9	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.6	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yittrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium 98.1	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (266)	107 Ns Neilsbohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (272)	111 Rg Roentgenium (272)	112 Uub Ununbium (277)		114 Uuq Ununquadium (289)				

Lanthanide series	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.3	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinide series	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.1	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (255)	103 Lr Lawrencium (256)

DATA SHEET

Physical Constants

F = 96 500 C mol^{-1}

R = 8.31 JK^{-1} mol^{-1}

V_m (STP) = 22.4 L mol^{-1}

V_m (SLC) = 24.5 L mol^{-1}

Specific heat of water = 4.184 J mL^{-1} $^oC^{-1}$

Ideal gas equation

$pV = nRT$

The Electrochemical Series

		$E°$ in volt
$F_2(g) + 2e^-$	$\rightarrow 2F^-(aq)$	+ 2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^-$	$\rightarrow 2H_2O(l)$	+ 1.77
$Au^+(aq) + e^-$	$\rightarrow Au(s)$	+ 1.68
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$	$\rightarrow Mn^{2+}(aq) + 4H_2O(l)$	+ 1.50
$Cl_2(g) + 2e^-$	$\rightarrow 2Cl^-(aq)$	+ 1.36
$O_2(g) + 4H^+(aq) + 4e^-$	$\rightarrow 2H_2O(l)$	+ 1.23
$Br_2(l) + 2e^-$	$\rightarrow 2Br^-(aq)$	+ 1.09
$Ag^+(aq) + e^-$	$\rightarrow Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^-$	$\rightarrow Fe^{2+}(aq)$	+ 0.77
$I_2(s) + 2e^-$	$\rightarrow 2I^-(aq)$	+ 0.54
$O_2(g) + 2H_2O(l) + 4e^-$	$\rightarrow 4OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2e^-$	$\rightarrow Cu(s)$	+ 0.34
$CO_2(g) + 8H^+(aq) + 8e^-$	$\rightarrow CH_4(g) + 2H_2O(l)$	+ 0.17
$S(s) + 2H^+(aq) + 2e^-$	$\rightarrow H_2S(g)$	+ 0.14
$2H^+(aq) + 2e^-$	$\rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^-$	$\rightarrow Pb(s)$	- 0.13
$Sn^{2+}(aq) + 2e^-$	$\rightarrow Sn(s)$	- 0.14
$Ni^{2+}(aq) + 2e^-$	$\rightarrow Ni(s)$	- 0.23
$Co^{2+}(aq) + 2e^-$	$\rightarrow Co(s)$	- 0.28
$Fe^{2+}(aq) + 2e^-$	$\rightarrow Fe(s)$	- 0.44
$Zn^{2+}(aq) + 2e^-$	$\rightarrow Zn(s)$	- 0.76
$2H_2O(l) + 2e^-$	$\rightarrow H_2(g) + 2OH^-(aq)$	- 0.83
$Mn^{2+}(aq) + 2e^-$	$\rightarrow Mn(s)$	- 1.03
$Al^{3+}(aq) + 3e^-$	$\rightarrow Al(s)$	- 1.67
$Mg^{2+}(aq) + 2e^-$	$\rightarrow Mg(s)$	- 2.34
$Na^+(aq) + e^-$	$\rightarrow Na(s)$	- 2.71
$Ca^{2+}(aq) + 2e^-$	$\rightarrow Ca(s)$	- 2.87
$K^+(aq) + e^-$	$\rightarrow K(s)$	- 2.93
$Li^+(aq) + e$	$\rightarrow Li(s)$	- 3.02

Student Name……..

VCE Chemistry 2007 Industrial Test

SECTION A

MULTIPLE CHOICE ANSWER SHEET

Instructions:

For each question choose the response that is correct or best answers the question.
Circle the chosen response on this answer sheet.
Only circle **one** response for each question.

Question 1.	A	B	C	D
Question 2.	A	B	C	D
Question 3.	A	B	C	D
Question 4.	A	B	C	D
Question 5.	A	B	C	D
Question 6.	A	B	C	D
Question 7.	A	B	C	D
Question 8.	A	B	C	D
Question 9.	A	B	C	D
Question 10.	A	B	C	D
Question 11.	A	B	C	D
Question 12.	A	B	C	D

SECTION A - [12 marks, 15 minutes]

This section contains 12 multiple choice questions.
For each question choose the response that is correct or best answers the question.
Indicate your answer on the answer sheet provided.
*(Choose only **one** answer for each question.)*

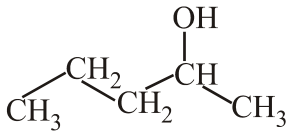
Question 1
The alcohol with the molecular formula, $C_4H_{10}O$ has

A. 6 structural isomers.
B. 4 structural isomers.
C. 3 structural isomers.
D. 2 structural isomers.

Question 2
In which one of the following semistructural formulae do the underlined atoms represent the carboxy functional group?

A. $CH_3\underline{COOC}H_3$
B. $CH_3CH_2\underline{O}CH_3$
C. $CH_3CH_2\underline{CHO}$
D. $\underline{HOOC}CH_2CH_2OH$

Question 3
The systematic name for the compound with the structure shown below is

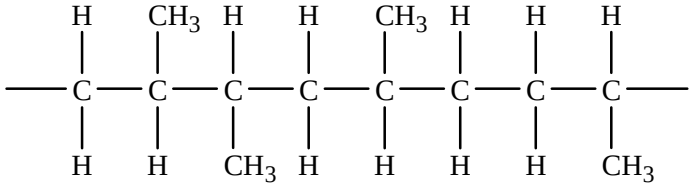


A. pentanol.
B. 1-methylbutan-1-ol.
C. pentan-2-ol.
D. 2-methylbutanol.

Question 4
What two functional groups are required to be present on the reactants used to produce a polyester?

A. The amino and carboxy functional groups.
B. The hydroxy and carboxy functional groups.
C. The amino and hydroxy functional groups.
D. The hydroxy and carbonyl functional groups.

Questions 5, 6 and 7 refer to the following information.
Polypropene is an extensively used polymer and the structure for part of a polypropene molecule is shown below.



Question 5
Which one of the following substances could **not** be used as a feedstock to produce the monomer required to make polypropene?

A. Propane.
B. Butane.
C. Hexane.
D. Ethane.

Question 6
What chemical process would be used to make the monomer required from a suitable feedstock?

A. Thermal cracking.
B. Fractional distillation.
C. Catalytic oxidation.
D. Catalytic cracking.

Question 7
The formation of polypropene from its monomer involves

A. condensation reactions.
B. addition reactions.
C. substitution reactions.
D. oxidative addition reactions.

Question 8
In the reaction between zinc and concentrated sulfuric acid described by the chemical equation

$$2H_2SO_4(l) + Zn(s) \rightarrow ZnSO_4(aq) + 2H_2O(l) + SO_2(g)$$

the sulfuric acid is acting as

A. an oxidant.
B. a reductant.
C. a strong acid.
D. a dehydrating agent.

Question 9
Which one of the following compounds could be produced from chloroethane by a substitution reaction?

A. Ethanal.
B. Ethene.
C. Ethanol.
D. Ethanoic acid.

Question 10
A drug such as Zyban® that is used to aid in smoking cessation is produced in relatively small quantities compared to sulfuric acid that is produced on a much larger scale. Two distinct processes are used industrially to produce various chemicals. Which processes are the most suitable to produce these two materials?

	Zyban®	Sulfuric acid.
A.	Batch	Batch
B.	Batch	Continuous flow
C.	Continuous flow	Continuous flow
D.	Continuous flow	Batch

Question 11
In the Contact process to produce sulfuric acid, sulfur trioxide is absorbed in sulfuric acid rather than water. This method is used because

A. sulfur trioxide will not react directly with water to form H_2SO_4.
B. the reaction between sulfur trioxide and water is highly endothermic and fine H_2SO_4 "ice" crystals form.
C. the reaction between sulfur trioxide and water is extremely slow and no suitable catalyst has been found to speed up this reaction.
D. the reaction between sulfur trioxide and water is highly exothermic and a fine H_2SO_4 mist forms.

Question 12
Polyethene is produced from ethene, yet the annual production of the polymer is about half the amount of ethene produced. Which one of the following would best account for this difference in the production of the two materials?

A. The yield for the polymerisation reaction is only about 50%.
B. Ethene is used as a fuel in the chemical industry, so some of it is used for this purpose.
C. Ethene is used to produce a range of other chemicals, so some of it is used for this purpose.
D. Ethene will decompose on storage, so some of it is not available for producing the polymer.

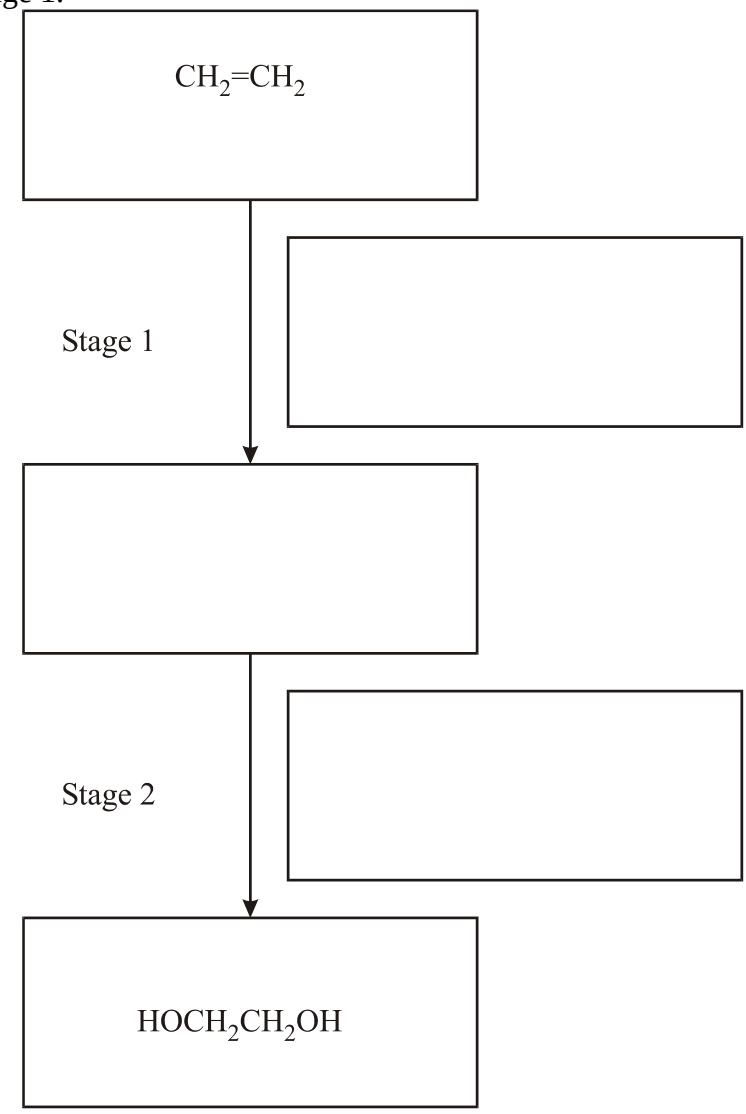
End of Section A

SECTION B - [28 marks, 35 minutes]

This section contains four questions, numbered 1 to 4.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 - [8 marks, 10 minutes]
Ethylene glycol, $HOCH_2CH_2OH$, is used as an antifreeze and de-icing agent and as a reactant to produce polyesters. It can be produced in two stages from ethene.

a. i. Complete the flow-chart below for the production of ethylene glycol, stating the reactants required for each stage, and the semistructural formula and systematic name for the carbon containing product produced by the reaction that occurs in stage 1.



[4 mark]

ii. What type of chemical reaction occurs in stage 1 of this process?

[1 mark]

iii. What type of chemical reaction occurs in stage 2 of this process?

[1 mark]

b. i. What would be the structural requirement/s for a substance that reacts with ethylene glycol to form a polyester?

[1 mark]

ii. What type of chemical reaction occurs when ethylene glycol reacts to form a polyester?

[1 mark]

Question 2 - [10 marks, 13 minutes]

The majority of sulfuric acid is now produced by the Contact process. This process has three distinct stages and different types of reactions occur during each of these.

a. i. Write an appropriate chemical equation to describe the reaction that occurs during the first stage of the Contact process.

[1 mark]

ii. What is the change in the oxidation state of the sulfur during this stage of the Contact process?

[1 mark]

b. i. Write an appropriate chemical equation to describe the reaction that occurs during the second stage of the Contact process.

[1 mark]

ii. What is the change in the oxidation state of the sulfur during this stage of the Contact process?

[1 mark]

iii. The equilibrium constants for the reaction that occurs in the second stage at various temperatures are listed in the table below.

Temperature (ºC)	Equilibrium Constant (M^{-1})
200	4×10^{13}
300	7×10^{9}
400	2×10^{7}
500	2×10^{5}
600	7×10^{3}

What does this suggest about the nature of the chemical stability of the reactants compared to the products of the reaction?

[1 mark]

iv. This stage of the Contact process is usually carried out at between 400 ºC and 500 ºC. How would carrying out the reaction at a lower temperature affect the equilibrium yield and the rate of reaction compared to the normal operating temperatures?

[2 mark]

v. What is the catalyst normally used in this stage of the Contact process and how does it effect the equilibrium yield for the reaction?

[1 mark]

c. Sulfuric acid is used to in a number of ways; one is to produce the fertilizer ammonium sulfate.

i. Write an appropriate chemical equation for the reaction between ammonia and sulfuric acid to form ammonium sulfate.

[1 mark]

ii. What chemical property of sulfuric acid is demonstrated by this reaction?

[1 mark]

Question 3 - [6 marks, 7 minutes]

a. Exposing a mixture of ethane and chlorine to light will result in the formation of a number of chlorinated hydrocarbon compounds that varies depending of the mole ratio of the reactants.

i. Write an appropriate chemical equation for the formation of dichloroethane from ethane.

[1 mark]

ii. Dichloroethane has two structural isomers 1,1-dichloroethane and 1,2-dichloroethane. Write the semistructural formulae for these two isomers.

1,1-dichloroethane

1,2-dichloroethane

[2 mark]

iii. What method could be used to separate these two isomers?

[1 mark]

b. Draw two possible structures for the hydrocarbon with the molecular formula C_4H_8.

[2 mark]

Question 4 - [4 marks, 5 minutes]

a. Give two reasons why a chemical plant may be sited a distance from the location where one or more of the reactants used are either mined or produced.

[2 mark]

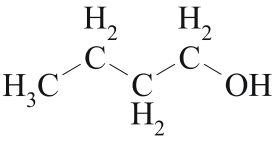
b. Give two reasons why some chemical plants tend to be located close to each other.

[2 mark]

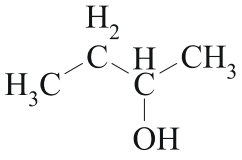
END OF TASK

Suggested Answers VCE Chemistry 2007 Industrial Test
SECTION A [1 mark per question.]

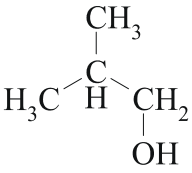
Q1 B A structural isomer is a different arrangement of the atoms in the compound. The compound is an **alcohol**; therefore it **must have the hydroxy, -OH, functional group**. The molecular formula $C_4H_{10}O$ can therefore be rewritten as C_4H_9OH. There are four carbon atoms present in the compound, therefore a four carbon atom backbone can be one possibility. There are two different places where the hydroxy functional group can be attached to this backbone, **I** and **II**, yielding **butan-1-ol** and **butan-2-ol** respectively.
The names butan-1-ol or 1-butanol, and butan-2-ol or 2-butanol, are equally acceptable. Another way of arranging the four carbon atoms is to have a three carbon atom backbone with the fourth carbon atom attached to the middle carbon atom. The hydroxy functional group can be attached to this backbone in either of two places, **III** and **IV**, yielding **2-methylpropan-1-ol** and **2-methylpropan-2-ol** respectively.



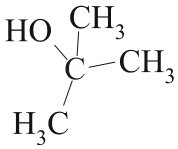
I



II



III

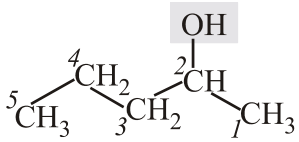


IV

Q2 D The carboxy functional group contains the –COOH group of atoms. Only response D fulfils this criterion.

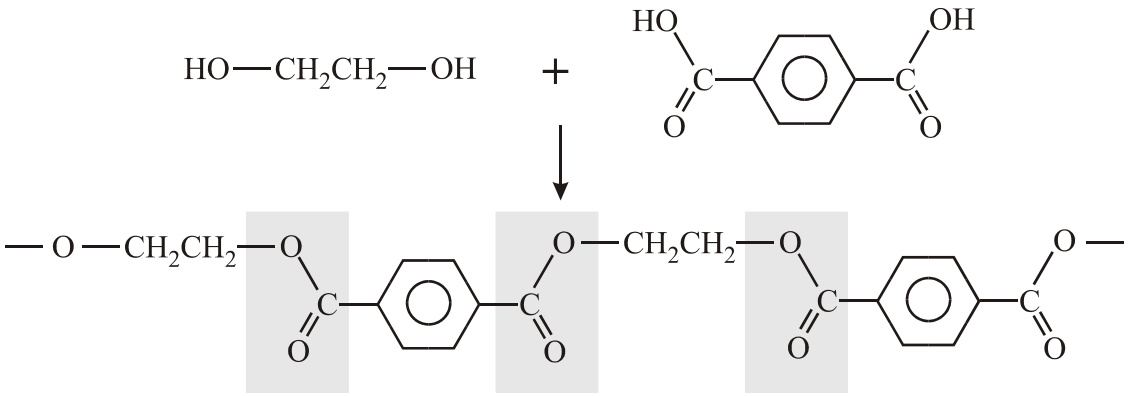
A. $CH_3\underline{COOC}H_3$ Underlined atoms represent the ester functional group.
B. $CH_3CH_2\underline{O}CH_3$ Underlined atoms represent the ether functional group.
C. $CH_3CH_2\underline{CHO}$ Underlined atoms represent the carbonyl functional group.

Q3 C The rules that are used to determine the systematic name for an organic compound are:



1. Locate the longest carbon-carbon atom backbone chain in the structure; 5 carbon atoms in this case therefore **pent**
2. Determine if there are any carbon-carbon atom multiple (double or triple) bonds in this backbone; in this case no therefore **pentan.**
3. Locate any groups attached to the carbon-carbon atom backbone; in this case an hydroxy functional group, -OH, therefore it is an alcohol and the name will end with the suffix **–ol**. This group is attached to the second carbon atom from the end of the chain therefore the systematic name is **pentan-2-ol (2-pentanol)**.

Q4 B A polyester contains the ester, -COO-, functional group between the repeat units in the polymer. Esters are formed by the condensation reaction between alcohols, containing the hydroxy, -OH, functional group and carboxylic acids containing the carboxy, -COOH, functional group. Polyethylene terephthalate, PET, used to make soft drink bottles is an example of a polyester and is formed by reacting ethylene glycol (1,2-dihydroxyethane) with terephthalic acid as shown below.



Ester functional groups

Q5 D The monomer required to manufacture polypropene is propene, $CH_3CH=CH_2$, therefore the hydrocarbons, used to produce this monomer **must contain a minimum of three carbon atoms**. Response D, ethane, CH_3CH_3, does not fulfil this criterion. The remaining three hydrocarbons could all be used to produce propene by thermal cracking reactions.

Propane: $CH_3CH_2CH_3(g) \rightleftharpoons CH_3CH=CH_2(g) + H_2(g)$

Butane: $CH_3CH_2CH_2CH_3(g) \rightleftharpoons CH_3CH=CH_2(g) + CH_4(g)$

Hexane: $CH_3CH_2CH_2CH_2CH_2CH_3(g) \rightleftharpoons CH_3CH=CH_2(g) + CH_3CH_2CH_3(g)$

Q6 A **Thermal cracking is used to produce unsaturated hydrocarbons from saturated hydrocarbons**. In this process suitable feedstocks would be mixed with steam and heated to between 750 ºC and 900 ºC. Steam is added to the mixture to reduce the formation of by-products. The reactions, such as those described by the chemical equations in Q5 above are all endothermic.

Q7 B This process involves an **addition reaction** between the monomer units. The polymer would have the same empirical formula as the monomer.
An oxidative addition reaction involves both an addition and an oxidation reaction to occur.

Q8 A In the reaction the oxidation state of the zinc is changing from 0 to +2, therefore it is being oxidised, and hence the sulfuric acid must be acting as the **oxidant**.
$2H_2SO_4(l) + Zn(s) \rightarrow ZnSO_4(aq) + 2H_2O(l) + SO_2(g)$
The oxidation state for the sulfur atom in sulfuric acid is +6. In sulfur dioxide, SO_2, the oxidation state is +4, therefore the sulfuric acid has been reduced. An appropriate half-equation for this reaction is;
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow SO_2(g) + 2H_2O(l)$

Q9 C In a substitution reaction an atom or group of atoms are replaced by another atom or group of atoms. Reacting chloroethane, CH_3CH_2Cl, with hydroxide ions would result in the substitution of the chlorine by the OH group forming **ethanol**, CH_3CH_2OH.

$CH_3CH_2Cl(l) + OH^-(aq) \rightleftharpoons CH_3CH_2OH(l) + Cl^-(aq)$

Responses A and D would require oxidation reactions in addition to the substitution reaction described above, and response B would require the removal of HCl to form ethene.

Q10 B **Chemicals that are produced on the large scale are best and most economically produced in a continuous flow process** where reactants are added at various stages as they flow from one reactor to the next. **Smaller scale production is best suited to batch production** as the equipment can be utilised to produce other products.

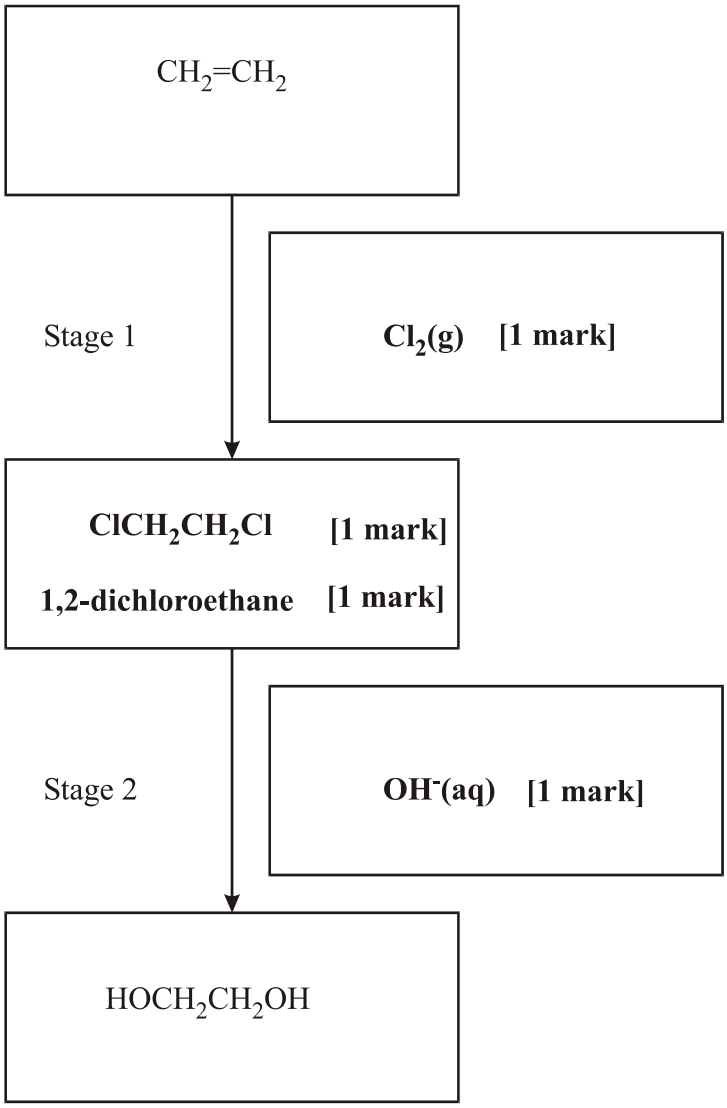
Q11 D The reaction between sulfur trioxide, SO_3, and water is exothermic
$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$ $\Delta H = -130$ kJ mol^{-1}
This reaction will release heat that produces an acid mist that is difficult to collect and hazardous to deal with.

Q12 C Ethene with its carbon-carbon double bond makes it an ideal starting material for the production of a range of other products as the carbon-carbon double bond can readily undergo addition reactions. Some products that can be directly produced from ethene are; chloroethane, 1,2-dichloroethane, ethanol and ethylene glycol, to list just a few. These can then be used as starting materials to manufacture a wider range of other chemicals.

SECTION B

Question 1 - [8 marks, 10 minutes]

a. i.



ii. The reaction between ethene and chlorine to form 1,2-dichloroethane is an **addition reaction**. **[1 mark]**

iii. In this reaction the chlorine atoms have been replaced by hydroxy groups, therefore this is a **substitution reaction. [1 mark]**

b. i. To form an ester with ethylene glycol, an alcohol, the other reactant would need to be a carboxylic acid. For the formation of a polyester the reactant would need to have **two carboxy functional groups, -COOH,** as part of its structure. **[1 mark]**
See the answer for Question 4 in Section A for reaction.

ii. The reaction between an alcohol and carboxylic acid to form an ester is **a condensation reaction. [1 mark]**

Question 2 - [10 marks, 13 minutes]

a. i. Stage 1 of the Contact process involves burning sulfur to form sulfur dioxide.
$S(l) + O_2(g) \rightarrow SO_2(g)$ [1 mark]

ii. In this reaction the oxidation state of sulfur changes from **0 to +4. [1 mark]**

b. i. Stage 2 of the Contact process involves the conversion of sulfur dioxide to sulfur trioxide.
$2SO_2(g) + O_2 \rightleftharpoons 2SO_3(g)$ [1 mark]

ii. In this stage the oxidation state of the sulfur changes from **+4 in SO_2 to +6 in SO_3. [1 mark]**

iii. The value of the equilibrium constant for this reaction decreases with increasing temperature, therefore the **forward reaction is exothermic**. Based on Le Chatelier's principle a system will shift its position to oppose any change, the reverse reaction, being endothermic, becomes more favoured as the temperature is increased. Since the **forward reaction is exothermic the chemical stability of the reactants is less than that of the products**. **[1 mark]**

iv. Since the value of the equilibrium constant increases as the temperature is lowered, then **the equilibrium yield will be increased** at temperatures lower than the normal operating conditions because the forward reaction is favoured. **[1 mark]**
Lowering the temperature will **decrease the rate of reaction** because fewer molecules will undergo fruitful collisions. **[1 mark]**

v. The catalyst normally used in the Contact process is **vanadium(V) oxide (vanadium pentoxide), V_2O_5.** The addition of a catalyst **has no effect on the equilibrium yield** only on the rate that the reaction achieves equilibrium. **[1 mark]**

c. i. The reaction between ammonia, NH_3, and sulfuric acid, H_2SO_4, to yield ammonium sulfate, $(NH_4)_2SO_4$.
$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)SO_4(aq)$ [1 mark]

ii. In this reaction sulfuric acid is acting as a **strong acid** because it is donating a proton to the ammonia molecule to form the ammonium ion**. [1 mark]**

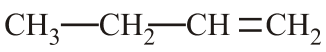
Question 3 - [6 marks, 7 minutes]

a. i. **$CH_3CH_3(g) + 2Cl_2(g) \rightarrow CH_3CHCl_2(l) + 2HCl(g)$ [1 mark]**
The formula for the chlorohydrocarbon can be either that shown above or CH_2ClCH_2Cl. *The state of the chlorohydrocarbon is not essential to be liquid.*
An alternative chemical equation would be;
$C_2H_6(g) + 2Cl_2(g) \rightarrow C_2H_4Cl_2(l) + 2HCl(g)$

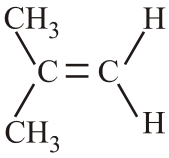
ii. **1,1-dichloroethane CH_3CHCl_2 [1 mark]**
1,2-dichloroethane $ClCH_2CH_2Cl$ [1 mark]

iii. The two isomers could be separated from each other using **fractional distillation**. **[1 mark]** Because the forces of attraction between the molecules of the two compounds will be different their boiling temperatures will be different.
[1,1-dichloroethane: 57.3 ºC; 1,2-dichloroethane: 83.5 ºC]

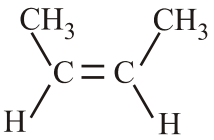
b. A hydrocarbon with the molecular formula C_4H_8, will be an alkene as it has the general formula C_nH_{2n}. Therefore the molecule will contain a carbon-carbon double bond. There are three structural isomers for this compound. One of these isomers has two conformational isomers, this type of isomer is NOT required for VCE.
[Total marks allocated 2 marks, 1 mark for each correct structure]



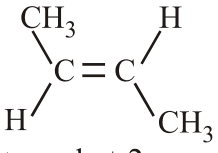
but-1-ene



2-methyl-prop-1-ene



cis-but-2-ene



trans-but-2-ene

conformational isomers

Question 4 - [4 marks, 5 minutes]

a. Some possible answers include:
[1 mark for each correct answer. Total mark allocation 2 marks.]
The availability of energy at cheap rates. *[The location of aluminium smelters in areas where there is cheap electricity.]*
The accessibility to a market for the products. *[The location of petrol refineries close to capital cities.]*
The accessibility to transport systems such as ports, rail and road networks.
The availability of a skilled workforce.
Access to appropriate waste disposal facilities.
Location in a politically stable environment.
The availability of land a reasonable prices.

b. Some possible answers include:
[1 mark for each correct answer. Total mark allocation 2 marks.]
Reduces the transportation costs of materials from one plant to another.
Allows plants to use by-products of one process in another.
Pipelines becomes a viable economic transportation alternative.
Sharing in the cost of infrastructure such as roads, rail, ports, security and energy supplies.
One plant may utilise the 'waste' energy from another.
Containment of any environmental impact to a single area.