

## 14.6 Alcohols

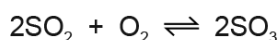
01.0620\_w21\_qp\_41 Q: 4

Chalcopyrite,  $\text{FeCuS}_2$ , is used in the manufacture of sulfuric acid in the Contact process.

- (a) In the first stage of the process, chalcopyrite reacts with oxygen in the air to produce sulfur dioxide,  $\text{SO}_2$ , iron(III) oxide and copper(II) oxide.

Complete the chemical equation for the reaction of  $\text{FeCuS}_2$  with oxygen.

- (b) Sulfur dioxide is then converted to sulfur trioxide.



The reaction is exothermic. It is also an equilibrium.

- (i) State **two** features of an equilibrium.

1 .....

2 .....

[2]

- (ii) State the temperature and pressure used in this reaction. Include units.

- temperature .....

- pressure .....

[2]

- (iii) Name the catalyst used.

..... [1]

- (iv) Explain why a catalyst is used.

..... [1]

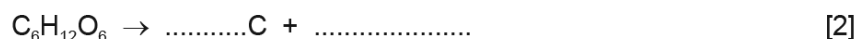
- (v) Describe and explain, in terms of equilibrium, what happens when the temperature is increased.

.....

..... [2]

- (c) Concentrated sulfuric acid is a dehydrating agent.

When glucose is dehydrated, carbon and one other product are formed.

Complete the equation to show the dehydration of glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ .

[Total: 12]

14.6. ALCOHOLS

02. 0620\_w21\_qp\_42 Q: 6

Ethanol,  $C_2H_5OH$ , belongs to the homologous series called alcohols.

(a) Write the general formula of alcohols.

..... [1]

(b) Explain why ethanol **cannot** be described as a hydrocarbon.

..... [1]

(c) Ethanol can be manufactured from different substances by reaction with steam or by fermentation.

(i) Give the formula of the substance which reacts with steam to form ethanol.

..... [1]

(ii) Name a substance which will undergo fermentation to form ethanol.

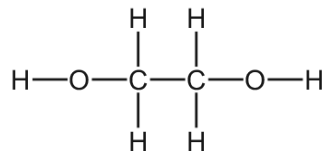
..... [1]

(d) Ethanol is a fuel.

Write the chemical equation for the complete combustion of ethanol.

..... [2]

(e) Ethane-1,2-diol has two alcohol functional groups.



One molecule of ethane-1,2-diol will react with two molecules of ethanoic acid to form molecule **X**.

**X** has two ester functional groups and a molecular formula of  $\text{C}_6\text{H}_{10}\text{O}_4$ .

(i) State the empirical formula of **X**.

..... [1]

(ii) Draw the structure of **X**.

Show all of the atoms and all of the bonds.

[2]

(iii) Name the **other** substance formed in this reaction.

..... [1]

(f) Each alcohol functional group in ethane-1,2-diol reacts with acidified potassium manganate(VII) to form a different organic compound, **Y**.

(i) Name the functional groups formed in **Y**.

..... [1]

(ii) Draw the structure of **Y**.

Show all of the atoms and all of the bonds.

[1]

[Total: 12]

14.6. ALCOHOLS

03. 0620\_w21\_qp\_43 Q: 1

A list of substances is shown.

- ammonia
- bauxite
- carbon dioxide
- carbon monoxide
- ethanol
- hematite
- oxygen
- sodium chloride
- sulfur dioxide

Answer the questions using the list of substances.

Each substance may be used once, more than once or not at all.

State which substance is:

- (a) an element ..... [1]
- (b) an ore of aluminium ..... [1]
- (c) a gas that causes acid rain ..... [1]
- (d) used as a fuel ..... [1]
- (e) an ionic compound ..... [1]
- (f) produced in the Haber process ..... [1]
- (g) a product of respiration ..... [1]
- (h) a toxic product of the incomplete combustion of hydrocarbons  
..... [1]
- (i) a gas produced in the test for nitrate ions. .... [1]

[Total: 9]

04. 0620\_p20\_qp\_40 Q: 8

The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

.....

.....

.....

..... [3]

(b) The following two alcohols are members of an homologous series and they are isomers.



(i) Explain why they are isomers.

.....

.....

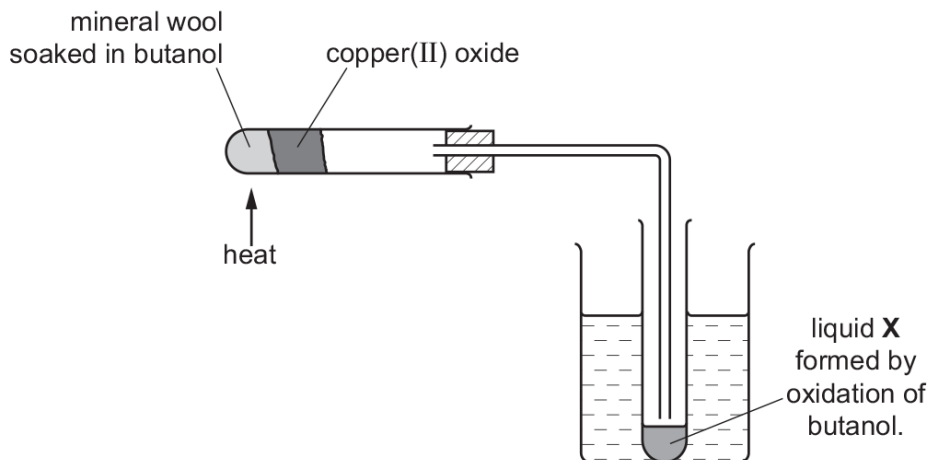
..... [2]

(ii) Deduce the structural formula of another alcohol which is also an isomer of these alcohols.

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[1]

(c) Copper(II) oxide can oxidise butanol to liquid X, whose pH is 4.



(i) Give the name of another reagent which can oxidise butanol.

..... [1]

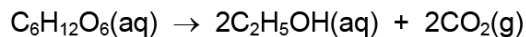
(ii) Which homologous series does liquid X belong to?

..... [1]

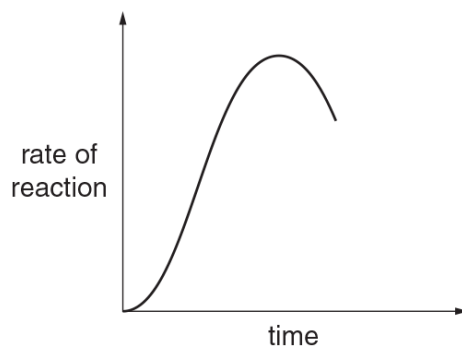
(iii) State the formula of liquid X.

..... [1]

- (d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.



Carbon dioxide is given off and the mixture becomes warm, as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.



- (i) Suggest a method of measuring the rate of this reaction.

.....  
 ..... [2]

- (ii) Why does the rate initially increase?

.....  
 ..... [1]

- (iii) Suggest **two** reasons why the rate eventually decreases.

.....  
 ..... [2]

[Total: 14]

14.6. ALCOHOLS

05.0620\_s20\_qp\_41 Q: 3

Sulfur dioxide, SO<sub>2</sub>, is used in the manufacture of sulfuric acid.

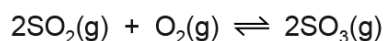
(a) In the first stage of the process, sulfur dioxide is obtained from sulfur-containing ores.

Name **one** of these ores.

..... [1]

(b) The next stage of the process is a reaction which can reach equilibrium.

The equation for this stage is shown.



(i) Describe **two** features of an equilibrium.

..... [2]

(ii) Name the catalyst used in this stage.

..... [1]

(iii) Why is a catalyst used?

..... [1]

(iv) Explain, in terms of particles, why a high temperature increases the rate of this reaction.

..... [3]

(v) In this stage, only a moderate temperature of 450°C is used.

What does this suggest about the forward reaction?

..... [1]

(vi) Calculate the percentage by mass of sulfur in sulfur trioxide, SO<sub>3</sub>.

percentage = ..... [2]

- (c) Concentrated sulfuric acid is a dehydrating agent which can chemically remove water from substances.

Both hydrated copper(II) sulfate crystals and sucrose (a sugar),  $C_{12}H_{22}O_{11}$ , can be completely dehydrated by concentrated sulfuric acid.

Name the solid product formed in each case.

hydrated copper(II) sulfate crystals .....

sucrose .....

[2]

- (d) When propan-1-ol is heated with concentrated sulfuric acid as a catalyst an unsaturated hydrocarbon of relative molecular mass 42 is formed and one other product.

- (i) What is meant by the term *unsaturated*?

..... [1]

- (ii) Write the chemical equation for this reaction.

..... [2]

- (iii) Name the unsaturated hydrocarbon formed.

..... [1]

[Total: 17]

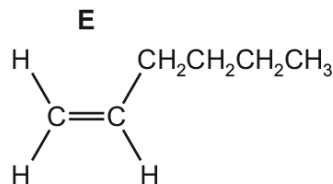
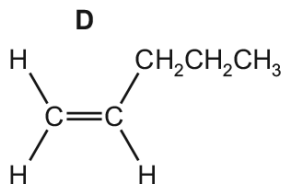
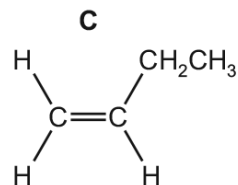
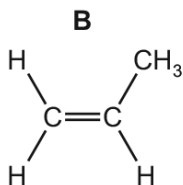
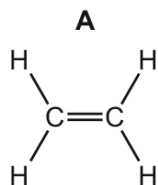
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14.6. ALCOHOLS

06.0620\_s19\_qp\_41 Q: 5

The structures of five alkenes, **A**, **B**, **C**, **D** and **E**, are shown.



(a) What is the general formula of alkenes?

..... [1]

(b) What is the molecular formula of alkene **D**?

..... [1]

(c) Predict which alkene, **A**, **B**, **C**, **D** or **E**, has the highest boiling point. Explain your answer.

alkene .....

explanation .....

..... [2]

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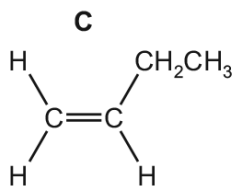
(d) Which alkene, **A**, **B**, **C**, **D** or **E**, diffuses most quickly? Explain your answer.

alkene .....

explanation .....

..... [2]

- (e) A student added aqueous bromine to alkene **C**.



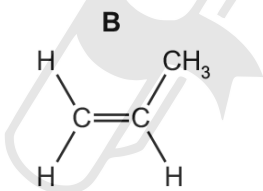
Describe the colour change seen and draw the structure of the product. Show all of the atoms and all of the bonds.

colour change from ..... to .....

structure

[2]

- (f) Two different alcohols can be produced from alkene **B** by an addition reaction.



- (i) Draw the structures of the **two** alcohols. Show all of the atoms and all of the bonds.

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[2]

- (ii) State the reagent and conditions needed to produce an alcohol from alkene **B**.

reagent .....

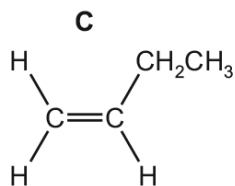
conditions .....

.....

[3]

14.6. ALCOHOLS

(g) Alkene **C** can be converted into a polymer.



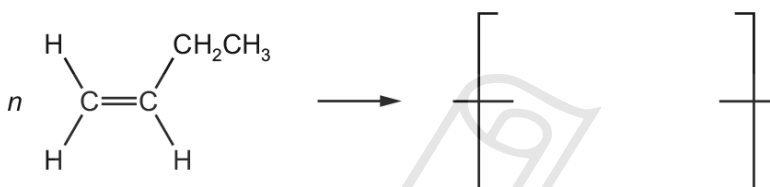
(i) What type of polymerisation occurs?

..... [1]

(ii) Suggest the name of the polymer formed.

..... [1]

(iii) Complete the chemical equation to show this polymerisation.



[3]

(iv) State the empirical formula of the polymer formed.

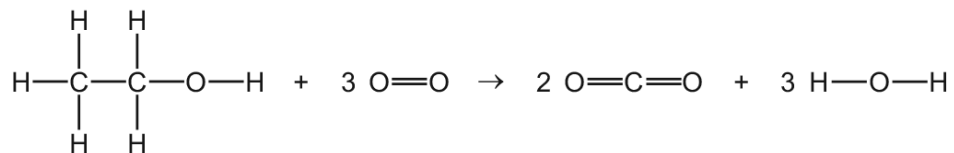
..... [1]

[Total: 19]



14.6. ALCOHOLS

(b) The equation for the complete combustion of ethanol is shown.



Use the bond energies in the table to calculate the energy change, in kJ/mol, for the complete combustion of ethanol.

bond	bond energy in kJ/mol
C–C	347
C–H	413
C–O	358
C=O	805
O–H	464
O=O	498

- Energy needed to break bonds.

..... kJ

- Energy released when bonds are formed.

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Paper Perfection, Crafted With Passion..... kJ

- Energy change for the complete combustion of ethanol.

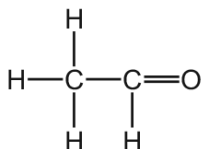
energy change = ..... kJ/mol  
[3]

(c) Ethanol can be oxidised by hydrogen peroxide to form ethanal,  $\text{CH}_3\text{CHO}$ . A catalyst for this reaction is  $\text{Fe}^{3+}$ .

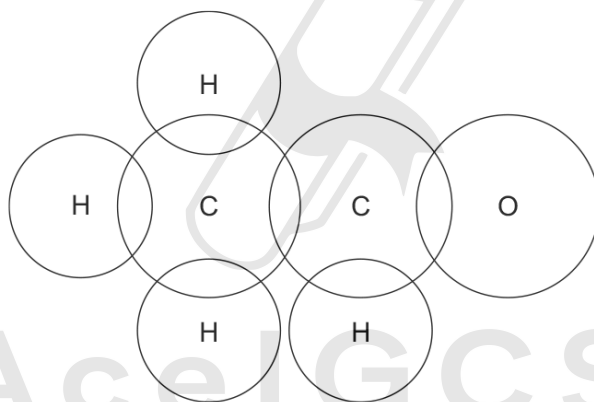
(i) What is meant by the term *catalyst*?

.....  
 .....  
 ..... [2]

(ii) The structure of ethanal is shown.



Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanal. Show outer shell electrons only.



[3]

(iii) The table gives the boiling points of ethanal and ethanol.

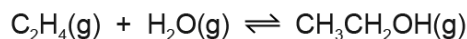
substance	boiling point/ $^{\circ}\text{C}$
ethanal	20
ethanol	78

In terms of attractive forces between particles, suggest why ethanal has a lower boiling point than ethanol.

.....  
 ..... [1]

14.6. ALCOHOLS

(d) Ethene gas reacts with steam to form gaseous ethanol.



The reaction can reach a position of equilibrium. The forward reaction is exothermic.

(i) State and explain the effect of increasing the pressure on the **position of equilibrium**. All other conditions are unchanged.

.....  
.....  
..... [2]

(ii) Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the reaction. All other conditions are unchanged.

.....  
.....  
..... [2]

(iii) State and explain the effect of increasing the temperature on the **position of equilibrium**. All other conditions are unchanged.

.....  
.....  
..... [2]

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[Total: 20]

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08.0620\_s17\_qp\_42 Q: 1

**(a)** State the name of the process that is used to**(i)** separate oxygen from liquid air,

..... [1]

**(ii)** separate the individual dyes in ink,

..... [1]

**(iii)** produce ethanol from simple sugars,

..... [1]

**(iv)** obtain water from aqueous sodium chloride,

..... [1]

**(v)** separate the precipitate formed when aqueous silver nitrate is added to aqueous sodium chloride.

..... [1]

**(b)** State what is meant by the terms**(i)** *element*,.....  
..... [1]**(ii)** *compound*,.....  
..... [1]**(iii)** *ion*......  
..... [1]

[Total: 8]

14.6. ALCOHOLS

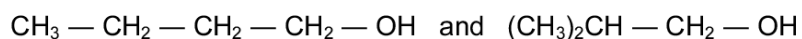
09.0620\_p16\_qp\_40 Q: 8

The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

.....  
.....  
.....  
..... [3]

(b) The following two alcohols are members of an homologous series and they are isomers.



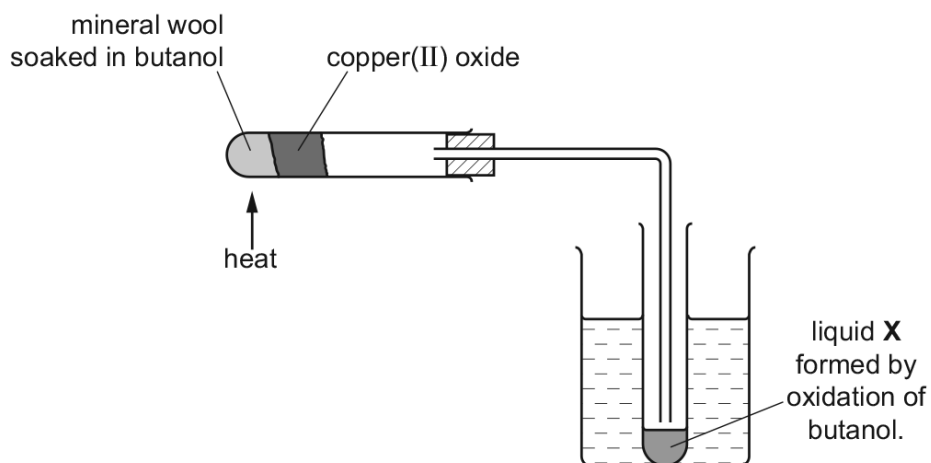
(i) Explain why they are isomers.

.....  
.....  
..... [2]

(ii) Deduce the structural formula of another alcohol which is also an isomer of these alcohols.

  
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(c) Copper(II) oxide can oxidise butanol to liquid **X**, whose pH is 4.



(i) Give the name of another reagent which can oxidise butanol.

..... [1]

(ii) Which homologous series does liquid **X** belong to?

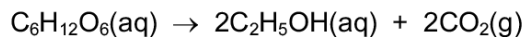
..... [1]

(iii) State the formula of liquid **X**.

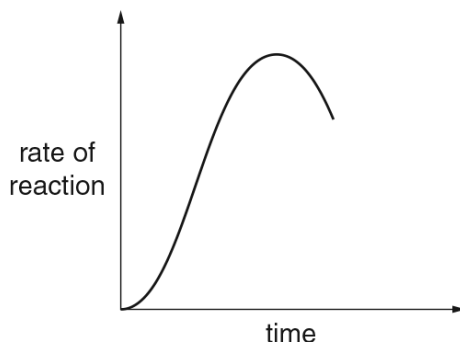
..... [1]

14.6. ALCOHOLS

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.



Carbon dioxide is given off and the mixture becomes warm, as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.



(i) Suggest a method of measuring the rate of this reaction.

.....  
..... [2]

(ii) Why does the rate initially increase?

.....  
..... [1]

(iii) Suggest **two** reasons why the rate eventually decreases.

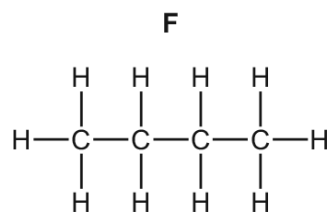
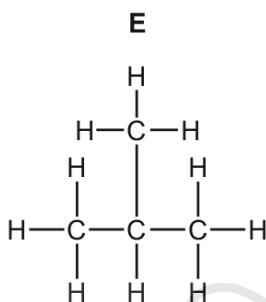
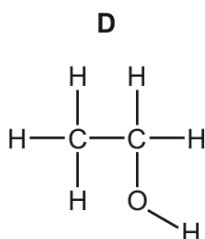
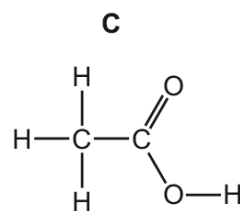
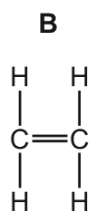
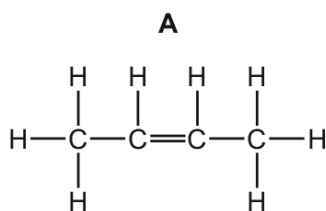
.....  
..... [2]

[Total: 14]

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10. 0620\_s16\_qp\_43 Q: 2

The structures of six organic compounds are shown.



(a) Give the name of F.

..... [1]

(b) Identify **two** of the compounds that are members of the same homologous series.  
Give the general formula of this homologous series.

compounds .....

general formula ..... [2]

(c) Which **two** compounds are isomers of each other?  
Explain why they are isomers.

compounds .....

explanation .....

..... [3]

(d) Explain why B is an unsaturated hydrocarbon.

.....

.....

..... [2]

14.6. ALCOHOLS

(e) Describe how **D** is manufactured from **B**. Give a chemical equation for the reaction.

.....  
.....  
..... [3]

(f) Compound **A** forms an addition polymer.

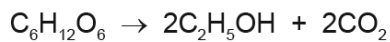
Draw **two** repeat units of the addition polymer formed from **A**.



[2]

[Total: 13]

10. 0620\_m15\_qp\_32 Q: 7

Ethanol is manufactured from glucose,  $C_6H_{12}O_6$ , by fermentation according to the following equation.

(a) State the conditions required for this reaction.

.....  
 ..... [2]

(b) In an experiment, 30.0 g of glucose was fermented.

(i) Calculate the number of moles of glucose in 30.0 g.

..... mol [2]

(ii) Calculate the maximum mass of ethanol that could be obtained from 30.0 g of glucose.

..... g [2]

(iii) Calculate the volume of carbon dioxide at room temperature and pressure that can be obtained from 30.0 g of glucose.

.....  $dm^3$  [1]

(c) Ethanol can also be manufactured from ethene.

(i) Name the raw material which is the source of ethene.

..... [1]

(ii) Write a balanced equation for the manufacture of ethanol from ethene.

..... [1]

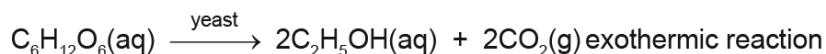
[Total: 9]

14.6. ALCOHOLS

12. 0620\_s15\_qp\_32 Q: 7

Alcohols can be made by fermentation or from petroleum.

(a) Ethanol can be made by the fermentation of glucose.



Yeast are living single-cell fungi which ferment glucose by anaerobic respiration. This reaction is catalysed by enzymes from the yeast.

(i) What is meant by the term *respiration*?

.....  
.....  
..... [3]

(ii) *Anaerobic* means in the absence of oxygen.

Name the products formed from respiration in the **presence** of oxygen.

..... [1]

(iii) What are enzymes?

..... [1]

(iv) Suggest a method of measuring the rate of this reaction.

.....  
..... [1]

(b) The following observations were noted.

- When a small amount of yeast was added to the aqueous glucose the reaction started and the solution went slightly cloudy.
- The reaction rate increased and the solution became cloudier and warmer.
- After a while, the reaction rate decreased and eventually stopped, leaving a 14% solution of ethanol in water.

(i) Why did the reaction rate increase?

..... [1]

(ii) Suggest an explanation for the increase in cloudiness of the solution.

..... [1]

(iii) Give **two** reasons why the fermentation stopped.

.....  
..... [2]

(c) One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

..... [2]

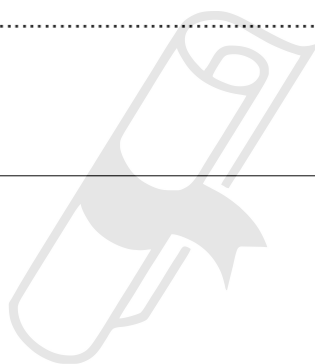
(d) Alcohols can be made from petroleum by the following sequence of reactions.

alkanes from petroleum → alkene → alcohol

Describe the manufacture of ethanol from hexane,  $C_6H_{14}$ . Include in your description an equation and type of reaction for each step.

.....  
.....  
.....  
..... [5]

[Total: 17]



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14.6. ALCOHOLS

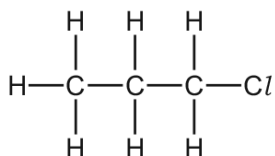
13. 0620\_w15\_qp\_32 Q: 4

(a) Propane reacts with chlorine to form a mixture of chloropropanes. This is a photochemical reaction.

(i) What is meant by the phrase *photochemical reaction*?

.....  
..... [1]

(ii) The products of this reaction include two isomers, one of which has the following structural formula.



Draw the structural formula of the other isomer.



[1]

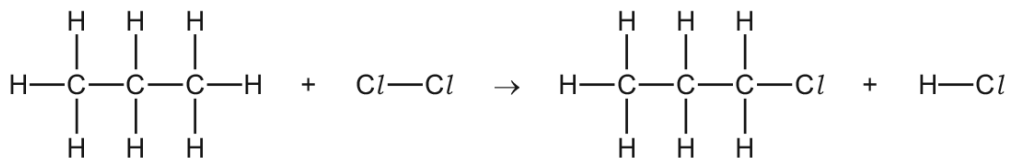
(iii) Explain why these two different compounds are isomers.

.....  
..... [2]

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(b) Bond breaking is an endothermic change and bond forming is an exothermic change.

Bond energy is the amount of energy in kJ/mol needed to break one mole of the specified bond.



Use the following bond energies to determine whether this reaction is exothermic or endothermic. You must show your reasoning.

bond	bond energies in kJ/mol
C-Cl	338
C-H	412
Cl-Cl	242
H-Cl	431
C-C	348

.....

.....

.....

..... [3]

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14.6. ALCOHOLS

- (c) (i) Chloropropane can be hydrolysed to propanol,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ , by sodium hydroxide.

Write the equation for this reaction.

..... [2]

- (ii) Propanol can be dehydrated. It loses a water molecule to form a hydrocarbon.

Give the name and structural formula of this hydrocarbon.

name .....

structural formula

[2]

- (iii) Propanol is oxidised to a carboxylic acid by acidified potassium manganate(VII).

Deduce the name of this acid.

..... [1]

- (d) Propanol reacts with methanoic acid to form the ester propyl methanoate.



4.0g of methanoic acid was reacted with 6.0g of propanol.

- (i) Calculate the  $M_r$  of methanoic acid = ..... [1]

- (ii) Calculate the  $M_r$  of propanol = ..... [1]

- (iii) Determine which one is the limiting reagent. Show your reasoning.

.....

.....

..... [2]

- (iv) Calculate the maximum yield in grams of propyl methanoate,  $M_r = 88$ .

..... [1]

[Total: 17]

14. 0620\_w13\_qp\_33 Q: 6

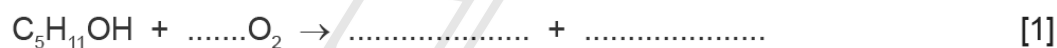
The alcohols form a homologous series. The first five members are given in the table below.

(a)

alcohol	formula	heat of combustion in kJ/mol
methanol	CH <sub>3</sub> OH	730
ethanol	CH <sub>3</sub> -CH <sub>2</sub> -OH	1380
propan-1-ol		
butan-1-ol	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -OH	2680
pentan-1-ol	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -OH	3350

(i) Complete the table. [2]

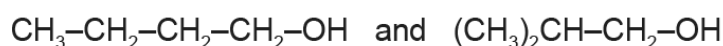
(ii) Complete the equation for the combustion of pentan-1-ol in excess oxygen.



(b) State **three** characteristics of a homologous series other than the variation of physical properties down the series.

.....  
 .....  
 ..... [3]

(c) The following alcohols are isomers.



(i) Explain why they are isomers.

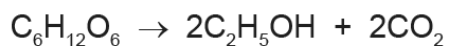
.....  
 .....  
 ..... [2]

(ii) Draw the structural formula of another isomer of the above alcohols.

[1]

(d) Alcohols can be made by fermentation and from petroleum.

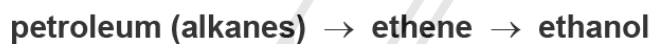
(i) Ethanol is made from sugars by fermentation.



The mass of one mole of glucose,  $C_6H_{12}O_6$ , is 180 g.  
Calculate the maximum mass of ethanol which could be obtained from 72 g of glucose.

.....  
.....  
.....  
..... [3]

(ii) Describe how ethanol is made from petroleum.



.....  
.....  
.....  
..... [3]

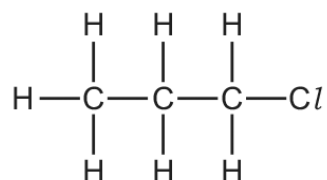
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[Total: 15]

15. 0620\_w12\_qp\_32 Q: 3

Many organic compounds which contain a halogen have chloro, bromo or iodo in their name.

(a) The following diagram shows the structure of 1-chloropropane.



(i) Draw the structure of an isomer of this compound.

[1]

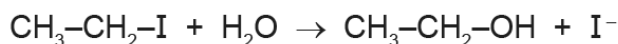
(ii) Describe how 1-chloropropane could be made from propane.

.....  
 ..... [2]

(iii) Suggest an explanation why the method you have described in (ii) does not produce a pure sample of 1-chloropropane.

.....  
 ..... [2]

(b) Organic halides react with water to form an alcohol and a halide ion.



(i) Describe how you could show that the reaction mixture contained an iodide ion.

.....  
 ..... [2]

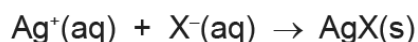
(ii) Name the alcohol formed when 1-chloropropane reacts with water.

..... [1]

- (c) The speed (rate) of reaction between an organic halide and water can be measured by the following method.

A mixture of 10 cm<sup>3</sup> of aqueous silver nitrate and 10 cm<sup>3</sup> of ethanol is warmed to 60 °C. Drops of the organic halide are added and the time taken for a precipitate to form is measured.

Silver ions react with the halide ions to form a precipitate of the silver halide.



Typical results for four experiments, **A**, **B**, **C** and **D**, are given in the table.

experiment	organic halide	number of drops	time / min
<b>A</b>	bromobutane	4	6
<b>B</b>	bromobutane	8	3
<b>C</b>	chlorobutane	4	80
<b>D</b>	iodobutane	4	0.1

- (i) Explain why it takes longer to produce a precipitate in experiment **A** than in **B**.
- .....
- ..... [2]
- (ii) How does the order of reactivity of the organic halides compare with the order of reactivity of the halogens?
- .....
- ..... [2]
- (iii) Explain why the time taken to produce a precipitate would increase if the experiments were repeated at 50 °C.
- .....
- .....
- ..... [3]

[Total: 15]

01. 0620\_w21\_ms\_41 Q: 4

Question	Answer	Marks
(a)	$(4\text{FeCuS } 13\text{O}_2) \rightarrow 2\text{Fe}_2\text{O}_3 + 4\text{CuO} + 8\text{SO}_2$ Fe <sub>2</sub> O <sub>3</sub> and CuO as a product (1) Equation fully correct (1)	2
(b)(i)	<b>M1</b> rate of forward reaction = rate of reverse reaction (1) <b>M2</b> concentration of reactants and products are constant (1)	2
(b)(ii)	<b>M1</b> 450 °C (1) <b>M2</b> 1-2 atm (1)	2
(b)(iii)	vanadium(V) oxide	1
(b)(iv)	increase rate of reaction	1
(b)(v)	<b>M1</b> equilibrium shifts to left hand side (1) <b>M2</b> forward reaction is exothermic (1)	2
(c)	$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 6\text{C} + 6\text{H}_2\text{O}$ H <sub>2</sub> O (1) balance (1)	2

02. 0620\_w21\_ms\_42 Q: 6

Question	Answer	Marks
(a)	C <sub>n</sub> H <sub>2n+1</sub> OH (1)	1
(b)	not all atoms are C or H	1
(c)(i)	C <sub>2</sub> H <sub>4</sub>	1
(c)(ii)	glucose	1
(d)	$\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 3\text{H}_2\text{O} + 2\text{CO}_2$ species (1) correct equation (1)	2
(e)(i)	C <sub>3</sub> H <sub>5</sub> O <sub>2</sub>	1
(e)(ii)	any one ester link (1) rest of molecule (1)	2
(e)(iii)	water	1
(f)(i)	carboxylic acid	1

Question	Answer	Marks
(f)(ii)	structure of ethanedioic acid	1

03. 0620\_w21\_ms\_43 Q: 1

Question	Answer	Marks
(a)	oxygen	1
(b)	bauxite	1
(c)	sulfur dioxide	1
(d)	ethanol	1
(e)	sodium chloride	1
(f)	ammonia	1
(g)	carbon dioxide	1
(h)	carbon monoxide	1
(i)	ammonia	1

04. 0620\_p20\_ms\_40 Q: 8

- (a) Any three from:  
same general formula;  
consecutive members differ by  $\text{CH}_2$ ;  
similar chemical properties;  
same functional group;  
physical properties vary in a predictable way / give trend such as mp increases with n; [3]
- (b) (i) they have the same molecular formula; [1]  
not: general formula [1]  
different structures / structural formulae; [1]
- (ii)  $\text{CH}_3\text{-CH}_2\text{-CH(OH)-CH}_3$  /  $(\text{CH}_3)_3\text{C-OH}$  [1]  
allow: butan-2-ol and 2-methylpropan-2-ol
- (c) (i) (acidified) potassium manganate(VII) [1]  
allow: oxygen / air / (acidified) potassium chromate(VI)
- (ii) carboxylic acid [1]  
allow: aldehyde / ketone
- (iii)  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$  /  $\text{C}_3\text{H}_7\text{COOH}$  /  $\text{C}_4\text{H}_8\text{O}_2$  [1]  
allow:  $\text{C}_4\text{H}_7\text{OOH}$   
allow: ecf on (c)(ii)
- (d) (i) measure volume of gas; [1]  
measure time; [1]
- (ii) increase in temperature / more yeast present / yeast multiplies [1]
- (iii) glucose used up; [1]  
concentration of ethanol high enough to kill yeast; [1]

05. 0620\_s20\_ms\_41 Q: 3

(a)	zinc blende	1
(b)(i)	reaction is reversible rate of forward reaction = rate of reverse reaction	2
(b)(ii)	vanadium(V) oxide	1

(b)(iii)	increases the rate of reaction	1
(b)(iv)	particles have more energy (E)	1
	rate of collisions increase	1
	a higher proportion of particles have energy greater than activation energy ( $E > E_A$ )	1
(b)(v)	exothermic	1
(b)(vi)	$M_r$ of $\text{SO}_3 = 80$	1
	$100 \times \frac{32}{80} = 40\%$	1
(c)	anhydrous copper(II) sulfate carbon	2
(d)(i)	not all (C–C) bonds are single	1
(d)(ii)	$\text{C}_3\text{H}_7\text{OH} \rightarrow \text{C}_3\text{H}_6 + \text{H}_2\text{O}$ M1 $\text{C}_3\text{H}_6$ M2 rest of the equation	2
(d)(iii)	propene	1

06. 0620\_s19\_ms\_41 Q: 5

(a)	$\text{C}_n\text{H}_{2n}$ (1)	1
(b)	$\text{C}_5\text{H}_{10}$ (1)	1
(c)	E (1)	2
	it has the longest carbon chain (1)	
(d)	A (1)	2
	it has the lowest $M_r$ (1)	
(e)	orange to colourless (1)	2
	structure of 1,2-dibromobutane (1)	
(f)(i)	structure of propan-1-ol (1) structure of propan-2-ol (1)	2
	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} \\   &   &   &   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   &   &   & \\ \text{H} & \text{H} & \text{H} & \end{array}$ $\begin{array}{c} & \text{H} & & \\ &   & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\   &   &   & \\ \text{H} & \text{H} & \text{H} & \end{array}$	
(f)(ii)	steam (1)	3
	catalyst (1)	
one other condition: either 60 atm pressure OR 300 °C (1)		
(g)(i)	addition	1
(g)(ii)	poly(but-1-ene)	1
(g)(iii)	M1 2 C atoms (only) with a single bond between them linked to the continuation bonds shown	3
	M2 correct repeat unit showing one $\text{C}_2\text{H}_5$ / $\text{CH}_2\text{CH}_3$ side chain attached to one of the C atoms in M1	
	M3 correct use of 'n'	
(g)(iv)	$\text{CH}_2$	1

07. 0620\_w19\_ms\_41 Q: 7

(a)	$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ (1) any three from <input type="checkbox"/> anaerobic <input type="checkbox"/> 30 °C <input type="checkbox"/> yeast <input type="checkbox"/> glucose aqueous fractional distillation (of aqueous ethanol) (1)	5
(b)	(energy to break bonds) = 4728 (1) (energy released by making bonds) = 6004 (1) -1276 (1)	3

(c)(i)	speeds up a (chemical) reaction (1) not used up or unchanged (at end) (1)	2
(c)(ii)	4 electrons in double bond between C and O (1) all single bonds correct (1) C and O each have 8 electrons in outer shell, all H have 2 electrons in outer shell (1)	3
(c)(iii)	(attractive) forces between molecules weaker in ethanal	1
(d)(i)	moves right (1) fewer moles / molecules (of gas) on right (1)	2
(d)(ii)	(reaction is faster) because more collisions per second (1) particles / molecules closer together or more particles / molecules per unit volume (1)	2
(d)(iii)	moves left (1) (forward) reaction is exothermic or backward reaction is endothermic (1)	2

08. 0620\_s17\_ms\_42 Q: 1

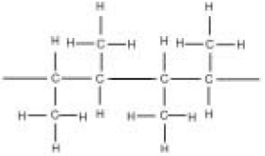
(a)(i)	fractional distillation	1
(a)(ii)	chromatography	1
(a)(iii)	fermentation / ferment	1
(a)(iv)	(simple) distillation / distil	1
(a)(v)	filtration / decantation / centrifugation	1
(b)(i)	(substance that) cannot be split up / broken down into (two or more) simpler substances by chemical means OR (substance) made of atoms with the same atomic number / number of protons / proton number	1
(b)(ii)	(two or more) elements joined or combined or bonded (together)	1
(b)(iii)	(particle) containing different numbers of protons and electrons OR atom or group of atoms that has gained or lost an electron / electrons	1

09. 0620\_p16\_ms\_40 Q: 8

- (a) Any three from:  
 same general formula;  
 consecutive members differ by  $\text{CH}_2$ ;  
 similar chemical properties;  
 same functional group;  
 physical properties vary in a predictable way / give trend such as mp increases with n; [3]
- (b) (i) they have the same molecular formula; [1]  
 not: general formula [1]  
 different structures / structural formulae; [1]
- (ii)  $\text{CH}_3\text{-CH}_2\text{-CH(OH)-CH}_3$  /  $(\text{CH}_3)_3\text{C-OH}$  [1]  
 allow: butan-2-ol and 2-methylpropan-2-ol
- (c) (i) (acidified) potassium manganate(VII) [1]  
 allow: oxygen / air / (acidified) potassium chromate(VI)
- (ii) carboxylic acid [1]  
 allow: aldehyde / ketone
- (iii)  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$  /  $\text{C}_3\text{H}_7\text{COOH}$  /  $\text{C}_4\text{H}_8\text{O}_2$  [1]  
 allow:  $\text{C}_4\text{H}_7\text{OOH}$   
 allow: ecf on (c)(ii)
- (d) (i) measure volume of gas; [1]  
 measure time; [1]
- (ii) increase in temperature / more yeast present / yeast multiplies [1]
- (iii) glucose used up; [1]  
 concentration of ethanol high enough to kill yeast; [1]

10. 0620\_s16\_ms\_43 Q: 2

(a)	butane;	1
(b)	compounds: E and F; general formula: $\text{C}_n\text{H}_{2n+2}$ ; <b>OR</b> compounds: A and B; general formula: $\text{C}_n\text{H}_{2n}$ ;	1 1 1 1
(c)	compounds: E and F; explanation: same molecular formula / contain the same number of atoms each element; different structures / different structural formulae / different arrangement of atoms;	1 2
(d)	contains a double bond / not all bonds are single bonds; C and H <u>only</u> ;	1 1
(e)	$\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}$ ;  any 2 from: high temperature / $220\text{ }^\circ\text{C}$ – $350\text{ }^\circ\text{C}$ ; high pressure / 60 atm–70 atm; phosphoric acid catalyst;	1 2

(f)		<b>2</b>
<b>M1</b> correct carbon structure with only single bonds; <b>M2</b> continuation bonds;		

11. 0620\_m15\_ms\_32 Q: 7

- (a) Any **two** from:  
 yeast/20–40 °C/anaerobic or without oxygen or without air/(aqueous)  
 solution or water or aqueous [2]
- (b) (i)  $Mr = 180 (1) (30/180) = 0.167 (1)$  [2]  
 (ii)  $2 \times 0.167$  or  $2 \times 46$  or  $0.333$  or  $92$  [1]  
 $(2 \times 0.167 \times 46) = 15.3(33)$  (g) [1]  
 (iii)  $(2 \times 0.167 \times 24) = 8$  (dm<sup>3</sup>) [1]
- (c) (i) Crude oil/petroleum [1]  
 (ii)  $C_2H_4 + H_2O \rightarrow C_2H_5OH / CH_3CH_2OH$  [1]
- [Total:9]

12. 0620\_s15\_ms\_32 Q: 7

(a)(i)	living/organism or named example e.g. yeast/cells/plants/animals/part of animal or plant e.g. muscle/humans/micro-organisms;  produces/releases or gain or obtain energy/exothermic/heat;  from food/named foodstuff/carbohydrate/named carbohydrate/sugar/named sugar/glucose/nutrients;	3	<b>A</b> 'we/us' for 'humans'  <b>I</b> products/breathing/oxygen/anaerobic/aerobic
(a)(ii)	<b>Any 2 from 3:</b> carbon dioxide/CO <sub>2</sub> ; water/H <sub>2</sub> O; adenosine triphosphate/ATP;	1	<b>I</b> energy
(a)(iii)	biological catalyst or protein catalyst;	1	<b>R</b> biocatalyst/living biological catalyst
(a)(iv)	<b>answer must include both</b> measuring the time and measuring a relevant quantity; <b>OR</b> alternatively measuring the time taken for something to happen;  alternatives to time are: units of time/apparatus to measure time/regular intervals/how long  examples of relevant quantities are: (Increase in/decrease in) amount/mass/volume/bubbles of carbon dioxide/bubbles of gas <b>OR</b> (Increase in/decrease in) mass of apparatus;	1	Examples: <b>A</b> time taken for lime water to turn milky <b>A</b> time taken for bubbling to stop/gas stop being evolved <b>A</b> count bubbles per minute <b>A</b> measure temperature (change) with time <b>R</b> time taken for reaction to end <b>R</b> measure carbon dioxide/gas with time (no reference to amount)
(b)(i)	temperature increase/heat increase/warmer/high temperature/exothermic/ <b>more</b> yeast/yeast reproduces/yeast increases/yeast multiplies;	1	<b>R</b> yeast was added
(b)(ii)	<b>more</b> yeast/yeast reproduces/increases/multiplies;	1	<b>R</b> yeast was added

(b)(iii)	<p>all glucose or reactant(s) reacted  <b>OR</b> no glucose or reactant(s) left  <b>OR</b> glucose or reactant(s) used up / finished / runs out / reacted completely / fully reacted;</p> <p>yeast (cells) dies  <b>OR</b> enzymes denatured  <b>OR</b> ethanol is toxic to yeast / ethanol kills yeast;</p>	<p>I glucose or reactants reacted / stopped reacting</p> <p><b>2</b>  <b>R</b> enzyme dies / yeast denatures  <b>R</b> yeast used up</p>
(c)	<p><b>Any two from:</b>  fuel;  <b>OR</b> petrol additive;  <b>OR</b> solvent / tinctures;  <b>OR</b> (making) perfumes;  <b>OR</b> varnishes;  <b>OR</b> preserving biological specimens / preserving food;  <b>OR</b> essence / flavourings;  <b>OR</b> antiseptic / kill bacteria (in medicine) / sterilizer;  <b>OR</b> antitussive agent;  <b>OR</b> (in) disinfectant / hand sanitizer;  <b>OR</b> to make esters / esterification;  <b>OR</b> to make ether(s);  <b>OR</b> to make amines;  <b>OR</b> to make carboxylic acid(s) / vinegar / ethanoic acid;  <b>OR</b> thermometers;  <b>OR</b> alcohol lamp / spirit burners;  <b>OR</b> any other suitable use;</p>	<p>I medicine (unqualified) / chemical feedstock</p> <p><b>2</b></p>
(d)	<p>cracking / crack;</p> <p>(hexane to obtain) ethene / C<sub>2</sub>H<sub>4</sub> ;</p> <p>C<sub>6</sub>H<sub>14</sub> → C<sub>2</sub>H<sub>4</sub> + C<sub>4</sub>H<sub>10</sub> ;</p> <p>hydration (of ethene) / hydrate / hydrated <b>or</b> add(ition of) water / add(ition of) steam / addition;</p> <p>C<sub>2</sub>H<sub>4</sub> + H<sub>2</sub>O → C<sub>2</sub>H<sub>5</sub>OH ;</p>	<p>I fractional distillation / distillation wherever mentioned</p> <p>I catalytic / thermal + other conditions</p> <p>Ethene / C<sub>2</sub>H<sub>4</sub> can be given in either equation whether the equation is otherwise correct or not</p> <p>I state symbols  <b>A</b> multiples / other equations e.g.  C<sub>6</sub>H<sub>14</sub> → 3C<sub>2</sub>H<sub>4</sub> + H<sub>2</sub>  C<sub>6</sub>H<sub>14</sub> → 2C<sub>2</sub>H<sub>4</sub> + C<sub>2</sub>H<sub>6</sub>  C<sub>6</sub>H<sub>14</sub> → C<sub>2</sub>H<sub>4</sub> + C<sub>4</sub>H<sub>8</sub> + H<sub>2</sub>  <b>A</b> any correct equations in which carbon is produced e.g. C<sub>6</sub>H<sub>14</sub> → 2C<sub>2</sub>H<sub>4</sub> + 2C + 3H<sub>2</sub></p> <p><b>A</b> additional  I conditions / react with water</p> <p><b>5</b>  I C<sub>2</sub>H<sub>6</sub>O / state symbols  <b>A</b> multiples</p>

13. 0620\_w15\_ms\_32 Q: 4

(a)(i)	a reaction whose rate is influenced by light / reaction which occurs in presence of light;	1
(a)(ii)	CH <sub>3</sub> CHC(CH <sub>3</sub> );	1
(a)(iii)	(both have) same molecular formula; different structural formula or structure;	2
(b)	<p><b>M1</b> bonds breaking = (8 × 412) + (2 × 348) + 242 = 4234;  <b>M2</b> bonds forming = (7 × 412) + (2 × 348) + 338 + 431 = 4349;  <b>M3</b> 4234 – 4349 = –115 <b>and</b> exothermic;</p>	3
(c)(i)	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> Cl + NaOH → CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH + NaCl NaCl as product; rest of equation;	2
(c)(ii)	propene; CH <sub>2</sub> =CHCH <sub>3</sub> ;	2
(c)(iii)	propanoic acid;	1
(d)(i)	46;	1
(d)(ii)	60;	1
(d)(iii)	moles of CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH = 0.1; moles of HCOOH = 0.087 (0.09) <b>and</b> limiting reagent is methanoic acid;	2
(d)(iv)	88 × (mol of limiting reagent in <b>4(d)(iii)</b> ); expected answer: 88 × 0.087 = 7.65 g;	1

14. 0620\_w13\_ms\_33 Q: 6

- (a) (i)  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$  [1]  
**NOT:**  $\text{C}_3\text{H}_8\text{O}$   
between 2030 and 2050 [1]
- (ii)  $\text{C}_5\text{H}_{11}\text{OH} + 7\frac{1}{2} \text{O}_2 \rightarrow 5\text{CO}_2 + 6\text{H}_2\text{O}$  [1]
- (b) any three from:  
same general formula  
same functional group  
same chemical properties  
same methods of preparation  
accept consecutive members differ by  $\text{CH}_2$  [3]
- (c) (i) same molecular formula [1]  
different structures / different structural formulae [1]
- (ii)  $\text{CH}_3\text{-CH}_2\text{-CH(OH)-CH}_3$  /  $(\text{CH}_3)_3\text{C-OH}$  [1]
- (d) (i) number of moles of glucose =  $72/180 = 0.4$  [1]  
maximum number of moles ethanol = 0.8 [1]  
maximum mass of ethanol,  $M_r = 46$  g,  $0.8 \times 46 = 36.8$  g [1]  
**or**  
180 (g) produces  $2 \times 46 = 92$  (g) (1)  
(72 (g) produces)  $72/180 \times 92$  (1)  
= 36.8 (g) (1)
- (ii) crack (petroleum or alkane) [1]  
react with water / hydrate (ethene to make ethanol) [1]
- conditions for cracking  
(temperature) 450 to 800°C / (catalyst) zeolites / aluminosilicates / silica / aluminium oxide / alumina / china / broken pot / chromium oxide  
**or**  
conditions for hydration  
(temperature) 300°C / (pressure) 60 atmospheres /  
(catalyst) phosphoric acid [1]

[Total: 15]

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- (a) (i) correct structure of an isomer e.g. 2-chloropropane; [1]
- (ii) chlorine; [1]  
light / heat / lead tetraethyl; [1]
- (iii) could produce 2-chloropropane; [1]  
could produce HCl; [1]  
**or**  
could produce dichloropropanes = [2]
- (b) (i) add silver nitrate / lead nitrate; [1]  
yellow precipitate; [1]  
**note:** do not insist on presence of dilute nitric acid
- (ii) propanol / propan-1-ol; [1]
- (c) (i) for A;  
reaction slower;  
decreased collision rate;  
less bromobutane present / concentration of bromobutane less / less reacting particles; [2]  
any two  
**accept:** reverse arguments for B
- (ii) halogens Cl > Br > I reactivity / reactivity decreases down group; [1]  
organic halides I > Br > Cl / reactivity increases down group; [1]  
opposite without explanation = [1]
- (iii) any three from:  
less energy;  
particles move slower;  
less collisions / fewer particles have energy to react / fewer successful collisions;  
slower rate; [3]

**[Total: 15]**AcelGCSE  
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