

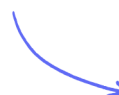
Exam Questions

Reactions of Alkenes & Alcohols

Alkenes / Combustion of Alkenes / Addition Reactions of Alkenes / Alcohols / Carboxylic Acids / Carboxylic Acids as Acids

Easy (5 questions)	/36
Medium (6 questions)	/22
Hard (7 questions)	/46
Total Marks	/104

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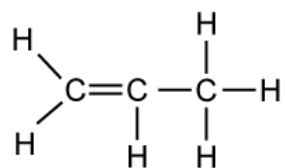


Easy Questions

1 (a) This question is about alkenes.

The structure of propene is shown in **Figure 1**.

Figure 1



What is the molecular formula of propene?

Answer

The formula of propene is:

- C_3H_6 ; [1 mark]

[Total:1 mark]

- The molecular formula tells you the actual number of atoms of each element
- From the displayed formula you can deduce there are 3 carbon atoms and 6 hydrogen atoms
- Make sure you capitalise C and H in these formulas as they are the symbols for carbon and hydrogen

(1 mark)

(b) Which **two** statements are correct about alkenes?

Tick (✓) **two** boxes.

Alkenes are saturated	
Alkenes are unsaturated	
Alkenes have covalent bonds	
Alkenes are unreactive	

Answer

The two statements which apply to alkenes are:

- Alkenes are unsaturated; [1 mark]
- Alkenes have covalent bonds; [1 mark]

[Total: 2 marks]

- **Remember:** if there are only single bonds then the compound is saturated
- In alkenes, there is a double bond present so they are unsaturated
- Alkenes consist of only carbon and hydrogen atoms, both non-metals and therefore have covalent bonds
- Alkenes are able to react due to the presence of the double bond

(2 marks)

(c) The beginning of the general formula of alkenes is written below.

Complete the general formula of alkenes.



Answer

The general formula is:



- $2n$; [1 mark]

[Total: 1 mark]

- If you look at Figure 1, the number of hydrogen atoms is double that of the number of carbon atoms
- Therefore if n represents the number of carbon atoms, $2n$ represents double this number

(1 mark)

(d) Alkenes can undergo incomplete combustion.

What is meant by incomplete combustion?

Answer

Incomplete combustion is:

- A fuel burns in insufficient/limited oxygen; [1 mark]

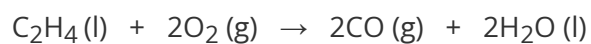
[Total: 1 mark]

- The opposite is complete combustion whereby there is a plentiful supply of oxygen for the fuel to burn
- The amount of oxygen determines the product formed

(1 mark)

(e) The following equation shows the incomplete combustion of ethene.

Name the **two** products formed in this reaction.



Answer

The two products formed are:

- Carbon monoxide; [1 mark]
- Water; [1 mark]

[Total: 2 marks]

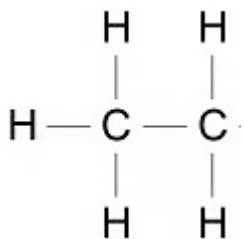
- Incomplete combustion produces carbon monoxide (and sometimes just carbon or soot) as opposed to carbon dioxide as there hasn't been enough oxygen for the alkene to burn in

(2 marks)

2 (a) This question is about ethanol.

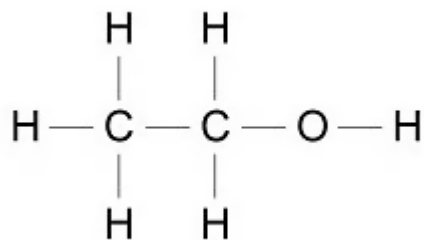
Ethanol belongs to the homologous series, alcohols.

Complete the structure of ethanol.



Answer

The completed structure of ethanol is:



- -O-H; [1 mark]

Allow -OH

[Total: 1 mark]

(1 mark)

(b) Ethanol can be used in alcoholic drinks.

Tick (✓) **two** other uses of ethanol.

As fuels	
As polymers	
As solvents	
As perfumes	

Answer

Two uses of ethanol are:

- As fuels; [1 mark]
- As solvents; [1 mark]

[Total: 2 marks]

(2 marks)

(c) Why can ethanol not be referred to as a hydrocarbon?

Answer

Ethanol is not a hydrocarbon because:

- Hydrocarbons contain carbon and hydrogen atoms only; [1 mark]
- Ethanol/ alcohols contain an oxygen atom; [1 mark]

[Total: 2 marks]

(2 marks)

(d) Ethanol is made by a process called fermentation.

Use the words in the box to complete the sentences on fermentation.

cool	energy	yeast	warm
------	--------	-------	------

high	oxygen	carbon dioxide
------	--------	----------------

During fermentation, sugar is converted to ethanol by adding _____.

The reaction takes place at a _____ temperature in the absence of _____.

Answer

The completed sentences are:

During fermentation, sugar is converted to ethanol by adding **yeast**.

The reaction takes place at a **warm** temperature in the absence of **oxygen**.

- Yeast; [1 mark]
- Warm; [1 mark]
- Oxygen; [1 mark]

[Total: 3 marks]

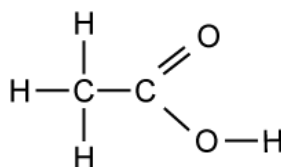
- Fermentation occurs at around 37 °C as this is the optimum temperature the yeast will work at
- If the temperature is too high or too low the enzymes can become denatured or the reaction will occur at a much slower rate
- It is also carried out in slightly acidic conditions

(3 marks)

3 (a) This question is about carboxylic acids.

The structure of ethanoic acid is shown in **Figure 1**.

Figure 1



Circle the functional group of ethanoic acid.

Answer

The functional group is

- - COOH; [1 mark]

[Total: 1 mark]

- All four atoms should be circled

(1 mark)

(b) Ethanoic acid can be formed from ethanol.

Which element does ethanol react with to form ethanoic acid?

Circle the correct answer.

oxygen	carbon	hydrogen
--------	--------	----------

Answer

The element added is:

- Oxygen; [1 mark]

[Total: 1 mark]

- Alcohols are oxidised to form carboxylic acids.
- Ethanol will react with oxygen to give ethanoic acid, propanol will react with oxygen to give propanoic acid and so on

(1 mark)

(c) Ethanoic acid will react with sodium carbonate in a neutralisation reaction.

Complete the word equation for this reaction:

ethanoic acid + sodium carbonate → sodium ethanoate + _____ + _____

Answer

The completed equation is:

Ethanoic acid + sodium carbonate → sodium ethanoate + **carbon dioxide** + **water**

- Carbon dioxide; [1 mark]
- Water; [1 mark]

[Total: 2 marks]

- Carboxylic acids react in much the same way as other acids
- They react with carbonates to produce, a salt, in this case sodium ethanoate, carbon dioxide and water
- Ethanoic acid will always form an ethanoate, propanoic acid will form a propanoate and so on

(2 marks)

(d) Ethanoic acid can dissolve in water.

Tick (✓) **two** statements which correctly describe this reaction.

Ethanoic acid partially ionises in water	
Ethanoic acid releases OH^- ions	
Ethanoic acid forms a solution with a pH of 1	
Ethanoic acid is a weak acid	

Answer

The two correct statements are:

- Ethanoic acid partially ionises; [1 mark]
- Ethanoic acid is a weak acid; [1 mark]

[Total: 2 marks]

- When an acid is dissolved in water, they produce hydrogen, H^+ ions, not OH^-
- When ethanoic acid dissolves in water, it only partially ionises which means that not all acid molecules form hydrogen ions
- As a result, the concentration of hydrogen ions is lower resulting in a weak acid, with a higher pH

(2 marks)

(e) Ethanoic acid will react with ethanol to form an ester.

Name the ester formed from this reaction.

Tick (✓) **one** box.

Ethene	
Ethyl ethanoate	
Ethane	

Answer

The ester formed is:

- Ethyl ethanoate; [1 mark]

[Total: 1 mark]

- Esters are formed from alcohols and carboxylic acids
- They are used as flavourings and in perfumes as they have nice smells

(1 mark)

4 (a) This question is about the reactions of alkenes.

Which substance is an alkene?

Tick (✓) **one** box.

C ₅ H ₁₂	
C ₇ H ₁₄	
C ₁₂ H ₂₀	

Answer

The alkene is:

- C₇H₁₄; [1 mark]

[Total: 1 mark]

- Alkenes have the general formula C_nH_{2n}
- Therefore the number of hydrogen atoms is double the number of carbons
- C₅H₁₂ would be an alkane as the general formula for them is C_nH_{2n+2}

(1 mark)

(b) Alkenes are produced from the cracking of long chain hydrocarbons.

Give **one** use of the alkenes produced by this reaction.

Answer

One use of the alkenes produced from cracking is:

Any **one** from:

- Making polymers / plastics; [1 mark]
- As starting materials for other products; [1 mark]

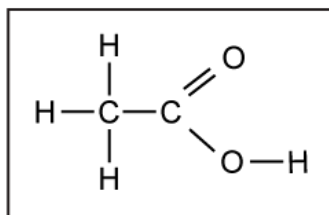
[Total: 1 mark]

(1 mark)

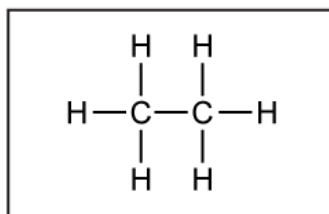
(c) Ethene can react with hydrogen, water and chlorine due to the presence of the double bond.

Draw **one** line to show the displayed formula of the product formed when ethene reacts with hydrogen, water and chlorine.

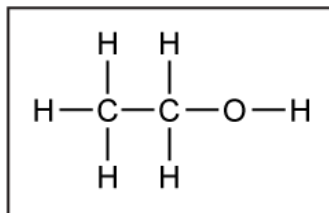
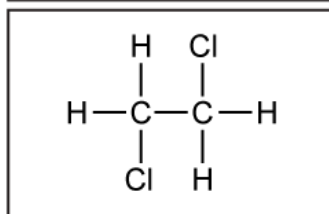
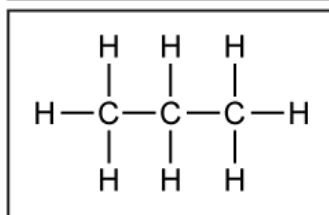
Water



Hydrogen

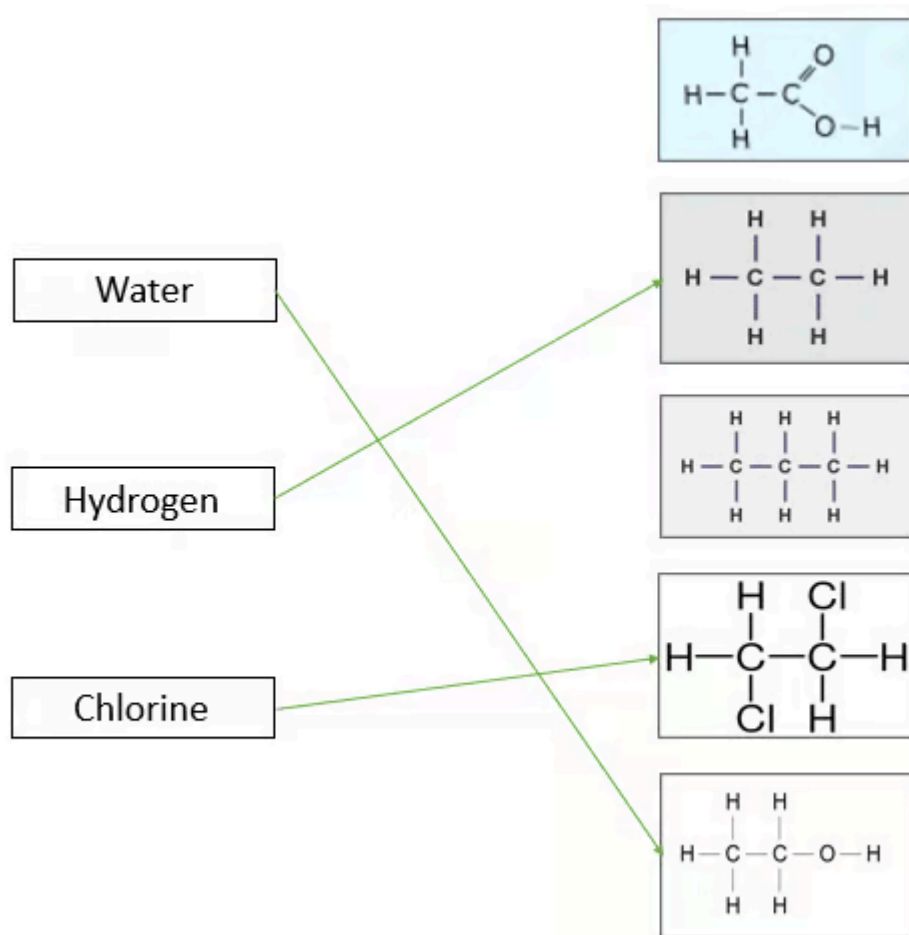


Chlorine



Answer

The correct pairs are:



- Water with ethanol; [1 mark]
- Hydrogen with ethane [1 mark]
- Chlorine with dichloroethane; [1 mark]

[Total: 3 marks]

- When ethene reacts with hydrogen, H_2 the hydrogen adds across the double bond producing ethane
- When ethene reacts with water, H_2O , one hydrogen, and one OH group add across the double bond forming ethanol
- When ethene reacts with chlorine, Cl_2 the chlorine atoms add across the double bond

- In all cases, the product is a saturated compound due to the loss of the double bond

(3 marks)

(d) Name the type of reaction that occurs when alkenes react with each substance in 4c.

Circle **one** answer.

Substitution	Decomposition	Addition	Neutralisation
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Answer

The type of reaction is:

- Addition; [1 mark]

[Total: 1 mark]

- In each case, hydrogen, water and chlorine **add** across the double bond

(1 mark)

5 (a) This question is about organic chemistry.

Draw **one** line from each homologous series to the correct functional group.

Ester

$C = C$

Alkene

- OH

Carboxylic acid

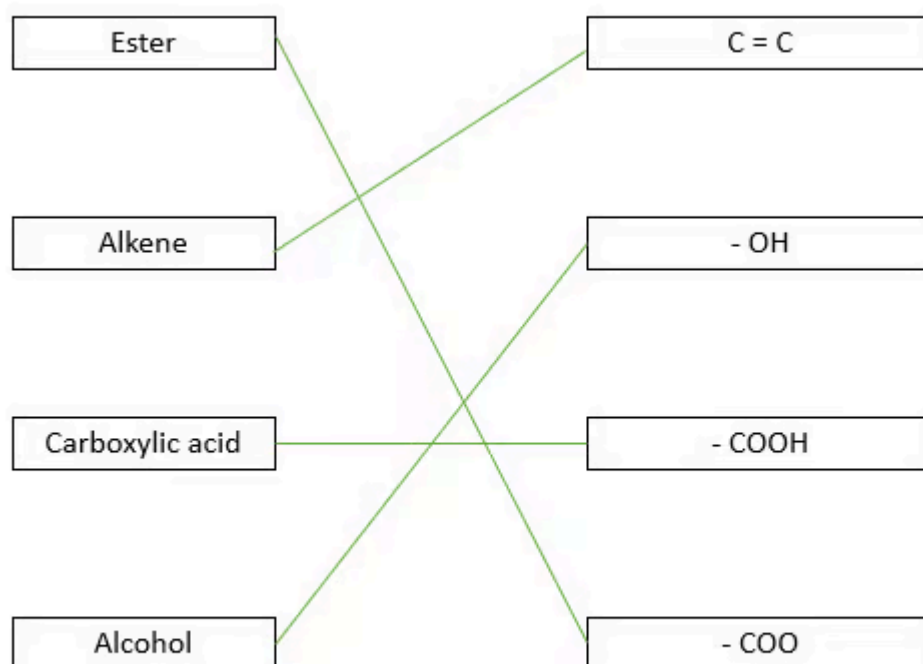
- COOH

Alcohol

- COO

Answer

The correct pairings are:



- Ester: - COO; [1 mark]
- Alkene: C=C; [1 mark]
- Carboxylic acid: - COOH; [1 mark]
- Alcohol: - OH; [1 mark]

[Total: 4 marks]

(4 marks)

(b) Complete each sentence about organic compounds by circling the correct word.

To test for the presence of an alkene you add

limewater.
bromine water.
litmus paper.

When sodium is added to ethanol

oxygen
carbon dioxide
hydrogen

 is produced.

Propanoic acid will dissolve in water to give a solution with a pH of

4.
7.
13.

Esters, such as ethyl ethanoate are used

as fuels.
in perfumes.
as solvents.

Answer

The correct sentences are:

- To test for the presence of an alkene you add bromine water; [1 mark]
- When sodium is added to ethanol, hydrogen is produced; [1 mark]
- Propanoic acid will dissolve in water to give a solution with a pH of 4; [1 mark]
- Esters such as ethyl ethanoate are used in perfumes; [1 mark]

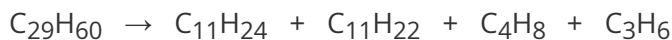
[Total: 4 marks]

- Bromine water is used as it can add across the double bond in the alkene and form a colourless solution
- Propanoic acid only partially ionises in water and therefore there is a higher concentration of hydrogen ions giving the acid a higher pH than a strong acid
- Esters have distinctive smells so can be used in perfumes

(4 marks)

Medium Questions

1 (a) The equation shows the cracking of a long chain hydrocarbons.



One of the products formed is a different type of hydrocarbon to the other products.

Give the formula for this product and explain why the chemical formula of this compound is different to the others.

You should include the name of the family of compounds.

Answer

The product

- Has the formula $\text{C}_{11}\text{H}_{24}$: [1 mark]
- It does not have a carbon carbon double bond

OR

It is a saturated compound; [1 mark]

- It is an alkane; [1 mark]

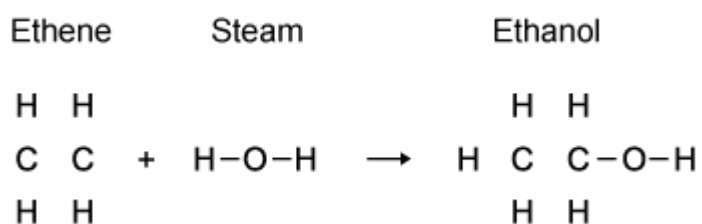
[Total: 3 marks]

(3 marks)

(b) Ethanol is produced from the reaction of ethene and steam in the presence of a hot catalyst.

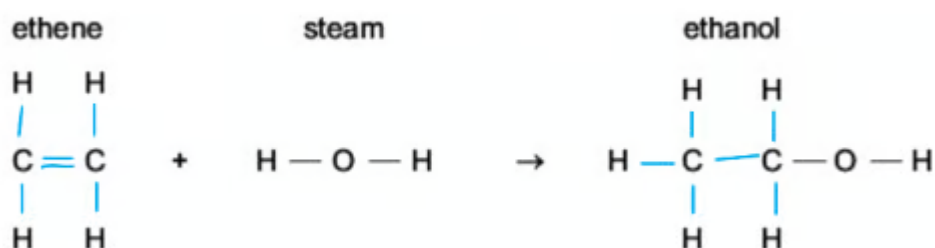
Add the missing bonds to complete the displayed structures in **Figure 1**.

Figure 1



Answer

The correct bonds are:



- Ethene: 4 x single C-H bonds [1 mark] 1 C=C double bond [1 mark]
- **Ethanol: 5 x single C-H bonds [1 mark]** **1 x single C-C bond [1 mark]**

[Total: 4 marks]

(4 marks)

(c) Ethanol can also be produced by the fermentation of sugars from plants.

Draw a ring around the temperature that is most suitable for this process.

10 °C	25 °C	350 °C
-------	-------	--------

Answer

The correct temperature is:

- 25°C [1 mark]

[Total: 1 mark]

(1 mark)

- (d) Ethanol produced by fermentation is often added to petrol to create a biofuel.

Explain why increasing the use of biofuels may cause food shortages.

Answer

It will potentially cause food shortages because:

- Fertile land is used to grow fuel crops; [1 mark]
- Instead of being used to grow conventional crops for human consumption; [1 mark]

[Total: 2 marks]

(2 marks)

- (e) Burning biofuels contributes less to climate change than burning fossil fuels.

Explain why.

Answer

They contribute less because:

- They remove CO₂ from the atmosphere (when they photosynthesise); [1 mark]
- So the CO₂ released (when burning the biofuel) was previously removed from the atmosphere; [1 mark]

[Total: 2 marks]

(2 marks)

2 Which of the following molecules is an alkene?

- A. C_6H_{10}
- B. C_4H_{10}
- C. C_5H_{10}
- D. C_6H_{14}

Answer

The correct answer is C because:

- This fits the general formula of an alkene C_nH_{2n}
- The formula for 5 carbons: C_5H_{10}

A is incorrect as this molecule has a general formula C_nH_{2n-2}

B & D are incorrect as these molecules have a general formula C_nH_{2n+2}

(1 mark)

3 What gas is formed when sodium is added to propanol?

- A. Carbon dioxide
- B. Hydrogen
- C. Carbon Monoxide
- D. Ethene

Answer

The correct answer is B because:

- When alcohols are reacted with sodium, effervescence is seen and hydrogen gas is given off
- The alcohols produce a strongly alkaline solution of a sodium alkoxide
- In this case propanol reacts with sodium to form sodium propoxide

(1 mark)

4 (a) This question is about the reactions of alkenes and carboxylic acids.

Halogens react with alkenes.

Name this type of reaction.

Answer

The type of reaction is:

- Addition reaction; [1 mark]

[Total: 1 mark]

- Addition reactions involve adding atoms to a molecule
- Halogens can be added to alkenes, breaking the double bond in the process

(1 mark)

(b) Name **two** other substances which also react with alkenes in this way.

Answer

Two substances include:

- Hydrogen; [1 mark]
- Water; [1 mark]
accept H₂O

[Total: 2 marks]

- Hydrogen adds across the double bond in an alkene to form an alkane
- Water adds across the double bond to form an alcohol

(2 marks)

- (c) Butanoic acid is a carboxylic acid with the formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$.

Write down the functional group of the carboxylic acids.

Answer

The functional group is:

- $-\text{COOH}$; [1 mark]

[Total: 1 mark]

- The formula can also be written as $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- The functional group is easily identifiable from this
- You may also be asked to circle the functional group on a diagram

(1 mark)

- (d) Butanoic acid reacts with magnesium carbonate to form magnesium butanoate and two other products.

Complete and balance the equation for the reaction.



Answer

The equation is:



- Correct formula for water; [1 mark]
- Correct formula for carbon dioxide; [1 mark]

[Total: 2 marks]

- The reaction is the same for any metal carbonate and acid in that a salt, carbon dioxide and water are formed
- The equation above does not need additional balancing, as it is already balanced

(2 marks)

5 Which is **not** true about carboxylic acids?

- A. Solutions of carboxylic acids have a higher pH than solutions of strong acids of the same concentration
- B. Carbonates fizz vigorously in solutions of carboxylic acids
- C. Carboxylic acids are volatile
- D. They react with alcohols to make esters

Answer

The correct answer is B because:

- Carboxylic acids are weak acids and fizz gently with carbonates
- The acids dissolve in water and ionise to form H^+ and negative ions, but only a small proportion of the molecules will ionise in solution
- The lack of a large number of H^+ ions means the reaction with carbonates is slow

(1 mark)

6 Which is of these is true about the manufacture of ethanol?

- A. Fermentation has a 100% atom economy
- B. The hydration of ethene has a 100% atom economy
- C. Fermentation produces pure ethanol
- D. Alkenes are reactive so the hydration of ethene occurs readily at room temperature

Answer

The correct answer is B because:

- The hydration of ethene has only one product, ethanol, so it has a 100% atom economy



A is incorrect as fermentation produces ethanol and carbon dioxide. Since the question is about the manufacture of ethanol, which is the desired product, then we cannot say the process has 100% atom economy

C is incorrect as the ethanol produced by fermentation is very impure as it contains a lot of water

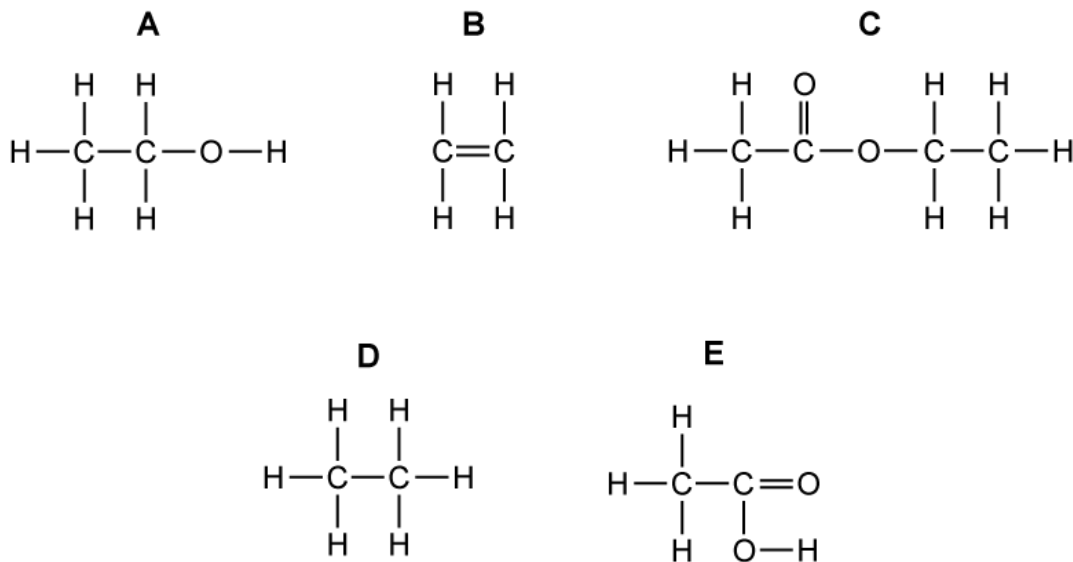
D is incorrect as alkenes are reactive and will undergo some reactions at room temperature. However, the hydration of ethene requires steam and a catalyst, so does not occur at room temperature

(1 mark)

Hard Questions

1 (a) This question is about the reactions of organic compounds **A** - **E** shown in **Figure 1**.

Figure 1



Name compound **C**.

Answer

Compound **C** is:

- Ethyl ethanoate; [1 mark]

[Total: 1 mark]

- Ethyl ethanoate is an ester
- Esters have a $-\text{COO}$ functional group and are formed from an alcohol reacting with a carboxylic acid
- Ethanol and ethanoic acid react to produce the ester, ethyl ethanoate and water:



- The first part of the ester name comes from the alcohol
 - The second part of the ester name comes from the carboxylic acid
- For exam purposes, you only need to know the name and recognise the structure of this particular ester

(1 mark)

(b) Name the products formed when **E** reacts with sodium.

Answer

The products formed when compound **E** reacts with sodium are:

- Sodium ethanoate; [1 mark]
- Hydrogen; [1 mark]

[Total: 2 marks]

- Compound **E** is ethanoic acid, a carboxylic acid
- Carboxylic acids behave the same way other acids do, so will react with a metal as follows:



- For this specific example the following reaction happens:



(2 marks)

(c) Which compound reacts with compound **A** to produce compound **C**?

Answer

The compound that reacts with compound **A** to produce compound **C** is:

- Compound **E** / **E**; [1 mark]
allow ethanoic acid

[Total: 1 mark]

- Compound **C** is the ester, ethyl ethanoate
- Ethyl ethanoate is formed by the reaction between ethanol (compound **A**) and ethanoic acid (compound **E**)
- This reaction is called esterification and requires an acid catalyst, usually conc H_2SO_4

(1 mark)

(d) Give the catalyst needed for the reaction that produces compound **D** from compound **B**.

Answer

The catalyst needed to convert compound **B** to compound **D** is:

- Nickel catalyst; [1 mark]

[Total: 1 mark]

- Compound **B** is ethene, an unsaturated hydrocarbon
- This can undergo an addition reaction with hydrogen due to the presence of the double bond
 - The hydrogen atoms add across the double bond to form ethane, a saturated hydrocarbon
- This is also called hydrogenation
- Temperatures of approximately $150\text{ }^{\circ}\text{C}$ and a nickel catalyst are required

(1 mark)

(e) Which compound dissolves in water to produce a neutral solution?

Answer

The compound which dissolves in water to form a neutral solution is:

- Compound **A** / **A**; [1 mark]
allow ethanol

[Total: 1 mark]

- Compound A is the alcohol, ethanol
- Ethanol is soluble in water due to the presence of the –OH group
- It dissolves to give a neutral solution, as do methanol, propanol and butanol
however the solubility of alcohols decreases as the chain length increases

(1 mark)

2 (a) This question is about carboxylic acids.

The table below shows information about three carboxylic acids.

Complete the table.

Name	Formula
Ethanoic acid	CH ₃ COOH
	CH ₃ CH ₂ CH ₂ COOH
Propanoic acid	

Answer

The completed table is:

Name	Formula
Ethanoic acid	CH ₃ COOH
Butanoic acid; [1 mark]	CH ₃ CH ₂ CH ₂ COOH
Propanoic acid	CH ₃ CH ₂ COOH; [1 mark]

- Formula for propanoic acid; [1 mark]
- Name of butanoic acid; [1 mark]

[Total: 2 marks]

- You need to be able to draw, name and give the formula for the first four carboxylic acids
- To name all organic compounds, the number of carbon atoms determines the prefix
 - 1= meth
 - 2= eth
 - 3= prop
 - 4= but
- The structural formula for carboxylic acids (shown in the second column) has the functional group at the end
 - **Remember:** The carbon atom of the -COOH group is counted within the total number of carbon atoms in the compound

(2 marks)

- (b) Solutions of ethanoic acid and hydrochloric acid have different pH levels at the same concentration.

Explain the difference in pH levels between the two acids

Answer

Solutions of ethanoic acid and hydrochloric acid have different pH values at the same concentration because:

- Ethanoic acid only partially ionises (in solution); [1 mark]
allow it does not completely dissociate
- There is a lower concentration of hydrogen ions; [1 mark]
- (So) the pH value is higher than that of HCl ; [1 mark]
allow converse for hydrochloric acid
*do **not** allow the term ionising*

[Total: 3 marks]

- The pH scale is a measure of hydrogen ion concentration
- The lower the pH the higher the concentration of hydrogen ions
- Strong acids such as hydrochloric acid fully dissociate into ions in solution:



- All acid molecules dissociate and therefore the concentration of H^+ ions is high
- Weaker acids, such as ethanoic acid only partially dissociate into ions in solution:



- An equilibrium is established but most acid molecules are undissociated so there are less H^+ ions in the solution
 - Questions sometimes ask how you can tell from the equation the acid is weak: the presence of the reversible reaction arrow is your answer!

(3 marks)

(c) A student adds sodium to a solution of ethanoic acid in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

Answer

When sodium is added to a solution of ethanoic acid:

- The mass will decrease; [1 mark]
- (Because) hydrogen gas is given off; [1 mark]
- Which escapes; [1 mark]

[Total: 3 marks]

- The following reaction happens:



- The law of conservation of mass states the mass of the products will equal the mass of the reactants
- When a gas is produced, the gas escapes so the mass on the balance will go down so it appears like mass has been lost during the reaction

(3 marks)

(d) In a separate reaction, a student adds ethanoic acid to zinc carbonate.

Describe and give the result of a test the student would do to identify the gas produced.

Answer

The test and result for the gas produced are:

- Add limewater; [1 mark]
- It turns cloudy/ milky; [1 mark]

[Total: 2 marks]

- When ethanoic acid reacts with zinc carbonate the following reaction occurs:

ethanoic acid + zinc carbonate → zinc ethanoate + water + carbon dioxide

- The gas produced is carbon dioxide
- **Remember:** carboxylic acids behave like other acids

(2 marks)

3 Which two substances react together to form potassium propanoate?

	Reactant 1	Reactant 2
A	propanol	potassium
B	propene	potassium iodide
C	propanoic acid	potassium carbonate
D	ethyl propanoate	potassium

Answer

The correct answer is C because:

- Potassium propanoate is a salt
- Like all salts it can be made from an acid and a base
- The corresponding acid is propanoic acid and the base is potassium carbonate
- It could also be made from the base potassium hydroxide

A is incorrect as this reaction produces potassium propoxide

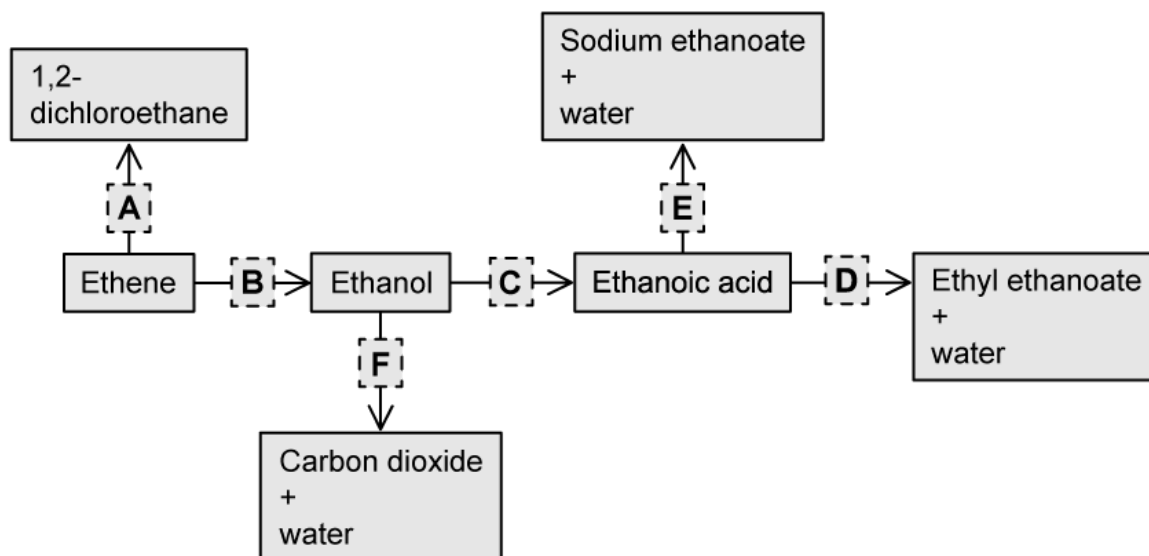
B & D are incorrect as these reactions do not take place

(1 mark)

4 (a) This question is about the reactions of organic compounds.

A flow chart of different reactions involving organic compounds is shown in **Figure 1**.

Figure 1



Name the type of reaction which occurs at:

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

Answer

The reactions for **A-F** are:

- (A) Addition; [1 mark] *accept halogenation*
- (B) Addition; [1 mark] *accept hydration*
- (C) Oxidation; [1 mark]
- (D) Esterification; [1 mark]
- (E) Neutralisation; [1 mark]
- (F) (Complete) combustion; [1 mark]
accept oxidation or burning

[Total: 6 marks]

- **A + B : Addition**
 - Alkenes undergo addition reactions with halogens, steam and hydrogen to form saturated compounds
 - They react with steam to form alcohols in the presence of a catalyst
 - They react with halogens to form halogenoalkanes (compounds where at least one hydrogen atom has been replaced by a halogen)
- **C: Oxidation**
 - Alcohols can be oxidised to form carboxylic acids
 - Ethanol will be oxidised to ethanoic acid, propanol to propanoic acid and so on
 - An oxidising agent is used which is represented in an equation using [O]:



- **D: Esterification**
 - Ethanol and ethanoic acid react to form an ester
- **E: Neutralisation**
 - As discussed in previous questions, ethanoic acid behaves as a typical acid so when reacting with an alkali will form a salt and water
- **F: Combustion**
 - Alcohols undergo combustion reactions to produce carbon dioxide and water
 - This is complete combustion as the product is carbon dioxide which indicates the fuel had a plentiful supply of oxygen to burn in
 - **Remember:** During incomplete combustion carbon monoxide or carbon would be made in place of the carbon dioxide

(6 marks)

(b) What type of chemical is used as a catalyst in reaction **D**?

Answer

The type of chemical used as a catalyst is:

- Acid; [1 mark]

allow any strong acid

allow correct formulae

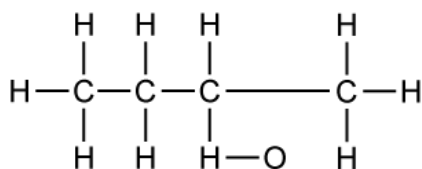
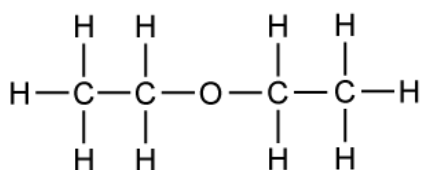
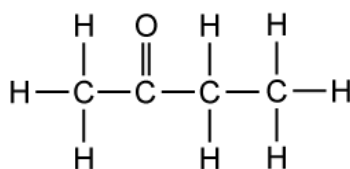
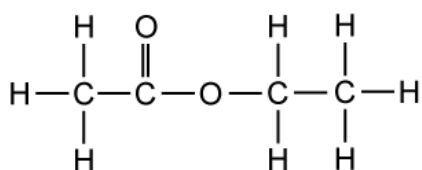
[Total:1 mark]

- Ethanol reacts with ethanoic acid to form an ester
- An acid catalyst is used, usually concentrated sulfuric acid
- Students often get this wrong as they incorrectly state that a transition metal can be used

(1 mark)

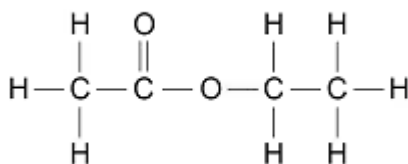
(c) Which is the correct structure of ethyl ethanoate?

Tick (✓) **one** box.

☐☐☐☐

Answer

The correct structure of ethyl ethanoate is:



- Correct structure; [1 mark]

[Total: 1 mark]

- The functional group of an ester is -COO
- Of the four structures given, only the bottom one has two oxygen atoms

(1 mark)

(d) Why can ethyl ethanoate be described as volatile?

Answer

Ethyl ethanoate can be described as volatile because:

- It evaporates easily; [1 mark]
allow it has a low boiling point
*do **not** allow it is flammable*

[Total: 1 mark]

- Esters volatility mean it can be used in applications such as perfumes
- As well as producing nice smells, it evaporates quickly once sprayed onto the skin

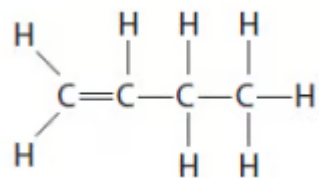
(1 mark)

5 (a) This question is about alkenes.

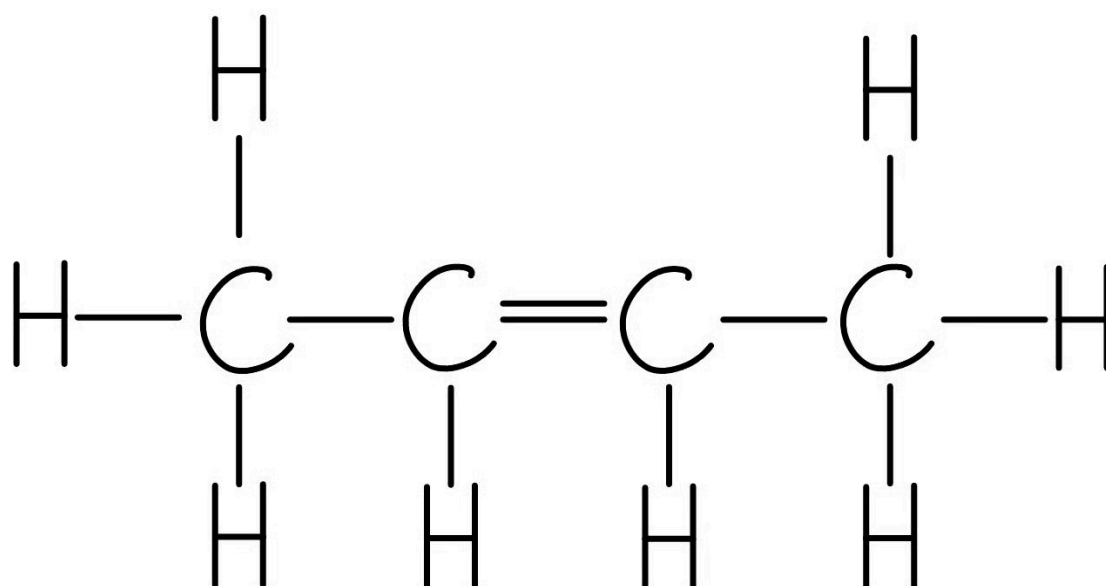
Draw the displayed formulae of butene.

Answer

The displayed formula of butene is:



OR



- Correct displayed formula; [1 mark]

[Total:1 mark]

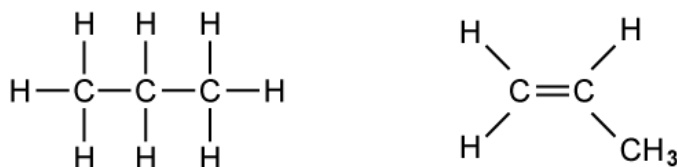
- You need to be able to name and draw the first four alkenes in the homologous series
- The first alkene in the series is ethene, as a double bond needs to exist between two carbon atoms for it to classify as this type of compound

- You therefore need to know ethene, propene, butene and pentene
- It does not matter which carbon atoms you draw the double bond between as long as it follows the general formula C_nH_{2n}

(1 mark)

(b) The structures of an alkane and an alkene are shown below.

Compare the structures and reactions of propene with propane.



Answer

Six mark questions are marked using the following criteria:

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted. **(4–6 marks)**

Level 1: Relevant features are identified and differences noted. **(1–3 marks)**

No relevant content (0 marks)

Indicative content

Structure and bonding

- Both are hydrocarbons
- Both contain three carbon atoms (per molecule)
- Propane contains eight hydrogen atoms (per molecule)
- (But) propene contains six hydrogen atoms (per molecule)
- Both have covalent bonds

- Propane contains single C—C bonds only
- (But) propene contains a double bond
- Both contain C—H bonds
- Both small molecules

Reactions

- Both react with oxygen in complete combustion reactions
- To produce water and carbon dioxide
- Both react with oxygen in incomplete combustion reactions
- To produce water, carbon monoxide and carbon
- Incomplete combustion is more likely with propene
- Propene decolourises bromine water
- (But) propane does not decolourise bromine water
- Propene is more reactive (than propane)
- Propene can react with hydrogen (to produce propane)
- Propene can react with water (to produce propanol)
- Propene can react with halogens (to produce halogenoalkanes)
- Propene can undergo addition reactions
- Propene can polymerise (to produce poly(propene))

ignore physical properties

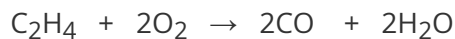
ignore references to flammability **[Total: 6 marks]**

(6 marks)

- (c) Write a balanced symbol equation for the incomplete combustion of ethene to form carbon monoxide and water.

Answer

The balanced symbol equation is:



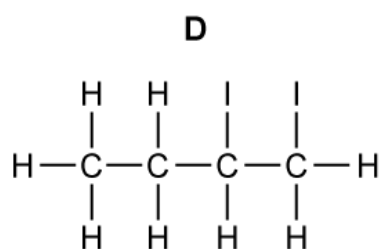
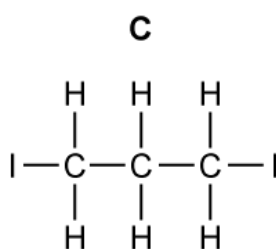
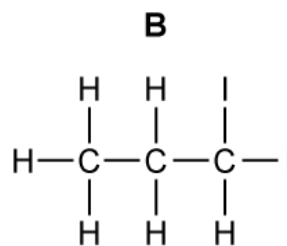
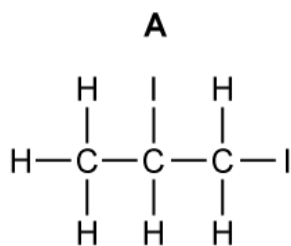
- Correct formulae of all products and reactants; [1 mark]
- Correct balancing; [1 mark]

[Total: 2 marks]

- You should know that combustion involves the hydrocarbon reacting with oxygen, and the products are stated in the question
 - $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow \text{CO} + \text{H}_2\text{O}$
- Balance the carbon atoms first
 - $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow 2\text{CO} + \text{H}_2\text{O}$
- Balance the hydrogen atoms second
 - $\text{C}_2\text{H}_4 + \text{O}_2 \rightarrow 2\text{CO} + 2\text{H}_2\text{O}$
- Balance the oxygen atoms last
 - $\text{C}_2\text{H}_4 + 2\text{O}_2 \rightarrow 2\text{CO} + 2\text{H}_2\text{O}$

(2 marks)

6 Which of the following shows the product of the reaction between propene and iodine?



Answer

The correct answer is A because:

- Propene has the chemical formula $\text{CH}_3\text{CH}=\text{CH}_2$
- Iodine undergoes an addition reaction with propene
- The double bond breaks and iodine atoms are added on either side of the double bond
- The result is $\text{CH}_3\text{CHICH}_2\text{I}$ which corresponds to option **A**

B is incorrect as both iodine atoms have been added to the same carbon atom

C is incorrect as the iodine atoms have been added to both ends of the chain instead of across the double bond

D is incorrect as the molecule contains too many carbon atoms for propene

(1 mark)

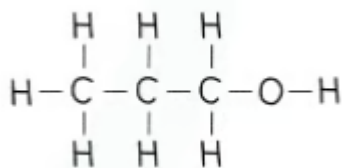
7 (a) This question is about alcohols.

Alcohols have the general formula $\text{C}_n\text{H}_{2n+1}\text{OH}$.

Draw the displayed formula of propanol.

Answer

The displayed formulae of propanol is:



- Correct displayed formula; [1 mark] *accept -OH*

[Total: 1 mark]

- The displayed formula shows how the atoms are arranged in space

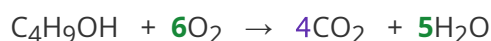
(1 mark)

(b) Alcohols undergo combustion reactions.

Write a balanced symbol equation for the complete combustion of butanol.

Answer

The balanced symbol equation for the complete combustion of butanol is:



- Correct formulae of all reactants and products; [1 mark]
- Correct balancing LHS; [1 mark]
- Correct balancing RHS; [1 mark] accept $\text{C}_4\text{H}_{10}\text{O}$ in place of $\text{C}_4\text{H}_9\text{OH}$

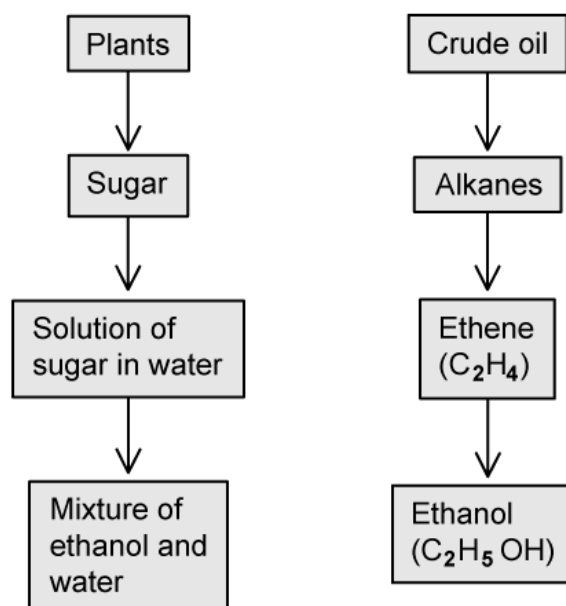
[Total: 3 marks]

- You should be able to use the general formula for alcohols given in part (a) to work out the chemical formula of butanol as $\text{C}_4\text{H}_9\text{OH}$
- Complete combustion indicates there is a plentiful supply of oxygen so carbon dioxide and water are produced
- **Remember:** When balancing combustion equations:
 - Balance the carbon atoms first
 - $\text{C}_4\text{H}_9\text{OH} + \text{O}_2 \rightarrow 4\text{CO}_2 + \text{H}_2\text{O}$
 - Then balance the hydrogen atoms
 - $\text{C}_3\text{H}_7\text{OH} + \text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$
 - Calculate the total number of oxygen atoms on the right hand side and balance these last
 - $\text{C}_3\text{H}_7\text{OH} + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$

(3 marks)

(c) Figure 1 shows two methods of ethanol production.

Figure 1



Explain how ethanol is made from sugar solution.

Give the name of the process.

Answer

Ethanol is made from sugar solution by:

- Fermentation; [1 mark]

Any **two** from:

- Add yeast; [1 mark]
- (Carry out the reaction in) anaerobic conditions; [1 mark] *allow in the absence of oxygen*
- Warm conditions; [1 mark]
allow temperatures in the range of 20-45 °C

[Total: 3 marks]

- The solution contains a mixture of sugars including glucose
- The following reaction happens during fermentation;



- The yeast respire anaerobically and provide the enzymes required to break down the glucose to form ethanol and carbon dioxide
- The conditions need to be correct as if the reaction is too cold, the rate of reaction will be very slow but too warm and the enzymes will denature

(3 marks)

(d) Describe the conditions needed to convert ethene to ethanol.

Answer

The conditions needed to convert ethene to ethanol:

- Steam; [1 mark]

Any **two** from:

- High temperature; [1 mark]
allow temperature of approximately 300- 330 °C
- High pressure; [1 mark]
allow pressures between 60 and 70 atmospheres
- Acid catalyst; [1 mark]
allow conc phosphoric acid

[Total: 3 marks]

- Ethanol is produced from ethene via an **addition** reaction
 - The steam, H₂O **adds** across the double bond –H on one carbon atom and –OH on another
- This method of producing ethanol uses non-renewable raw materials, as the ethene for the reaction is produced by cracking the hydrocarbons in crude oil

(3 marks)