# Organic chemistry – 2021 O Level

**1.** Nov/2021/Paper_11/No.36

Which statement about alkanes is correct?

**A** Alkanes are described as being saturated because they are insoluble in water.

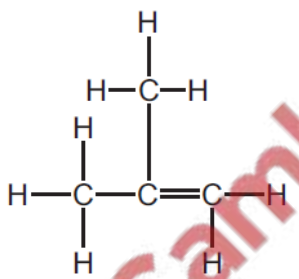
**B** Alkanes react with chlorine in an addition reaction.

**C** The alkane containing 10 carbon atoms in each molecule has a higher viscosity than the alkane containing 20 carbon atoms.

**D** The formula of an alkane with 35 carbon atoms in each molecule is $C_{35}H_{72}$.

**2.** Nov/2021/Paper_11/No.37

The structure of compound X is shown.



Four statements are made about compound X.

1 X burns in air to form carbon dioxide and water.

2 X turns bromine water from colourless to brown.

3 X is propene.

4 The number of C–C single bonds is increased by reacting X with hydrogen.

Which statements are correct?

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

**3.** Nov/2021/Paper_11/No.38

When ethene reacts with steam to form ethanol, which type of reaction takes place?

**A** addition

**B** fermentation

**C** polymerisation

**D** reduction

**4.** Nov/2021/Paper_11/No.39

Which compound could be a flavouring in a non-alcoholic fruit drink?

**A** $CH_3CH_2OH$

**B** $CH_3CH_2CH_2CH_2COOH$

**C** $CH_3COOCH_2CH_2CH_2CH_2CH_3$

**D** $CH_3CH_2CH_2CH_2CH_2OH$

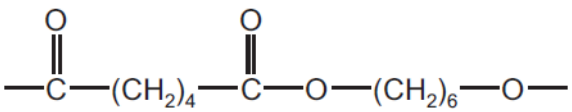
**5.** Nov/2021/Paper_11/No.40

P is a polymer that:

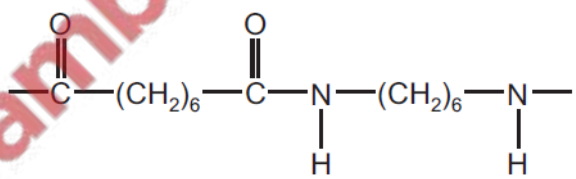
- has six carbon atoms in each of the monomers from which it is formed
- is **not** a polyester
- is formed using condensation polymerisation.

What is the partial structure of P?

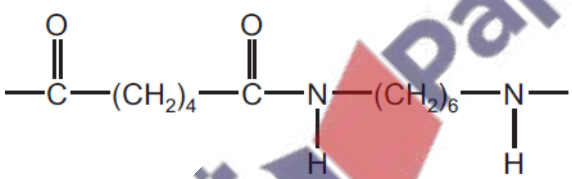
**A**



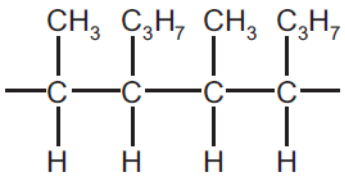
**B**



**C**



**D**



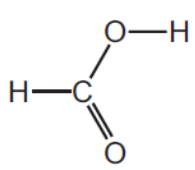


**6.** Nov/2021/Paper_12/No.9

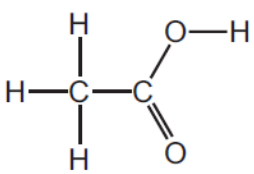
A covalent compound P has the empirical formula $CH_2O$.

Which structure represents P?

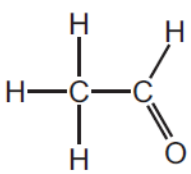
**A**



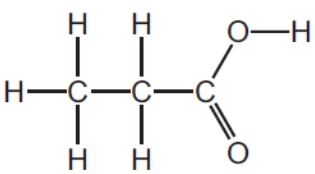
**B**



**C**

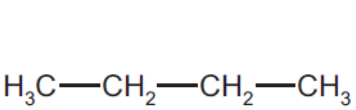


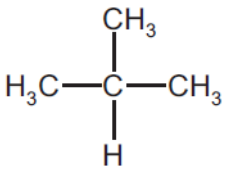
**D**



**7.** Nov/2021/Paper_12/No.36

Two isomers are shown.





Which statements about these isomers are correct?

1 They have the same empirical formula.

2 They have different molecular formulae.

3 They are members of the same homologous series.

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

**8.** Nov/2021/Paper_12/No.37

A hydrocarbon compound Q has molecular formula $C_xH_y$.

Q reacts with hydrogen to form a single product with molecular formula $C_xH_{y+2}$.

Which statement about Q is correct?

**A** Q does not burn in air.

**B** Q is a saturated hydrocarbon.

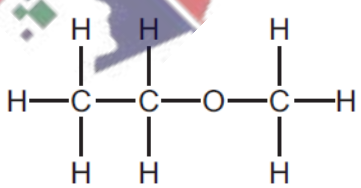
**C** Q reacts with bromine to form a single product with molecular formula $C_xH_{y-1}Br$.

**D** Q reacts with steam to form a single product with molecular formula $C_xH_{y+2}O$.

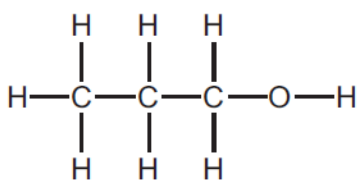
**9.** Nov/2021/Paper_12/No.38

Which structural formula represents an alcohol?

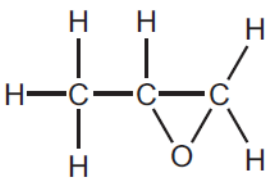
**A**



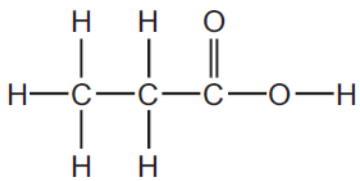
**B**



**C**



**D**



**10.** Nov/2021/Paper_12/No.39

Which statement about carboxylic acids is correct?

**A** They are prepared by the oxidation of alkanes.

**B** They decolourise bromine water.

**C** They react with alcohols to form esters.

**D** They react with carbonates to form a salt, hydrogen and water.

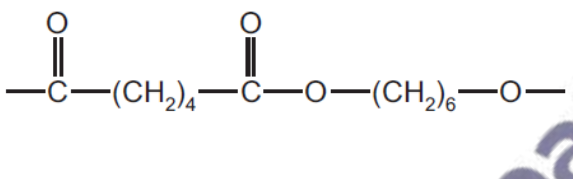
**11.** Nov/2021/Paper_12/No.40

P is a polymer that:

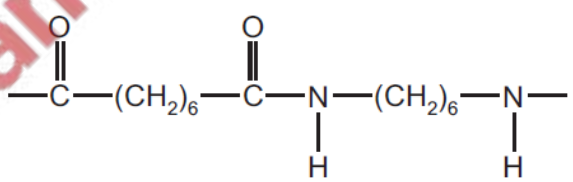
- has six carbon atoms in each of the monomers from which it is formed
- is **not** a polyester
- is formed using condensation polymerisation.

What is the partial structure of P?

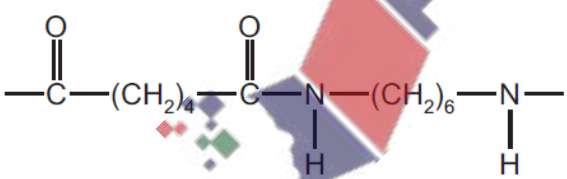
**A**



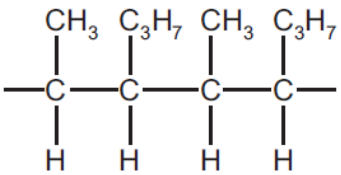
**B**



**C**



**D**



**12.** Nov/2021/Paper_21/No.4

Alkenes are a homologous series of hydrocarbons.

**(a)** Alkenes are produced by cracking.

State the meaning of the term *cracking*.

.....

..... [2]

**(b)** Margarine is manufactured from vegetable oils using a nickel catalyst.

**(i)** Name the other reactant used in this reaction.

..... [1]

**(ii)** State the type of chemical reaction which occurs when margarine is manufactured from vegetable oils.

..... [1]

**(c)** Ethanol is produced by the reaction of ethene with steam.

Construct the equation for this reaction.

[1]

**(d)** An organic compound contains 54.5% carbon, 9.10% hydrogen and 36.4% oxygen by mass.

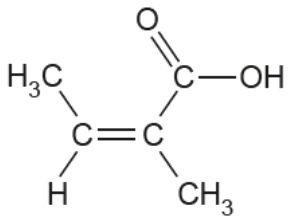
Calculate the empirical formula of this compound.

empirical formula ..... [2]

[Total: 7]

**13.** Nov/2021/Paper_21/No.8

The structure of angelic acid is shown.




**(a)** Explain how this structure shows that angelic acid is an unsaturated compound.

.....[1]

**(b)** Deduce the molecular formula of angelic acid.

.....[1]

**(c)** Angelic acid is a weak acid.

**(i)** Define the term *acid*.

.....[1]

**(ii)** Explain the meaning of the term *weak* as applied to acids.

.....

.....[1]

**(d)** Angelic acid can be polymerised.

**(i)** State the name of the type of polymerisation that occurs.

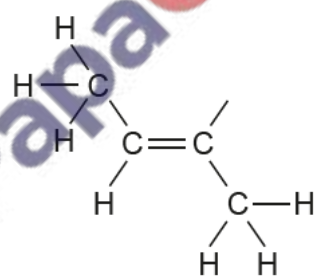
..... [1]

**(ii)** Draw the partial structure of the polymer of angelic acid. Show two repeat units.

[2]

**(e)** Angelic acid reacts with methanol, $CH_3OH$, to form an ester.

Complete the structure of this ester to show all the atoms and all the bonds.




[1]

**(f)** Construct the equation for the complete combustion of methanol.

..... [2]

[Total: 10]

**14.** Nov/2021/Paper_22/No.4

Alkanes are a homologous series of hydrocarbons. The boiling point, melting point and density of alkanes increase as the number of carbon atoms increases.

**(a)** **(i)** Give one **other** physical property of alkanes which increases as the number of carbon atoms increases.

..... [1]

**(ii)** Give two **other** characteristics of a homologous series.

1 .....

2 .....

[2]

**(b)** Two typical reactions of alkanes are combustion and cracking.

State the name of another typical chemical reaction of alkanes and the reactant needed to react with the alkanes.

type of reaction .....

reactant .....

[2]

**(c)** Alkenes are produced by cracking alkanes.

**(i)** State two conditions needed for cracking alkanes.

1 .....

2 .....

[2]

**(ii)** Tridecane, $C_{13}H_{28}$, can be cracked to produce an alkene with four carbon atoms and one other hydrocarbon only.

Construct an equation for this reaction.

..... [1]

**(d)** A hydrocarbon contains 88.9% carbon by mass.

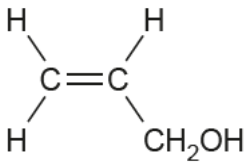
Calculate the empirical formula of this compound.

empirical formula ..... [2]

[Total: 10]

**15.** Nov/2021/Paper_22/No.8

The structure of an organic compound, **T**, is shown.




**(a)** Deduce the molecular formula of compound **T**.

..... [1]

**(b)** Compound **T** is a colourless liquid.

State the colour change when excess compound **T** is added to aqueous bromine.

from ..... to ..... [1]

**(c)** Compound **T** can be oxidised to a carboxylic acid.

Suggest a suitable oxidising agent for this reaction.

..... [1]

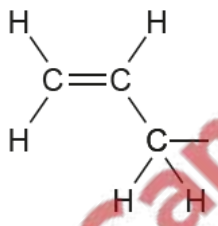
**(d)** Compound **T** can be polymerised.

Draw the partial structure of the polymer of compound **T**. Show two repeat units.

[2]

**(e)** Compound **T** reacts with methanoic acid, HCOOH, to form an ester.

Complete the structure of this ester to show all the atoms and all the bonds.




[1]

**(f)** Methanoic acid is a weak acid. Hydrochloric acid is a strong acid.

**(i)** Give the formula of the positive ion that is present in all acids.

..... [1]

**(ii)** Explain why the rate of reaction of 1.0 mol / $dm^3$ methanoic acid with magnesium is less than the rate of reaction of 1.0 mol / $dm^3$ hydrochloric acid with magnesium.

.....

..... [1]

**(g)** Construct the equation for the reaction of methanoic acid with magnesium.

..... [2]

[Total: 10]

**16.** Jun/2021/Paper_11/No.16

These statements refer to hydrogen and its use as a fuel.

1 Both water and hydrocarbons can be used as a source of hydrogen.

2 In a fuel cell hydrogen reacts with oxygen to generate electricity.

3 The reaction taking place in a fuel cell is a redox reaction.

Which statements are correct?

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

**17.** Jun/2021/Paper_11/No.17

Ethanol is produced by the fermentation of glucose from sugar cane. In some countries ethanol is used as a fuel.

Which statements are correct?

1 Sugar cane is a non-renewable (finite) resource.

2 When sugar cane is growing it removes carbon dioxide from the atmosphere.

**A** 1 only

**B** 2 only

**C** both 1 and 2

**D** neither 1 nor 2

**18.** Jun/2021/Paper_11/No.37

Which statements about alcohols are correct?

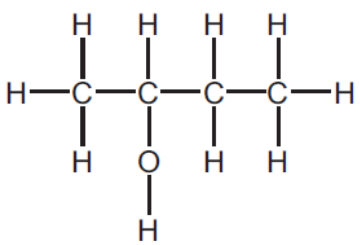
1 All alcohols contain the hydroxide ion, $OH^-$.

2 Ethanol can be formed from ethene using a reaction catalysed by yeast.

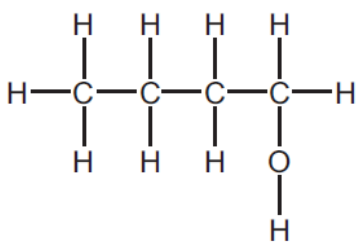
3 Methanol can be oxidised to methanoic acid.

4 The alcohols X and Y shown are isomers.

X



Y



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

**19.** Jun/2021/Paper_11/No.38

An ester has the formula $C_2H_5COOC_2H_5$.

Which pair of compounds would react together to form this ester?

**A** ethanoic acid and ethanol

**B** ethanol and propanoic acid

**C** propanoic acid and propanol

**D** propanol and ethanoic acid

**20.** Jun/2021/Paper_11/No.39

Which statement about polymers is correct?

**A** Nylon and *Terylene* are both polyesters.

**B** Proteins and nylon have the same monomer units.

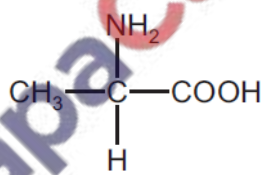
**C** Proteins have the same amide linkages as nylon.

**D** *Terylene* and fats are esters but with different linkages.

**21.** Jun/2021/Paper_11/No.40

X is a polymer.

When X is hydrolysed one of the products is substance Y.




Y

Which type of polymer is X?

**A** a complex carbohydrate

**B** a fat

**C** a protein

**D** an addition polymer

**22.** Jun/2021/Paper_12/No.16

Natural gas is used as a source of energy.

What is the main compound in natural gas?

**A** ethane

**B** ethene

**C** methane

**D** methanol

**23.** Jun/2021/Paper_12/No.17

Ethanol is produced by the fermentation of glucose from sugar cane. In some countries ethanol is used as a fuel.

Which statements are correct?

1 Sugar cane is a non-renewable (finite) resource.

2 When sugar cane is growing it removes carbon dioxide from the atmosphere.

**A** 1 only

**B** 2 only

**C** both 1 and 2

**D** neither 1 nor 2



**24.** Jun/2021/Paper_12/No.35

How many moles of hydrogen chloride are formed when one mole of methane reacts with a large excess of chlorine in sunlight?

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

**25.** Jun/2021/Paper_12/No.36

Vegetable oils can be made into margarine.

Which row describes the changes which take place?

| | hydrogen | viscosity |
|---|---|---|
| **A** | is added | increases |
| **B** | is removed | decreases |
| **C** | is added | decreases |
| **D** | is removed | increases |

**26.** Jun/2021/Paper_12/No.37

Which statements about alcohols are correct?

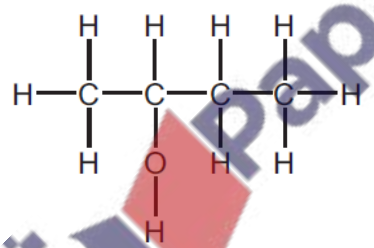
1 All alcohols contain the hydroxide ion, $OH^-$.

2 Ethanol can be formed from ethene using a reaction catalysed by yeast.

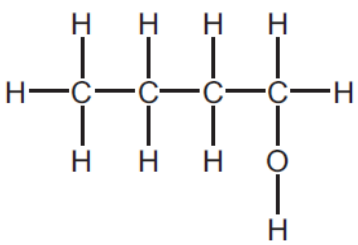
3 Methanol can be oxidised to methanoic acid.

4 The alcohols X and Y shown are isomers.

X



Y

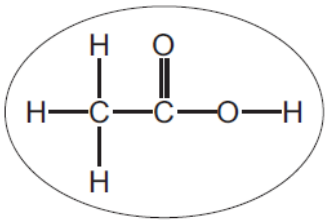


**A** 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

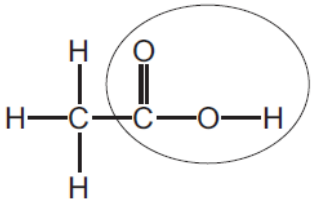
**27.** Jun/2021/Paper_12/No.38

Which circled structure shows only the functional group of a carboxylic acid?

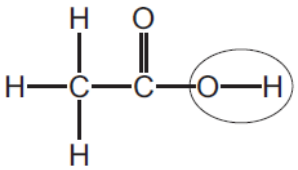
**A**



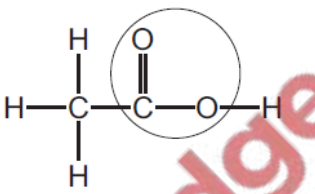
**B**



**C**



**D**



**28.** Jun/2021/Paper_12/No.39

Which statement about polymers is correct?

**A** Nylon and *Terylene* are both polyesters.

**B** Proteins and nylon have the same monomer units.

**C** Proteins have the same amide linkages as nylon.

**D** *Terylene* and fats are esters but with different linkages.

**29.** Jun/2021/Paper_12/No.40

Some information about compound X is given.

X contains the elements carbon, hydrogen and oxygen only.

The product of the hydrolysis of X is the simple sugar, glucose.

What is X?

**A** a polyester

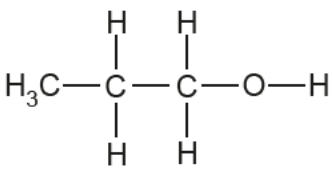
**B** a protein

**C** nylon

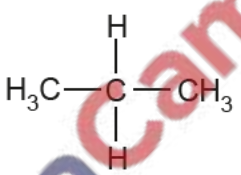
**D** starch

**30.** Jun/2021/Paper_21/No.1

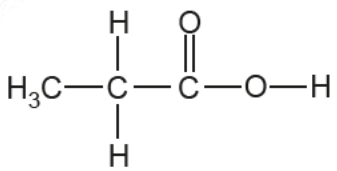
Choose from the following compounds to answer the questions.



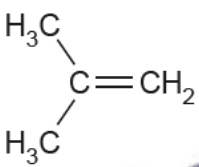
**A**



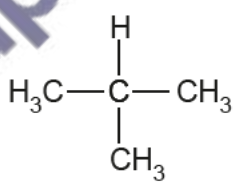
**B**



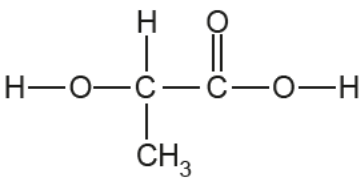
**C**



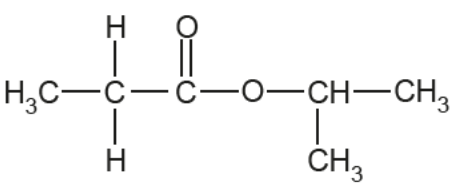
**D**



**E**



**F**



**G**

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

**(a)** State which compound:

**(i)** has a molecule with only 14 atoms

..... [1]

**(ii)** can be oxidised to form propanoic acid

..... [1]

**(iii)** is an isomer of butane

..... [1]

**(iv)** reacts with steam to make an alcohol

..... [1]

**(v)** can be polymerised to make a polyester.

..... [1]

**(b)** State which **two** compounds in aqueous solution turn blue litmus red.

..... [1]

[Total: 6]

**31.** Jun/2021/Paper_21/No.3

Petroleum (crude oil) is a mixture of hydrocarbons.

**(a)** Petroleum (crude oil) is separated into fractions such as liquefied petroleum gas, petrol (gasoline) and naphtha.

**(i)** Name the process used to separate petroleum (crude oil) into fractions.

..... [1]

**(ii)** Name one **other** fraction separated from petroleum (crude oil).

Give a large-scale use for this fraction.

fraction .....

use .....

[1]

**(iii)** Petroleum (crude oil) does not contain enough of the fractions that contain smaller hydrocarbon molecules such as petrol (gasoline).

Petroleum contains a high proportion of larger hydrocarbon molecules such as naphtha.

Describe how the demand for smaller hydrocarbon molecules is satisfied.

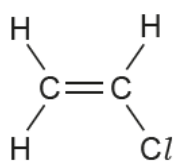
.....

.....

.....

..... [2]

**(b)** The structure of chloroethene is shown.




Chloroethene is the monomer used to make poly(chloroethene).

Poly(chloroethene) is non-biodegradable.

**(i)** Explain the meaning of the term *non-biodegradable*.

.....

..... [1]

**(ii)** Describe one environmental problem caused by the disposal of non-biodegradable plastics.

.....

..... [1]

**(iii)** Draw the partial structure of poly(chloroethene).

Show at least **two** repeat units.

[2]

**(iv)** A factory uses 100 tonnes of chloroethene to make poly(chloroethene).

Deduce the mass of poly(chloroethene) made. Assume the percentage yield is 100%.

Explain your answer.

.....

..... [1]

**(v)** Chloroethene reacts with hydrogen in the presence of a catalyst.

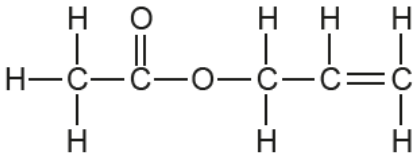
Suggest the structure of the product of this reaction.

[1]

[Total: 10]

**32.** Jun/2021/Paper_21/No.9

The structure of propenyl ethanoate is shown.



**(a)** Use the structure to explain why propenyl ethanoate is unsaturated.

.....

..... [1]

**(b)** Describe a chemical test to show that propenyl ethanoate is unsaturated.

test .....

observation .....

.....

[2]

**(c)** Propenyl ethanoate is prepared by the reaction between a carboxylic acid and an alcohol, as shown.

**(i)** Name the carboxylic acid used.

..... [1]

**(ii)** The reaction uses concentrated sulfuric acid as a catalyst.

Describe how a catalyst speeds up a chemical reaction.

.....

.....

..... [2]

**(d)** In an experiment 11.6 g of the alcohol is reacted with an excess of the carboxylic acid. The experimental yield of propenyl ethanoate is 6.72 g.

[The relative formula mass of propenyl ethanoate is 100.]

**(i)** Show that the maximum possible yield of propenyl ethanoate is 20.0 g.

[3]

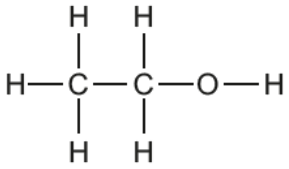
**(ii)** Calculate the percentage yield of propenyl ethanoate in this experiment.

% yield ..... [1]

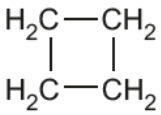
[Total: 10]

**33.** Jun/2021/Paper_22/No.1

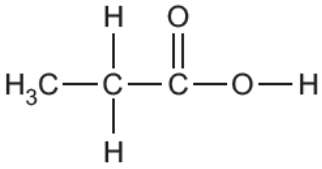
Choose from the following compounds to answer the questions.



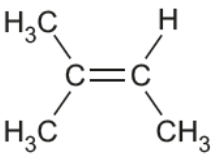
**A**



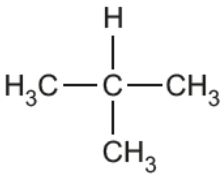
**B**



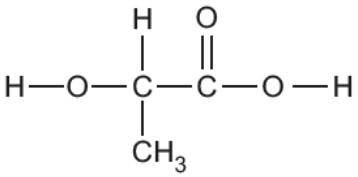
**C**



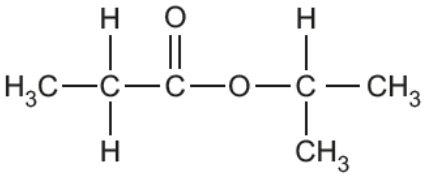
**D**



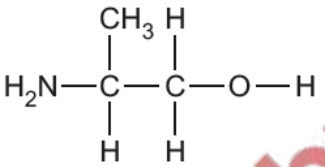
**E**



**F**



**G**



**H**

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

**(a)** State which compound:

**(i)** has a molecule with only 11 atoms

..... [1]

**(ii)** is oxidised to form ethanoic acid

..... [1]

**(iii)** is an isomer of butene

..... [1]

**(iv)** reacts with hydrogen in the presence of a catalyst to make an alkane

..... [1]

**(v)** contains four different elements chemically combined.

..... [1]

**(b)** Identify two compounds that have a pH of less than 7 in aqueous solution.

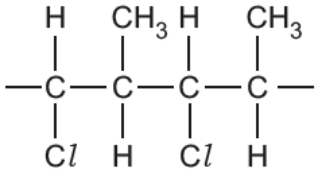
..... [1]

[Total: 6]

**34.** Jun/2021/Paper_22/No.3

There is concern about the disposal of plastics made from non-biodegradable polymers.

**(a)** The partial structure of a non-biodegradable polymer is shown.



**(i)** Name the type of polymer shown.

..... [1]

**(ii)** Draw the structure of the monomer used to make this polymer.

[1]

**(iii)** This polymer is often disposed of by combustion.

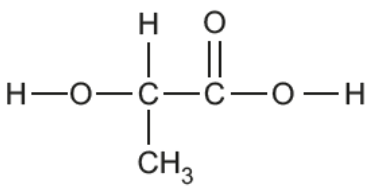
Suggest one problem associated with this method of disposal.

.....

..... [1]

**(b)** Lactic acid is used to make poly(lactic acid), a biodegradable polymer.

The structure of lactic acid is shown.



**(i)** Suggest what is meant by the term *biodegradable*.

.....

..... [1]

**(ii)** Draw the partial structure of poly(lactic acid).

Show at least two repeat units.

[2]

**(iii)** A factory uses 500 tonnes of lactic acid to make poly(lactic acid).

The percentage yield is 100% but the mass of poly(lactic acid) made is less than 500 tonnes.

Explain why the mass of poly(lactic acid) made is less than 500 tonnes.

.....

..... [1]

**(iv)** Aqueous lactic acid reacts with acidified potassium manganate(VII).

There is a colour change from purple to colourless.

Suggest what happens to the lactic acid in this reaction.

..... [1]

**(v)** Aqueous lactic acid is neutralised by aqueous sodium hydroxide.

Write the ionic equation for this neutralisation.

..... [1]

**(vi)** Aqueous lactic acid reacts with magnesium.

Name the gas made in this reaction.

..... [1]

[Total: 10]

**35.** Jun/2021/Paper_22/No.5

Petroleum (crude oil) provides the raw materials for making ethanol and ammonia.

**(a)** Describe how petroleum (crude oil) is separated to make fractions such as naphtha and petrol (gasoline).

.....

.....

..... [2]

**(b)** Compounds such as $C_{11}H_{24}$ in the naphtha fraction are cracked to make hydrogen, alkenes and smaller alkanes.

**(i)** Explain how the molecular formula $C_{11}H_{24}$ shows the compound is an alkane.

.....

..... [1]

**(ii)** Construct an equation to show the cracking of $C_{11}H_{24}$ to make ethene and an alkane only.

..... [1]

**(c)** Describe how hydrogen is converted into ammonia in the Haber process.

Include the conditions used in the Haber process.

.....

.....

.....

.....

..... [3]

**(d)** State one **other** use for hydrogen.

..... [1]

**(e)** Ethene reacts with a compound to make ethanol.

**(i)** Name the compound.

..... [1]

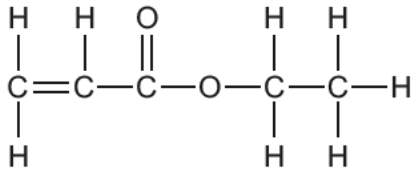
**(ii)** State one condition for this reaction.

..... [1]

[Total: 10]

**36.** Jun/2021/Paper_22/No.9

The structure of ethyl propenoate is shown.



**(a)** Circle the atoms in the structure that show that ethyl propenoate is an ester. [1]

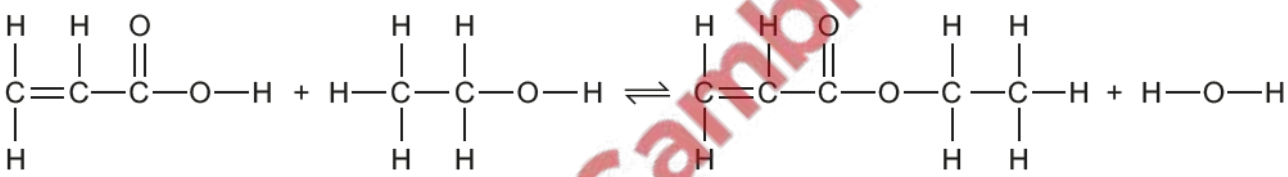
**(b)** Aqueous bromine is shaken with a sample of ethyl propenoate.

Explain, in terms of the structure of ethyl propenoate, why the aqueous bromine turns colourless.

.....

..... [1]

**(c)** Ethyl propenoate is prepared by the reversible reaction between a carboxylic acid and an alcohol, as shown.



A mixture of the carboxylic acid and the alcohol is allowed to reach equilibrium.

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

..... [1]

**(ii)** The reaction uses an acid catalyst.

State the effect of this catalyst on the position of equilibrium.

..... [1]

**(iii)** The concentration of the alcohol is increased.

Describe and explain what happens to the position of equilibrium.

.....

.....

..... [2]

**(d)** In an experiment 10.8 g of the carboxylic acid is reacted with an excess of the alcohol. The experimental yield of ethyl propenoate is 9.45 g.

[The relative formula mass of the carboxylic acid is 72.]

**(i)** Show that the maximum possible yield of ethyl propenoate is 15.0 g.

[3]

**(ii)** Calculate the percentage yield of ethyl propenoate in this experiment.

% yield ..... [1]

[Total: 10]