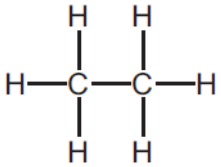
Organic chemistry – 2020 O Level

1. Nov/2021/Paper_11/No.12

The diagram shows the covalent bonds in an organic compound.



The total number of electrons in one molecule of this compound is .....X..... .

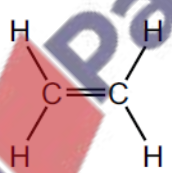
The total number of electrons in the bonds in one molecule of this compound is .....Y..... .

Which numbers correctly complete gaps X and Y?

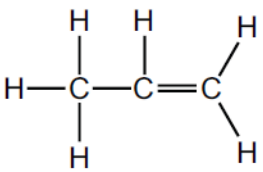
	X	Y
A	14	12
B	14	14
C	18	12
D	18	14

2. Nov/2021/Paper_11/No.17

The diagrams show the structures of ethene and propene.



ethene



propene

Which statement about equal volumes of ethene gas and propene gas at r.t.p. is correct?

A They contain equal numbers of atoms.

B They give equal volumes of carbon dioxide when burnt completely in oxygen.

C They give equal masses of ethane and propane when reacted with hydrogen.

D They react with equal masses of bromine.

3. Nov/2021/Paper_11/No.34

Chlorine reacts with methane.

Which row is correct?

	chemical equation	conditions required
A	$Cl_2 + CH_4 \rightarrow CH_2Cl_2 + H_2$	methane and chlorine gases are mixed in the presence of ultraviolet light
B	$Cl_2 + CH_4 \rightarrow CH_2Cl_2 + H_2$	methane is bubbled into concentrated aqueous chlorine
C	$Cl_2 + CH_4 \rightarrow CH_3Cl + HCl$	methane and chlorine gases are mixed in the presence of ultraviolet light
D	$Cl_2 + CH_4 \rightarrow CH_3Cl + HCl$	methane is bubbled into concentrated aqueous chlorine

4. Nov/2021/Paper_11/No.35

Which statements about alkenes are correct?

1 They have the general formula of C_nH_{2n}.

2 They undergo addition reactions with steam.

3 They burn in air to form carbon dioxide and water.

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

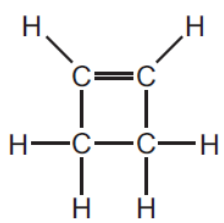
5. Nov/2021/Paper_11/No.36

X is a branched hydrocarbon with the ratio of carbon atoms to hydrogen atoms being 1 : 2.

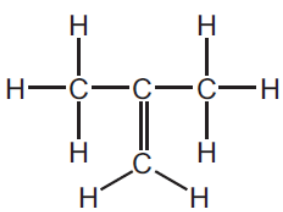
X has a relative molecular mass of 56.

What is the identity of X?

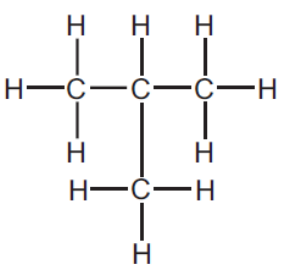
A



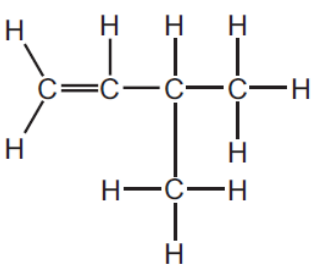
B



C



D



6. Nov/2021/Paper_11/No.37

The reactions listed all involve ethanol.

1 $C_2H_5OH + O_2 \rightarrow CH_3COOH + H_2O$

2 $C_2H_5OH + CH_3COOH \rightarrow CH_3COOC_2H_5 + H_2O$

3 $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

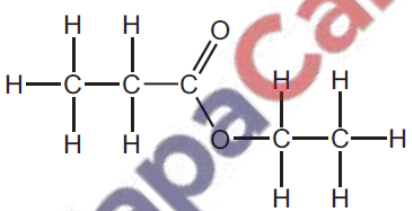
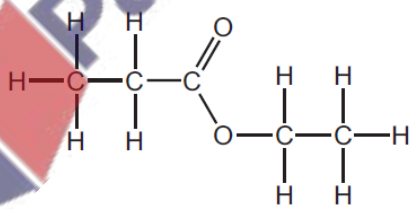
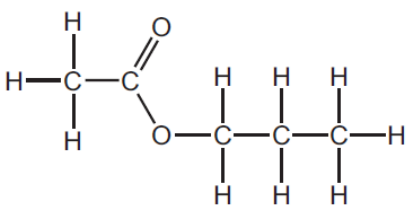
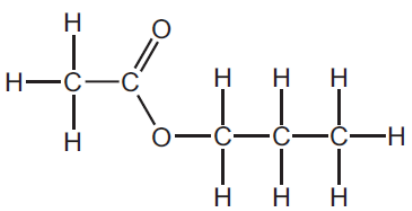
Which row correctly describes each reaction?

	1	2	3
A	combustion	acidification	fermentation
B	combustion	esterification	addition
C	oxidation	acidification	addition
D	oxidation	esterification	fermentation

7. Nov/2021/Paper_11/No.38

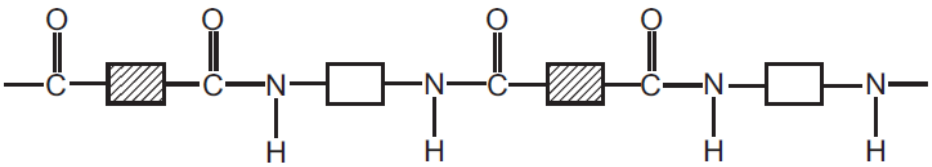
Ethanoic acid is reacted with propanol.

What is the name and what is the structure of the ester produced?

	name	structure
A	propyl ethanoate	
B	ethyl propanoate	
C	propyl ethanoate	
D	ethyl propanoate	

8. Nov/2021/Paper_11/No.39

The diagram shows the partial structure of a polymer.



Which type of polymer does it represent?

A polyamide

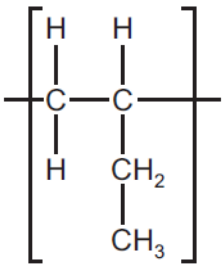
B polyester

C poly(ethene)

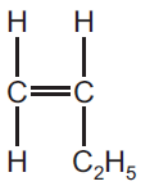
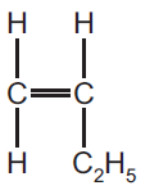
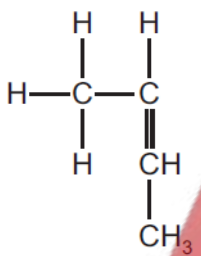
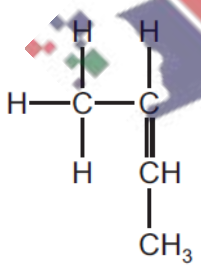
D polysaccharide

9. Nov/2021/Paper_11/No.40

The diagram shows the repeat unit of a polymer.



Which row correctly identifies the monomer and type of polymerisation involved in making this polymer?

	monomer	type of polymerisation
A		addition
B		condensation
C		addition
D		condensation

10. Nov/2021/Paper_12/No.34

Propane undergoes substitution reactions when mixed with chlorine gas in the presence of ultraviolet light.

Which compound could be formed when propane and chlorine are mixed in the presence of ultraviolet light?

A $CH_3CCl_2CH_3$

B CH_2ClCH_2Cl

C $CH_3CH_2CH_3Cl$

D $CH_3CHClCH_2CH_3$

11. Nov/2021/Paper_12/No.35

The hydrocarbon CH_3CHCH_2 will undergo a number of chemical reactions.

In which reaction will the carbon to carbon single bond be broken?

A combustion with oxygen

B hydrogenation

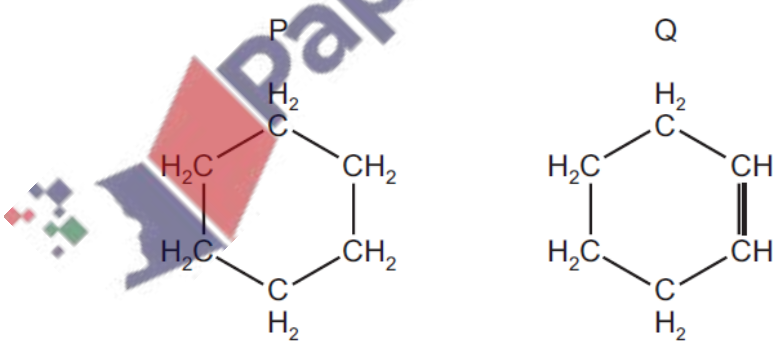
C polymerisation

D reaction with steam

12. Nov/2021/Paper_12/No.36

Hydrocarbon compounds can form rings of carbon atoms as well as chains.

The structures of two hydrocarbon rings are shown.



Which of P and Q is unsaturated and which reacts with aqueous bromine?

	is unsaturated	reacts with aqueous bromine
A	P	P
B	P	Q
C	Q	P
D	Q	Q

13. Nov/2021/Paper_12/No.37

A sample of aqueous glucose is fermented with yeast at 37 °C in the absence of air.

The main organic product, X, is purified by fractional distillation. X is then oxidised, by heating under reflux with acidified potassium manganate(VII), to give a final product Y.

What is the identity of Y?

A ethanoic acid

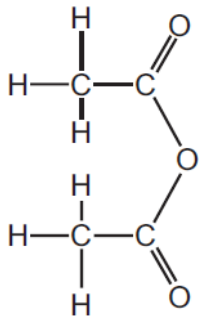
B ethene

C propanoic acid

D propene

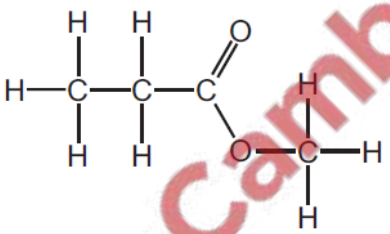
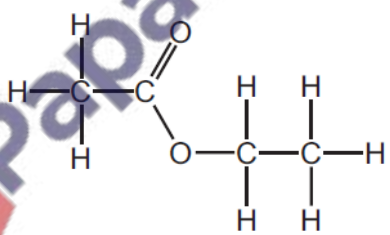
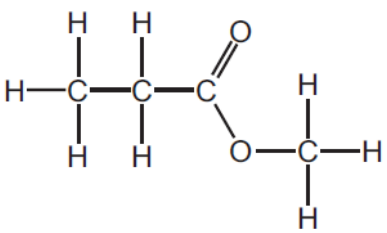
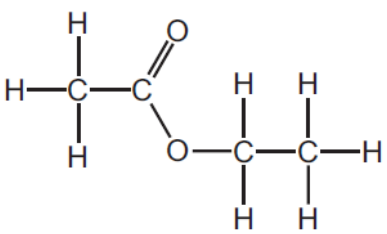
14. Nov/2021/Paper_12/No.38

The diagram shows the structure of a compound called ethanoic anhydride.



1 mol of ethanoic anhydride reacts with water to form 2 mol of a carboxylic acid only. This carboxylic acid reacts with ethanol to form an ester.

How many moles of water react with 1 mol of the ethanoic anhydride and what is the structure of the ester?

	number of moles of water	structure of the ester
A	1	
B	1	
C	2	
D	2	

15. Nov/2021/Paper_12/No.39

Burning polymers can cause atmospheric pollution.

Which polymer, on burning, could produce nitrogen oxides?

A nylon

B poly(ethene)

C starch

D *Terylene*

16. Nov/2021/Paper_21/No.2c,d,e,f

(c) Ethyne is an unsaturated hydrocarbon.

State the meaning of the term *hydrocarbon*.

.....

..... [1]

(d) Ethyne is a member of the alkyne homologous series.

The molecular formulae of the first four members of the alkyne homologous series are shown.

C_2H_2
C_3H_4
C_4H_6
C_5H_8

Predict the formula for the fifth member of the alkyne homologous series.

..... [1]

(e) Ethyne reacts with hydrogen in a similar way to ethene reacting with hydrogen.

The reaction between ethyne and hydrogen is exothermic.

(i) What type of chemical reaction occurs when ethyne reacts with hydrogen?

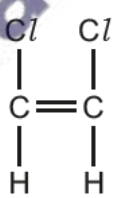
..... [1]

(ii) Predict the molecular formula of a product formed when ethyne reacts with hydrogen.

..... [1]

(f) 1,2-dichloroethene is produced when excess ethyne reacts with chlorine.

The structure of 1,2-dichloroethene is shown.



Deduce the partial structure of the polymer of 1,2-dichloroethene.

Show three repeat units.

[2]

17. Nov/2021/Paper_21/No.6

(a) The table shows some properties of five alcohols.

alcohol	formula	density in g/cm^3	boiling point in °C
methanol	CH_3OH	0.791	65
ethanol	C_2H_5OH	0.789	79
propanol	C_3H_7OH	0.803	97
butanol	C_4H_9OH	0.810	117
pentanol	$C_5H_{11}OH$	0.814	138

(i) What is the general trend in the density of the alcohols as the number of carbon atoms in a molecule increases?

.....

..... [1]

(ii) Describe and explain the change in the boiling point of the alcohols as the number of carbon atoms in a molecule increases.

.....

..... [1]

(b) Ethanol, C_2H_5OH, reacts with butanoic acid, $C_3H_7CO_2H$, to produce an ester.

A few drops of a strong acid are added to catalyse the reaction.

(i) What does the term *strong* mean, when applied to acids?

.....

..... [1]

(ii) Name and draw the structure of the ester produced when ethanol reacts with butanoic acid, showing all of the atoms and all of the bonds.

name .....

structure

[2]

(c) Ethanol can be oxidised to ethanoic acid in the laboratory.

State the reagents and conditions used in this reaction.

reagent .....

conditions .....

[2]

(d) Concentrated ethanoic acid, CH_3CO_2H, reacts with calcium.

The products are calcium ethanoate and hydrogen.

(i) Construct the equation for this reaction.

..... [1]

(ii) State and explain how the rate of this reaction changes when the experiment is repeated using dilute ethanoic acid.

All other conditions stay the same.

Include in your answer ideas about collisions between particles.

.....

.....

..... [2]

[Total: 10]

18. Nov/2021/Paper_22/No.3c

(c) Paper is made of cellulose.

Cellulose is a complex carbohydrate (polysaccharide).

(i) Name one other complex carbohydrate (polysaccharide).

..... [1]

(ii) Describe how complex carbohydrates can be hydrolysed to simple sugars.

.....

..... [2]

19. Nov/2021/Paper_22/No.4a

(e) A fuel cell generates electricity when hydrogen and oxygen react on platinum electrodes.

(i) Name a process used in industry to produce hydrogen.

..... [1]

(ii) Some cars use a hydrogen–oxygen fuel cell instead of a petrol (gasoline) engine as a source of energy.

Describe two advantages of a hydrogen–oxygen fuel cell compared with a petrol (gasoline) engine.

1. .....

2. .....

[2]

20. Nov/2021/Paper_22/No.5

Alkenes are made in an oil refinery by cracking hydrocarbons.

(a) (i) Give one **other** reason why petroleum companies carry out cracking.

.....

..... [1]

(ii) Complete the equation for the cracking of tridecane, $C_{13}H_{28}$, to form propene, C_3H_6, and one other hydrocarbon.

$$C_{13}H_{28} \rightarrow C_3H_6 + \text{.....} \quad [1]$$

(b) Propene is an alkene.

(i) Write the general formula for an alkene.

..... [1]

(ii) Propene reacts with steam by an addition reaction.

Predict the molecular formula of the product of this reaction.

..... [1]

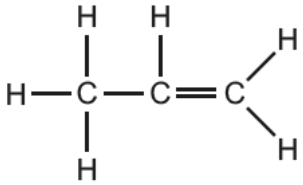
(iii) When propene undergoes incomplete combustion, a small amount of carbon dioxide is formed.

Name two **other** substances formed when propene undergoes incomplete combustion.

..... and .....

[2]

(c) The structure of propene is shown.



Deduce the partial structure of poly(propene) to show three repeat units.

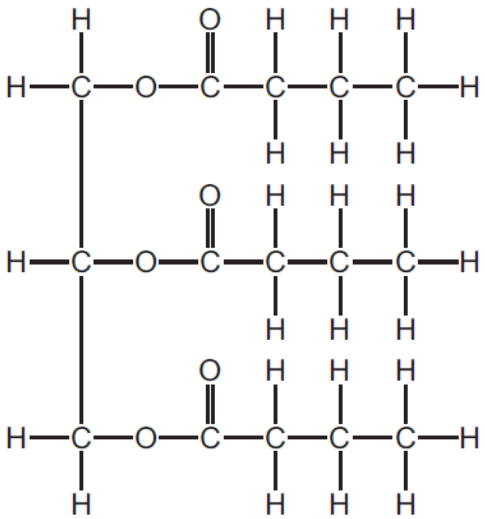
[2]

[Total: 8]

21. Jun/2020/Paper_11/No.33

Fats are essential components of the human diet.

The diagram shows a fat molecule.



Which description of this fat molecule is correct?

A saturated carboxylic acid

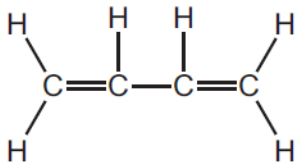
B saturated ester

C unsaturated carboxylic acid

D unsaturated ester

22. Jun/2020/Paper_11/No.34

A molecule of the compound C_4H_6 is shown.



This molecule undergoes an addition reaction with excess bromine and an addition reaction with steam.

One molecule of C_4H_6 reacts with .....1..... of bromine.

When C_4H_6 reacts with steam, ...2..... is formed.

Which words complete gaps 1 and 2?

	1	2
A	one molecule	an alcohol
B	one molecule	a carboxylic acid
C	two molecules	an alcohol
D	two molecules	a carboxylic acid

23. Jun/2020/Paper_11/No.35

The molecules of two hydrocarbon compounds X and Y each contain only four carbon atoms.

X is saturated and Y is unsaturated.

Which statements are correct?

1 Under suitable conditions Y polymerises.

2 The complete combustion of 1 mole of Y produces more carbon dioxide than the complete combustion of 1 mole of X.

3 One molecule of Y contains more hydrogen atoms than one molecule of X.

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

24. Jun/2020/Paper_11/No.36

Which conversions involve oxidation?

1 ethanol → carbon dioxide + water

2 ethanol → ethanoic acid

3 ethene → poly(ethene)

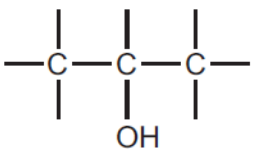
A 1 only **B** 2 only **C** 1 and 2 only **D** 1, 2 and 3

25. Jun/2020/Paper_11/No.37

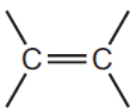
Compound T reacts with magnesium, aqueous sodium hydroxide and ethanol.

Which group does T contain?

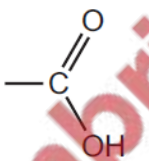
A



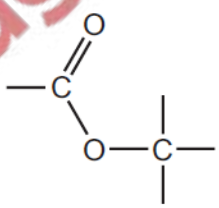
B



C



D



26. Jun/2020/Paper_11/No.38

Which type of reaction could be used in the polymerisation of ethene?

A addition

B condensation

C cracking

D esterification

27. Jun/2020/Paper_11/No.39

Insulin is a protein made in the human body.

Which statements about insulin are correct?

1 It is a condensation polymer.

2 It is a synthetic polymer.

3 When hydrolysed it produces only one monomer.

4 It contains amide linkages.

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

28. Jun/2020/Paper_11/No.40

Which statement about polymers is correct?

A Nylon and *Terylene* are produced by addition polymerisation.

B Nylon and *Terylene* both contain the amide linkages.

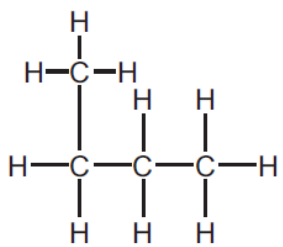
C Simple sugars are produced by hydrolysing proteins.

D Starch contains the elements carbon, hydrogen and oxygen.

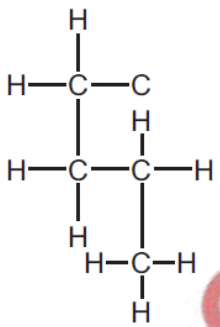
29. Jun/2020/Paper_12/No.33

Which structure represents an isomer of butane?

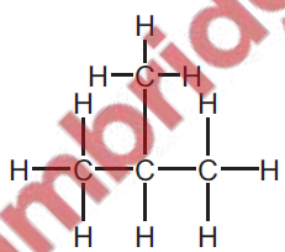
A



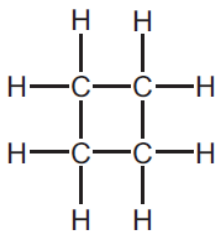
B



C



D



30. Jun/2020/Paper_12/No.34

Which statement about the organic compounds CH_4, C_2H_4, C_2H_6 and C_3H_8 is correct?

A Only C_2H_4 and C_2H_6 decolourise bromine water.

B They are all saturated compounds.

C They are all unsaturated compounds.

D They are all hydrocarbons.

31. Jun/2020/Paper_12/No.35

The alkenes are a homologous series.

Which statement about alkenes is correct?

A An alkene molecule contains four fewer hydrogen atoms than an alkane molecule with the same number of carbon atoms.

B If a food is described as *polyunsaturated* it means that it contains polymers.

C Propene reacts with steam to form propanol.

D The general formula for the alkenes is C_nH_{2n+2}.

32. Jun/2020/Paper_12/No.36

Which organic compound is used as a solvent, a renewable fuel and in the production of vinegar?

A ethanoic acid

B ethanol

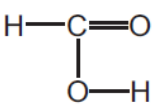
C propanoic acid

D propanol

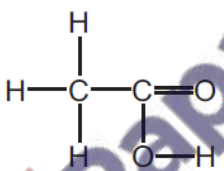
33. Jun/2020/Paper_12/No.37

Which structure shows the carboxylic acid with the lowest relative molecular mass?

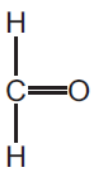
A



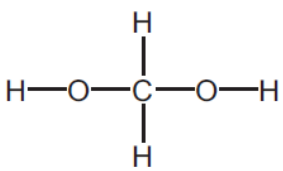
B



C

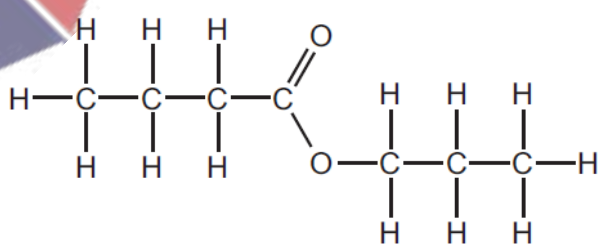


D



34. Jun/2020/Paper_12/No.38

What is the name of the ester shown?



A butyl propanoate

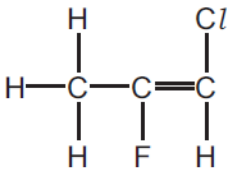
B propyl butanoate

C propyl ethanoate

D propyl propanoate

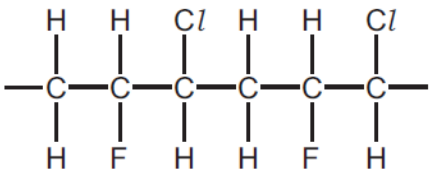
35. Jun/2020/Paper_12/No.39

The diagram shows the structure of a monomer.

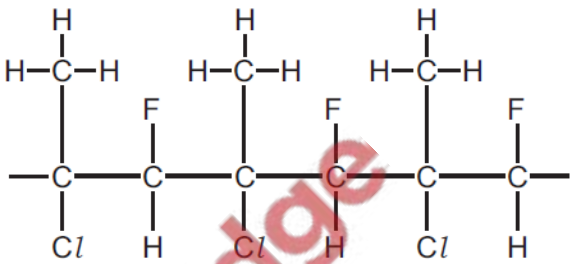


Which diagram shows the partial structure of its polymer?

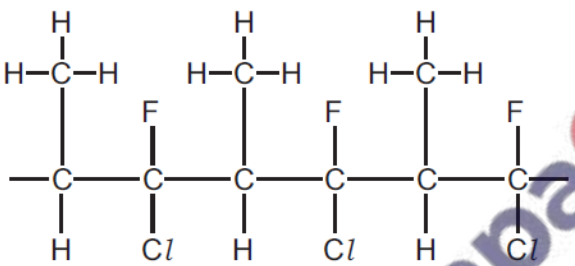
A



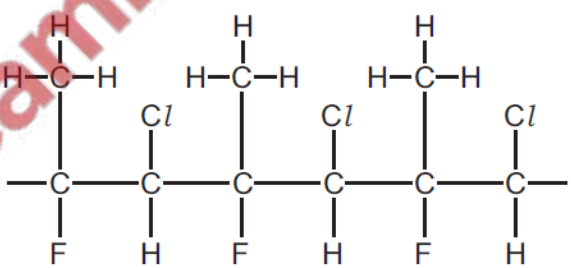
B



C



D



36. Jun/2020/Paper_12/No.40

Which statement about polymers is correct?

A Nylon and *Terylene* are produced by addition polymerisation.

B Nylon and *Terylene* both contain amide linkages.

C Simple sugars are produced by hydrolysing proteins.

D Starch contains the elements carbon, hydrogen and oxygen.

37. Jun/2020/Paper_21/No.4

The table shows some properties of five esters.

name	structure	relative molecular mass	melting point /°C	boiling point /°C
methyl ethanoate	CH_3COOCH_3	74	–98	57
ethyl ethanoate	$CH_3COOCH_2CH_3$	88	–84	77
propyl ethanoate	$CH_3COOCH_2CH_2CH_3$	102	–95	102
butyl ethanoate	$CH_3COOCH_2CH_2CH_2CH_3$	116	–78	126
pentyl ethanoate	$CH_3COOCH_2CH_2CH_2CH_2CH_3$	130	–71	148

(a) These esters are part of a homologous series.

State **two** characteristics of a homologous series.

1. .....

.....

2. .....

..... [2]

(b) The next member of the homologous series is hexyl ethanoate.

Explain why it is more difficult to predict the melting point than the boiling point of hexyl ethanoate.

.....

.....

..... [1]

(c) At 25 °C ethyl ethanoate is a liquid.

Explain how the data in the table shows this.

.....

..... [1]

(d) State one use for an ester.

..... [1]

(e) Propyl ethanoate is prepared by the reaction between ethanoic acid and propanol.

$$CH_3CO_2H + CH_3CH_2CH_2OH \rightleftharpoons CH_3COOCH_2CH_2CH_3 + H_2O$$

(i) Calculate the maximum mass of propyl ethanoate that can be made from 7.20 g of ethanoic acid and excess propanol.

Give your answer to **three** significant figures.

mass of propyl ethanoate ..... g [2]

(ii) The concentration of ethanoic acid is increased.

State and explain, in terms of particles, what happens to the rate of the forward reaction.

.....

.....

.....

..... [3]

(iii) The water formed in the reaction is removed.

State and explain what happens to the position of the equilibrium.

.....

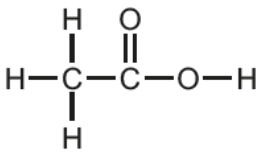
.....

..... [2]

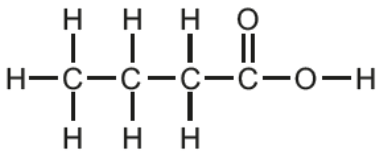
[Total: 12]

38. Jun/2020/Paper_21/No.6

The structures of two carboxylic acids are shown.



ethanoic acid



carboxylic acid **B**

(a) An isomer of carboxylic acid **B** has the name methylpropanoic acid.

(i) What is the name of carboxylic acid **B**?

..... [1]

(ii) What is the meaning of the term *isomer*?

.....

.....

..... [1]

(b) Vinegar contains ethanoic acid.

Describe the formation of vinegar from ethanol.

.....

.....

..... [2]

(c) Ethanoic acid reacts with calcium carbonate.

(i) Give the formula of the calcium salt formed in this reaction.

..... [1]

(ii) Name the other **two** products formed in this reaction.

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

[Total: 6]

39. Jun/2020/Paper_21/No.10

Fractional distillation and cracking are important processes in the conversion of petroleum (crude oil) into useful substances.

(a) Complete the sentence about petroleum (crude oil).

Choose from the list.

an alloy	**a compound**	**an element**
a mixture	**a polymer**	**a salt**

Petroleum (crude oil) is ..... of hydrocarbons. [1]

(b) Fractional distillation separates petroleum (crude oil) into fractions such as paraffin (kerosene) and naphtha.

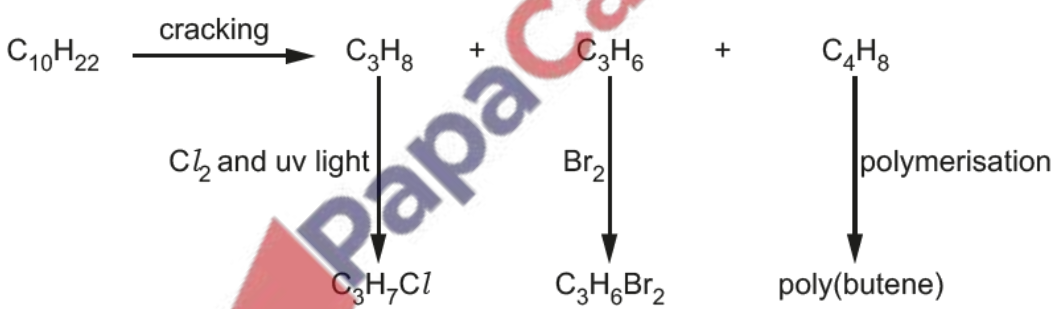
Give one use for the paraffin (kerosene) fraction.

..... [1]

(c) The naphtha fraction is used as a chemical feedstock.

One of the hydrocarbons in naphtha has the molecular formula $C_{10}H_{22}$.

The flow chart shows some compounds that can be made from $C_{10}H_{22}$.



(i) C_3H_8 is an alkane and C_3H_6 is an alkene.

Explain why, in terms of their general formulae, C_3H_8 is an alkane and C_3H_6 is an alkene.

.....

.....

.....

..... [2]

(ii) In the presence of uv light chlorine reacts with C_3H_8.

Two of the products formed are HCl and C_3H_7Cl.

What type of reaction takes place when C_3H_8 reacts with chlorine?

.....

Give the formula of one other product of this reaction.

.....

[2]

(iii) Describe the colour change when C_3H_6 reacts with bromine.

.....

..... [1]

(d) (i) Suggest a possible structure for C_4H_8.

[1]

(ii) Draw the partial structure of poly(butene) that shows at least two repeat units.

[2]

[Total: 10]

40. Jun/2020/Paper_22/No.3

The table shows some properties of five esters.

name	structure	relative molecular mass	melting point / °C	boiling point / °C
methyl methanoate	$HCOOCH_3$	60	−100	32
methyl ethanoate	CH_3COOCH_3	74	−98	57
methyl propanoate	$CH_3CH_2COOCH_3$	88	−88	80
methyl butanoate	$CH_3CH_2CH_2COOCH_3$	102	−95	102
methyl pentanoate	$CH_3CH_2CH_2CH_2COOCH_3$			

(a) These esters are part of a homologous series.

(i) State the relative molecular mass of methyl pentanoate.

..... [1]

(ii) Predict the boiling point of methyl pentanoate.

..... °C [1]

(iii) Explain why it is **not** possible to predict the melting point of methyl pentanoate.

.....

..... [1]

(b) At 35 °C methyl methanoate is a gas.

Explain how the data in the table shows this.

.....

..... [1]

(c) Methyl pentanoate is used to flavour food.

Suggest one **other** use for esters.

..... [1]

(d) Methyl propanoate is prepared by the reaction between propanoic acid and methanol.

$$CH_3CH_2CO_2H + CH_3OH \rightleftharpoons CH_3CH_2COOCH_3 + H_2O$$

The forward reaction is exothermic.

(i) Calculate the maximum mass of methyl propanoate that can be made from 11.0 g of propanoic acid and excess methanol.

Give the answer to **three** significant figures.

mass of methyl propanoate ..... g [2]

(ii) The temperature of the reaction mixture is increased.

State and explain, in terms of particles, what happens to the rate of the forward reaction.

.....

.....

.....

.....

..... [3]

(iii) The temperature of the reaction mixture is increased.

State and explain what happens to the position of the equilibrium.

.....

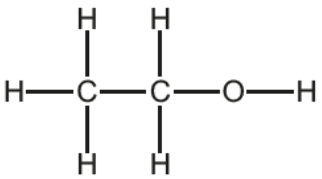
.....

..... [2]

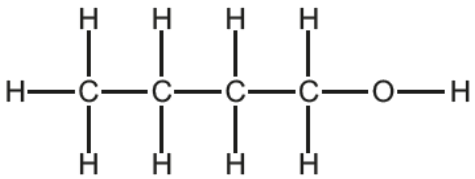
[Total: 12]

41. Jun/2020/Paper_22/No.6

The structures of two alcohols are shown.



ethanol



alcohol **B**

(a) What is the name of alcohol **B**?

..... [1]

(b) Draw the structure of one other alcohol which is an isomer of **B**.

Show all of the atoms and all of the bonds.

[1]

(c) Ethanoic acid is produced by the oxidation of ethanol.

State the reagent for this reaction.

..... [1]

(d) Ethanol is a simple molecular compound.

Explain why liquid ethanol does **not** conduct electricity.

.....

..... [1]

(e) Ethanol can be dehydrated to form ethene, C_2H_4.

Describe, using a dot-and-cross diagram, the bonding in a molecule of ethene.

Only include the outer shell electrons.

[2]

[Total: 6]

42. Jun/2020/Paper_22/No.10

Fractional distillation and cracking are important processes in the conversion of petroleum (crude oil) into useful hydrocarbons.

(a) Fractional distillation separates petroleum (crude oil) into fractions such as bitumen and naphtha.

(i) Which physical property allows the petroleum (crude oil) to be separated into fractions?

..... [1]

(ii) Describe the separation of petroleum (crude oil) by fractional distillation.

.....

.....

.....

..... [2]

(iii) Give one use of the bitumen fraction.

..... [1]

(b) The naphtha fraction is used as a chemical feedstock.

One of the hydrocarbons in naphtha has the molecular formula $C_{10}H_{22}$.

Use the general formula for an alkane to show that $C_{10}H_{22}$ is an alkane.

.....

.....

..... [2]

(c) In an experiment $C_{10}H_{22}$ is cracked to form products **A**, **B** and **C**.

(i) Product **A** gives a squeaky pop when ignited with a burning splint.

Identify product **A**.

..... [1]

(ii) Product **B** has a relative molecular mass of 98 and decolourises aqueous bromine.

Suggest the molecular formula for **B**.

Explain your answer.

molecular formula .....

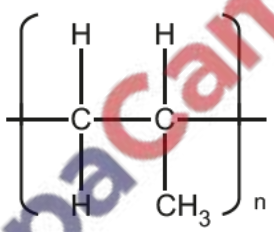
explanation .....

.....

.....

[2]

(iii) Product **C** can be polymerised to give the polymer shown.



Draw the structure of product **C**.

[1]

[Total: 10]