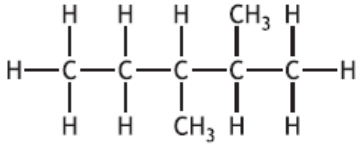
National 5 Unit 2 Nature's Chemistry

Past Paper Book by Key Area

Fuels and Homologous Series

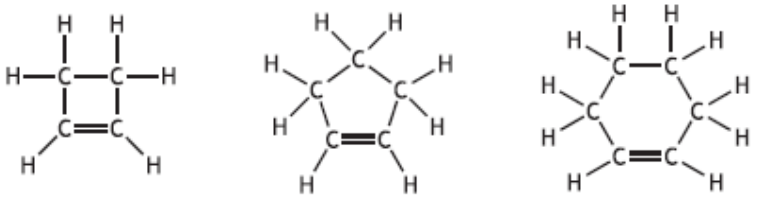
1.



The name of this compound is

A 2,3-dimethylpropane
B 3,4-dimethylpropane
C 2,3-dimethylpentane
D 3,4-dimethylpentane

2. Three members of the cycloalkene homologous series are



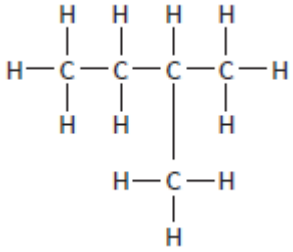
Which of the following is the general formula for this homologous series?

A C_nH_{2n-4}
B C_nH_{2n+2}
C C_nH_{2n}
D C_nH_{2n-2}

3. The molecular formula for cyclohexane is

A C_6H_6
B C_6H_{10}
C C_6H_{12}
D C_6H_{14}

4.



The systematic name for the structure shown is

A 1,1-dimethylpropane
B 2-methylbutane
C 3-methylbutane
D 2-methylpentane

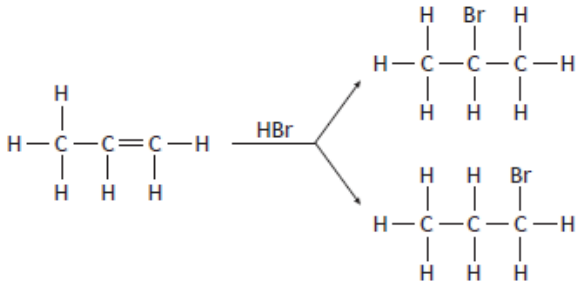
5. Petrol is a mixture of hydrocarbons.
The tendency of a hydrocarbon to ignite spontaneously is measured by its octane number.

	Hydrocarbon	*Octane number*
1	3-methylpentane	74·5
2	butane	93·6
3	pentane	61·7
4	2-methylpentane	73·4
5	hexane	24·8
6	methylcyclopentane	91·3

A student made the hypothesis that as the chain length of a hydrocarbon increases, the octane number decreases.
Which set of three hydrocarbons should have their octane numbers compared in order to test this hypothesis?

A 1, 4, 6
B 1, 2, 4
C 2, 3, 5
D 3, 4, 5

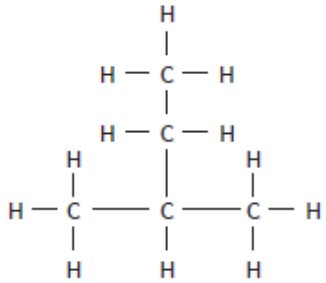
6. Propene reacts with hydrogen bromide to form two products.



Which of the following alkenes does **not** form two products on reaction with hydrogen bromide?

A But-1-ene
B But-2-ene
C Pent-1-ene
D Pent-2-ene

7.



The name of the above compound is

A 2-ethylpropane
B 1,1-dimethylpropane
C 2-methylbutane
D 3-methylbutane

8. Which of the following could be the molecular formula of a cycloalkane?

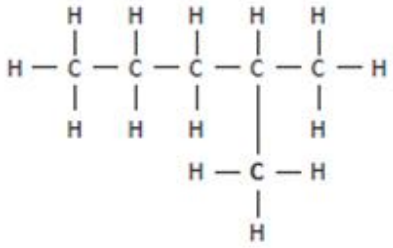
A C_6H_8
B C_6H_{10}
C C_6H_{12}
D C_6H_{14}

9. In which of the following reactions is oxygen used up?

A Combustion
B Neutralisation
C Addition
D Polymerisation

10. Which of the following molecules is an isomer of hept-2-ene?

A



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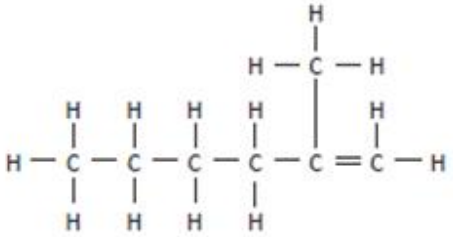
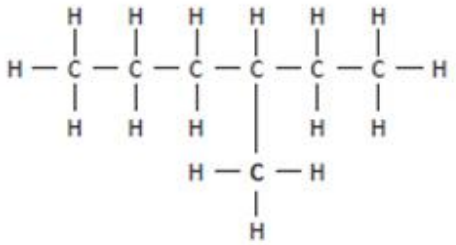
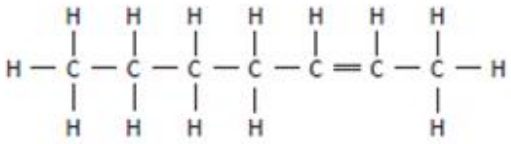


B



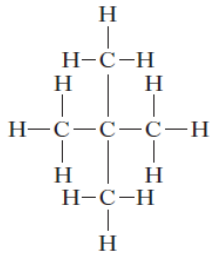
D



11. Which of the following compounds fits the general formula, C_nH_{2n}, and will rapidly decolourise bromine solution?

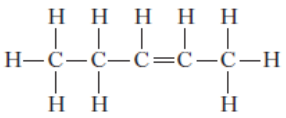
A Cyclopentane
B Cyclopentene
C Pentane
D Pentene

12.

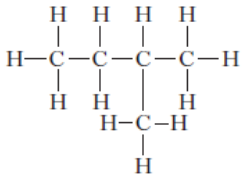


Which of the following compounds is an isomer of the one shown above?

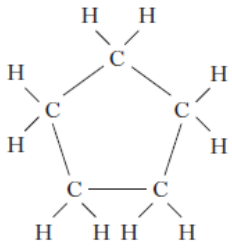
A



C



B



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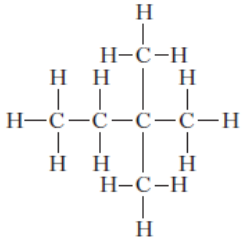


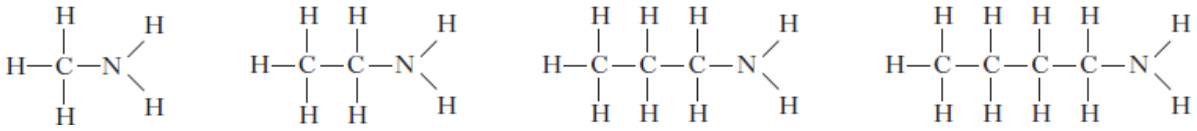
13. When a compound is burned completely, the products are carbon dioxide and water. From this information, it can be concluded that the compound must contain

A carbon only
B hydrogen only
C carbon and hydrogen
D carbon, hydrogen and oxygen

14. Which of the following hydrocarbons could be cyclohexane?

Hydrocarbon	Molecular formula	Observations on adding bromine solution
A	C_6H_{14}	no colour change
B	C_6H_{12}	rapid decolourisation
C	C_6H_{12}	no colour change
D	C_6H_{10}	rapid decolourisation

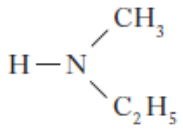
15. The first four members of the amine homologous series are:



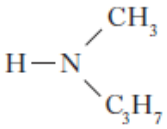
What is the general formula for this homologous series?

A $C_nH_{n+4}N$
B $C_nH_{2n+3}N$
C $C_nH_{3n+2}N$
D $C_nH_{4n+1}N$

16. The following structure represents an amine called ethylmethylamine:



Another amine has the following structure:



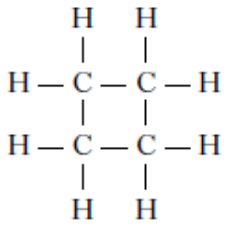
This amine is called

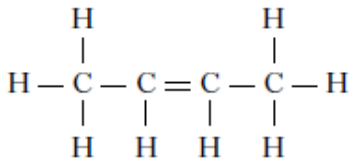
A methylamine
B butylamine
C propylamine
D methylpropylamine

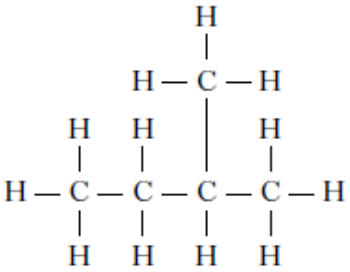
17. What name is given to the reaction shown by the following equation?
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

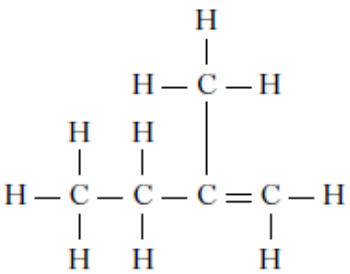
A Combustion
B Condensation
C Dehydration
D Hydrolysis

18. Which of the following compounds belongs to the same homologous series as the compound with the molecular formula C_3H_8?

A 

B 

C 

D 

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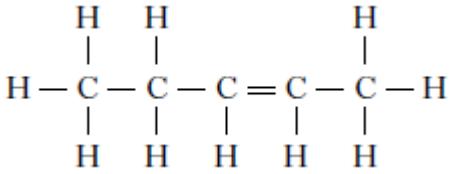
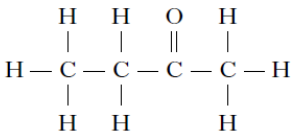
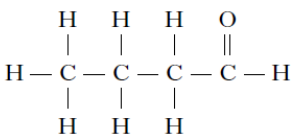


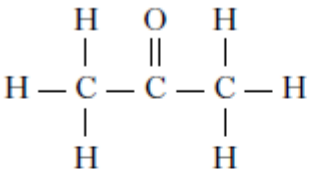
The name of the above compound is

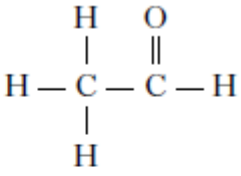
A but-2-ene
B pent-2-ene
C but-3-ene
D pent-3-ene

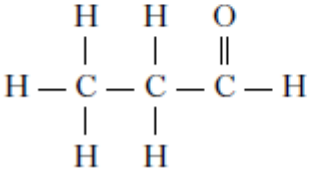
20. The table shows the result of heating two compounds with acidified potassium dichromate solution.

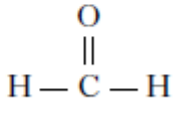
Compound	Acidified potassium dichromate solution
	stays orange
	turns green

Which of the following compounds will **not** turn acidified potassium dichromate solution green?

A 

C 

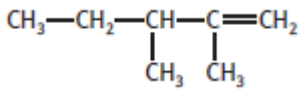
B 

D 

21. When methane burns in a plentiful supply of air, the products are

A carbon and water
B carbon dioxide and water
C carbon monoxide and water
D carbon dioxide and hydrogen.

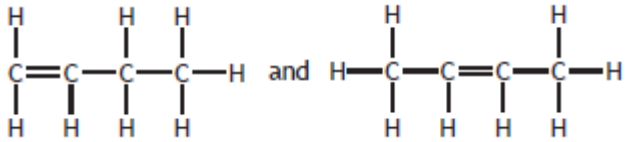
22.



The systematic name for the structure shown is

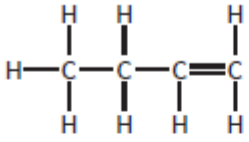
A 1,2-dimethylpent-1-ene
B 2,3-dimethylpent-1-ene
C 3,4-dimethylpent-4-ene
D 3,4-dimethylpent-1-ene.

23. Two isomers of butene are

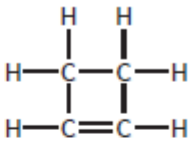


Which of the following structures represents a third isomer of butene?

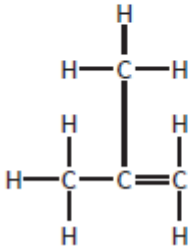
A



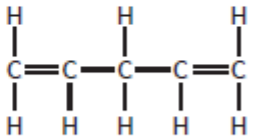
C



B



D



24. The lowest temperature at which a hydrocarbon ignites is called its flash point.

Hydrocarbon	*Formula*	*Boiling point (°C)*	*Flash point (°C)*
hexene	C_6H_{12}	63	–25
hexane	C_6H_{14}	69	–23
cyclohexane	C_6H_{12}	81	–20
heptane	C_7H_{16}	98	–1
octane	C_8H_{18}	126	15

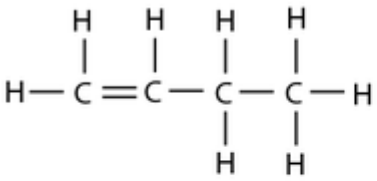
Using information in the table, identify the correct statement.

A Octane will ignite at 0 ºC.
B Hydrocarbons with the same molecular mass have the same flash point.
C The flash point of a hydrocarbon increases as the boiling point increases.
D In a homologous series the flash point decreases as the number of carbon atoms increases.

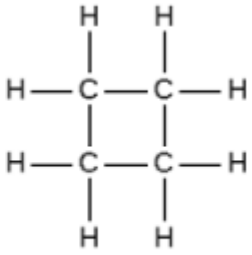
25. Which of the following could be the molecular formula for an alkane?

A C_7H_{16}
B C_7H_{14}
C C_7H_{12}
D C_7H_{10}

26. A student added bromine solution to compound X and compound Y.



Compound X



Compound Y

Which line in the table is correct?

	Decolourises bromine solution immediately	
	Compound X	Compound Y
A	No	No
B	No	Yes
C	Yes	Yes
D	Yes	No

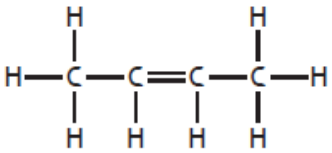
27. A compound burns in air. The only products of the reaction are carbon dioxide, sulfur dioxide and water.
    The compounds **must** contain

    A carbon and sulfur only
    B carbon and hydrogen only
    C carbon, hydrogen and sulfur
    D carbon, hydrogen, sulfur and oxygen

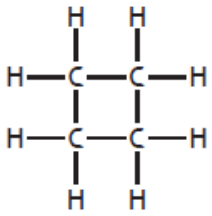
28. A reaction is exothermic if

    A energy is absorbed from the surroundings
    B energy is released to the surroundings
    C energy is required to start the reaction
    D there is no energy change.

29. The structural formulae of two hydrocarbons are shown.



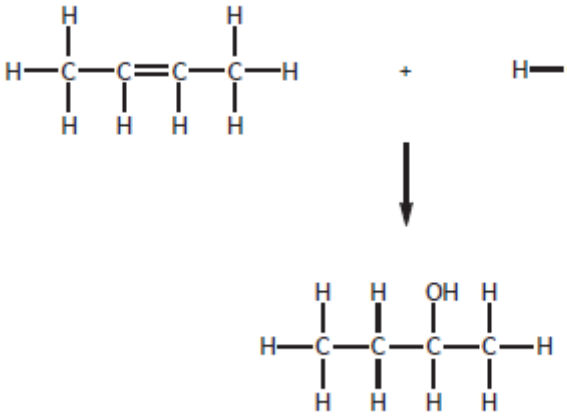
A



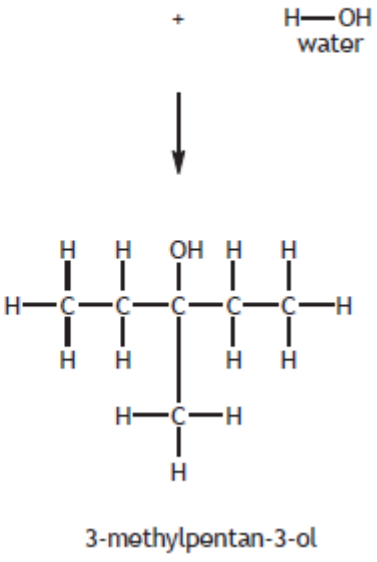
B

a) Name hydrocarbon **A**. **1**

b) Hydrocarbon **A** can undergo an addition reaction with water to form butan-2-ol as shown.

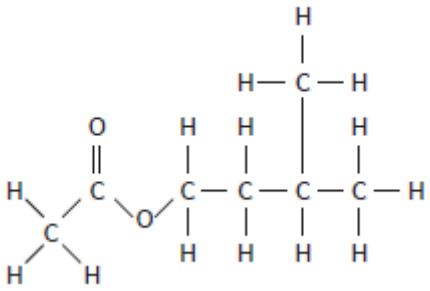


A similar reaction can be used to produce 3-methylpentan-3-ol.
Draw a structural formula for the hydrocarbon used to form this molecule. **1**

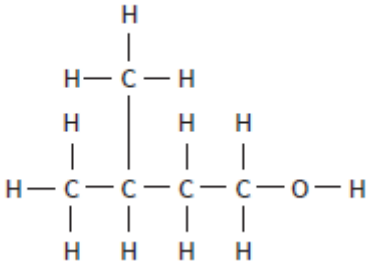


3-methylpentan-3-ol

30. Pheromones are chemicals, produced by living things, that trigger a response in members of the same species.
When a bee stings an animal the bee also releases a pheromone containing the ester below.

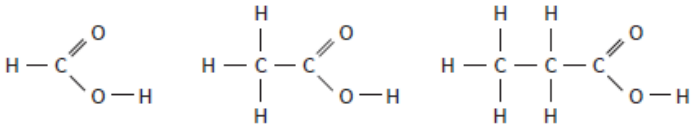


a) A student made the ester above using ethanoic acid and the following alcohol.



Draw a structural formula for an isomer of this alcohol. **1**

b) Ethanoic acid is the second member of a family of compounds which contain the carboxyl functional group.
The full structural formulae for the first three members of this family are shown.



methanoic acid

ethanoic acid

propanoic acid

Suggest a general formula for this family of compounds. **1**

31. Liquefied petroleum gas (LPG), which can be used as a fuel for heating, is a mixture of propane and butane.

a) Propane and butane are members of the homologous series of alkanes.
Tick (✓) the **two** boxes that correctly describe members of the same homologous series. **1**

	Tick (✓)
They have similar chemical properties.	
They have the same molecular formula.	
They have the same general formula.	
They have the same physical properties.	
They have the same formula mass.	

b) The table gives some information about propane and butane.

Alkane	*Boiling Point* (°C)
propane	−42
butane	−1

Explain why butane has a higher boiling point than propane. **2**

c) LPG is odourless. In order to detect gas leaks, ethyl mercaptan, C_2H_6S, a smelly gas, is added in small quantities to the LPG mixture.
Suggest one disadvantage of adding sulfur compounds, such as ethyl mercaptan, to fuels such as LPG. **1**

32. The lowest temperature at which a hydrocarbon ignites is called its flash point.

Hydrocarbon	*Flash point* (°C)
hexane	−23
heptane	−4
octane	13
nonane	31

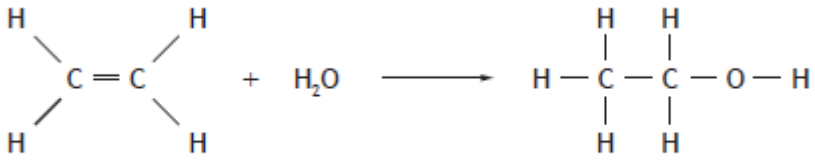
a) Using the information in the table, make a general statement linking the flash point to the number of carbon atoms. **1**

b) Predict the flash point, in °C, of decane, $C_{10}H_{22}$. **1**

33. In the 2012 London Olympics, alkanes were used as fuels for the Olympic flame.
The torches that carried the Olympic flame across Britain burned a mixture of propane and butane.
Propane and butane are members of the same homologous series.
What is meant by the term homologous series? **1**

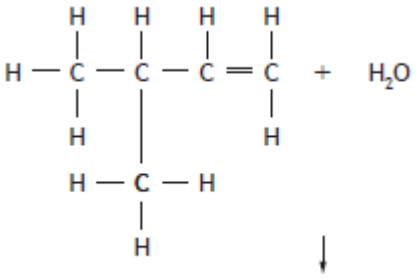
34. Car manufacturers have developed flexible fuel engines for vehicles. These vehicles can run on ethanol or petrol or a mixture of both.
Ethanol can be produced from ethene which comes from cracking crude oil. It can also be made by fermenting glucose which is obtained from crops such as sugar cane and maize.

a) Ethanol is produced from ethene as shown.



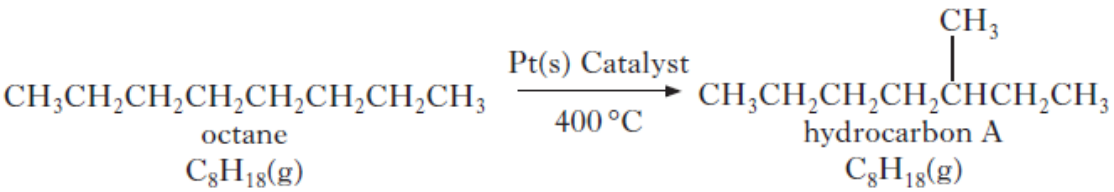
i) Name the **type** of chemical reaction taking place. **1**

ii) Draw a structural formula for a product of the following reaction. **1**



b) Suggest **one** disadvantage of producing ethanol from crops. **1**

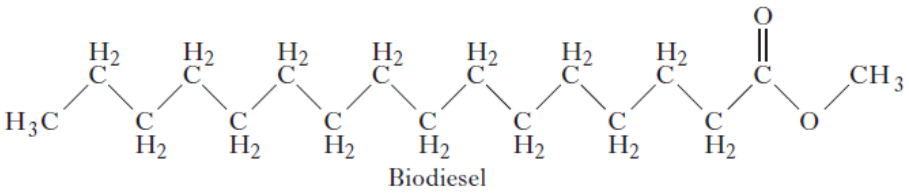
35. Octane is a hydrocarbon found in petrol.
The quality of the petrol can be improved by reforming octane (changing its structural formula).
During reforming the following reaction occurs.



a) Name hydrocarbon A. **1**

b) Draw another possible structure for C_8H_{18}. **1**

36. Biodiesel is a renewable source of energy which is being used as a fuel for cars.
The structure of a molecule of biodiesel is shown



Why can this molecule be described as saturated? **1**

37. The car industry and the Government have taken a number of steps to reduce the emissions of pollutant gases from cars.

Car tax is based on the mass of carbon dioxide gas produced per kilometre travelled by a car.

a) The volume of carbon dioxide produced by a car is measured and then converted into mass using the following equation.

$$\text{Mass of carbon dioxide gas (g)} = \frac{100 \times \text{volume of carbon dioxide gas (l)}}{56{\cdot}3}$$

Calculate the mass, in g, of carbon dioxide gas which is produced by a car emitting 70·4 l of carbon dioxide gas. **1**

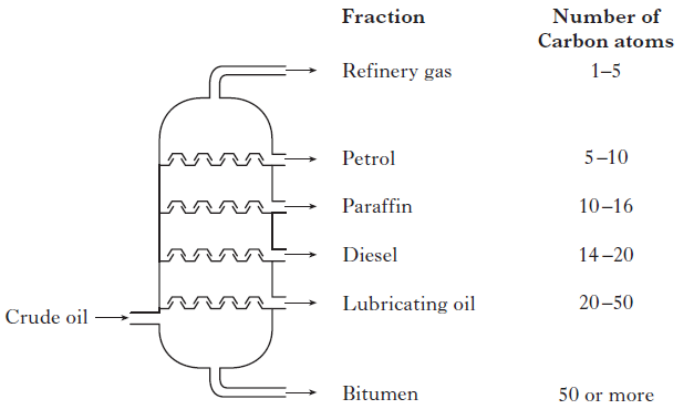
b) Information about car tax bands is shown in the tables.

Car tax band	Mass of carbon dioxide gas emitted per kilometre (g)
A	Up to 100
B	101–110
C	111–120
D	121–130
E	131–140
F	141–150
G	151–165

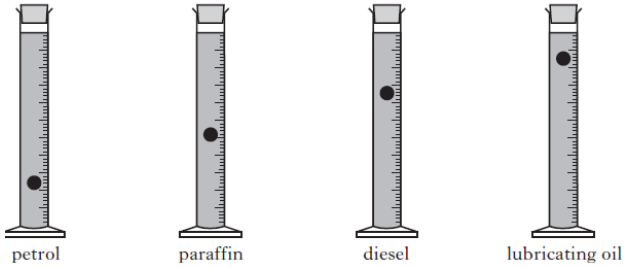
Car tax band	12 month rate (£)
A	0·00
B	20·00
C	30·00
D	95·00
E	115·00
F	130·00
G	165·00

What would it cost, in £, to tax a car, for 12 months, which emits 146g of carbon dioxide per kilometre travelled? **1**

38. Crude oil is a mixture of hydrocarbons which can be separated into fractions by fractional distillation.

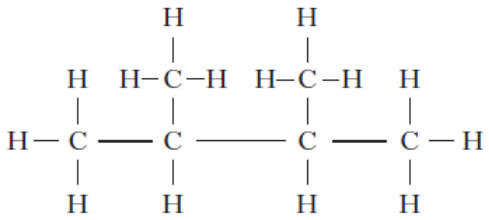


The viscosity of four fractions was compared by measuring the rate of fall of a ball bearing. The diagram shows the position of the ball bearings 10 seconds after being dropped.



a) What effect does the number of carbon atoms have on the viscosity of a fraction? **1**

b) Petrol contains the following molecule.



Name this molecule. **1**

39. The alkanals are a homologous series of compounds that all contain the elements carbon, hydrogen and oxygen.

a) What is meant by the term homologous series? **1**

b) The combustion of alkanals releases heat energy.

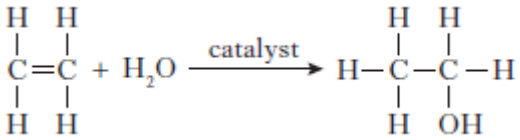
Name of alkanal	Heat energy released when one mole burns (kJ)
methanal	510
ethanal	1056
propanal	1624
butanal	2304

i) Make a general statement linking the amount of heat energy released and the number of carbon atoms in the alkanal molecules. **1**

ii) Predict the amount of heat energy released, in kJ, when 1 mole of pentanal burns. **1**

40. Ethanol is a member of the alkanol family of compounds.

Ethanol can be manufactured from ethene as shown in the following addition reaction.



What other name can be given to this type of addition reaction? **1**

41. A student completed the experiment **"Testing for Unsaturation"**. Results from the experiment are shown in the table.

Hydrocarbon	Molecular Formula	Observation with bromine solution	Saturated or unsaturated
A	C_6H_{14}	no change	
B	C_6H_{12}		unsaturated
C	C_6H_{12}		saturated
D	C_6H_{10}	bromine decolourises	

a) Complete the table. 2

b) Suggest a possible name for hydrocarbon C. **1**

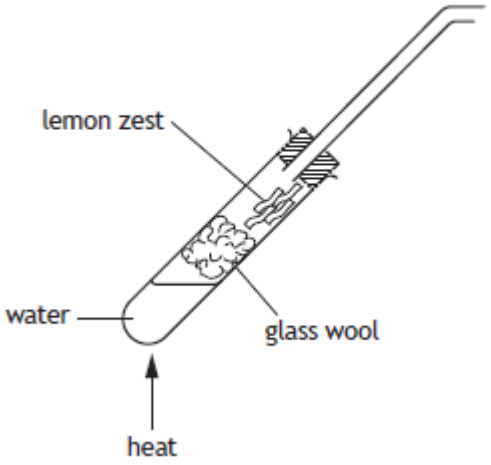
42. Hydrogen gas can be produced in the laboratory by adding a metal to dilute acid. Heat energy is also produced in the reaction.

State the term used to describe all chemical reactions that release heat energy. **1**

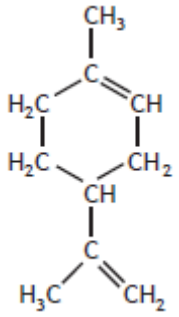
43. State the term used to describe all chemical reactions that release heat energy.

a) Essential oils contain compounds called terpenes.
A terpene is a chemical made up of a number of isoprene molecules joined together.
The shortened structural formula of isoprene is $CH_2C(CH_3)CHCH_2$.
Draw the full structural formula for isoprene. **1**

b) Essential oils can be extracted from the zest of lemons in the laboratory by steam distillation.
The process involves heating up water in a boiling tube until it boils. The steam produced then passes over the lemon zest which is separated from the water by glass wool. As the steam passes over the lemon zest it carries the essential oils into a delivery tube. The condensed liquids (essential oils and water) are collected in a test tube placed in a cold water bath.
Complete the diagram to show the apparatus required to collect the essential oils. **1**



c) Limonene, $C_{10}H_{16}$, is an essential oil which is added to some cleaning products to give them a lemon scent.



The concentration of limonene present in a cleaning product can be determined by titrating with bromine solution.

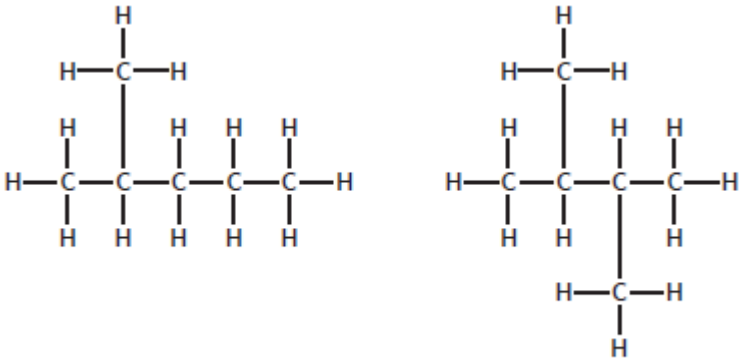
i) Name the type of chemical reaction taking place when limonene reacts with bromine solution. **1**

ii) Write the molecular formula for the product formed when limonene, $C_{10}H_{16}$, reacts completely with bromine solution. **1**

44. The alkanes are a homologous series of saturated hydrocarbons.

a) State what is meant by the term homologous series. **1**

b) The structural formula of two alkanes is shown.

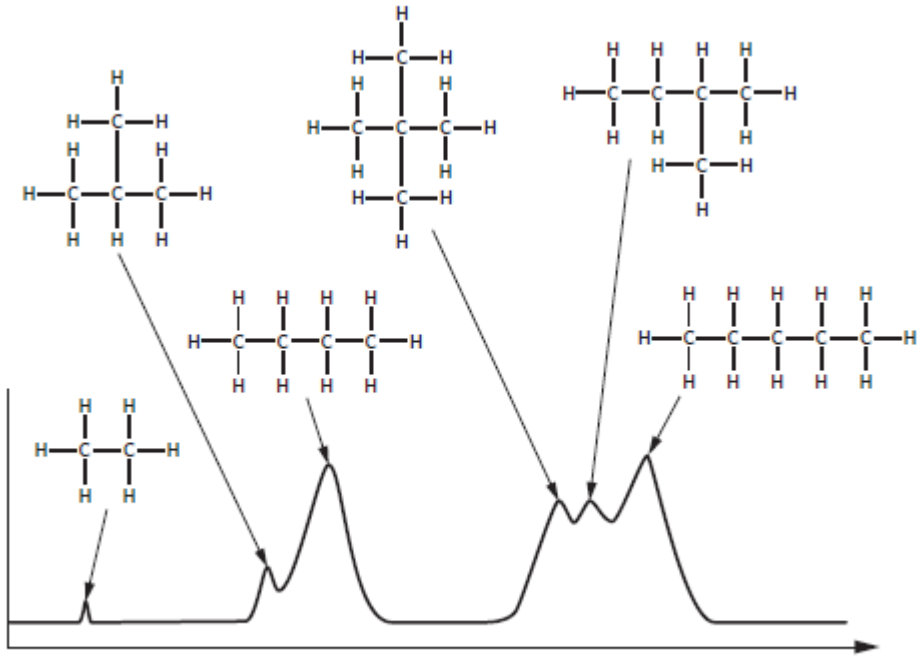


2-methylpentane

2,3-dimethylbutane

State the term used to describe a pair of alkanes such as 2-methylpentane and 2,3-dimethylbutane. **1**

c) The alkanes present in a mixture were separated using a technique known as HPLC. The mixture was vaporised and then passed through a special column. Different alkanes take different amounts of time to pass through the column.
The results are shown.

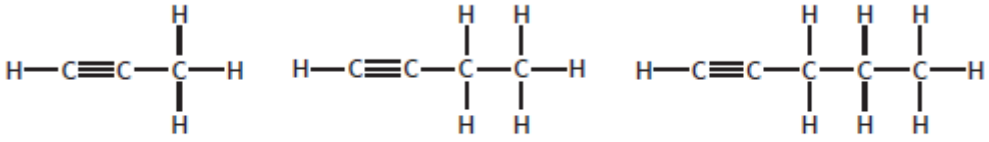


Time taken to pass through the column

i) Write a general statement linking the structure of the alkane to the length of time taken to pass through the column. **1**

ii) Propane was added to the mixture and the HPLC technique was repeated.
Draw an arrow on the graph to show the expected time taken for propane to pass through the column. **1**

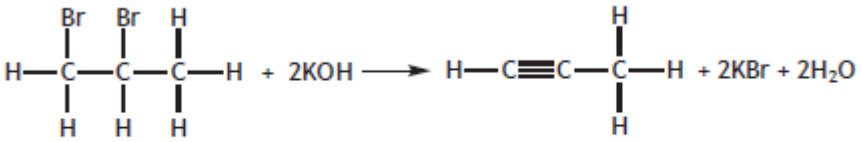
45. The alkynes are a family of hydrocarbons which contain a carbon to carbon triple bond. Three members of this family are shown.



propyne but-1-yne pent-1-yne

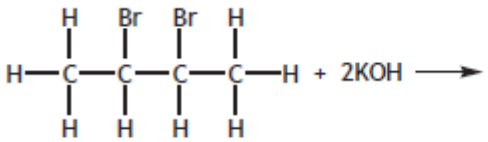
a) Suggest a general formula for the alkyne family. **1**

b) Alkynes can be prepared by reacting a dibromoalkane with potassium hydroxide solution.



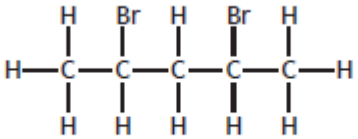
1,2-dibromopropane propyne

i) Draw the full structural formula for the alkyne formed when 2,3-dibromobutane reacts with potassium hydroxide. **1**



2,3-dibromobutane

ii) The structure for 2,4-dibromopentane is shown below.

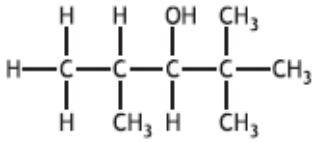


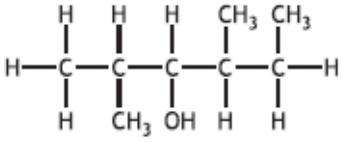
2,4-dibromopentane

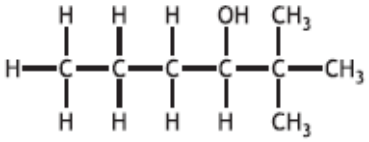
Suggest a reason why 2,4-dibromopentane does not form an alkyne when it is added to potassium hydroxide solution. **1**

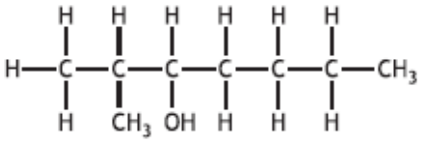
Everyday Consumer Products

46. The shortened structural formula for an organic compound is
$CH_3CH(CH_3)CH(OH)C(CH_3)_3$
Which of the following is another way of representing this structure?

A 

C 

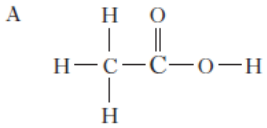
B 

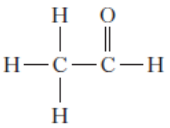
D 

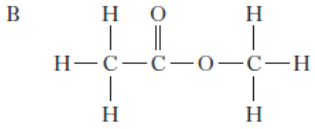
47. Which of the following alcohols has the highest boiling point?
You may wish to use your data booklet to help you.

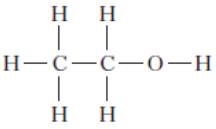
A Propan-1-ol
B Propan-2-ol
C Butan-1-ol
D Butan-2-ol

48. Which structural formula represents a carboxylic acid?

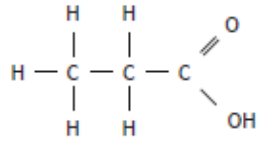
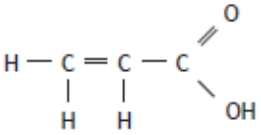
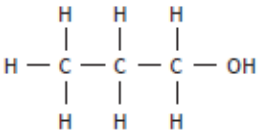
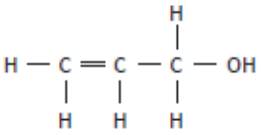
A 

C 

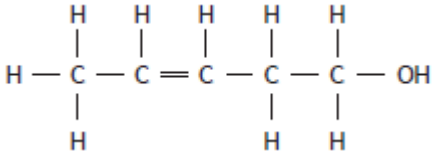
B 

D 

49. A student tested some compounds. The results are given in the table.

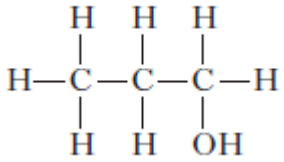
Compound	*pH of aqueous solution*	*Effect on bromine solution*
	4	no effect
	4	decolourised
	7	no effect
	7	decolourised

Which line in the table below shows the correct results for the following compound?



	pH of aqueous solution	*Effect on bromine solution*
A	4	decolourised
B	7	decolourised
C	4	no effect
D	7	no effect

50. Propan-1-ol can be dehydrated.



Which of the following compounds is a product of the reaction?

A Propanoic acid
B Propyl propanoate
C Propene
D Propane

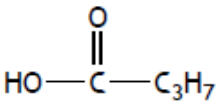
51. Vinegar is a solution of

A ethanol
B methanol
C ethanoic acid
D methanoic acid

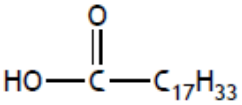
52. Butter contains different triglyceride molecules.

a) A triglyceride molecule is made when the alcohol glycerol reacts with carboxylic acids. Name the functional group present in glycerol**.** **1**

b) When butter goes off, a triglyceride molecule is broken down, producing compounds **X** and **Y**.



X

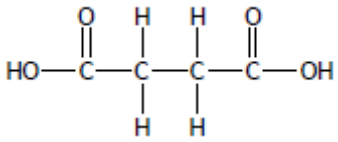


Y

i) Name compound **X**. **1**

ii) Describe the chemical test, including the result, to show that compound **Y** is unsaturated. **1**

53. Succinic acid is a natural antibiotic.
The structure of succinic acid is shown.

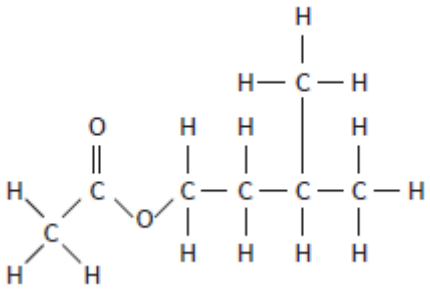


Name the functional group present in succinic acid. **1**

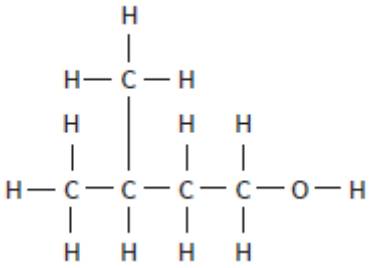
54. A student is given three different compounds each containing carbon.
Using your knowledge of chemistry, describe how the student could identify the compounds.
3

55. Pheromones are chemicals produced by living things that trigger a response in members of the same species.

When a bee stings an animal the bee also releases a pheromone containing the ester below.



a) A student made the ester above using ethanoic acid and the following alcohol.



Name the functional group present in this alcohol. **1**

b) The table gives information on some other esters.

Alcohol	*Carboxylic acid*	*Ester*
methanol	ethanoic acid	methyl ethanoate
propanol	methanoic acid	propyl methanoate
butanol	ethanoic acid	butyl ethanoate
pentanol	butanoic acid	pentyl butanoate
X	Y	ethyl propanoate

Name **X** and **Y**. **2**

56. Read the passage below and answer the question that follows.

Potassium Permanganate ($KMnO_4$)—The Purple Solution

Potassium permanganate's strong oxidising properties make it an effective disinfectant. Complaints such as athlete's foot and some fungal infections are treated by bathing the affected area in $KMnO_4$ solution.

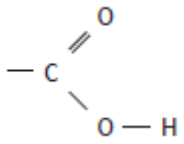
In warm climates vegetables are washed in $KMnO_4$ to kill bacteria such as E. coli and S. aureus. Chemists use $KMnO_4$ in the manufacture of saccharin, ascorbic acid (vitamin C) and benzoic acid.

Baeyer's reagent is an alkaline solution of $KMnO_4$ and is used to detect unsaturated organic compounds. The reaction of $KMnO_4$ with alkenes is also used to extend the shelf life of fruit. Ripening fruit releases ethene gas which causes other fruit to ripen. Shipping containers are fitted with gas scrubbers that use alumina or zeolite impregnated with $KMnO_4$ to stop the fruit ripening too quickly.

$$C_2H_4 + 4KMnO_4 \rightarrow 4MnO_2 + 4KOH + 2CO_2$$

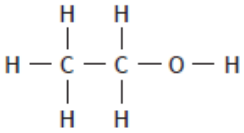
The scrubbers indicate when they need to be replaced because the purple colour changes to brown as the $KMnO_4$ is used up.

Name a chemical mentioned in the passage which contains the following functional group. **1**



57. Car manufacturers have developed flexible fuel engines for vehicles. These vehicles can run on ethanol or petrol or a mixture of both.
Ethanol can be produced from ethene which comes from cracking crude oil. It can also be made by fermenting glucose which is obtained from crops such as sugar cane and maize.

The structure of ethanol is shown below.



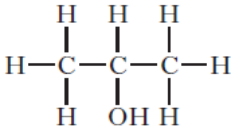
a) Circle the functional group in this molecule. **1**

b) Ethanol can be used to produce ethanoic acid.

i) Draw a structural formula for ethanoic acid. **1**

ii) To which family of compounds does ethanoic acid belong? **1**

58. Hand sanitisers are now used in many locations such as restaurants and hospitals.
The structure of the active ingredient in many hand sanitisers is



a) Name this compound. **1**

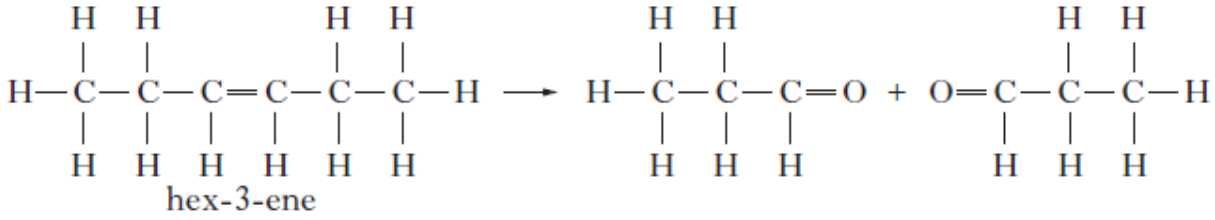
b) This compound can be formed when propene reacts with water.

i) Draw the structural formula for another compound which can be formed when propene reacts with water. **1**

ii) Name this type of chemical reaction. **1**

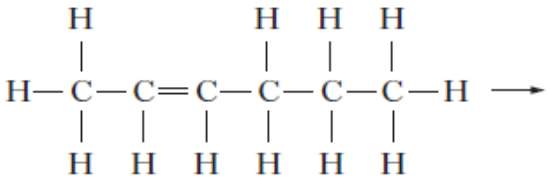
59. Alkenes can undergo different reactions.

a) In ozonolysis an alkene reacts with ozone forming two molecules. The ozonolysis of hex-3-ene is shown.

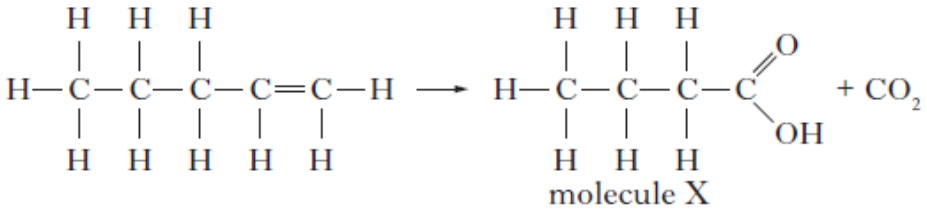


hex-3-ene

Draw the products formed by the ozonolysis of hex-2-ene. **1**



b) Potassium permanganate can be used to convert alkenes into two molecules. The conversion of pent-1-ene is shown.

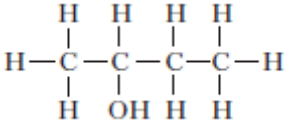


molecule X

i) Name molecule X. **1**

ii) State the test for carbon dioxide. **1**

60. Butan-2-ol is a member of the alkanol family.



Draw the full structural formula for an isomer of butan-2-ol. **1**

61.

The little pen-tailed tree shrew, found in the jungles of West Malaysia, feeds on nectar from the Bertam palm tree. This nectar contains glucose which ferments, producing solutions of up to 3·8 % alcohol. Therefore, the tree shrew regularly drinks a solution which is equivalent to a man drinking 9 units of alcohol per day. It seems that the tree shrew never gets drunk because it is able to breakdown the alcohol much quicker than humans can.

a) The alcohol produced is ethanol.
Draw the **shortened structural formula** for ethanol. **1**

b) Using information in the passage above, calculate the volume of alcohol, in cm^3, solution the tree shrew drinks each day. **1**

$$\text{Volume of alcohol solution} = \frac{\text{units of alcohol} \times 1{\cdot}25}{\text{\% of alcohol}}$$

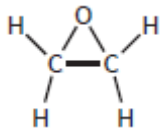
62. Ethers are a group of compounds containing carbon, hydrogen and oxygen.

Name of ether	*Structural formula*	*Boiling point (°C)*
methoxyethane	$CH_3-O-CH_2CH_3$	7
ethoxyethane	$CH_3CH_2-O-CH_2CH_3$	35
X	$CH_3-O-CH_2CH_2CH_3$	39
propoxybutane	$CH_3CH_2CH_2-O-CH_2CH_2CH_2CH_3$	117

a) Name ether X. **1**

b) Suggest a general formula for this homologous series. **1**

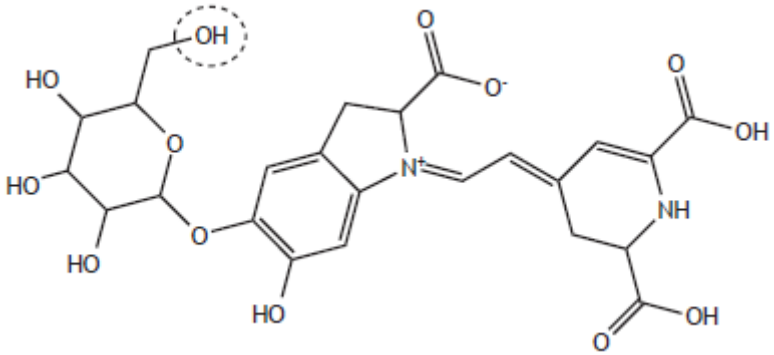
c) Epoxides are a family of cyclic ethers.
The full structural formula for the first member of this family is shown.



i) Epoxides can be produced by reacting an alkene with oxygen.
Name the alkene which would be used to produce the epoxide shown. **1**

ii) Epoxides have three atoms in a ring, one of which is oxygen.
Draw a structural formula for the epoxide with the chemical formula C_3H_6O. **1**

63. Betanin is responsible for the red colour in beetroot and can be used as a food colouring.



a) Name the functional group circled in the diagram above. **1**

b) Betanin can be used as an indicator in a neutralisation reaction.
The pH range at which some indicators change colour is shown.

Indicator	*pH range of colour change*
methyl orange	3·2 to 4·4
litmus	5·0 to 8·0
phenolphthalein	8·2 to 10·0
betanin	9·0 to 10·0

The indicator used in a neutralisation reaction depends on the pH at the end point.
The table below shows the end point of neutralisation reactions using different types of acid and base.

Type of acid	*Type of base*	*pH at the end point*
strong	strong	7
strong	weak	below 7
weak	strong	above 7

Betanin can be used to indicate the end point in the reaction between oxalic acid and sodium hydroxide solution.
State the type of acid and the type of base used in this reaction. **1**

64. Carboxylic acids can be used in household cleaning products.
a) Name the functional group found in all carboxylic acids. **1**

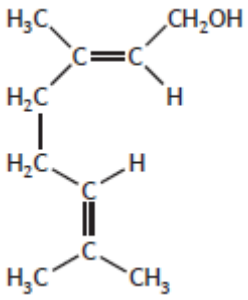
b) Carboxylic acids have a range of physical and chemical properties.
Melting point is an example of a physical property.
The table gives information about propanoic acid and butanoic acid.

Carboxylic acid	*Melting point* (°C)
propanoic acid	−21
butanoic acid	−5

i) Draw a structural formula for butanoic acid. **1**

ii) Explain why butanoic acid has a higher melting point than propanoic acid. **2**

65. Geraniol is an essential oil known to have anti-inflammatory properties.
A structure for the geraniol molecule is shown.



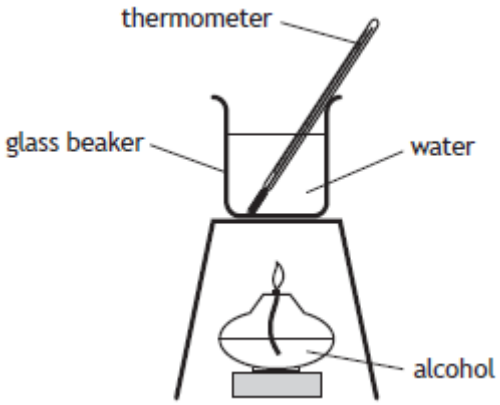
a) Circle a functional group found in the geraniol molecule. **1**

b) A student prepared a sample of geranyl propanoate from geraniol and propanoic acid.

geraniol	+	propanoic acid	⟶	geranyl propanoate	+	water
$C_{10}H_{18}O$	+	$C_3H_6O_2$	⟶	$C_{13}H_{22}O_2$	+	H_2O

15·4 g of geraniol was reacted with excess propanoic acid.
Calculate the mass, in grams, of geranyl propanoate which would be produced. **3**
Show your working clearly.

66. A group of students carried out an experiment to measure the energy produced when 5 g samples of different alcohols were burned.



The results are shown.

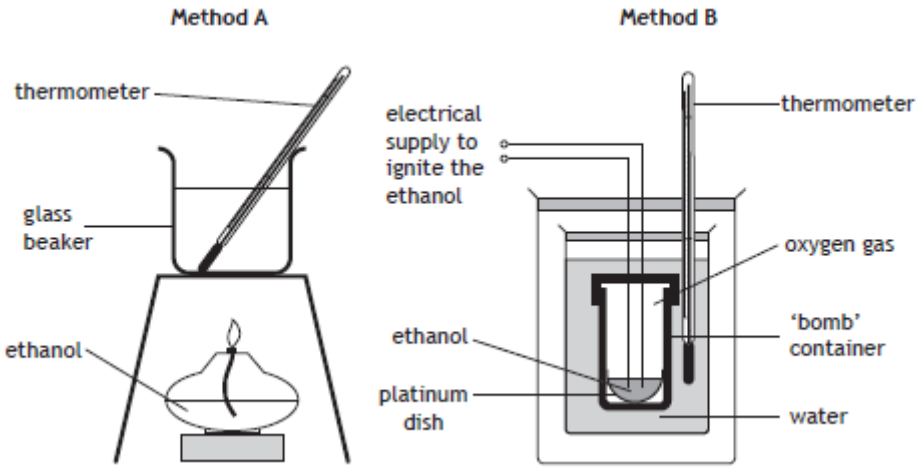
Alcohol	*Energy released* (kJ)
propan-1-ol	158
butan-1-ol	170
pentan-1-ol	179
hexan-1-ol	185

i) Draw a structural formula for hexan-1-ol. **1**

ii) Predict the energy released, in kJ, if the same mass of heptan-1-ol was burned. **1**

Energy from Fuels

67. A student calculated the energy absorbed by water when ethanol is burned using two different methods.



The student recorded the following data.

	Method	
	A	B
Mass of ethanol burned (g)	0·5	0·5
Mass of water heated (g)	100	100
Initial temperature of water (°C)	24	24
Final temperature of water (°C)	32	58

a) The final temperature of water in method **B** is higher than in method **A**.
Suggest why there is a difference in the energy absorbed by the water. **1**

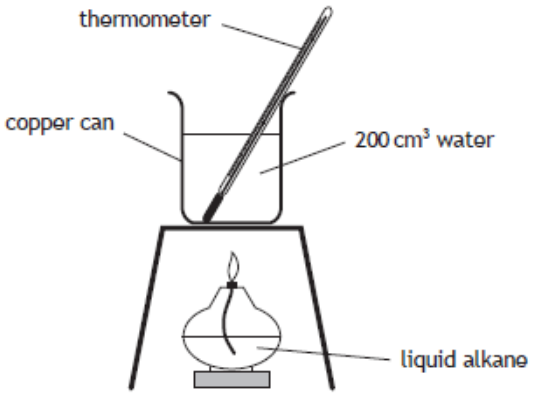
b) Calculate the energy, in kJ, absorbed by the water in method **B**. **3**
You may wish to use the data booklet to help you.
Show your working clearly.

68. 25 kg of water at 10 °C is heated by burning some LPG.
Calculate the energy, in kJ, required to increase the temperature of the water to 30 °C. **3**
You may wish to use the data booklet to help you.
Show your working clearly.

69. Alkanes burn, releasing energy

a) What name is given to any chemical reaction which releases energy? **1**

b) A student investigated the amount of energy released when an alkane burns using the apparatus shown.



The student recorded the following data.

Mass of alkane burned	1 g
Volume of water	200 cm^3
Initial temperature of water	15 °C
Final temperature of water	55 °C
Specific heat capacity of water	4·18 $kJ\,kg^{-1}\,°C^{-1}$

Calculate the energy released, in kJ. **3**

You may wish to use the data booklet to help you.

Show your working clearly.

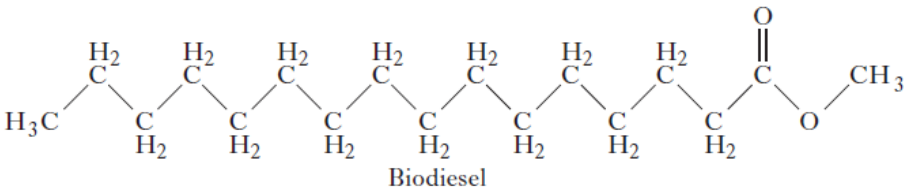
c) The table gives information about the amount of energy released when one mole of some alkanes are burned.

Name of alkane	*Energy released when one mole of alkane is burned (kJ)*
methane	891
ethane	1560
propane	2220
butane	2877

i) Describe the relationship between the amount of energy released and the number of carbon atoms in the alkane molecule. **1**

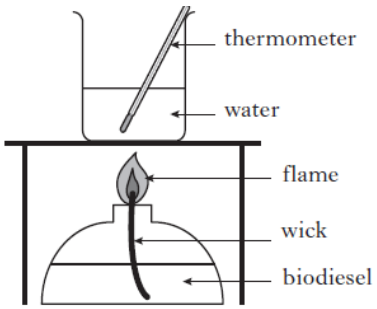
ii) Predict the amount of heat released, in kJ, when one mole of pentane is burned. **1**

70. Biodiesel is a renewable source of energy which is being used as a fuel for cars.
The structure of a molecule of biodiesel is shown



Biodiesel

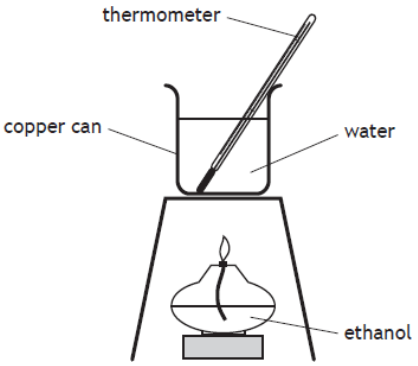
The energy produced from biodiesel can be measured using the following arrangement.



Calculate the energy absorbed by the water when 0·1 kg of water is heated from 18°C to 26°C using 50cm^3 of biodiesel. **3**

71. Ethanol can be used as an alternative fuel for cars.

a) A student considered two methods to confirm the amount of energy released when ethanol burns.



Method A	*Method B*
1. Record the initial temperature of the water.	1. Record the initial temperature of the water.
2. Weigh the burner containing the fuel.	2. Weigh the burner containing the fuel.
3. Place the burner under the copper can and then light the burner.	3. Light the burner and then place it under the copper can.
4. Extinguish the flame after 2 minutes.	4. Extinguish the flame after 2 minutes.
5. Record the final temperature and reweigh the burner.	5. Record the final temperature and reweigh the burner.

Explain which method would give a more accurate result. **2**

b) The table gives information about the amount of energy released when 1 mole of some alcohols are burned.

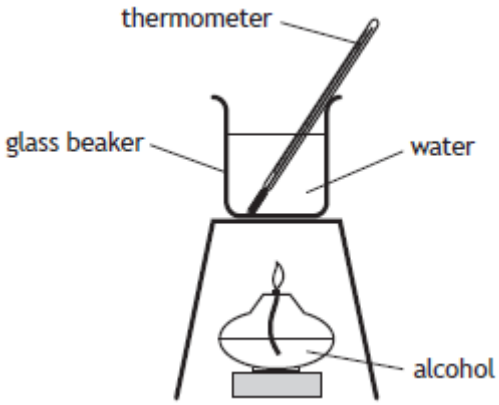
Name of alcohol	*Energy released when one mole of alcohol is burned* (kJ)
propan-1-ol	2021
propan-2-ol	2005
butan-1-ol	2676
butan-2-ol	2661
pentan-1-ol	3329
pentan-2-ol	3315
hexan-1-ol	3984

i) Write a statement linking the amount of energy released to the position of the functional group in an alcohol molecule. **1**

ii) Predict the amount of energy released, in kJ, when 1 mole of hexan-2-ol is burned. **1**

c) Ethanol can also be used in portable camping stoves.
The chemical reaction in a camping stove releases 23 kJ of energy. If 100 g of water is heated using this stove, calculate the rise in temperature of the water, in °C. **3**
You may wish to use the data booklet to help you.
Show your working clearly.

72. A group of students carried out an experiment to measure the energy produced when 5 g samples of different alcohols were burned.



The energy released when an alcohol burns can be used to heat liquids other than water. The data below was collected when the energy released, by burning an alcohol, was used to heat a sodium chloride solution.

Energy released when the alcohol was burned (kJ)	13·3
Initial temperature of sodium chloride solution (°C)	15
Final temperature of sodium chloride solution (°C)	49
Mass of sodium chloride solution heated (g)	100

Calculate the specific heat capacity, in kJ kg^{-1} $°C^{-1}$, of the sodium chloride solution. **3**

You may wish to use the data booklet to help you.

Show your working clearly.