

Mearns Castle H.S



# NATIONAL 5 CHEMISTRY

## Unit 2 Nature's Chemistry

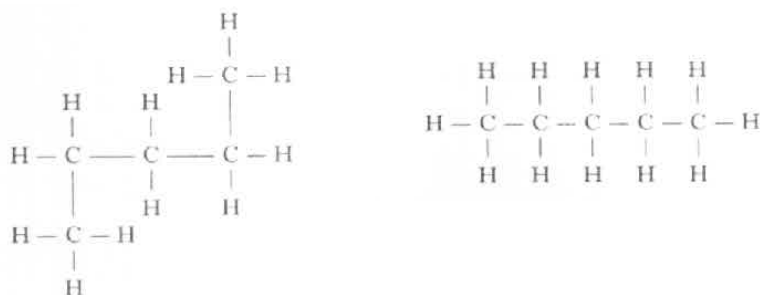


# Exam Questions

## Homologous series

2006 I2 13MC

1.



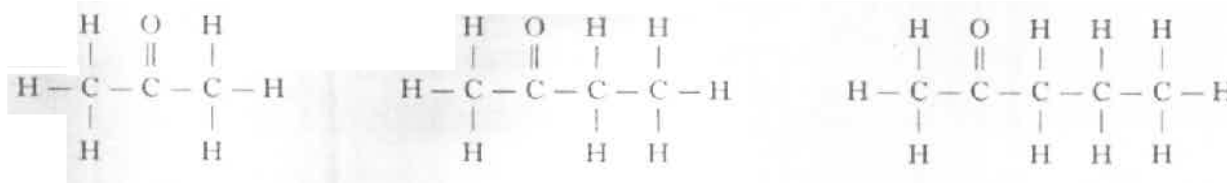
The above structural formulae represent

- A the same hydrocarbon
- B Different hydrocarbons
- C Isomers
- D Isotopes

1

2006 I2 14MC

2. The first three members of the alkanone series are:



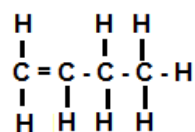
What is the general formula for this homologous series?

- A C<sub>n</sub>H<sub>2n-2</sub>O
- B C<sub>n</sub>H<sub>2n</sub>O
- C C<sub>n</sub>H<sub>2n-1</sub>O
- D C<sub>n</sub>H<sub>2n+2</sub>O

1

2006 I2 16MC

3. The structural formula for hydrocarbon X is



Which of the following statements about hydrocarbon X is true?

- A X is named but-2-ene
- B X is a saturated hydrocarbon
- C X rapidly decolorises bromine solution
- D X belongs to a group of hydrocarbons with the general formula C<sub>n</sub>H<sub>2n+2</sub>

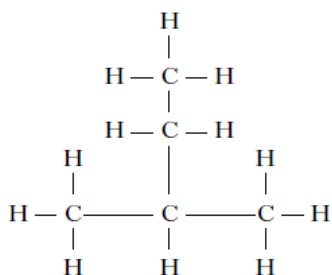
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2008 I2 13MC

4. Which of the following compounds fits the general formula, C<sub>n</sub>H<sub>2n</sub>, and will rapidly decolourise bromine solution?

- A Cyclopentane
- B Cyclopentene
- C Pentane
- D Pentene

5.



The name of the above compound is

A 1, 1-dimethylpropane

B 2-ethylpropane

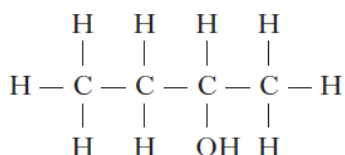
C 2-methylbutane

D 3-methylbutane.

1

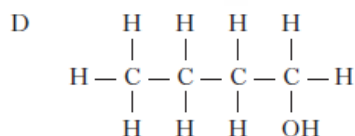
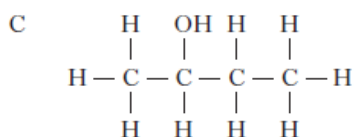
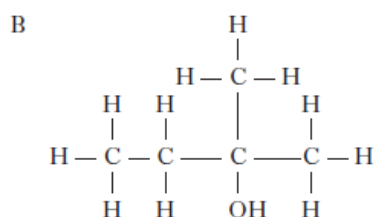
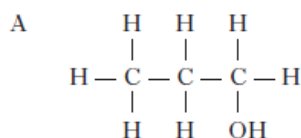
2007 I2 10 MC

6.



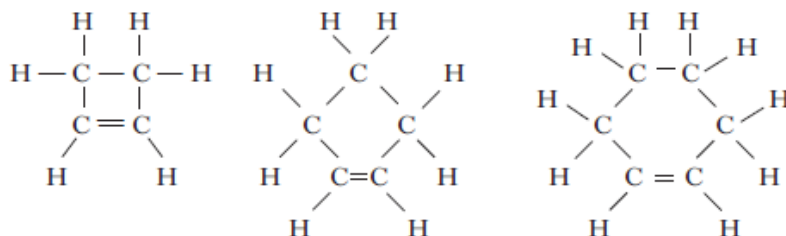
Which of the following compounds is an isomer of the one above?

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2008 I2 14MC

7. Three members of the cycloalkane homologous series are:



The general formula for this homologous series is

A  $\text{C}_n\text{H}_{2n+2}$

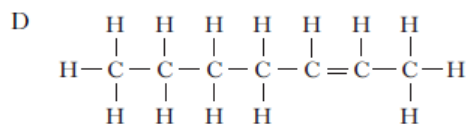
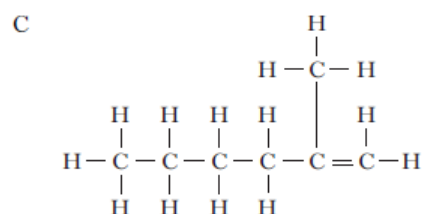
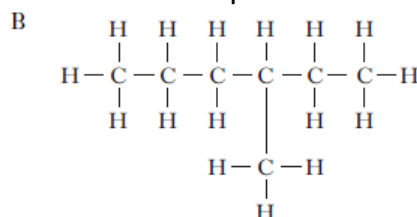
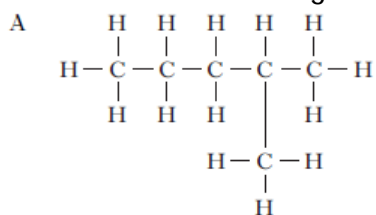
B  $\text{C}_n\text{H}_{2n}$

C  $\text{C}_n\text{H}_{2n-2}$

D  $\text{C}_n\text{H}_{2n-4}$

1

8. Which of the following molecules is an isomer of heptane?



2009 I2 15MC

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

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

1

2010 I2 10MC

10. 1 mole of a hydrocarbon burns completely in oxygen to produce 2 moles of carbon dioxide and 2 moles of water.

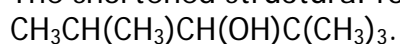
The formula for the hydrocarbon is

- A  $C_2H_4$   
 B  $C_2H_6$   
 C  $C_4H_8$   
 D  $C_4H_{10}$ .

1

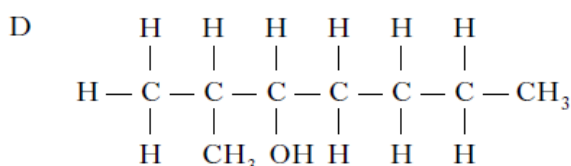
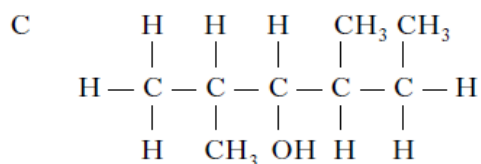
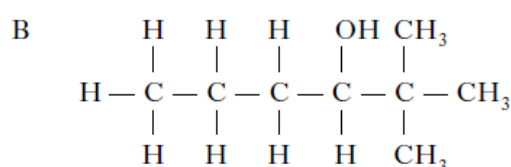
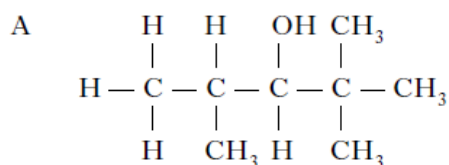
2009 I2 16MC

11. The shortened structural formula for an organic compound is



Which of the following is another way of representing this structure?

1

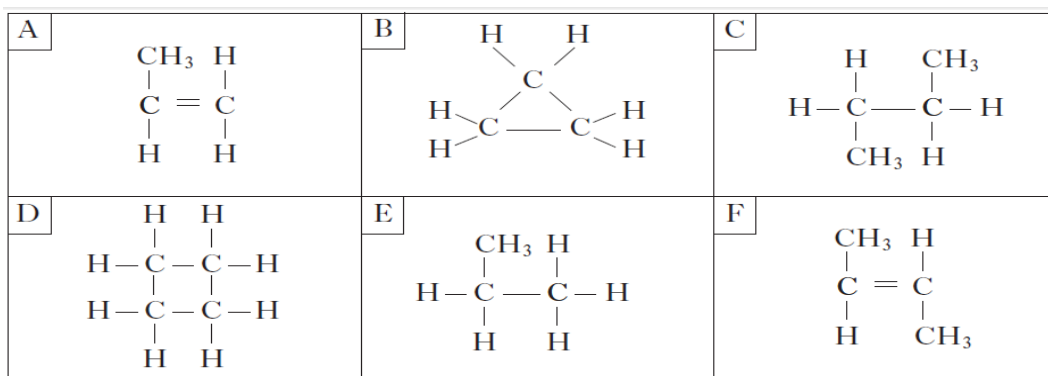


12. Which of the following hydrocarbons does not belong to the same homologous series as the others?
- A  $\text{CH}_4$   
 B  $\text{C}_3\text{H}_8$   
 C  $\text{C}_4\text{H}_{10}$   
 D  $\text{C}_6\text{H}_{12}$

1

2006 CRED 4

13. The structural formulae for some hydrocarbons are shown below.



- (a) Identify the hydrocarbon which could be used to make poly(butene).

1

A	B	C
D	E	F

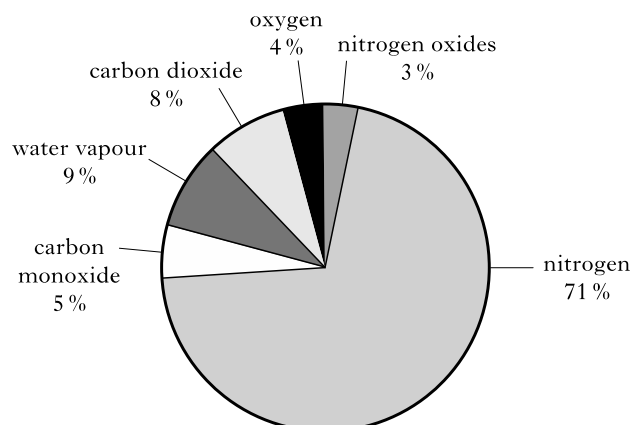
- (b) Identify the two hydrocarbons with the general formula  $\text{C}_n\text{H}_{2n}$  which do not react quickly with hydrogen.

1

A	B	C
D	E	F

2011 I2 8

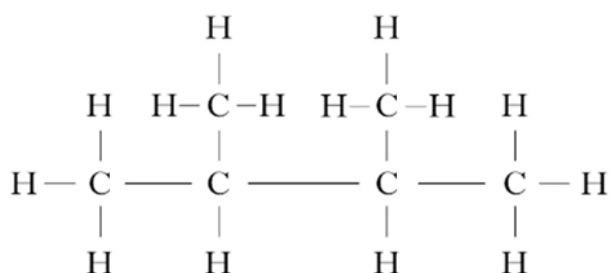
14. Many different gases are found in car exhaust fumes. Some of these gases are produced by the combustion of petrol in car engines. The pie chart shows the gases present in the exhaust fumes of a car.



What evidence in the pie chart shows that incomplete combustion of petrol has taken place?

1

15. Crude oil is a mixture of hydrocarbons which can be separated into fractions by fractional distillation.  
Petrol contains the following molecule.

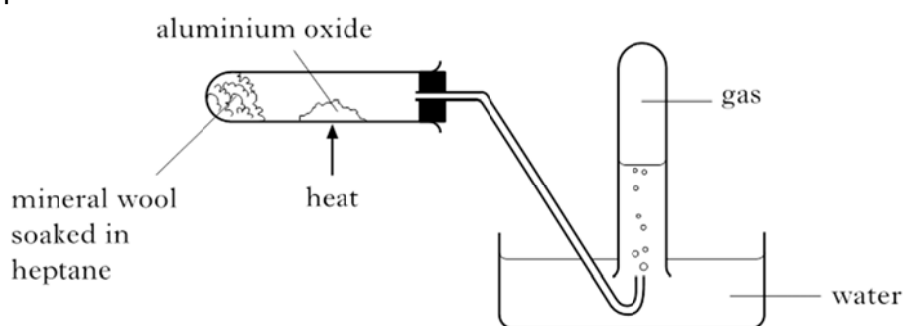


Name this molecule.

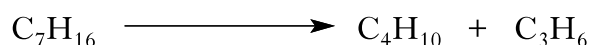
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2011 C 16

16. Heptane can be cracked as shown.



One of the reactions which takes place is:



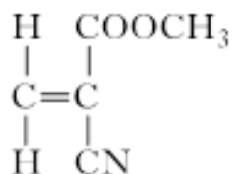
The product  $\text{C}_3\text{H}_6$  decolourises bromine solution quickly.

Draw a structural formula for an isomer of  $\text{C}_3\text{H}_6$ , which would not decolourise bromine solution quickly.

1

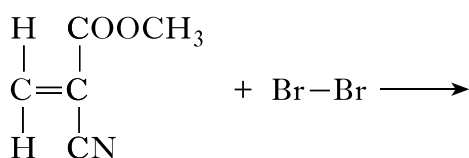
2012 C 20

17. The monomer in superglue has the following structure.



Bromine reacts with the monomer to produce a saturated compound. Draw the structural formula for this compound.

1

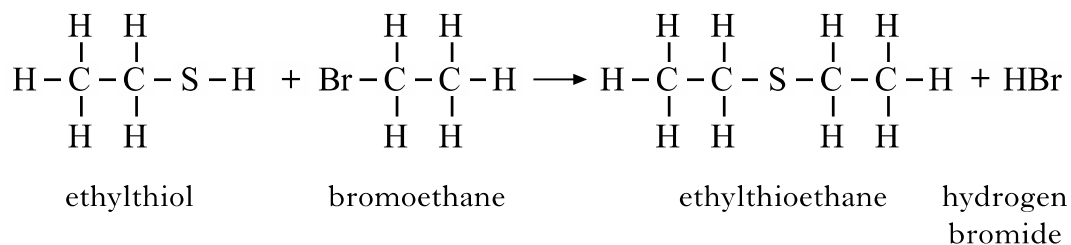


18. (a) Ethylthioethane belongs to a homologous series of compounds called thioethers.

What is meant by a homologous series?

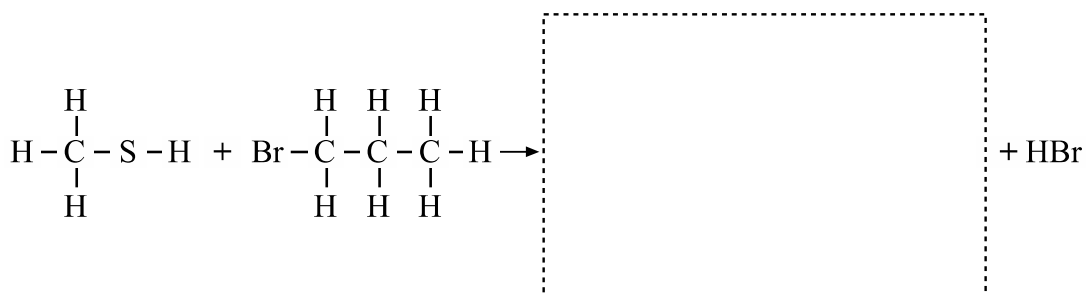
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- (b) Ethylthioethane is formed when ethylthiol reacts with bromoethane as shown.



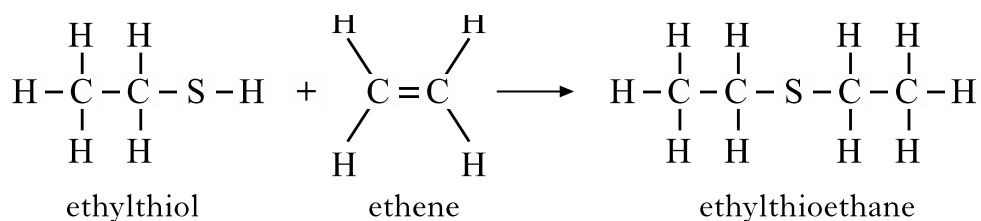
Draw the full structural formula for the thioether produced in the following reaction.

1



- (c) Ethylthioethane can also be formed by the reaction of ethylthiol with ethene.

1



Suggest a name for the type of chemical reaction taking place.

19. Thiols are organic compounds containing sulphur. Some thiols are listed in the table.

Formula	Name of thiol
CH <sub>3</sub> SH	methanethiol
CH <sub>3</sub> CH <sub>2</sub> SH	ethanethiol
$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3\text{CHCH}_2\text{SH} \end{array}$	<b>X</b>
$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3\text{CHCH}_2\text{CH}_2\text{SH} \end{array}$	3-methylbutane-1-thiol

- (a) Ethanethiol is added to natural gas to give it a smell.  
Draw the full structural formula for ethanethiol. 1
- (b) Suggest the name for thiol X. 1
- (c) Thiols undergo complete combustion.  
thiols + oxygen → carbon dioxide + water + .....  
Complete the word equation for this reaction. 1

20. A student carried out an experiment to test different hydrocarbons for saturation. Her results are shown in the table.

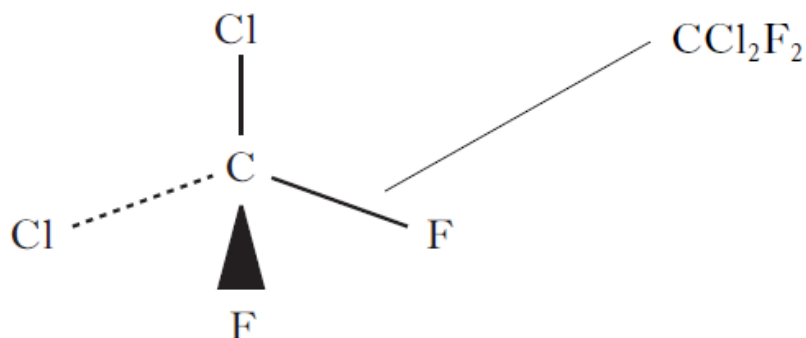
Hydrocarbon	Molecular formula	Observation with bromine solution	Saturated or unsaturated
<b>A</b>	C <sub>6</sub> H <sub>14</sub>	no change	
<b>B</b>	C <sub>6</sub> H <sub>12</sub>		unsaturated
<b>C</b>	C <sub>6</sub> H <sub>12</sub>		saturated
<b>D</b>	C <sub>6</sub> H <sub>10</sub>	bromine decolourises	

- (a) Complete the table. 2
- (b) Care had to be taken when using bromine solution. Give a safety precaution, **other** than eye protection, which should be taken when completing this test. 1
- (c) Suggest a possible name for hydrocarbon B. 1



21. Chlorofluorocarbons (CFCs) are a family of compounds which are highly effective as refrigerants and aerosol propellants. However, they are now known to damage the ozone layer.

One example of a CFC molecule is shown.

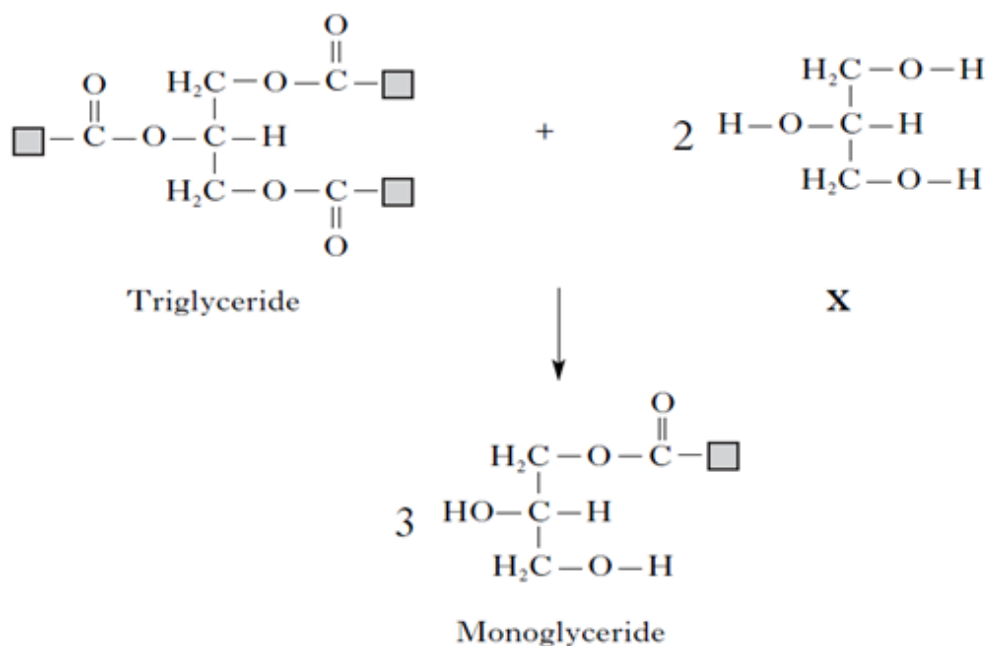


- (a) What term is used to describe the shape of this molecule? 1
- (b) Scientists have developed compounds to replace CFCs. The table shows information about the ratio of atoms in  $\text{CCl}_2\text{F}_2$  and compounds used to replace it.

Compound	Number of atoms				Atmospheric life (years)
	C	Cl	F	H	
$\text{CCl}_2\text{F}_2$	1	2	2	0	102
Replacement 1	1	1	2	1	13.3
Replacement 2	2	0	4	2	14.6
Replacement 3	1	0	2	2	5.6

- (i) Draw a possible structure for Replacement 2. 1
- (ii) Compared with  $\text{CCl}_2\text{F}_2$ , the replacement compounds contain less of which element? 1
- (iii) From the table, what is the advantage of using the replacement molecules as refrigerants and aerosol propellants? 1

22. Scientists have replaced oils in gloss paints with synthetic polyesters. This has improved the drying quality of the paint. The first step in the production of the synthetic polyester is shown.



- (a) What does the term synthetic mean? 1
- (b) Copy out the triglyceride and circle an ester link. 1
- (c) Name X. 1

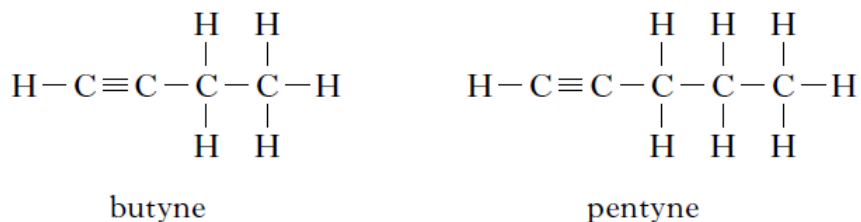
23. The octane number of petrol is a measure of how efficiently it burns as a fuel. The higher the octane number, the more efficient the fuel.

- (a) What is a fuel? 1
- (b) The octane numbers for some hydrocarbons are shown.

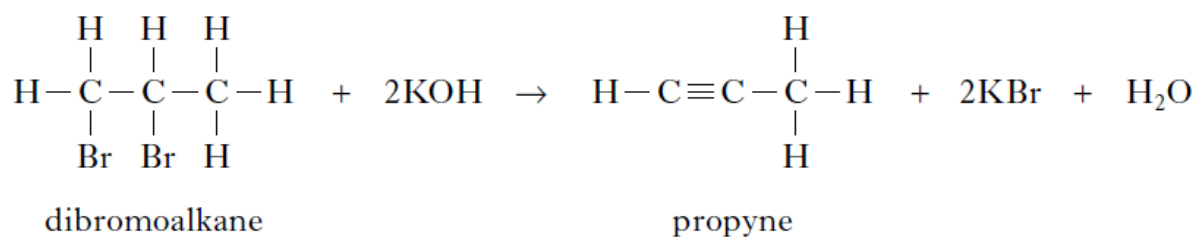
Hydrocarbon	Number of carbon atoms	Octane number
hexane	6	
heptane	7	0
octane	8	-19
2-methylpentane	6	71
2-methylhexane	7	44
2-methylheptane	8	23

- (i) Predict the octane number for hexane. 1
- (ii) State a relationship between the structure of the hydrocarbon and their efficiency as fuels. 1

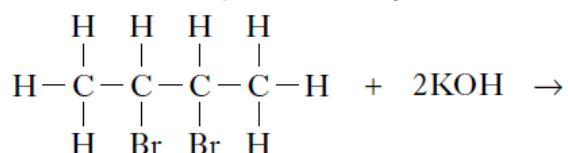
24. Alkynes are a homologous series of hydrocarbons which contain carbon to carbon triple bonds. Two members of this series are shown.



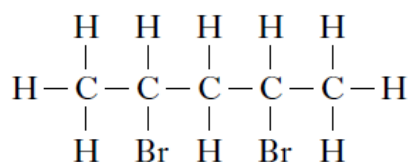
- (a) Name the first member of this series. 1
- (b) Alkynes can be prepared by reacting a dibromoalkane with potassium hydroxide solution.



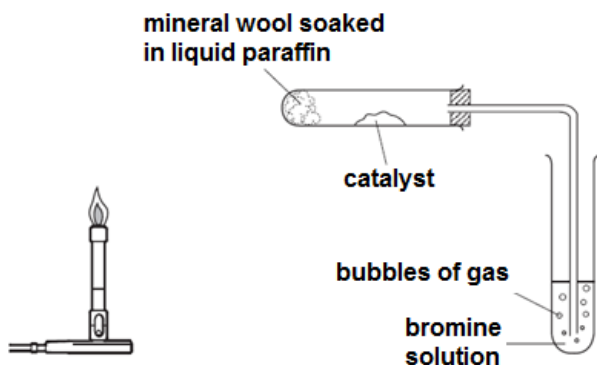
- (i) Draw a structural formula for the alkyne formed when the dibromoalkane shown below reacts with potassium hydroxide solution. 1



- (ii) Suggest a reason why the dibromoalkane shown below does not form an alkyne when it is added to potassium hydroxide solution. 1

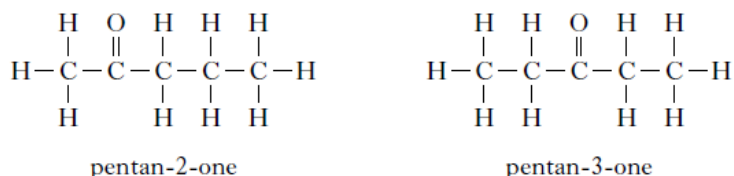


25. The diagram below shows the apparatus used to 'crack' a hydrocarbon.

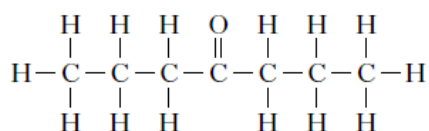


- (a) Describe how the bunsen burner is used to heat the apparatus. 1
- (b) Explain why the delivery tube must be removed from the bromine solution before heating is stopped. 1
- (c) (i) Name the catalyst that is used in this cracking reaction. 1
- (ii) Catalysts speed up the rate of a reaction without being used up. State another reason for using a catalyst. 1
- (d) One of the reactions taking place is:  
 $\text{CH}_2\text{CHCH}_3 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCHBrCH}_3$   
 What name is given to this type of chemical reaction? 1

26. Chemicals in food provide flavour and smell. Ketones are responsible for the flavour in blue cheese. Two examples of ketones are shown below.



- (a) Draw a structure for hexan-3-one. 1
- (b) Suggest a name for the ketone shown below. 1



- (c) Information about the boiling points of four ketones is shown in the table.

Ketone	Boiling point (°C)
$\text{C}_3\text{H}_6\text{O}$	56
$\text{C}_4\text{H}_8\text{O}$	80
$\text{C}_5\text{H}_{10}\text{O}$	102
$\text{C}_6\text{H}_{12}\text{O}$	127

Predict the boiling point of  $\text{C}_7\text{H}_{14}\text{O}$ .

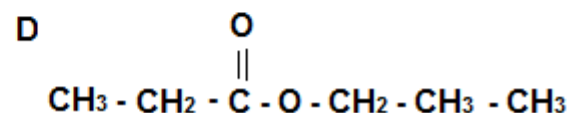
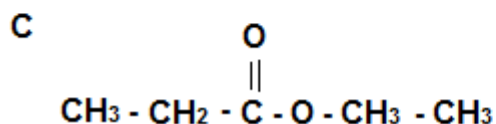
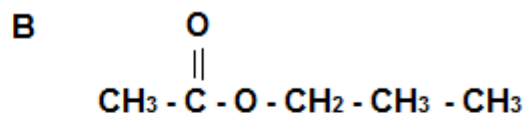
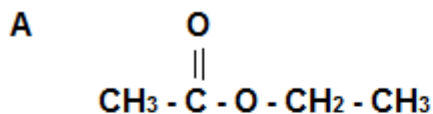
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## Everyday Consumer Products

2006 I2 15MC

1. Which of the following is the structural formula for propyl ethanoate?

1



2006 I2 18MC

2. The method used to increase the ethanol concentration of fermentation products is

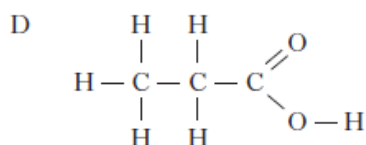
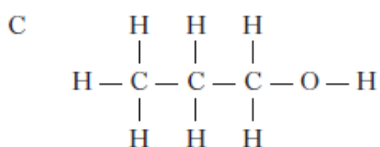
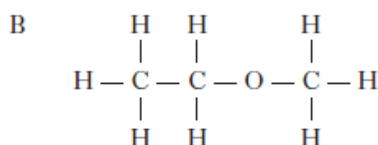
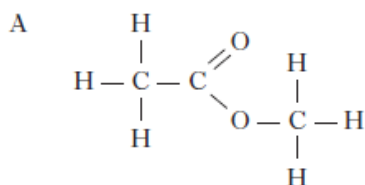
- A cracking
- B dehydration
- C distillation
- D hydrolysis

1

2007 I2 11MC

3. Which of the following represents an ester?

1



2008 I2 16MC

4. Fermentation of glucose to ethanol and carbon dioxide by yeast stops when the ethanol concentration reaches about 13%.

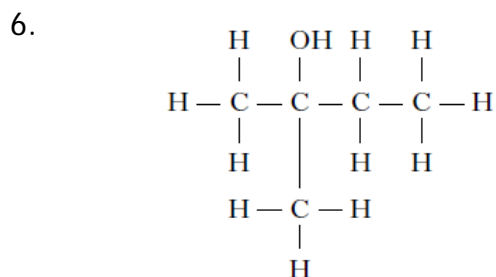
This is because

- A the ethanol has destroyed the yeast
- B all the glucose has been used up
- C carbon dioxide is harmful to yeast
- D the mixture is now saturated with ethanol.

1

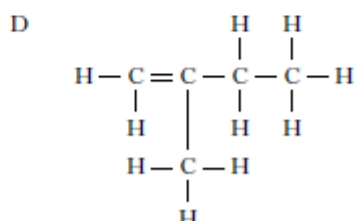
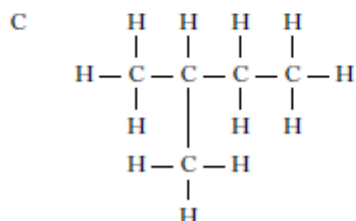
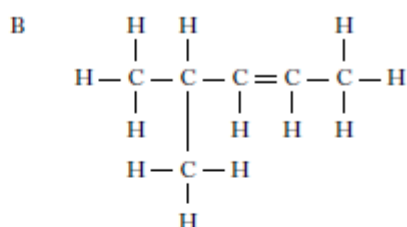
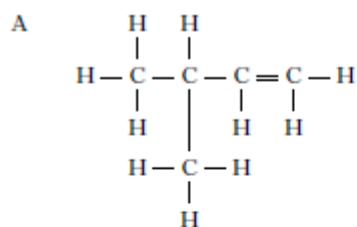
5. methanol + ethanoic acid  $\rightarrow$  methyl ethanoate + water  
 This reaction is an example of  
 A addition  
 B dehydration  
 C condensation  
 D neutralisation.

1

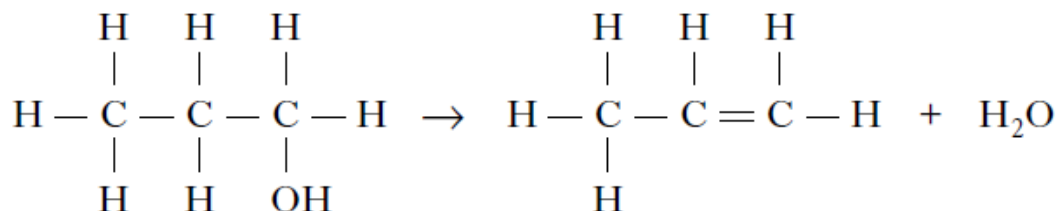


The above compound could be formed by adding water to

1



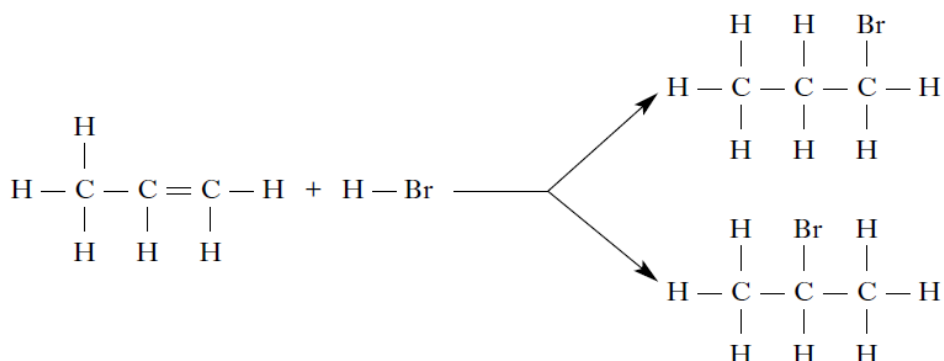
7. Which type of reaction is shown by the following equation?



- A Condensation  
 B Dehydration  
 C Hydration  
 D Hydrolysis

1

8. When propene undergoes an addition reaction with hydrogen bromide, two products are formed.



Which of the following alkenes will also produce **two** products when it undergoes an addition reaction with hydrogen bromide?

- A Ethene  
 B But-1-ene  
 C But-2-ene  
 D Hex-3-ene

1

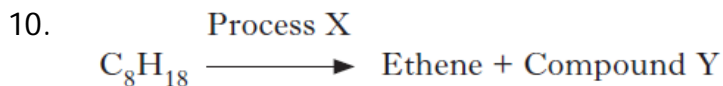
9. The table shows the result of heating two compounds with acidified potassium dichromate solution.

Compound	Acidified potassium dichromate solution
$  \begin{array}{c}  \text{H} \quad \text{H} \quad \text{O} \quad \text{H} \\    \quad   \quad    \quad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\    \quad   \quad \quad   \\  \text{H} \quad \text{H} \quad \quad \text{H}  \end{array}  $	stays orange
$  \begin{array}{c}  \text{H} \quad \text{H} \quad \text{H} \quad \text{O} \\    \quad   \quad   \quad    \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\    \quad   \quad   \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $	turns green

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

- A
 
$$\begin{array}{c}
 \text{H} \quad \text{O} \quad \text{H} \\
 | \quad || \quad | \\
 \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\
 | \quad \quad | \\
 \text{H} \quad \quad \text{H}
 \end{array}$$
- B
 
$$\begin{array}{c}
 \text{H} \quad \text{H} \quad \text{O} \\
 | \quad | \quad || \\
 \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\
 | \quad | \\
 \text{H} \quad \text{H}
 \end{array}$$
- C
 
$$\begin{array}{c}
 \text{H} \quad \text{O} \\
 | \quad || \\
 \text{H}-\text{C}-\text{C}-\text{H} \\
 | \\
 \text{H}
 \end{array}$$
- D
 
$$\begin{array}{c}
 \text{O} \\
 || \\
 \text{H}-\text{C}-\text{H}
 \end{array}$$

1



Which line in the table correctly identifies Process X and Compound Y?

1

	Process X	Compound Y
A	cracking	hexane
B	cracking	hexene
C	distillation	hexane
D	distillation	hexene

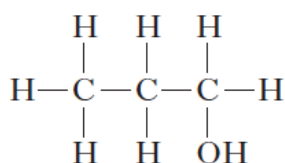
2013 I2 13MC

11. Ethanol can be produced from sugar cane by
- A oxidation
  - B fermentation
  - C polymerisation
  - D catalytic hydration.

1

2013 I2 14MC

12. 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

1



13.



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.

The alcohol produced is ethanol.

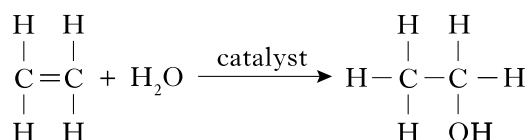
Draw the **shortened structural formula** for ethanol.

1

2012 I2 7

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

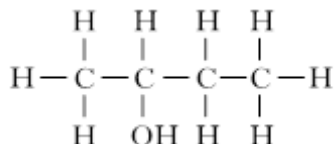
(a) Ethanol can be manufactured from ethene as shown in the following addition reaction.



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

1

(b) Butan-2-ol is another member of the alkanol family.



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

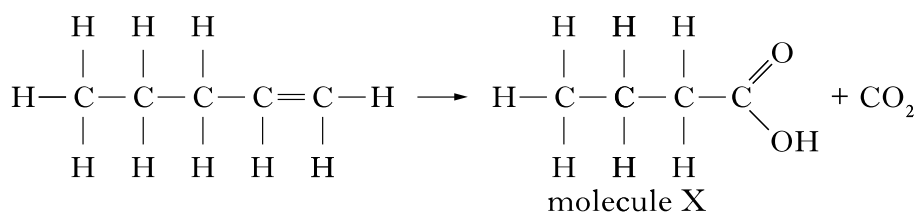
1

2013 I2 9

15. Alkenes can undergo different reactions.

Potassium permanganate can be used to convert alkenes into two molecules.

The conversion of pent-1-ene is shown.



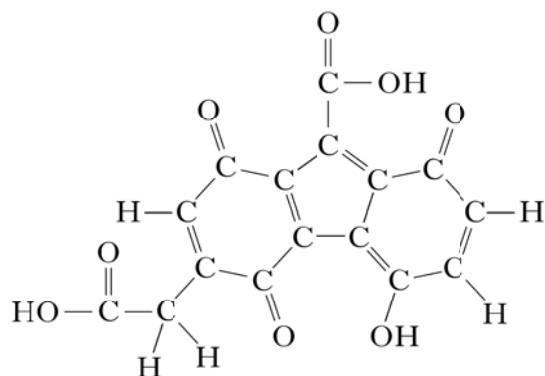
Name molecule X.

1

16.



When a hippopotamus is seen out of water it looks as though it is bleeding. This is due to a red coloured secretion which protects the hippopotamus against sunburn caused by UVB radiation. Scientists have found that one of the active ingredients in this natural sunscreen is a chemical called hipposudoric acid.

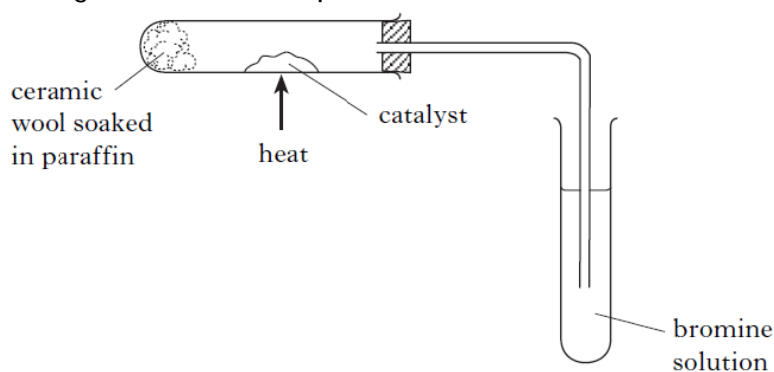


hipposudoric acid

- (a) Suggest a pH value for hipposudoric acid. 1
- (b) Hipposudoric acid contains a hydroxyl group. Circle the hydroxyl group in the structure of hipposudoric acid. 1

2009 I2 7

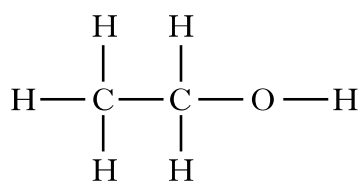
17. The diagram shows how paraffin,  $C_{12}H_{26}$ , can be cracked.



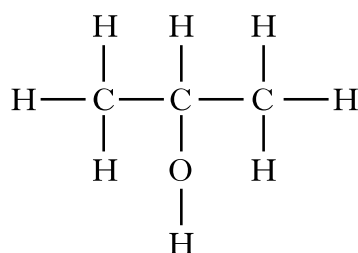
- (a) Name the catalyst used in cracking. 1
- (b) One of the reactions taking place when paraffin is cracked is  

$$C_{12}H_{26} \rightarrow C_8H_{18} + X$$
- (i) Identify molecule X. 1
- (ii) Describe what would be seen when X is added to bromine solution. 1

18. An antibacterial hand gel contains two alkanols, ethanol and propan-2-ol.

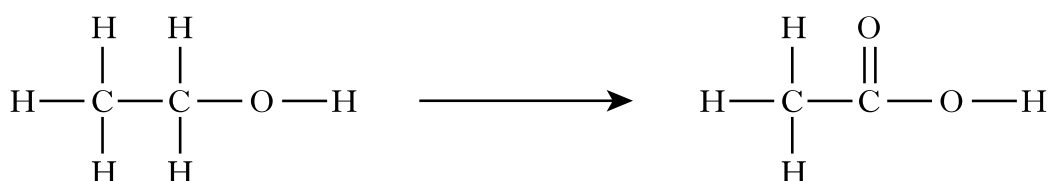


ethanol



propan-2-ol

- (a) When alkanols are oxidised alkanolic acids are produced.

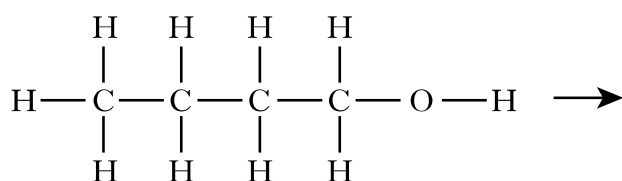


ethanol

ethanoic acid

Draw the full structural formula for the alkanolic acid produced when butanol is oxidised.

1



butanol

butanoic acid

- (b) Esters are produced when alkanols react with alkanolic acids.

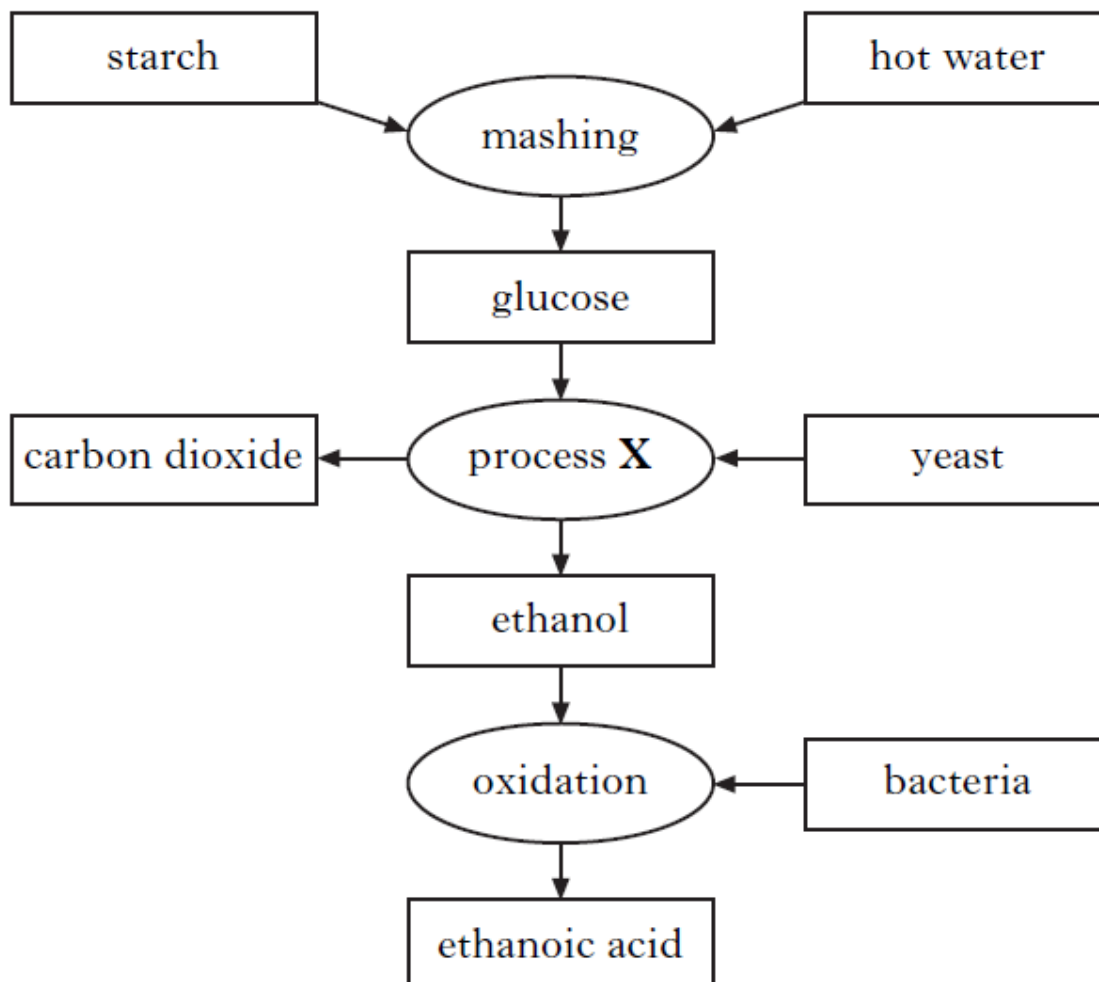
The table gives information on esters.

Alkanol	Alkanolic acid	Ester
methanol	ethanoic acid	methyl ethanoate
ethanol	propanoic acid	ethyl propanoate
propanol	methanoic acid	propyl methanoate
butanol	ethanoic acid	butyl ethanoate
pentanol	butanoic acid	<b>X</b>

Suggest a name for X.

1

19. The flow chart shows some of the stages in the manufacture of ethanoic acid.



- (a) In the mashing process, some of the starch is broken down into glucose. Using the flow chart, write the word equation for the reaction taking place in the mashing process. 1
- (b) Name process X. 1
- (c) Draw the full structural formula for ethanoic acid. 1
- d) Ethanoic acid can be reacted with methanol to form an ester, which is used as a solvent in nail varnish remover. Name this ester. 1

20. A recipe for making blackcurrant wine is shown.

1. Boil 4 litres of water and add 2 kg of sugar.
2. Stir until all the sugar dissolves.
3. Add 1.5 kg of crushed blackcurrants and let the mixture cool to room temperature.
4. Add some yeast.
5. Cover the container and leave it in a warm place for 5 days.
6. Filter the mixture into a glass jar and fit an airlock.
7. Leave the mixture for 3 months before filtering and bottling.

- (a) Yeast is used to convert sugar into ethanol.
- (i) What name is given to this process? 1
- (ii) What type of substance, found in yeast, acts as a catalyst? 1
- (b) Why was the mixture cooled at step 3, before the yeast was added to it? 1
- (c) When blackcurrant brandy is made from blackcurrant wine, the ethanol concentration is increased.  
How could this be done? 1

21. Sweets, such as pineapple cubes, contain the artificial flavouring methyl butanoate.

- (a) To which family of compounds does methyl butanoate belong? 1
- (b) Methyl butanoate can be broken down to form an alkanol and an alkanoic acid.
- (i) Name this type of chemical reaction. 1
- (ii) Draw the full structural formula for the alkanoic acid formed from the breakdown of methyl butanoate. 1

## Energy from Fuels

2012 I2 5

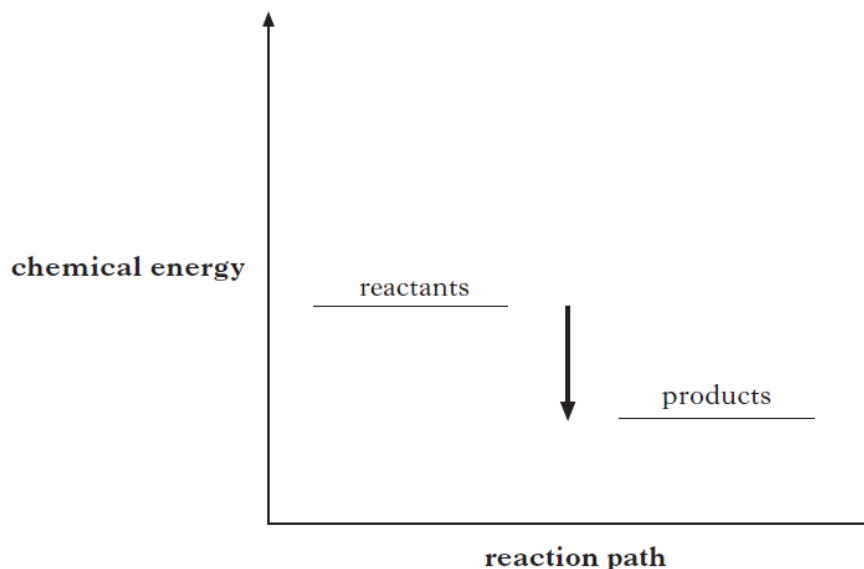
1. The alkanals are a homologous series of compounds that all contain the elements carbon, hydrogen and oxygen.  
The combustion of alkanals releases heat energy.

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

- (a) Make a general statement linking the amount of heat energy released and the number of carbon atoms in the alkanal molecules. 1
- (b) Predict the amount of heat energy released, in kJ, when 1 mole of pentanal burns. 1

2007 I2 15c

2. The diagram shows the chemical energies of the reactants and products when magnesium reacts with dilute acid.



In what way does the energy diagram show that the reaction is exothermic?

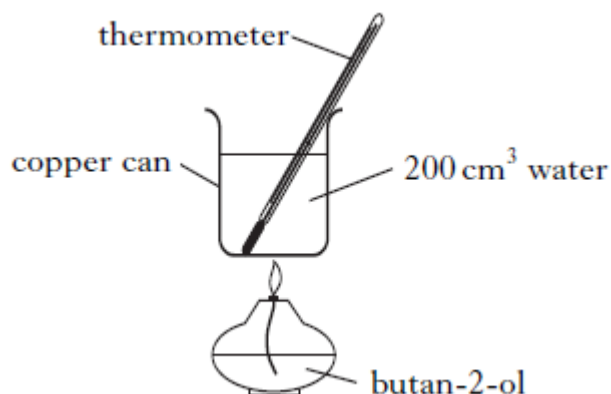
1

3. The energy changes taking place during chemical reactions have many everyday uses.
- (a) Some portable cold packs make use of the temperature drop that takes place when the chemicals in the pack dissolve in water.  
Name the type of reaction that results in a fall in temperature. 1
- (b) Flameless heaters are used by mountain climbers to heat food and drinks. The chemical reaction in a flameless heater releases 45 kJ of energy.  
If 200 g of water is heated using this heater, calculate the rise in temperature of the water, in °C. 1

4. The enthalpies of combustion of some alcohols are shown in the table.

Name of alcohol	Enthalpy of combustion/kJ mol <sup>-1</sup>
methanol	-727
ethanol	-1367
propan-1-ol	-2020

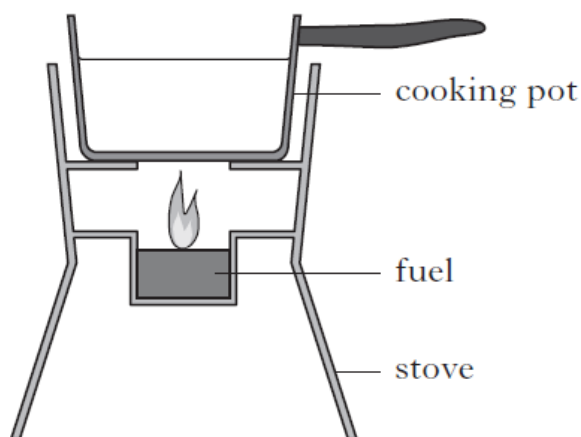
- (a) Using this data, predict the enthalpy of combustion of butan-1-ol, in kJ mol<sup>-1</sup>. 1
- (b) The following apparatus was used to measure how much heat was produced when butan-2-ol, C<sub>4</sub>H<sub>9</sub>OH, was burned.



Mass of butan-2-ol burned = 1.0 g  
 Initial temperature of water = 18 °C  
 Final temperature of water = 38 °C

- Use these results to calculate the heat released when 1g of butan-2-ol was burned. 1

5. Different fuels are used for different purposes.  
 (a) Ethanol,  $C_2H_5OH$ , can be used as a fuel in some camping stoves.



Theoretically, the amount of heat energy that should be released when one mole (46g) of ethanol burns is 1367 kJ.

Suggest two reasons why less energy is obtained from burning ethanol in the camping stove than is predicted.

2

- (b) Petrol is a fuel used in cars.

Energy released when 1.00 g of petrol burned/kJ	48.0
Volume of 1.00 g of petrol/cm <sup>3</sup>	1.45

A car has a 50.0 litre petrol tank.

Calculate the energy, in kJ, released by the complete combustion of one tank of petrol.

2