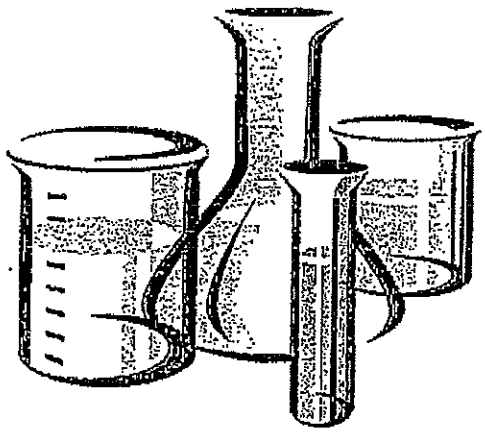
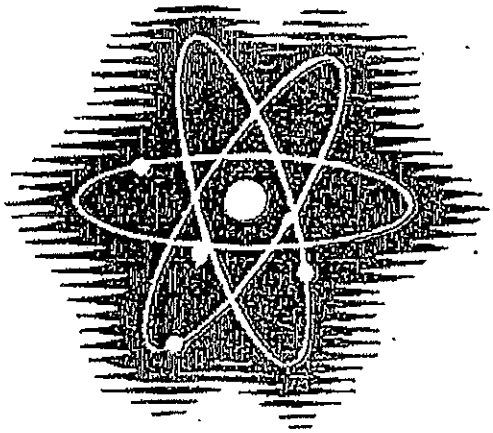
Nature's Chemistry

Homework





Fuels

1*. Petrol is an important **fuel**.
The **combustion** of petrol is an example of an **exothermic** reaction.
Explain what is meant by each of the terms underlined.

2*. Butane is a hydrocarbon; heat is produced when the gas burns.
(a) Explain what is meant by a hydrocarbon?
(b) What term is used to describe a reaction that produces heat?
(c) Which gas is used up when the gas burns?
(d) What are the **two** products when the gas burns in plenty of air?
(e) Explain why it is dangerous to burn the gas in a very poorly ventilated room.

3*. The burning of petrol can cause pollution of the air.
(a) Name the poisonous gas that is formed
(i) by the incomplete combustion of petrol,
(ii) from sulphur compounds when petrol is burned,
(iii) by the sparking of air in a car engine.
(b) Explain why air pollution is more of a problem in industrial areas.

4*. Powdered limestone (calcium carbonate) is used to remove sulphur dioxide from the gases given off in a coal fired power station.
Limestone is insoluble in water. A soluble carbonate would be more efficient.
(a) Why should sulphur dioxide be removed?
(b) Suggest why limestone is used rather than a soluble carbonate.

5*. Biomass is a renewable source of energy. As well as being used directly a a fuel, biomass material can be used to produce biofuels.

(a) Explain what is meant by
  (i) biomass,
  (ii) a renewable source of energy.

(b) Give **three** renewable sources of energy.

(c) Other than biomass, give an example of the use of biomass material a a fuel.

(d) Name a biofuel and state how it can be produced.

6*. Tree management in our forests is important. Organised felling of trees help to save our finite sources of energy.

(a) What is meant by a finite source of energy?

(b) Why can felling trees help to save our finite sources of energy?

7*. Carbon dioxide is one of the important greenhouse gases.

(a) What is meant by a greenhouse gas?

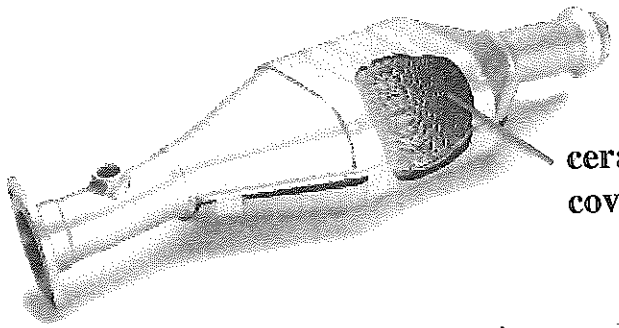
(b) Why are levels of carbon dioxide gas in the atmosphere significantly higher in the industrial areas of the world?

8*. Fires in coal mines can be caused by coal dust.

(a) Which element in air is needed for the coal dust to burn?

(b) In a limited supply of air, coal fires can produce a poisonous gas. Name this gas.

9*. Catalytic converters in cars can help to reduce carbon monoxide pollution. On the catalyst surface carbon monoxide reacts to form carbon dioxide.



(a) Why does burning petrol in a car engine produce carbon monoxide as well as carbon dioxide?

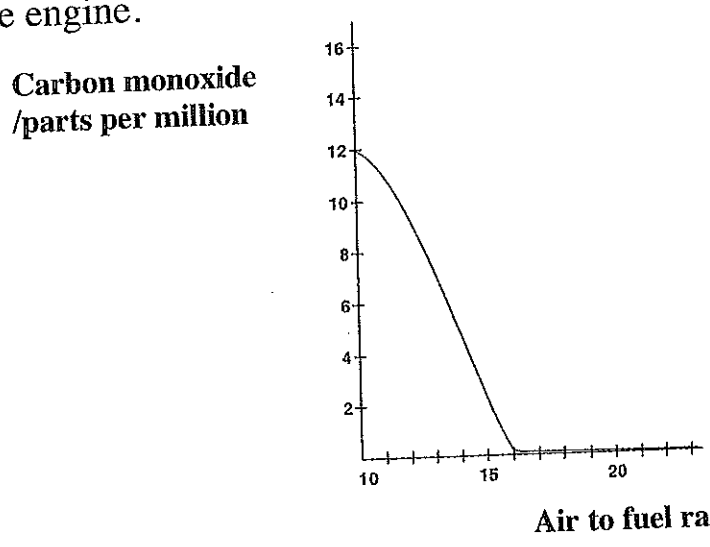
(b) Give another way by which carbon monoxide levels from a car engine can be reduced.

10*. Air pollution from the burning of petrol in a car engine can be reduced by using special exhaust systems and improving the efficiency of combustion.

(a) Describe how an exhaust system can be altered so that pollutant gases react to form harmless gases.

(b) Describe how to improve the efficiency of combustion.

11*. The following graph shows how the concentration of carbon monoxide in car exhaust fumes varies with the air to fuel ratio of the mixture that is burned in the engine.



Suggest why the carbon monoxide concentration approaches zero as the air to fuel ratio increases.

12*. Many important fuels are obtained from crude oil.

(a) Describe how crude oil is formed.

(b) Explain why crude oil can be described as a fossil fuel.

(c) Give **two** examples of pollution problems associated with oil.

13*. Crude oil is a mixture of chemical compounds. Before the compounds can be used, the crude oil must be separated into fractions, by fractional distillation.

(a) Name the kind of chemical compounds found in crude oil.

(b) Explain what is meant by

(i) fractional distillation,

(ii) a fraction.

(c) Give a use for each of the following fuels obtained from oil.

(i) petrol (ii) diesel (iii) gas

(iv) kerosene (v) bitumen

14*. (a) Explain what is meant by

(i) a flammable substance,

(ii) a viscous substance.

(b) Name the crude oil fraction that is

(i) most flammable,

(ii) most viscous.

15*. Consider the following fractions obtained from crude oil:

bitumen, diesel, gas, kerosene, petrol

(a) Name the fraction that contains molecules with carbon atoms in each of the following ranges.

(i) C1 to C4 (ii) C4 to C10 (iii) C9 to C16

(iv) C15 to C25 (v) more than C25

(b) (i) Which has the higher boiling point, petrol or diesel?

(ii) Explain your answer.

Structure of hydrocarbons

1. (a) Explain what is meant by a hydrocarbon.
   (b) In a hydrocarbon, state how many covalent bonds are formed by
      (i) carbon atoms,
      (ii) hydrogen atoms.
   (c) Which of the following carbon compounds are hydrocarbons?

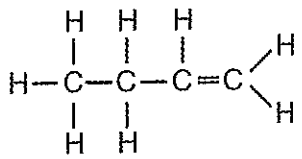
(i) heptane, C_7H_{16}	(ii) methylamine, CH_3NH_2
(iii) glucose, $C_6H_{12}O_6$	(iv) natural gas, CH_4
(v) octene, C_8H_{16}	(vi) carbon dioxide, CO_2
(vii) alcohol, C_2H_5OH	(viii) acetylene, C_2H_2

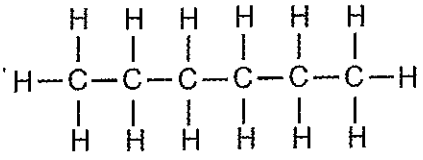
2. (a) Explain what is meant by
      (i) a saturated hydrocarbon,
      (ii) an unsaturated hydrocarbon.
   (b) Consider the following list of hydrocarbons:

   butane, ethene, cyclopropane, octane, methane, pentene, cyclohexene

   Name the hydrocarbons that are
      (i) saturated,
      (ii) unsaturated.

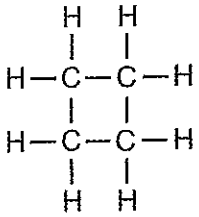
3. Name each of the following hydrocarbons.

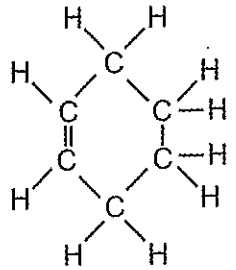
   (a) 

   (b) 

   (c) CH_3-CH_3

   (d) $CH_3-CH_2-CH_2-CH=CH_2$

   (e) 

   (f) 

4. For each of the following hydrocarbons
   (i) draw the **full** structural formula,
   (ii) draw a **shortened** structural formula.

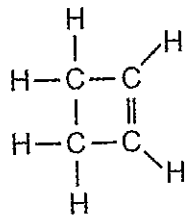
   (a) propene
   (b) methane
   (c) cyclopropane
   (d) butane
   (e) ethene
   (f) cyclooctene

5. State the molecular formula for each of the following hydrocarbons.
   (a) the saturated straight-chain hydrocarbon with 12 carbon atoms per molecule
   (b) the unsaturated straight-chain hydrocarbon with 10 carbon atoms per molecule
   (c) the saturated cyclic hydrocarbon with 7 carbon atoms per molecule
   (d) octane
   (e) hexene
   (f) cyclopentane

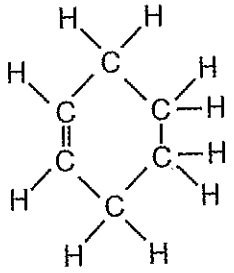
6. (a) Explain what is meant by a homologous series.
   (b) In each of the following lists of hydrocarbons identify the one that is in a different homologous series from the others.

(i)	ethane	butene	methane	octane
(ii)	C_3H_8	CH_4	C_7H_{14}	$C_{12}H_{26}$
(iii)	C_2H_4	C_6H_{12}	CH_4	C_4H_8

7. The full structural formulae below represent two members of a homologous series of compounds called the cycloalkenes.



cyclobutene

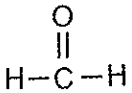


cyclohexene

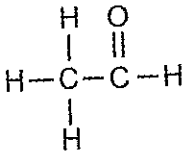
(a) Draw a full structural formula for the cycloalkene with five carbon atoms.

(b) What is the general formula for the cycloalkene series?

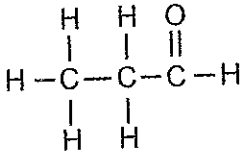
8. Methanal, ethanal and propanal are the first three members of a homologous series.



methanal



ethanal

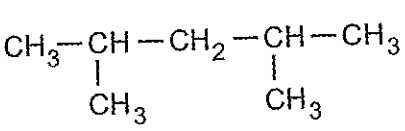


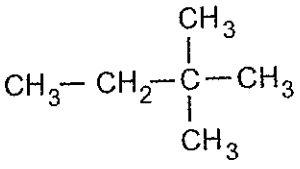
propanal

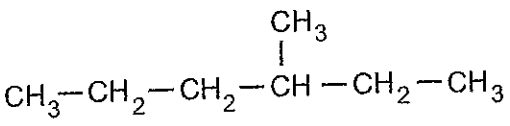
(a) Draw the full structural formula for butanal.

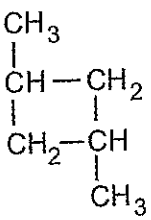
(b) Give the general formula for this homologous series.

9. Name each the following hydrocarbons.

(a) 

(b) 

(c) 

(d) 

10. Draw a structural formula for each of the following hydrocarbons.
    (a) 2,2-dimethylhexane
    (b) 2-ethylpentane
    (c) 2,3,5-trimethylhexane
    (d) 1,2-dimethylcyclopentane

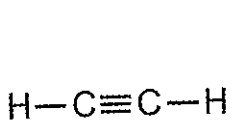
11. Name each of the following alkenes.
    (a) $CH_3-CH=CH-CH_2-CH_2-CH_3$

    (b) $CH_2=C(CH_3)-CH_2-CH_3$

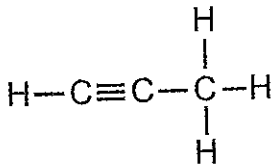
    (c) $CH_3-C(CH_3)=CH-CH_2-CH_3$

12. Draw a structural formula for each of the following hydrocarbons.
    (a) 2-methylbut-2-ene
    (b) 2,4-dimethylhex-3-ene
    (c) 3,5-dimethylcyclohexene

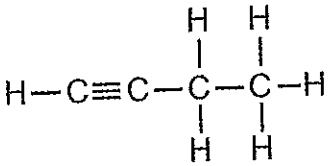
13. The alkynes are a homologous series of hydrocarbons that contain a carbon to carbon triple bond.



ethyne



propyne



but-1-yne

    (a) Draw the full structural formula for
        (i) pent-1-yne,
        (ii) pent-2-yne.
    (b) Give the general formula for this homologous series.

Reactions of hydrocarbons

1*. (a) Explain what is meant by cracking.

(b) (i) What is the purpose of the catalyst in catalytic cracking?

(ii) Name a catalyst that can be used in the lab.

2*. For each of the cracking reactions shown in the equations below, write the formula and give the name for the hydrocarbons **A** to **E**.

(a) $C_6H_{14} \rightarrow C_3H_6 + \mathbf{A}$

(b) $C_7H_{16} \rightarrow C_4H_{10} + \mathbf{B}$

(c) $C_{12}H_{26} \rightarrow C_6H_{12} + \mathbf{C}$

(d) $C_{10}H_{22} \rightarrow C_4H_{10} + C_2H_4 + \mathbf{D}$

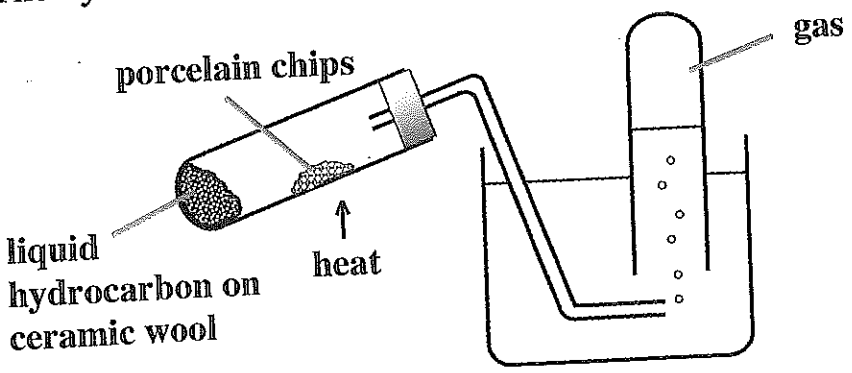
(e) $C_7H_{16} \rightarrow C_2H_6 + C_3H_8 + \mathbf{E}$

3*. A liquid hydrocarbon is used in two different experiments.

(a) In Experiment 1, the hydrocarbon has no immediate effect on bromine water.

What does this indicate?

(b) The hydrocarbon is used as shown in Experiment 2 below.



(i) The gas collected rapidly decolourises bromine water.

Why is this?

(ii) Name the chemical reaction occurring in the heated tube.

(iii) As soon as heating is stopped what precaution must be taken?

Explain why this is necessary.

4*. The cracking of paraffin can be carried out in the lab using strong heat. A mixture of saturated and unsaturated products is obtained.

(a) What effect would a suitable catalyst have on the level of heat needed to crack paraffin?

(b) Explain why cracking produces a mixture of saturated and unsaturated products.

5. Unsaturated hydrocarbons are present in white spirit.

Describe how you would test white spirit to show that it contains unsaturated hydrocarbons.

6. $C_2H_4 + Br_2 \rightarrow X$

(a) Draw the full structural formula for substance X.

(b) What name is given to this type of chemical reaction?

(c) Name the product of the reaction of C_2H_4 with hydrogen.

7. $C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$

(a) Is the hydrocarbon C_3H_6 saturated or unsaturated?

(b) Draw the full structural formula for the product of the reaction.

(c) Write the molecular formula for the product of the reaction of C_3H_6 with hydrogen.

8. Three different hydrocarbons were treated with bromine solution. Each of the hydrocarbons contained six carbon atoms. The results are shown.

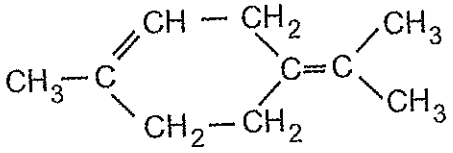
Formula	Hydrocarbon	Effect of bromine
C_6H_{12}	A	Decolourises quickly
C_6H_{14}	B	No immediate change
C_6H_{12}	C	No immediate change

Give the names and draw possible structures for A, B and C.

9. Write the molecular formula for the product of the complete reaction of each of the following hydrocarbons with bromine.

(a) buta-1,3-diene $CH_2=CH-CH=CH_2$

(b) terpinolene

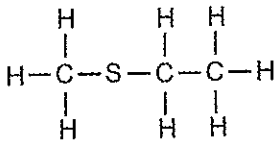


Isomers

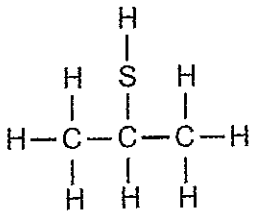
1. (a) Explain what is meant by isomers.
   (b) Illustrate your answer by drawing isomers of butane.

2. Draw the full structural formulae for each of the following.
   (a) **three** isomers of pentane
   (b) **five** isomers of C_4H_8.

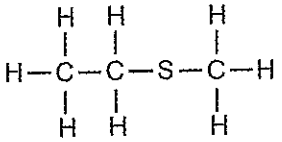
3. The full structural formula for three compounds are shown below.



A



B

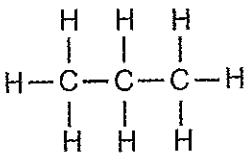


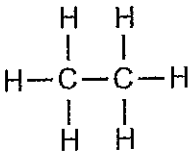
C

   (a) Why can compound **B** be described as an isomer of compound **A**?
   (b) Why is compound **C** **not** an isomer of compound **A**?

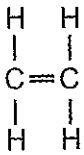
4. State whether or not each of the following pairs of molecules are isomers.

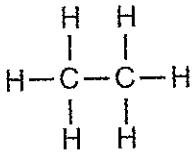
(a)



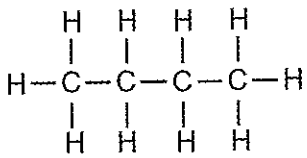


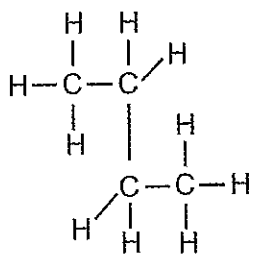
(b)



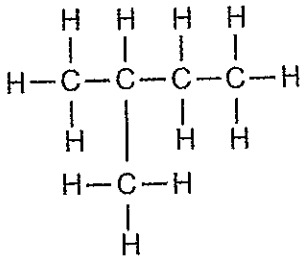


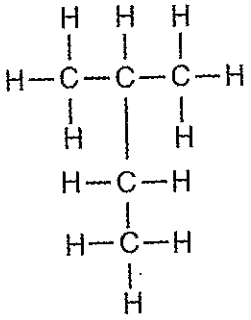
(c)



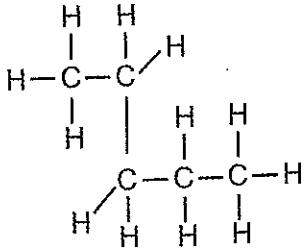


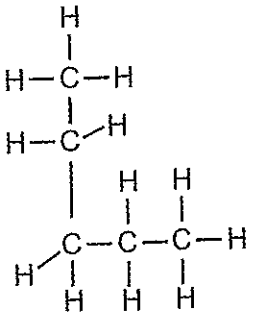
(d)



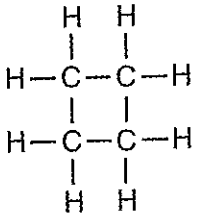


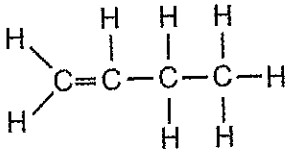
(e)



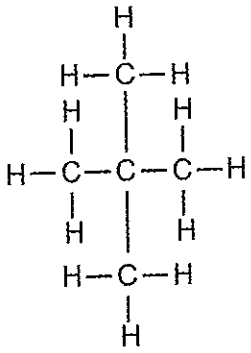


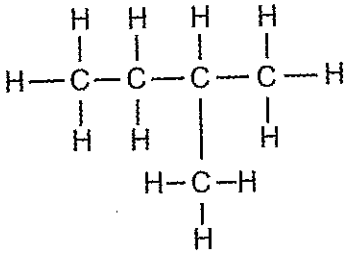
(f)



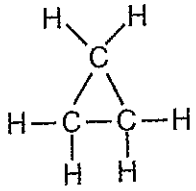


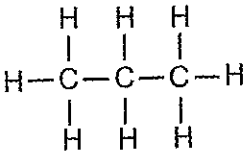
(g)



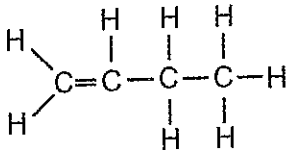


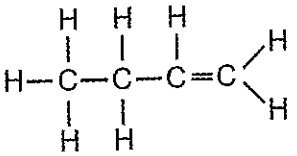
(h)



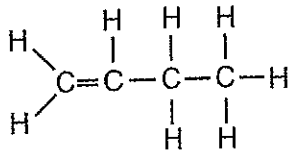


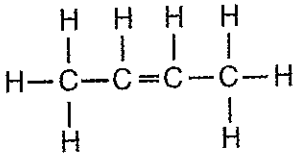
(i)





(j)



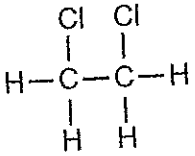


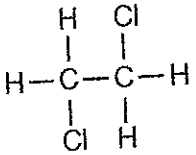
5. State whether or not each of the following pairs of hydrocarbons are isomers.

(a) 2-methylbutane	butane
(b) 2,3-dimethylhexane	octane
(c) 3-methylhexane	3-methylpentane
(d) 2-methylpent-1-ene	hex-2-ene
(e) pent-1-ene	methylcyclobutane

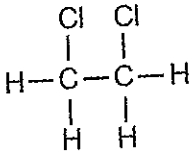
6. State whether or not each of the following pairs of molecules are isomers.

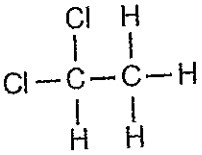
(a)



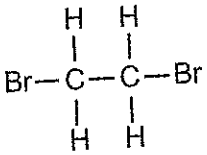


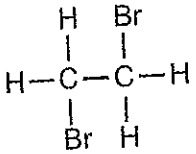
(b)



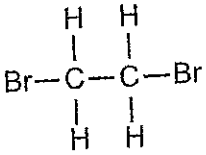


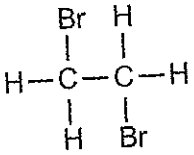
(c)



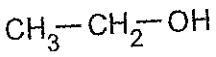


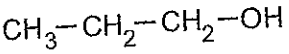
(d)



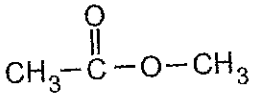


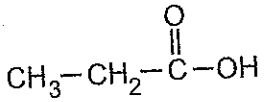
(e)



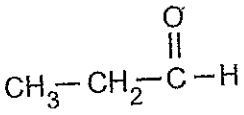


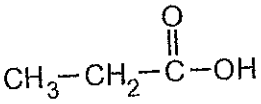
(f)





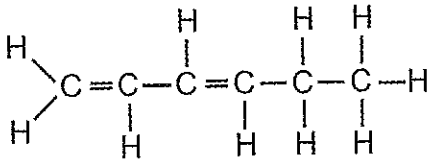
(g)





Hexa-1,3-diene is a hydrocarbon that contains two double bonds per molecule.

hexa-1,3-diene



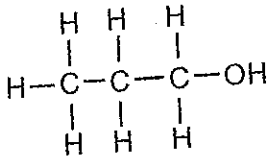
Draw the full structural formula for an isomer of hexa-1,3-diene that

(a) contains **two** double bonds per molecule,

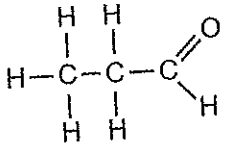
(b) contains **only** one double bond per molecule.

Patterns in carbon compounds

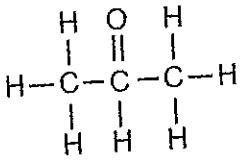
1. A student carried out three experiments with each of the following carbon compounds.



A



B



C

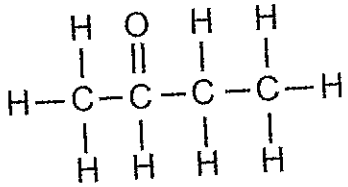
The results are shown.

Compound	Reaction with sodium	Effect on acidified potassium permanganate	Flammability
A	gas produced	goes colourless	flammable
B	no reaction	goes colourless	flammable
C	no reaction	none	flammable

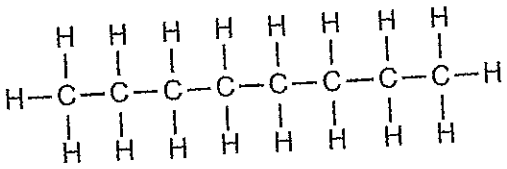
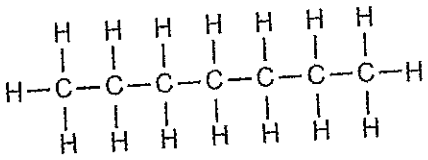
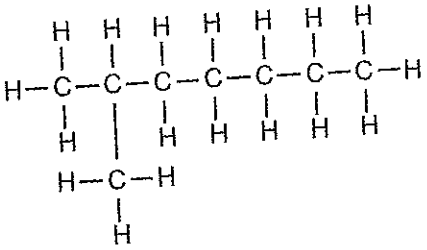
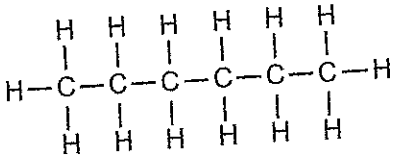
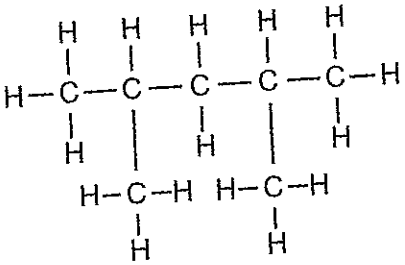
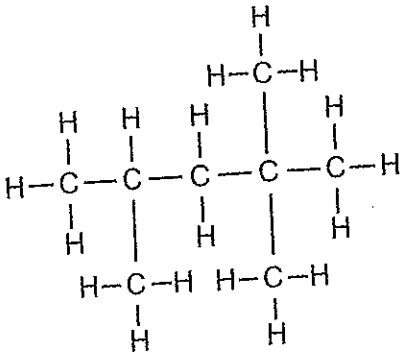
(a) From the results, what general statement can be made about all three compounds?

(b) From the results, describe how to distinguish
   (i) A from B,
   (ii) B from C.

(c) Predict what will happen when acidified potassium permanganate is added to the compound with the structure shown.



2. A way of grading types of petrol is to use 'octane numbers'.

Hydrocarbon	Octane number
	-10
	0
	23
	25
	83
	100

State **two** features of the molecular structure that give a high octane number.

3. The hydrocarbons present in a mixture can be separated by passing through a special column. Different hydrocarbons move through the column at different speeds.

The following graph was obtained for one mixture.

1 CH_3-CH_3

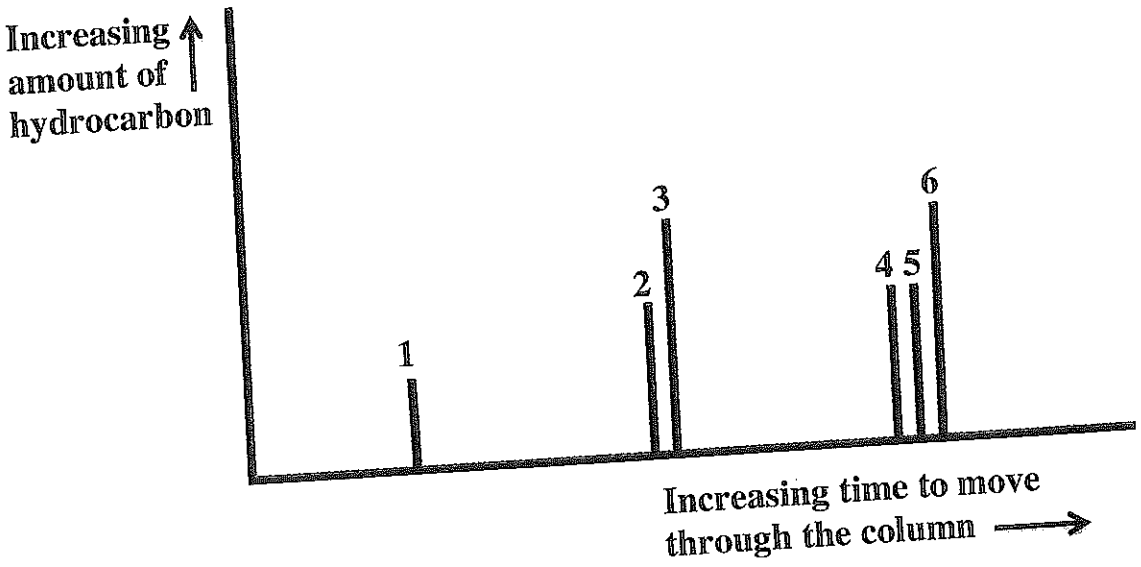
2 $CH_3-CH(CH_3)-CH_3$

3 $CH_3-CH_2-CH_2-CH_3$

4 $CH_3-C(CH_3)_2-CH_3$

5 $CH_3-CH_2-CH(CH_3)-CH_3$

6 $CH_3-CH_2-CH_2-CH_2-CH_3$

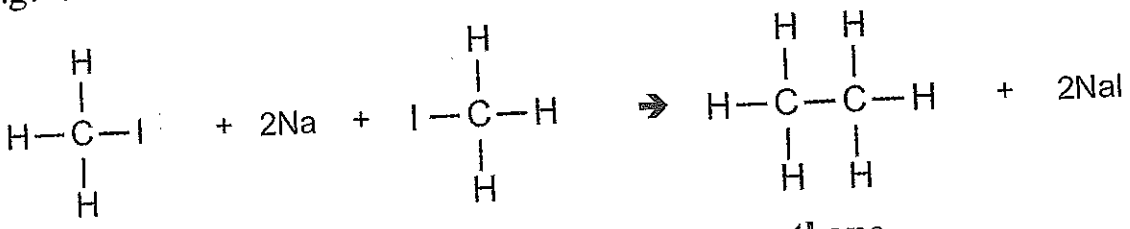


(a) Make two general statements linking the molecular structure of the hydrocarbon with the length of time taken to pass through the column.

(b) Copy the graph and show with an arrow, the expected position for propane.

4. Iodoalkanes are alkane molecules with a hydrogen atom replaced by an iodine atom. The reaction of iodoalkanes with sodium produces alkanes.

e.g. ethane can be made from iodomethane.



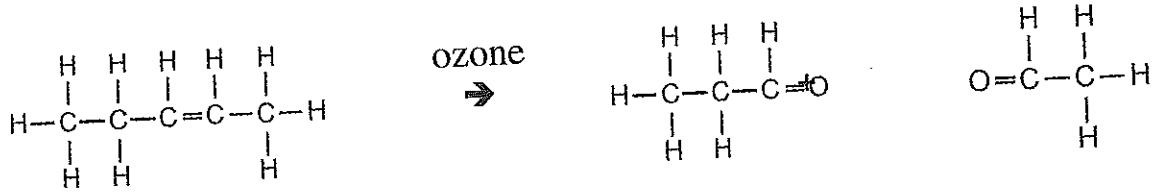
iodomethane **ethane**

(a) Name the alkane that forms when sodium reacts with iodoethane.

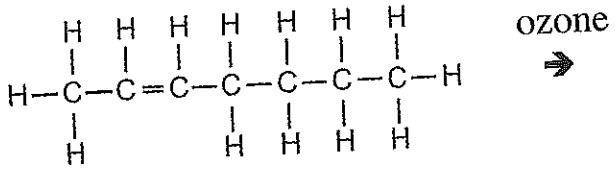
(b) Name the **two** iodoalkanes used to make propane.

(c) This type of reaction can also be used to make cycloalkanes.
Draw a structural formula for the compound that could be used to make cyclohexane.

5. The following reaction shows what happens when an alkene reacts with ozone.

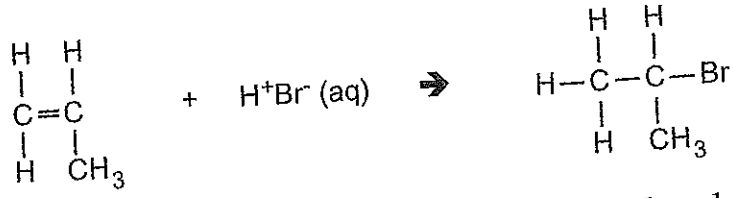


(a) Draw the full structural formulae for the products from the following reaction.

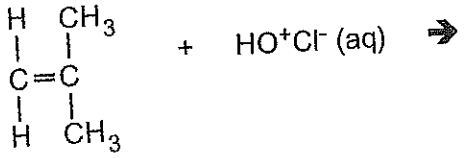


(b) Ozonolysis of alkenes can result in only **one** product.
Draw the full structural formula for an alkene that would react in this way.

6. Organic chemistry has a number of rules that can help to predict the products of a reaction.
The equation shows what happens when an ionic compound in solution is added to an alkene.



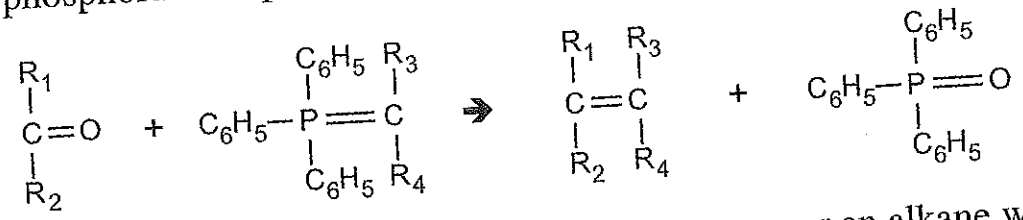
The positive ion adds on to the double-bonded carbon atom that has the greater number of hydrogen atoms bonded to it.

(a) 

Draw a structural formula for the product in the above reaction.

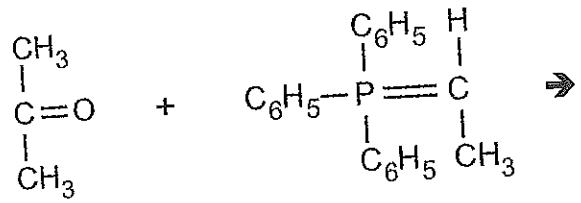
(b) Draw a structural formula for an isomer of butene that could **not** be used to demonstrate the above rule.

7. Alkenes can be made by the reaction of a carbon-oxygen compound with a phosphorus compound.



R is a shorthand way of writing a hydrogen atom or an alkane with one hydrogen atom removed,
e.g. –R could be –H, $-CH_3$, $-C_2H_5$, $-C_3H_7$, etc

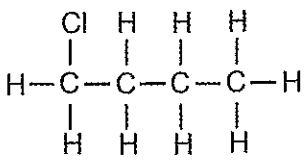
(a) Draw a structural formula for the alkene formed in the following reaction.



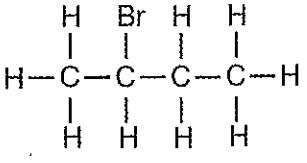
(b) Draw a structural formula for the carbon-oxygen compound that would be used to make ethene.

8. Haloalkanes are alkane molecules with a hydrogen atom replaced by a halogen atom.

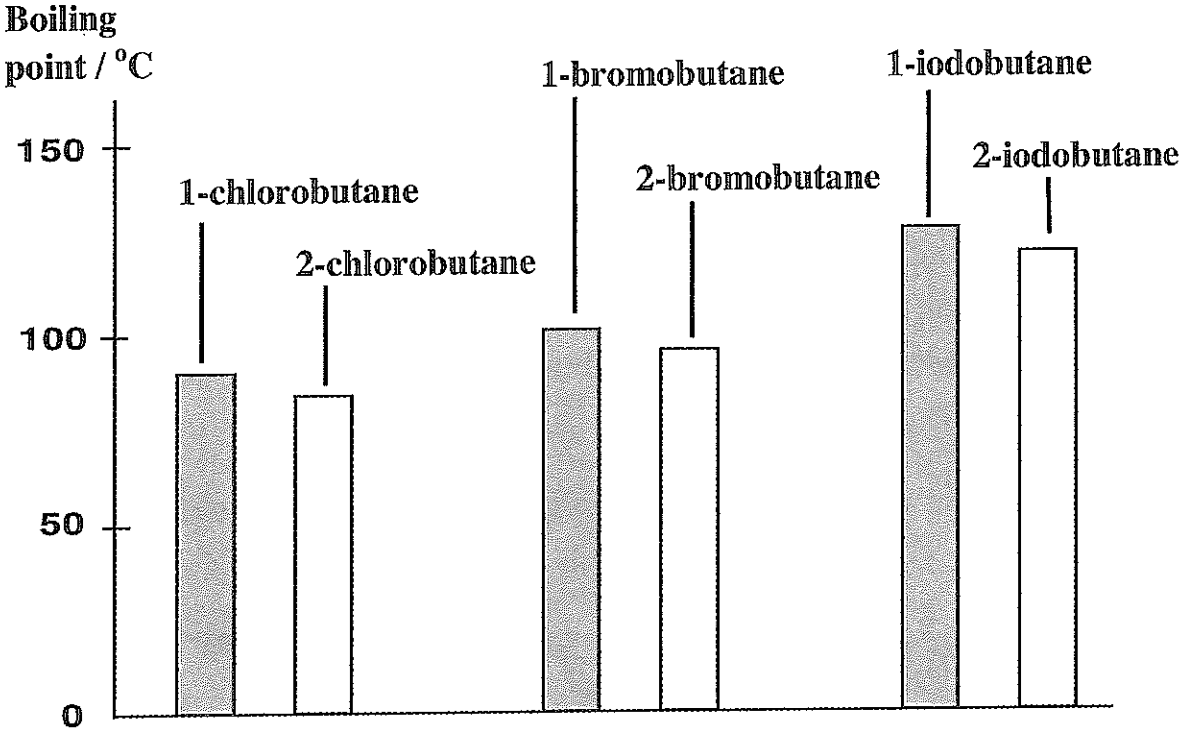
The name of the haloalkane depends on the position of the halogen atom in the molecule.



1-chlorobutane



2-bromobutane



(a) Describe the **two** trends shown by the information in the bar chart.

(b) Draw the full structural formula for

(i) 3-iodopentane,

(ii) 1-chloropropane.

Carbohydrates

1*. (a) Name **three** foodstuffs that contain a carbohydrate.
(b) Name the **three** elements that are present in carbohydrates.
(c) What kind of bonding is found in carbohydrates.

2*. Which of the following compounds are carbohydrates?
(a) glucose, $C_6H_{12}O_6$
(b) acetone, C_3H_6O
(c) carbon monoxide, CO
(d) hexane, C_6H_{12}
(e) sucrose, $C_{12}H_{22}O_{11}$
(f) water, H_2O
(g) alcohol, C_2H_5OH

3*. A spoonful of sugar is burned in air. It is then placed in a jar of oxygen.
(a) What difference will be observed in the burning?
(b) What are the products of the reaction?

4*. The diagram represents the process by which energy is produced in animals.

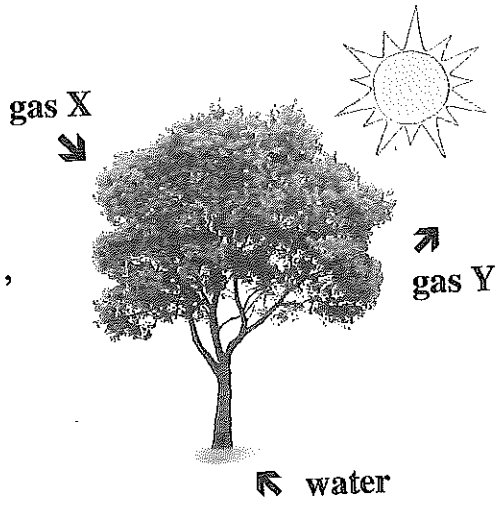
(a) Name the process.
(b) Name carbohydrate A.
(c) Name gases X and Y.
(d) Give **three** examples of how the energy produced can be used by animals.

5*. Plants make glucose by photosynthesis.

(a) Identify gases **X** and **Y**.

(b) To which family of compounds does glucose belong?

(c) Name the substance, stored in plants, that is made when glucose units join together.

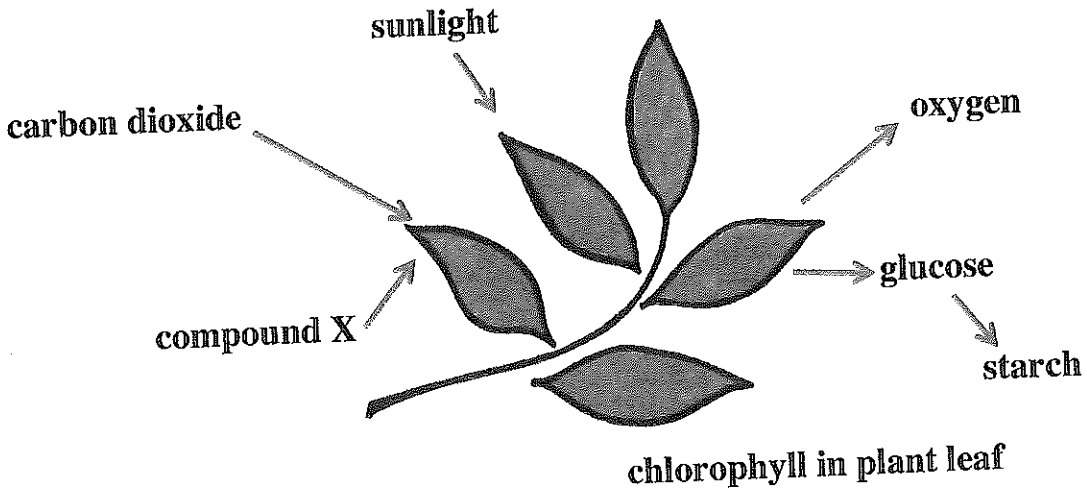


6*. Carbohydrates are energy-containing foods.

(a) Where does this energy come from?

(b) Write a word equation to show what happens when glucose combines with oxygen in our bodies.

7*. The flow diagram below shows an important process that occurs in green plants.



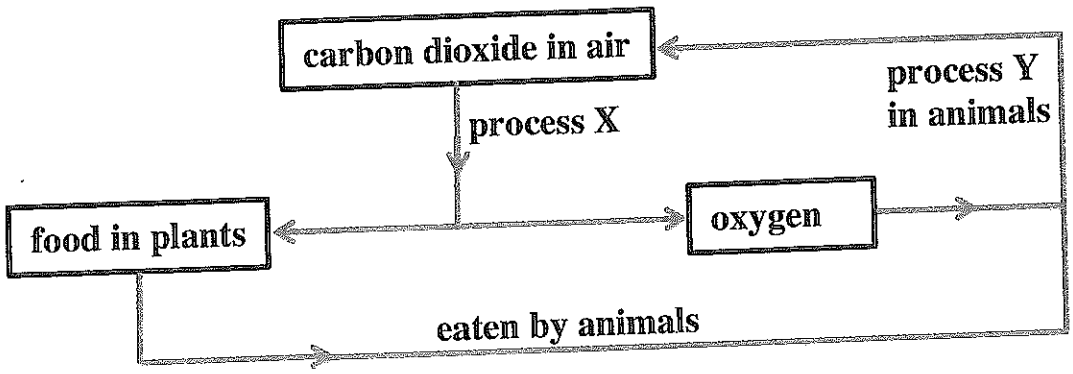
(a) Name the process.

(b) What is the purpose of the chlorophyll?

(c) Name compound **X**.

(d) What kind of reaction occurs in the change from glucose to starch?

8*. The flow chart shows part of the carbon cycle.



(a) Name processes **X** and **Y**.

(b) The amount of carbon dioxide entering the air has increased considerably in the last 50 years.
Suggest a reason for this increase.

(c) In recent years, many countries have cleared extensive areas of forest for the development of towns and industry.
Explain why this presents dangers to life on earth.

9*. The table shows the relationship between the temperature of sea water and the amount of dissolved oxygen.

Temperature of water /°C	0	20	40	60	70	80
Concentration of dissolved oxygen / grams in each cubic metre	69.4	43.4	30.8	22.7	18.6	13.8

(a) State the relationship between the solubility of oxygen in sea water and the temperature of the water.

(b) Suggest why Arctic seas support a lot more animal life than might be expected.

10*. Starch and glucose are both carbohydrates.

(a) What is the ratio of hydrogen to oxygen atoms in a carbohydrate?

(b) Why does glucose dissolve easily in water and yet starch does not?

(c) Explain what is seen when a beam of light is passed through
(i) glucose solution,
(ii) starch in water.

11*. Starch and glucose are both white solids.

(a) (i) What solution can be used to test for starch?

(ii) What is the colour change that takes place when the test is positive?

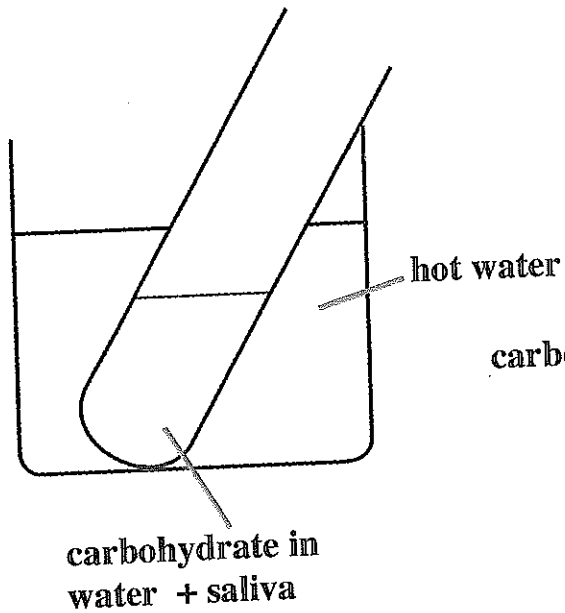
(b) (i) What solution can be used to test for glucose?

(ii) What is the colour change that takes place when the test is positive?

(iii) Why is a water bath used to heat the solution?

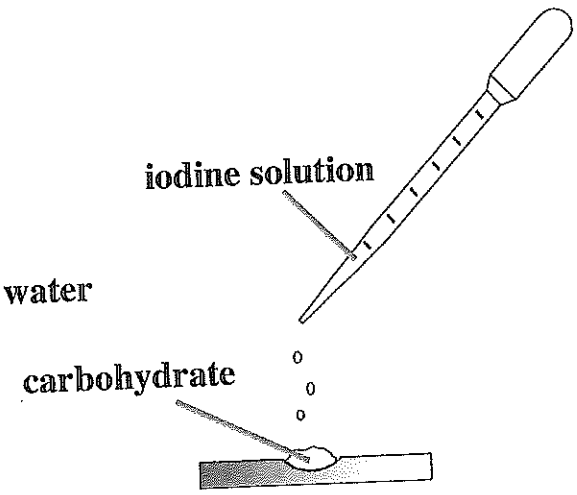
12*. A carbohydrate was tested as shown below.

Test 1



Result:
After the solution was neutralised, Benedict's solution gave an orange precipitate.

Test 2



Result:
Iodine solution turned blue/black.

(a) Name the carbohydrate used in Tests 1 and 2.

(b) Name the carbohydrate produced by the reaction in Test 1.

(c) What kind of substance, present in saliva, was responsible for the result in Test 1?

13*. Carbohydrates supply the body with energy.
Explain why eating a Mars bar (containing glucose) just before a race might be of more value to an athlete than eating bread (containing starch).

14*. (a) Give the approximate alcohol content (in units) of each of the following.

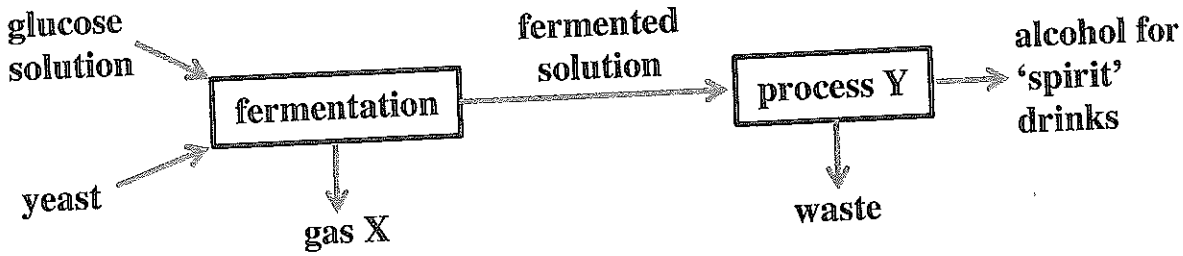
(i) pint of beer/lager
(ii) single measure of spirit
(iii) small glass of wine
(iv) bottle of alcopop
(v) large glass of wine

(b) Describe the effects of alcohol intake.

15*. Alcohol for drinks can be made from carbohydrates.

(a) Name this process.
(b) Name **three** sources of carbohydrates for the production of an alcoholic drink.
(c) Describe briefly how to obtain alcohol from carbohydrates.

16*. Two processes are involved in the manufacture of alcohol for 'spirit' drinks.



(a) Name gas X.
(b) What kind of substance, present in yeast, acts as a catalyst for the reaction?
(c) Name process Y.

'*. The production of alcohol from glucose is normally carried out at a temperature around 40 °C.

(a) (i) Would the reaction be speeded up by increasing the temperature?

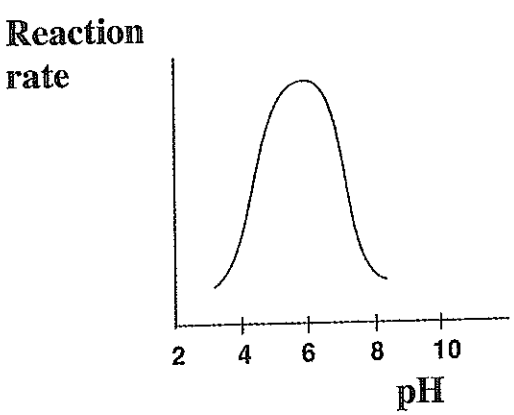
(ii) Explain your answer.

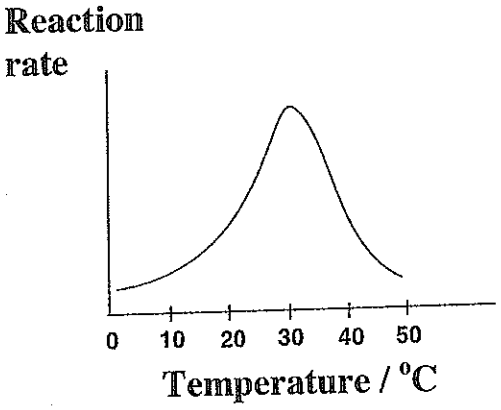
(b) Explain why there is a limit to the concentration of alcohol obtained in this reaction.

3*. Yeast is used in making bread, a food rich in carbohydrate. Alcohol is made from a source of carbohydrate; yeast contains an enzyme needed for this reaction.

Why does eating bread **not** lead to the body making alcohol?

)*. An enzyme is most efficient under optimum conditions. The effect of changing pH and temperature for one particular enzyme, A, is shown below.





(a) What is meant by the optimum conditions for an enzyme?

(b) For enzyme A, state

(i) the optimum pH,

(ii) the optimum temperature.

(c) Why do enzymes in the human body have an optimum temperature of about 37 °C?

Alcohols

1. Give the systematic name for each of the following alcohols.

(a) CH_3-CH_2-OH

(b) $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_3$

(c) $CH_3-CH_2-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle OH}{\underset{|}{C}}}}-CH_3$

(d) $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_3$

2. Draw a structural formula for each of the following alcohols.
   (a) butan-1-ol
   (b) hexan-3-ol
   (c) 3-methylpentan-1-ol
   (d) 3,3-dimethylbutan-2-ol

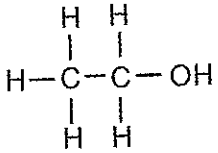
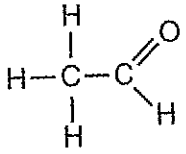
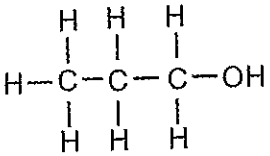
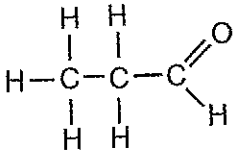
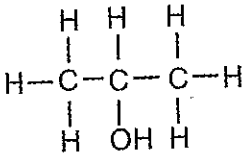
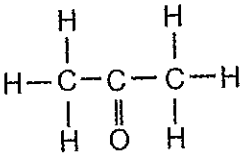
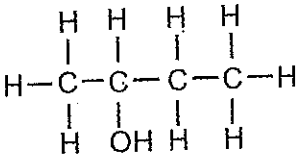
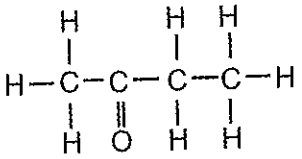
3. Two isomeric straight-chain alcohols, each having four carbon atoms, are known.
   (a) Draw a structural formula for each of these alcohols.
   (b) Draw a structural formula for each of the **two** isomeric branched-chain alcohols.

4. Ethane-1,2-diol is a dihydric alcohol used as anti-freeze for car cooling systems.

ethane-1,2-diol $\quad \underset{\displaystyle OH}{\underset{|}{CH_2}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$

   (a) Suggest what is meant by a dihydric alcohol.
   (b) Draw the full structural formula for propane-1,2,3-triol.
   (c) Give another **two** uses for alcohols other than for alcoholic drinks.

5. Alcohols can be oxidised by hot copper(II) oxide.
The product is either an aldehyde or a ketone.

Alcohol	Structural formula	Type of product	Structural formula
ethanol		aldehyde	
propan-1-ol		aldehyde	
propan-2-ol		ketone	
butan-2-ol		ketone	

(a) Write a general statement linking the type of product to the structure of the alcohol used.

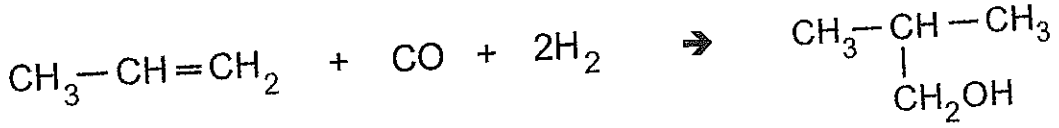
(b) Draw the full structural formula for the carbon compound formed by the oxidation of

(i) methanol,

(ii) pentan-1-ol,

(iii) hexan-3-ol.

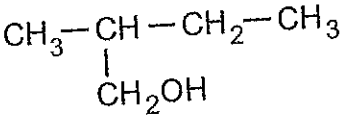
6. The product of the reaction between an alkene and a mixture of carbon monoxide and hydrogen is an alcohol.



propene

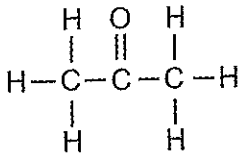
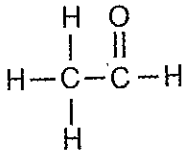
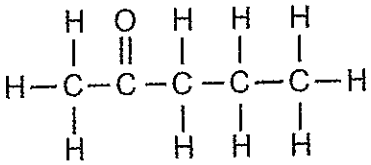
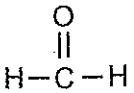
(a) Name the alcohol formed in the above reaction.

(b) Draw a structural formula for the alkene that would give the following alcohol.



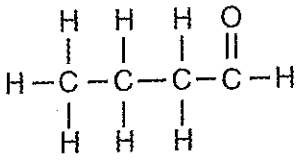
(b) Name the alcohol that would be obtained from ethene.

7. A class carried out a test with a number of carbon compounds.
The results are shown in the table.

Molecule	Structure	Name	Result of test
A		propanone	no reaction
B		ethanal	orange precipitate forms
C		pentanone	no reaction
D		methanal	orange precipitate forms

(a) Write a general statement linking the result of the test to the structure of the carbon compound.

(b) State whether or not an orange precipitate will form with the following molecule.



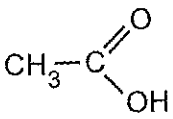
(c) Draw the full structural formula for

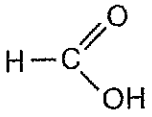
(i) butanone,

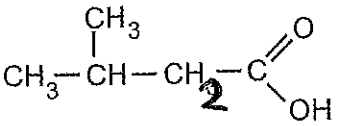
(ii) propanal.

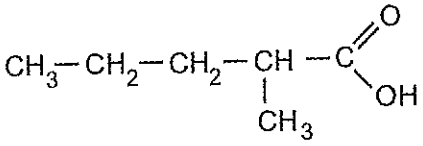
Carboxylic acids

1. Give the systematic name for each of the following carboxylic acids.

(a) 

(b) 

(c) 

(d) 

2. Draw a shortened structural formula for each of the following carboxylic acids.
   (a) propanoic acid
   (b) 3-methylpentanoic acid
   (c) 2-methylhexanoic acid

3. (a) Draw a structural formula for butanoic acid.
   (b) Draw a structural formula for an acid that is an isomer of butanoic acid.

4. Vinegar is a solution of a carboxylic acid in water.
   (a) Name the carboxylic acid used to make vinegar.
   (b) Give a use for vinegar
      (i) in the food industry,
      (ii) as a household cleaning product.

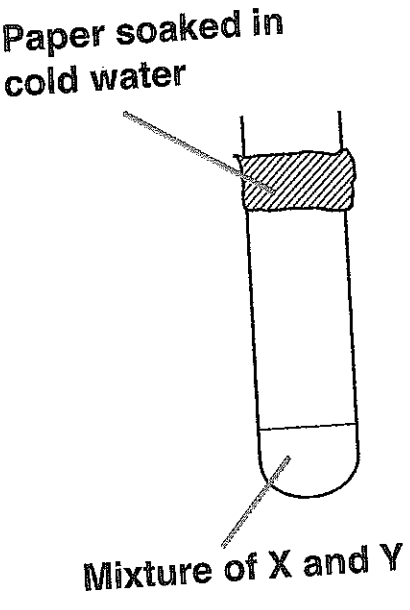
Esters

1. Esters are useful compounds. They can be made in the lab.
   (a) (i) Name the catalyst used in the lab preparation of an ester.
   (ii) Why is a Bunsen flame **not** used to heat the reactants?
   (iii) How can the ester be separated from the unreacted alcohol and carboxylic acid?
   (b) Give a use for esters that is related
   (i) to their smell,
   (ii) to their solvent properties.

2. Esters can be made in the lab as described in the workcard shown below

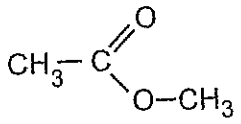
PREPARATION OF AN ESTER.

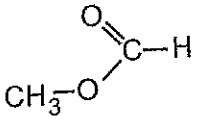
1. Mix 1 cm^3 of **X** with 1 cm^3 of **Y** in a test tube.
2. Wrap a piece of paper soaked in cold water around the test tube and hold in place as shown in the diagram.
3.
4.

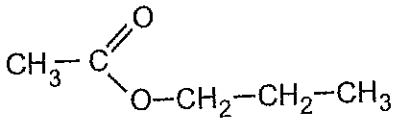


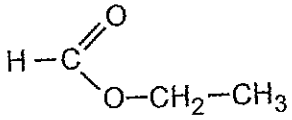
   (a) Describe the distinctive smell of an ester.
   (b) (i) Name the types of carbon compounds, **X** and **Y**, used to make an ester.
   (ii) Give appropriate instructions for Steps 3 and 4 to complete the workcard.
   (iii) What is the purpose of the paper soaked in cold water?

3. Name each of the following esters.

(a) 

(b) 

(c) 

(d) 

4. Draw a structural formula for each of the following esters.

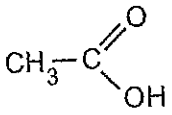
(a) ethyl butanoate

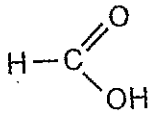
(b) propyl propanoate

5. For each of the following combinations, name the ester that is formed and draw a structural formula.

(a) ethanol / methanoic acid

(b) methanol / propanoic acid

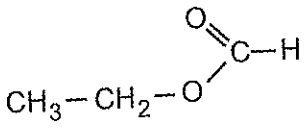
(c) CH_3-CH_2-OH / 

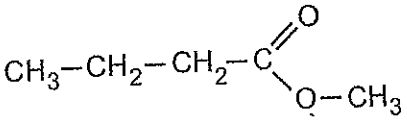
(d) $CH_3-CH_2-CH_2-OH$ / 

6 For the breakdown of each of the following esters, name the products and draw their structural formulae.

(a) ethyl propanoate

(b) methyl ethanoate

(c) 

(d) 

7. (a) Draw structural formulae for the two esters that are isomers of propanoic acid.

(b) Name each of the esters.

Energy from fuels

1. (a) Explain what is meant by
   (i) an exothermic reaction,
   (ii) an endothermic reaction.
   (b) Give an example of each.

2. Copy and complete the following:
   During an exothermic reaction, energy is required to ----- bonds in the ----- molecules. Energy is then ----- as the bonds are formed in the product molecules. In this type of reaction, more energy is released in the bond–----- step than is required in the bond- ----- step.

3. The energy released from the burning of different alcohols can be compared by calculating the energy released from the burning of one mole of each.

Alcohol	Structural formula	Heat released / kJ mol^{-1}
methanol	CH_3OH	727
ethanol	CH_3CH_2OH	1367
propan-1-ol	$CH_3CH_2CH_2OH$	2020

   (a) Make a general statement linking the heat released and the number of carbon atoms in the alcohol molecule.
   (b) Suggest why there is a fairly constant difference between the heat released per mole for any two successive members of the alcohol series.
   (c) Predict the heat released in the burning of one mole of butan-1-ol.
   (d) When calculating the heat energy released in the burning of a fuel in the lab, why is the experimental value less than the actual value?

4. For each of the following, calculate the heat energy released by the burning of the fuel.

   (a) The temperature of 50 cm^3 of water is increased by 15 °C.

   (b) The temperature of 100 cm^3 of water is increased by 23.6 °C.

   (c) The temperature of 150 cm^3 of water is increased from 20.9 °C to 39.1 °C

   (d) The temperature of 700 cm^3 of water is increased from 16.3 °C to 23.1 °C

Calculations based on equations

1. $Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$

Calculate the mass of magnesium chloride produced in the reaction of 4.9 g of magnesium with excess chlorine.

2. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Calculate the mass of carbon dioxide produced in the reaction of 3.2 g of methane (CH_4) with excess oxygen.

3. $4Na(s) + 2O_2(g) \rightarrow 2Na_2O(s)$

Calculate the mass of sodium oxide produced in the reaction of 2.3 g of sodium with excess oxygen.

4. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Calculate the mass of hydrogen required to react with 56 g of nitrogen.

5. $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

Calculate the mass of oxygen required to react with 2.7 g of aluminium.

6. $Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

Calculate the mass of copper produced in the reaction of 9.8 g of magnesium with excess copper(II) sulphate.

7. As a result of recycling, an industrial plant converts 7.7×10^4 kg of hydrogen to ammonia (NH_3) each day.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Calculate the mass of ammonia that is produced each day.

8. Ammonium sulphate is a fertiliser. The compound can be produced by the reaction of ammonia (NH_3) with sulphuric acid (H_2SO_4).

$$2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(s)$$

Calculate the mass of ammonium sulphate that could be produced from 170 kg of ammonia.

9. Ammonia (NH_3) can be formed by adding water to magnesium nitride.

$$Mg_3N_2(s) + 6H_2O(1) \rightarrow 3Mg(OH)_2(s) + 2NH_3(g)$$

Calculate the mass of ammonia produced when 20.3 g of magnesium nitride are added to excess water.

10. A power station produces sulphur dioxide, an atmospheric pollutant. The sulphur dioxide can be removed by reaction with limestone (calcium carbonate).

$$CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$$

Calculate the mass of calcium carbonate required to remove completely 320 tonnes of sulphur dioxide.

11. The monomer for polythene can be produced from ethanol.

$$\underset{\text{ethanol}}{C_2H_5OH} \rightarrow \underset{\text{ethene}}{C_2H_4} + \underset{\text{water}}{H_2O}$$

Calculate the maximum mass of ethene that can be produced from 6900 kg of ethanol.

12. Nitrogen is used to fill the air-bags which protect people in car crashes. It is produced when sodium azide (NaN_3) decomposes rapidly.

$$2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$$

A driver's air-bag contains 60 g of sodium azide.

Calculate the mass of nitrogen gas that would be produced.