Q1. Pentane is a member of the alkane homologous series.

(a) Give the general formula for the homologous series of alkanes.

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(1)

(b) One of the structural isomers of pentane is 2,2-dimethylpropane.

Draw the displayed formula of 2,2-dimethylpropane.

State the type of structural isomerism shown.

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(2)

(c) A molecule of hydrocarbon **Y** can be thermally cracked to form one molecule of pentane and two molecules of ethene only.

Deduce the molecular formula of **Y**.

State why high temperatures are necessary for cracking reactions to occur.

Give **one** reason why thermal cracking reactions are carried out in industry.

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(Extra space) .....

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(3)

(d) Write an equation for the incomplete combustion of pentane to form a solid pollutant.

Suggest why this solid pollutant is an environmental problem.

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(Extra space) .....

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(2)

(e) Pentane can react with chlorine as shown in the following equation.

$$C_5H_{12} + Cl_2 \rightarrow C_5H_{11}Cl + HCl$$

Calculate the percentage atom economy for the formation of $C_5H_{11}Cl$

Deduce how many straight-chain isomers of $C_5H_{11}Cl$ could be formed.

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(Extra space).....

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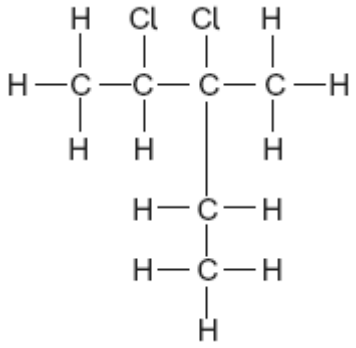
(3)

(f) Consider the following compound.



Name this compound.

Deduce the empirical formula of this compound.

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(2)
(Total 13 marks)

Q2. Alkanes are saturated hydrocarbons which can be obtained from crude oil. Pentane is an example of an alkane. A molecule of pentane contains five carbon atoms.

(a) (i) State the meaning of the term *saturated* and of the term *hydrocarbon* as applied to alkanes.

Saturated .....

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Hydrocarbon .....

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(2)

(ii) Give the general formula for the alkanes.

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(1)

(b) Pentane burns completely in oxygen.

(i) Write an equation for this reaction.

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(1)

(ii) State how the products of this reaction may affect the environment.

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(1)

(c) Give the name of a solid pollutant which may form when pentane burns incompletely in air.

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(1)

(d) One molecule of C_9H_{20} can be cracked to form one molecule of pentane and one other product.

(i) Write an equation for this cracking reaction.

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(1)

(ii) Suggest a type of compound that can be manufactured from the other product of this cracking reaction.

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(1)

(iii) State why a high temperature is needed for cracking reactions to occur.

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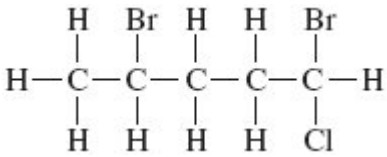
(1)

(e) Pentane can react to form the following haloalkane **Q**.



(i) Name **Q**.

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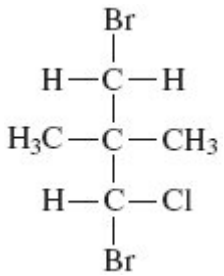
(1)

(ii) State the type of structural isomerism shown by **Q** and the haloalkane shown below.



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(1)
(Total 11 marks)

Q3. Petrol contains saturated hydrocarbons. Some of the molecules in petrol have the molecular formula C_8H_{18} and are referred to as octanes. These octanes can be obtained

from crude oil by fractional distillation and by cracking suitable heavier fractions.

Petrol burns completely in a plentiful supply of air but can undergo incomplete combustion in a car engine.

(a) State the meaning of both the words *saturated* and *hydrocarbon* as applied to the term *saturated hydrocarbon*.

Name the homologous series to which C_8H_{18} belongs.

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(3)

(b) Outline the essential features of the fractional distillation of crude oil that enable the crude oil to be separated into fractions.

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(4)

(c) C_8H_{18} is obtained by the catalytic cracking of suitable heavy fractions.
State what is meant by the term *cracking* and name the catalyst used in catalytic cracking.

Write an equation to show how one molecule of $C_{14}H_{30}$ is cracked to form one molecule of C_8H_{18} and one molecule of another hydrocarbon.

Explain why oil companies need to crack 'suitable heavy fractions'.

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(4)

(d) Write an equation for the incomplete combustion of C_8H_{18} to form carbon monoxide and water only.

A catalytic converter is used to remove carbon monoxide from the exhaust gases in a car. Identify a catalyst used in the catalytic converter.

Write an equation to show how carbon monoxide is removed in a catalytic converter.

State why the water produced in the exhaust gases may contribute to global warming.

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(4)

(e) When some petrol was accidentally contaminated in 2007, the sensors in the affected cars caused a decrease in the supply of petrol to the engine.

Suggest the effect that the contaminated fuel would have on the performance of the cars.

State how the oil company might have recognised the problem before the petrol was sold.

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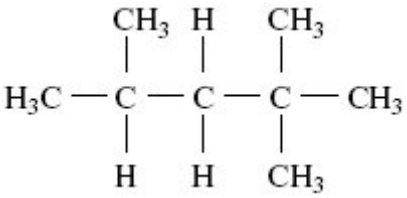
(2)

(f) The molecular formula C_8H_{18} represents several structural isomers.

State what is meant by the term *structural isomers*.

Name the following structural isomer of C_8H_{18}



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(3)
(Total 20 marks)

Q4. (a) (i) Name the process used to separate petroleum into fractions.

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(ii) Give the molecular formula for an alkane with nine carbon atoms.

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(iii) Write an equation for the complete combustion of the alkane $C_{11}H_{24}$

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(iv) Write an equation for the incomplete combustion of $C_{11}H_{24}$ to produce carbon and water only.

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(4)

(b) Alkenes can be produced by cracking the naphtha fraction obtained from petroleum.

(i) Write an equation for the thermal cracking of one molecule of $C_{10}H_{22}$ to give one molecule of propene and one molecule of an alkane only.

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(ii) Draw the structure of the chain isomer of but-1-ene.

(2)

(c) The alkanes and the alkenes are examples of homologous series of compounds. One feature of an homologous series is the gradual change in physical properties as the relative molecular mass increases. State **two** other general features of an homologous series of compounds.

Feature 1 .....

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Feature 2 .....

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(2)
(Total 8 marks)