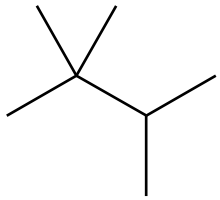
1 This question is about different alkanes present in crude oil.

(a) Compound **A**, shown below, is one of the structural isomers of C_7H_{16}.



Compound A

(i) What is meant by the term *structural isomers*?

.....

.....

..... **[1]**

(ii) Name compound **A**.

..... **[1]**

(b) The structural isomers of C_5H_{12} have different boiling points.

Draw the **skeletal formula** of the structural isomer of C_5H_{12} with the highest boiling point.

[1]

(c) A molecule of an alkane has 24 carbon atoms.

State the empirical formulae of this alkane.

.....

[1]

(d) Alkanes are used as fuels.

(i) Construct an equation for the complete combustion of octane C_8H_{18}.

..... **[1]**

(ii) Combustion of 36.48 g of octane produced 2.50 mol of carbon dioxide.

Show that this combustion was incomplete.

[2]

(e) Alkanes in crude oil can be used to manufacture ethene. Two stages are required.

(i) Name the **two** stages.

.....

..... **[1]**

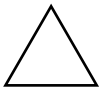
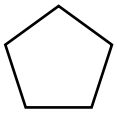
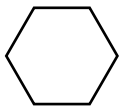
(ii) Write an equation for the preparation of ethene from an alkane.

..... **[1]**

[Total: 9]

2 This question is about cyclic organic compounds.

The table shows some information about cycloalkanes.

Cycloalkane	Skeletal formula	Boiling point / °C
Cyclopropane		–33
Cyclopentane		49
Cyclohexane		81

(a) These cycloalkanes are members of the same homologous series and have the same general formula.

(i) What is meant by the term *homologous series*?

.....

.....

.....

..... **[2]**

(ii) State the general formula for these cycloalkanes.

..... **[1]**

(iii) Explain the increase in boiling points of the cycloalkanes shown in the table.

.....

.....

.....

.....

..... **[2]**

(b) The C–C–C bond angles in **cyclohexane** are 109.5°.

State and explain the shape around each carbon atom in cyclohexane.

shape .....

explanation .....

.....

[2]

(c) In the absence of ultraviolet radiation, **cyclopropane** undergoes an addition reaction with bromine.

Suggest the structure of the organic product formed in this reaction.

[1]

(d) Petrol contains both **cyclohexane**, C_6H_{12}, and hexane.

Cyclohexane can be prepared from hexane.

(i) Construct the equation for this reaction.

..... **[1]**

(ii) Suggest **one** advantage of adding cyclohexane to hexane in petrol.

.....

..... **[1]**

(e) **Cyclobutane** is another cycloalkane.

There are several **unsaturated** isomers of cyclobutane that are alkenes.

Two of these isomers are stereoisomers.

(i) Explain what is meant by the term *stereoisomers*.

.....

..... **[1]**

(ii) Draw these **two** stereoisomers.

[2]

(f) In the presence of ultraviolet radiation, **cyclohexane** reacts with bromine.

A mixture of cyclic organic compounds is formed, including $C_6H_{11}Br$.

(i) Complete the table below to show the mechanism of the reaction between bromine and cyclohexane to form $C_6H_{11}Br$.

Include all possible termination steps in your answer.

Step	Equation
Initiation	.....
Propagation	....
Termination	....

[5]

(ii) The initiation step involves homolytic fission.

Explain why the initiation step is an example of *homolytic fission*.

.....

.....

..... **[1]**

(g) The reaction between cyclohexane and bromine in **(f)** also forms $C_6H_{10}Br_2$.

(i) Write an equation, using molecular formulae, for the reaction of cyclohexane and bromine in the presence of ultraviolet radiation to form $C_6H_{10}Br_2$.

..... **[1]**

(ii) Name **one** of the structural isomers of $C_6H_{10}Br_2$ formed in the reaction between cyclohexane and bromine.

..... **[1]**

[Total: 21]

9 Crude oil is processed by the petroleum industry to make fuels and petrochemicals.

(a) The straight-chain alkane, **A**, is present in crude oil.
A has molecules with ten carbon atoms.

(i) What is the molecular formula of **A**?

..... **[1]**

(ii) **B** is a branched-chain isomer of **A**.

Draw the skeletal formula of a possible structure for **B**.

Name your structure.

name ..... **[2]**

(iii) The branched-chain isomer **B** has a lower boiling point than the straight chain alkane **A**.

Explain why.

.....

.....

.....

..... **[2]**

(b) A chemist heats a pure sample of $C_{15}H_{32}$ in the presence of a catalyst.

A reaction called cracking happens.

(i) Construct an equation to show the cracking of $C_{15}H_{32}$.

..... **[1]**

(ii) When cracking takes place, a large number of products are formed.

Suggest why a large number of products are formed.

.....

.....

..... **[1]**

(c) The petroleum industry processes straight-chain alkanes into cyclic hydrocarbons.

For example, octane can be processed into a cyclic hydrocarbon and hydrogen.

(i) Suggest the structure of this cyclic hydrocarbon.

[1]

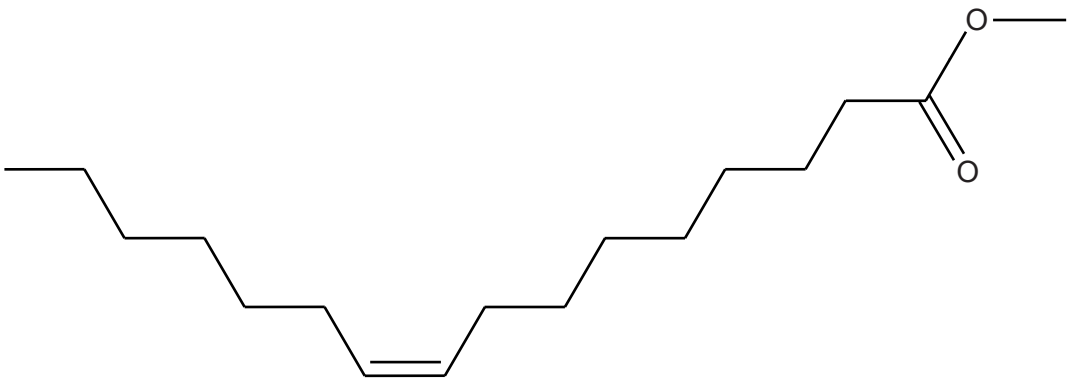
(ii) Why does the petroleum industry process straight-chain alkanes into cyclic hydrocarbons?

.....

..... **[1]**

[Total: 9]

4 Compound **I** is found in biodiesel. It has the skeletal formula shown below.



(a) Name the **two** functional groups that are present in a molecule of **I**.

.....

..... **[2]**

(b) Why is compound **I** unsaturated?

.....

..... **[1]**

(c) A sample of compound **I** is shaken with aqueous bromine.

What colour change would you see?

from ..... to ..... **[1]**

(d) Compound **J** is a stereoisomer of compound **I**.

(i) What is meant by the term *stereoisomers*?

.....

.....

..... **[1]**

(ii) Draw or describe how the structure of **J** differs from that of **I**.

.....

.....

..... **[1]**

(e) A student determined the enthalpy change of combustion for compound **I**.

In her experiment, 1.34 g of compound **I** was used to heat 50.0 g of water.

The temperature of the water changed from 20.2 °C to 54.0 °C.

(i) What is meant by the term *enthalpy change of combustion*, ΔH_c?

.....

.....

..... **[2]**

(ii) Calculate the energy released, in kJ, in the student's experiment.

The specific heat capacity of water is 4.18 J g^{-1} K^{-1}.

energy = ... kJ **[2]**

(iii) The molecular formula of compound **I** is $C_{17}H_{32}O_2$.

Calculate the amount, in moles, of compound **I** used by the student.

amount = ... mol **[2]**

(iv) Calculate the enthalpy change of combustion of compound **I**.

ΔH_c = ... kJ mol^{-1} **[3]**

(v) The student noticed that compound **I** burnt with a yellow flame and produced black smoke.

Suggest an explanation for these observations.

.....

.....

..... **[1]**

(f) Some scientists believe that we should use more biofuels such as biodiesel and bioethanol.

Bioethanol is made by the fermentation of plant sugars such as glucose.

Write the equation for the fermentation of glucose to make ethanol and state **two** essential conditions for this fermentation.

equation

.....

essential conditions

.....

..... **[3]**

[Total: 19]