Q1.(a)   The hydrocarbon but-1-ene (C_4H_8) is a member of the homologous series of alkenes. But-1-ene has structural isomers.

(i)   State the meaning of the term *structural isomers*.

....

....

....

....

(2)

(ii)   Give the IUPAC name of the **position** isomer of but-1-ene.

....

(1)

(iii)   Give the IUPAC name of the **chain** isomer of but-1-ene.

....

(1)

(iv)   Draw the displayed formula of a **functional group** isomer of but-1-ene.

(1)

(b)   But-1-ene burns in a limited supply of air to produce a solid and water only.

(i)   Write an equation for this reaction.

....

(1)

(ii)   State **one** hazard associated with the solid product in part (b)(i).

....

(1)

(c)   One mole of compound **Y** is cracked to produce two moles of ethene, one mole of but-1-ene and one mole of octane (C_8H_{18}) only.

    (i)   Deduce the molecular formula of **Y**.

      ....

(1)

    (ii)   Other than cracking, give **one** common use of **Y**.

      ....

(1)

(d)   In cars fitted with catalytic converters, unburned octane reacts with nitrogen monoxide to form carbon dioxide, water and nitrogen only.

    (i)   Write an equation for this reaction.

      ....

(1)

    (ii)   Identify a catalyst used in a catalytic converter.

      ....

(1)
(Total 11 marks)

Q2.   Pent-1-ene is a member of the alkene homologous series.

(a)   Pent-1-ene can be separated from other alkenes.

State the physical property of alkenes that allows them to be separated from a mixture by fractional distillation.
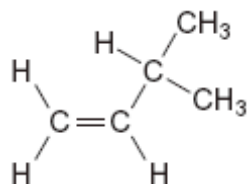
....

(1)

(b)   (i)   State the meaning of the term *structural isomerism*.

      ....

....

....

(2)

(ii) Name the branched chain isomer of pent-1-ene shown below.

....

(1)

(iii) Draw the structure of a functional group isomer of pent-1-ene.

(1)

(c) The cracking of one molecule of compound **X** produces pent-1-ene, ethene and butane in a 1:2:1 mol ratio.
Deduce the molecular formula of **X** and state a use for the ethene formed.

Molecular formula of **X** ....

....

Use of ethene ....

(2)
(Total 7 marks)

Q3. Hexane (C_6H_{14}) is a member of the homologous series of alkanes.

(a)　(i)　Name the raw material from which hexane is obtained.

　　　　　...

(1)

　　(ii)　Name the process used to obtain hexane from this raw material.

　　　　　...

(1)

(b)　C_6H_{14} has structural isomers.

　　(i)　Deduce the number of structural isomers with molecular formula C_6H_{14}

Write the number in this box. ☐

(Space for working)

(1)

　　(ii)　State **one** type of structural isomerism shown by the isomers of C_6H_{14}

　　　　　...

(1)

(c)　One molecule of an alkane **X** can be cracked to form one molecule of hexane and two molecules of propene.

　　(i)　Deduce the molecular formula of **X**.

　　　　　...

　　　　　...

(1)

(ii) State the type of cracking that produces a high percentage of alkenes. State the conditions needed for this type of cracking.

Type of cracking ....

Conditions ....

....

(2)

(iii) Explain the main economic reason why alkanes are cracked.

....

....

(1)

(d) Hexane can react with chlorine under certain conditions as shown in the following equation.

$$C_6H_{14} \quad + \quad Cl_2 \quad \longrightarrow \quad C_6H_{13}Cl \quad + \quad HCl$$

(i) Both the products are hazardous. The organic product would be labelled 'flammable'.
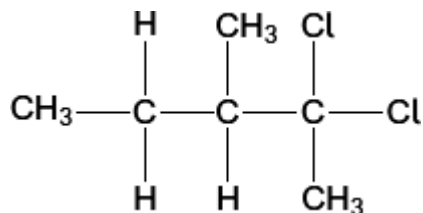Suggest the most suitable hazard warning for the other product.

....

(1)

(ii) Calculate the percentage atom economy for the formation of $C_6H_{13}Cl$ (M_r = 120.5) in this reaction.

....

....

(1)

(e) A different chlorinated compound is shown below. Name this compound and state its empirical formula.

H   CH$_3$ Cl

CH$_3$—C—C—C—Cl

H   H   CH$_3$

Name ....

Empirical formula ....
(2)
(Total 12 marks)

Q4.   Pentane is a member of the alkane homologous series.

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

....
(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.

....
(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.

....

....

....

....

....

....

(Extra space) ....

....

....

(3)

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

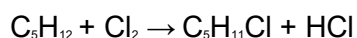Suggest why this solid pollutant is an environmental problem.

....

....

....

....

(Extra space) ....

....

(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.

....

....

....

....

....

(Extra space)...

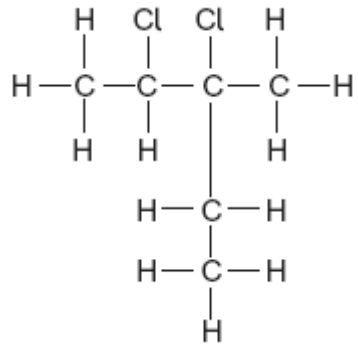...

(3)

(f)   Consider the following compound.

Name this compound.

Deduce the empirical formula of this compound.

....

....

....

....

(2)
(Total 13 marks)

Q5. Compound **X** is shown below. It is a member of a homologous series of hydrocarbons.
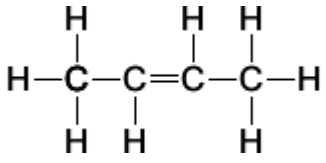
(a)   (i)   Deduce the general formula of the homologous series that contains **X**.

       ....

       (1)

       (ii)   Name a process used to obtain a sample of **X** from a mixture containing other members of the same homologous series.

       ....

       (1)

(b)   There are several isomers of **X**.

       (i)   Give the IUPAC name of the position isomer of **X**.

       ....

       (1)

       (ii)   Draw the structure of a functional group isomer of **X**.

       (1)

(c)   At high temperatures, one molecule of $C_{15}H_{32}$ can be converted into two molecules of **X** and one molecule of another compound.

       (i)   Write an equation for this reaction.

       ....

       (1)

       (ii)   State the name of the process used to obtain a high yield of **X** from $C_{15}H_{32}$ Give **one** reason why this process is used in industry.

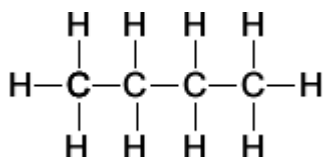   Name ....

       Reason ....

....

(2)

(iii) State why high temperatures are needed for this process.

....

....

(1)

(d) Compound **X** can be converted into compound **Y**.
Compound **Y** is shown below.

$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-H$$

(i) Suggest the formula of a reagent that could be added to **X** in order to convert it into **Y**.

....

(1)

(ii) Give **one** use of **Y**.

....

(1)

(iii) Write an equation to show the reaction of **Y** in a limited supply of air to produce a solid and water only.

....

(1)

(iv) When a sample of **Y**, contaminated with CH_3SH, is burned completely in air, a toxic gas is formed.
Identify this toxic gas and suggest a compound that could be used to remove the toxic gas from the products of combustion.

Toxic gas ....

PhysicsAndMathsTutor.com

Compound used to remove toxic gas ....

....

(2)

(v) Suggest the name of the process that occurs when the toxic gas in part (d)(iv) is removed.

....

(1)

(e) Explain why the boiling points of **X** and **Y** are similar.

....

....

....

....

(2)
(Total 16 marks)

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