2.24 Alkanes, Alkenes and Crude Oil: Test Pack

AQA 8464 · Calculator allowed · about 35 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Alkanes are a homologous series of hydrocarbons.

(a) Give the general formula for the alkane homologous series. **(1)**

(Total for Question 1 is 1 mark)

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2 Alkenes are a homologous series of unsaturated hydrocarbons.

(a) State the general formula of the homologous series of alkenes. **(1)**

(b) Name the alkene with molecular formula C_4H_8. **(1)**

(c) Give the molecular formula of propene. **(1)**

(Total for Question 2 is 3 marks)

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3 Alkanes belong to a homologous series with the general formula C_nH_{2n+2}.

(a) Use the general formula to deduce the molecular formula of heptane, the alkane with 7 carbon atoms. **(1)**

(b) Draw the displayed structural formula of propane (C_3H_8), showing all atoms and all covalent bonds. **(2)**

(Total for Question 3 is 3 marks)

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4 Polymerisation of alkenes forms addition polymers. A student polymerises ethene to make poly(ethene).

(a) Describe, in words or an equation, how ethene monomers form poly(ethene). **(2)**

(b) State one problem caused by some addition polymers in the environment. **(1)**

(Total for Question 4 is 3 marks)

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5 Bromine water is used as a chemical test to distinguish between alkanes and alkenes.

(a) Describe a chemical test, using bromine water, that could be used to distinguish between a sample of hexane (an alkane) and a sample of hexene (an alkene), including the result expected for each. **(2)**

(b) Explain, in terms of bonding, why alkenes react with bromine water in this way but alkanes do not. **(2)**

(Total for Question 5 is 4 marks)

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6 Complete combustion of a hydrocarbon fuel occurs when there is a plentiful supply of oxygen.

(a) Complete and balance the equation for the complete combustion of methane, including the missing state symbol: $CH_4(g)$ + ___O2(g) -> ___CO2(g) + ___H2O(_) **(2)**

(b) Complete and balance the equation for the complete combustion of propane: C_3H_8 + ___O2 -> ___CO2 + ___H2O **(2)**

(Total for Question 6 is 4 marks)

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7 Cracking converts long-chain hydrocarbons to shorter alkanes and alkenes. In a classroom catalytic cracking experiment a student passes vapour over a hot catalyst and collects products. They measure 5.00 g of a product mixture containing 2.00 g of ethene, C_2H_4.

(a) Calculate the mass percentage of ethene in the product mixture. Show working. **(2)**

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(b) Suggest two advantages of catalytic cracking compared with thermal cracking for industry. **(2)**

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.....

(Total for Question 7 is 4 marks)

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8 Higher tier only. When 2.90 g of a gaseous hydrocarbon, X, undergoes complete combustion, it produces 8.80 g of carbon dioxide and 4.50 g of water. (Relative atomic masses: Ar(C) = 12, Ar(H) = 1; Mr(CO_2) = 44, Mr(H_2O) = 18.)

(a) Calculate the number of moles of carbon atoms and the number of moles of hydrogen atoms present in the original sample of X. **(2)**

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(b) Deduce the empirical formula of hydrocarbon X. **(1)**

(c) Given that the relative formula mass of X is 58, determine its molecular formula and name the compound. **(2)**

(Total for Question 8 is 5 marks)

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Mark scheme · 2.24 Alkanes, Alkenes and Crude Oil: Test Pack

Question 1

(a) C n H 2n+2 or C_nH_{2n+2} cao **B1**

(a) Answer: C_nH_{2n+2}

Question 2

(a) C_nH_{2n} **B1**

(a) Answer: C_nH_{2n}

(b) butene **B1**

(b) Answer: Butene.

(c) C_3H_6 cao **B1**

(c) Answer: C_3H_6

Question 3

(a) C_7H_{16} cao **B1**

(a) Answer: C_7H_{16}

(b) correct skeleton of 3 carbon atoms joined in a chain by single C-C bonds **M1**

(b) all 8 hydrogen atoms correctly shown, each joined to a carbon by a single C-H bond (3 H on each end carbon, 2 H on the middle carbon) **A1**

(b) Answer:H H H| | |H-C-C-C-H| | |H H H
(a chain of 3 carbons, each joined by single bonds, with 8 hydrogens shown in total)

Question 4

(a) states that C=C bonds open and monomers join in an addition reaction to form long chain **M1**

(a) gives polymer equation such as nC2H4 -> -(C_2H_4)-n or description equivalent cao **A1**

(a) Answer: nC2H4 -> -(C_2H_4)-n; the C=C bonds open and monomers add together to form a long chain polymer.

(b) non-biodegradability leading to persistent waste that pollutes land and oceans, oe **B1**

(b) Answer: Many addition polymers are non-biodegradable, causing persistent plastic pollution.

Question 5

(a) add the hydrocarbon to bromine water and shake; the hexene decolourises the bromine water, turning it from orange(-brown) to colourless, oe **B1**

(a) the hexane does not decolourise the bromine water; it remains orange(-brown), oe **B1**

(a) Answer: Shake each sample with bromine water: hexene decolourises it (orange to colourless); hexane causes no change (stays orange).

(b) alkenes are unsaturated, containing a reactive C=C double bond, which reacts with bromine in an addition reaction, oe **B1**

(b) alkanes are saturated, containing only single covalent bonds, so have no double bond available to react in this way, oe **B1**

(b) Answer: Alkenes have a reactive C=C double bond that undergoes addition with bromine; alkanes are saturated (only single bonds) so cannot react in this way.

Question 6

(a) correctly balanced: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(_)$ **M1**

(a) correct state symbol (l) for water cao **A1**

(a) Answer: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

(b) $3CO_2$ and $4H_2O$ (carbon and hydrogen atoms balanced) **M1**

(b) $5O_2$ added so oxygen atoms balance; final equation $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ cao **A1**

(b) Answer: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Question 7

(a) substitutes into percentage: (2.00 / 5.00) x 100 **M1**

(a) 40.0% cao **A1**

(a) Answer: 40.0%

(b) higher yield of branched alkanes or more control over products, oe **B1**

(b) lower energy requirement or works at lower temperature so cheaper, oe **B1**

(b) Answer: Catalytic cracking gives more control over products and often lower energy costs because it operates at lower temperatures with a catalyst.

Question 8

(a) moles CO_2 = 8.80 / 44 = 0.2 mol, so moles C atoms = 0.2 mol **M1**

(a) moles H_2O = 4.50 / 18 = 0.25 mol, so moles H atoms = 0.25 x 2 = 0.5 mol **A1**

(a) Answer: 0.2 mol carbon atoms; 0.5 mol hydrogen atoms

(b) ratio C : H = 0.2 : 0.5 = 2 : 5, giving empirical formula C_2H_5 cao **B1**

(b) Answer: C_2H_5

(c) mass of empirical formula unit C_2H_5 = (2 x 12) + (5 x 1) = 29; 58 / 29 = 2 **M1**

(c) molecular formula C_4H_{10}, named butane (accept methylpropane, its isomer) cao **A1**

(c) Answer: C_4H_{10} (butane, or its isomer methylpropane)

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