WJEC EDUQAS AS CHEMISTRY · COMPONENT 2

CHEMISTRY



EXAM QUESTION PACK

2.5 HYDROCARBONS

SCORE	PERCENTAGE
/37	%

STEMUP

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1. Crude oil is a complex mixture of hydrocarbons, with samples from different locations in the world having different compositions. The table below gives the composition of crude oil from two locations.

Fraction	Percentage by mass	
	Brent Crude	Gulf of Suez
petroleum gases	2.4	1.2
naphtha	19.1	13.6
kerosene	14.2	12.7
gas oil	20.9	18.7
residue	43.4	53.8

(a) The different fractions are separated by fractional distillation. Explain why the different fractions have different boiling temperatures.

[2]

(b) The petroleum gases produced from crude oil can contain both propane and butane

(i) A barrel of Gulf of Suez crude oil has a mass of 145 kg. Assuming all the petroleum gas released from the oil is butane, calculate the volume that this gas would occupy at 1 atmosphere pressure.

[1 mol of gas occupies 24.0 dm^3 under these conditions]

[3]

Volume = ... dm^3

(ii) Propane can be chlorinated by a similar method to methane.

I. Give the condition(s) required for the chlorination of propane

[1]

II. Write an equation for the initiation stage of the chlorination of propane

[1]

III. The chlorination of propane also produces hexane as a minor product.Explain how this compound forms

[2]

(c) Naphtha is used as a starting material for the production of alkenes, and these are then used to produce polymers such as poly(ethene). Discuss how poly(ethene) is produced, starting from naphtha. Your answer should include:

- An explanation of which of the two types of crude oil given would be more useful for producing alkenes.
- How the naphtha is converted into alkenes.
- An equation for the production of ethene from decane, an alkane with 10 carbon atoms.
- An explanation of what is meant by polymerisation.
- An equation for the polymerisation of ethene, clearly stating the type of polymerisation that is occurring.
- A different polymer in common use, with the structure of the monomer used in its production.

[6] QWC [1]

(Total 16)

2. (a) Petroleum (crude oil) is separated into useful parts by fractional distillation.

(i) Briefly describe how *fractional distillation* can be carried out.

[2]

(ii) A fraction is treated further to give a **branched-chain** alkane. The mass spectrum of this alkane shows a molecular ion, M^+, at m/z 72.

Use this information to give the molecular formula and then suggest a displayed formula for this alkane. [2]

(b) Cracking is a process that is used in the petroleum industry to obtain smaller alkanes and alkenes from larger alkanes.

(i) State why this process of making smaller molecules is carried out.

[1]

(ii) Methane is one of the products when nonane, C_9H_{20}, is cracked. The other products are butane and butadiene, C_4H_6.
Give an equation that represents this reaction. [1]

(c) Methane reacts with chlorine in a substitution reaction.

(i) The first stage of the reaction is as follows.

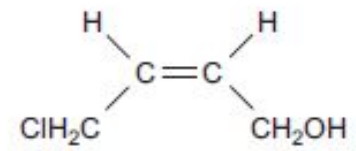
$$Cl_2 \longrightarrow 2Cl\bullet$$

State an essential condition for this stage. [1]

(ii) State what is meant by the term *propagation stage*. [1]

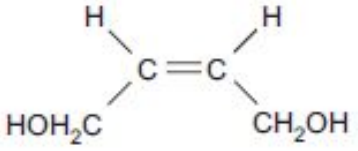
(iii) Write an equation that represents a propagation stage of this reaction. [1]

(d) Study the reaction sequence below and then answer the questions that follow.

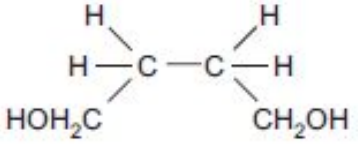


compound **A**

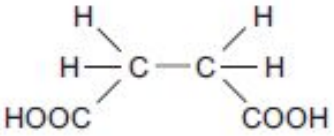
reagent **W**



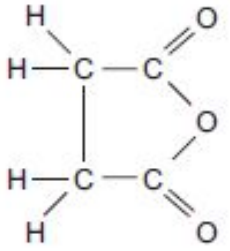
compound **B**



compound **C**



compound **D**



compound **E**

(i) Compound **A** is a (*Z*)-isomer.

Write the displayed formula of the (*E*)-isomer of compound **A**

[1]

(ii) State the name of reagent **W** and the solvent in which it is dissolved.

[1]

(iii) State the name of a catalyst used in the hydrogenation of compound **B** to produce compound **C**.

1

3.

State which **one** of the following formulae represents an **alkane**. [1]

A C_8H_{16}

B C_8H_{17}

C C_8H_{18}

D C_8H_{20}

4. The straight-chain alkane containing 19 carbon atoms is called nonadecane.

(a) Write the **molecular** formula of nonadecane.

[1]

(b) When nonadecane is cracked, one of the smaller products formed can be octane.

Write an equation to show the cracking of nonadecane to produce octane.

[1]

(Total 2)

5. The elements in Group 7 in the Periodic Table can be described as *p*-block elements.

(a) State why these are described as *p*-block elements. [1]

(b) All halogens are oxidising agents.

(i) Why are the halogens oxidising agents?

[1]

(ii) State, giving a reason, which halogen is the strongest oxidising agent.

[1]

(c) $NaClO_3$ was used as a weedkiller. Give the oxidation state of chlorine in $NaClO_3$.

Oxidation state ..... [1]

(d) Methane reacts with chlorine when exposed to sunlight. The first two stages of the mechanism of this reaction are **initiation** and **propagation**.

(i) Give the equation for the initiation reaction.

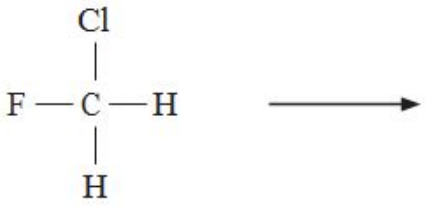
[1]

(ii) Give the equations for **two** propagation steps involved in the formation of chloromethane.

[2]

(e) Chlorofluorocarbons, CFCs, were widely used as refrigerants but they caused serious environmental damage as a result of reactions involving radical mechanisms.

The first stage of a radical mechanism is an initiation process similar to that in *(d)*. Complete the following equation to show the most likely initiation step for chlorofluoromethane, CH_2ClF, and give a reason for your answer. [2]



Reason .....

Total [9]

6. (a) Propene reacts with hydrogen bromide to give 2-bromopropane.

(i) Draw the mechanism for this reaction.

[3]

(ii) Explain why the product of this reaction is mainly 2-bromopropane rather than 1-bromopropane

[2]

(b) Compound **C** is a compound of carbon, hydrogen and bromine only. Bromine has two isotopes, ^{79}Br and ^{81}Br, in equal abundance. Use all the information below to deduce the structure of compound **C**, giving your reasoning. [6]

QWC [1]

- Compound **C** contains 29.8% carbon, 4.2% hydrogen and 66.0% bromine by mass.
- The mass spectrum of compound **C** contains peaks at m/z of 15, 41 and a pair of peaks at 120 and 122.
- The infrared spectrum of compound **C** has absorptions at 550 cm^{-1}, 1630 cm^{-1} and 3030 cm^{-1}.
- Compound **C** is a Z-isomer.

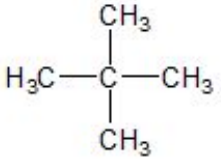
(Total 12)

2 (a) (i) Petroleum is heated/evaporated (1)
Fractions condense at different temperatures / separated into fractions with different boiling temperatures (1)

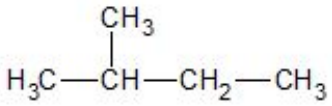
[2]

(ii) C_5H_{12} (1)

Branched chain therefore



or



(1)

[2]

(b) (i) It enables more useful compounds to be made from the compound

[1]

(ii) $C_9H_{20} \rightarrow CH_4 + C_4H_6 + C_4H_{10}$ [1]

(c) (i) UV light [1]

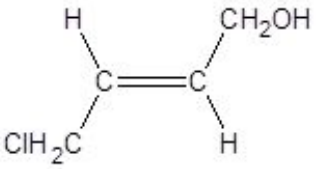
(ii) A step during which a radical reacts and another one is formed

[1]

(iii) $Cl\bullet + CH_4 \rightarrow \bullet CH_3 + HCl$

[or $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$] [1]

(d) (i)



[1]

(ii) Aqueous sodium hydroxide [1]

(iii) Pt / N / Pd [1]

(iv) Compound **E** does not contain an O—H bond (1)
This is present in Compound **D** at a frequency of 2500-3550 cm^{-1} (1)

[2]

Total [14]

3 C **[1]**

4 (a) $C_{19}H_{40}$ [1]

(b) $C_{19}H_{40} \rightarrow C_8H_{18} + C_{11}H_{22}$ - allow ecf [1]

5 (a) incomplete p sub-shell/ outer electron configuration s^2p^5/ outer electrons in p subshell/ outer electrons in p orbitals/ valence electrons in p subshell/ valence electrons in p orbital [1]

(b) (i) gaining one electron completes shell/ gives p^6/ takes an electron from another species/gains an electron
- do not accept 'attracts an electron' [1]

(ii) **fluorine** because it is the smallest/ has the greatest electron affinity/ has the least shielding/ has the greatest effective nuclear charge/ oxidising power decreases as the group is descended
[1]

(c) oxidation state is (+)5/ V
- do not accept '5+' [1]

(d) (i) $Cl_2 \rightarrow 2Cl^{\bullet}$ - ignore hf
[1]

(ii) $CH_4 + Cl^{\bullet} \rightarrow HCl + {}^{\bullet}CH_3$ (1)

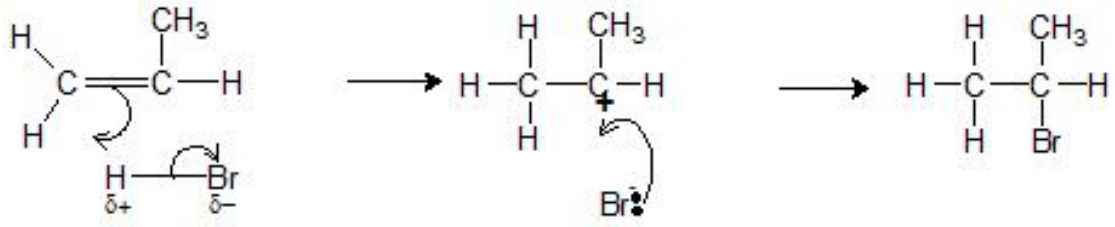
${}^{\bullet}CH_3 + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$ (1) [2]

(e) products: ${}^{\bullet}CFH_2$ and $Cl^{\bullet}$ (1)

C-Cl bond is the weakest/ **most** easily broken (1) [2]

Total [9]

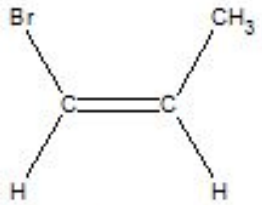
6 (a) (i) 1 mark for arrows in first diagram; 1 mark for arrow in second diagram; 1 mark for all charges



2 max if incorrect isomer given [3]

(ii) 2-bromopropane formed from a secondary carbocation (1)
Secondary carbocations are more stable than primary carbocations (1)
[2]

(b) Empirical formula = C_3H_5Br (1)
Molecular formula = C_3H_5Br
(must show use of mass spectrum to gain this mark) (1)
Two molecular ion peaks as there are two isotopes of bromine (1)
Peaks at 15 = CH_3^+ and 41 = $C_3H_5^+$ (1)
550 cm^{-1} = C–Br 1630 cm^{-1} = C=C 3030cm^{-1} = C–H (1)
Molecule is:



(1) [6]

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning [1]

Total [12]