Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 9CH0

Resource Set 2 – Topic Group 4

Topics included:

Topic 6: Organic Chemistry I

Topic 7: Modern Analytical Techniques I

Topic 17: Organic Chemistry II

Topic 18A: Arenes – benzene,

Topic 18B: Amines, amides, amino acids and proteins

(Public release version)

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1 This question is about alkanes.

(a) The reaction of ethane and chlorine in UV radiation produces chloroethane.

$$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$$

This reaction is classified as

(1)

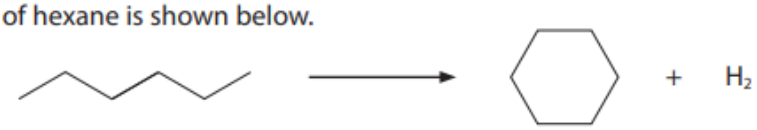
- ☒ **A** addition
- ☒ **B** elimination
- ☒ **C** initiation
- ☒ **D** substitution

(b) The black smoke produced from the incomplete combustion of alkane fuels is

(1)

- ☒ **A** carbon particulates
- ☒ **B** oxides of nitrogen
- ☒ **C** oxides of sulfur
- ☒ **D** unburnt hydrocarbons

(c) A reaction of hexane is shown below.

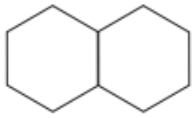


This is **best** described as

(1)

- ☒ **A** elimination
- ☒ **B** hydrogenation
- ☒ **C** isomerisation
- ☒ **D** reforming

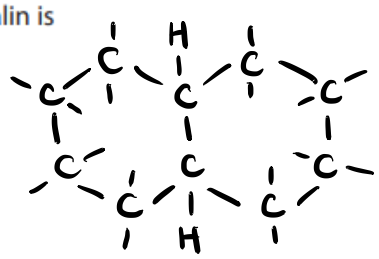
(d) The skeletal formula of decalin is



The molecular formula of decalin is

(1)

- ☐ **A** $C_{10}H_{22}$
- ☐ **B** $C_{10}H_{20}$
- ☒ **C** $C_{10}H_{18}$
- ☐ **D** $C_{10}H_{16}$



(Total for Question 1 = 4 marks)

3 This is a question about halogenoalkanes and related compounds.

(a) Explain the trend in reactivity of the **primary** chloro-, bromo- and iodoalkanes with aqueous hydroxide ions.

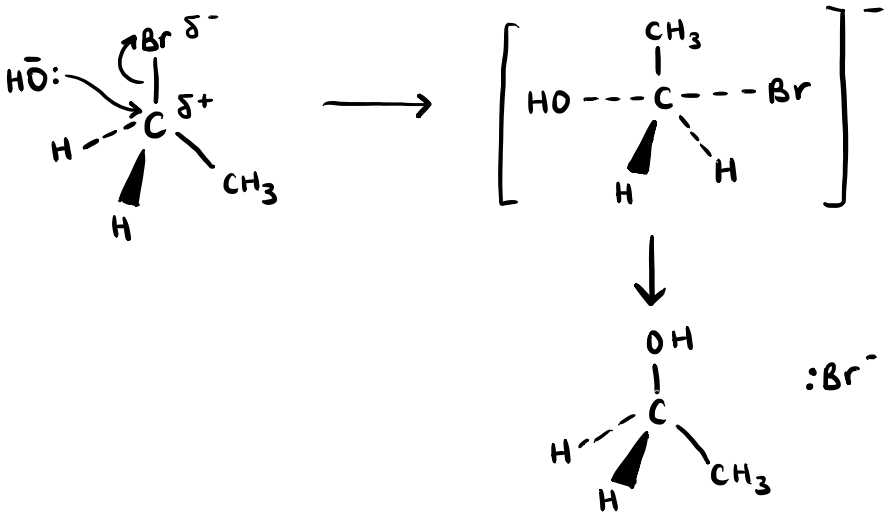
(2)

The reactivity of the primary halogenoalkanes goes up as the halogen size increases (chloro < bromo < iodo). This is because hydroxide ions replace the halogen that is towards the end of Group 7 (e.g. iodine) faster than the smaller halogen (e.g. Cl) as iodine is less electronegative and the C-I bond is weaker than the C-Cl bond.

(b) In aqueous sodium hydroxide, 1-bromoethane reacts to produce ethanol.

(i) Write the mechanism for this reaction, including all relevant curly arrows, lone pairs and dipoles. Include the transition state.

(4)



(ii) Give the reagents that are used to test that bromide ions are formed in this reaction mixture. Include the result of the test.

(2)

Dilute nitric acid + silver nitrate

If bromide ions are present, cream precipitate of silver bromide would form

(c) The halogenoalkane 2-bromobutane reacts with ethanolic potassium hydroxide to produce a mixture of alkenes.

Draw the **skeletal** formulae of all the alkenes that could be produced.

(3)

(d) Explain why ethene has a boiling temperature of −104 °C, whereas ethanol has a boiling temperature of 78 °C.

(3)

Ethene has only Van der Waals forces between the ethene molecules which can be easily overcome with small amount of energy. However, ethanol has a hydroxyl group (-OH) which can form hydrogen bonds with other hydroxyl groups on different ethanol molecules. As both Van der Waals forces and hydrogen bonds exist, ethanol requires more energy to overcome the stronger intermolecular attraction.

(Total for Question 3 = 14 marks)

5 Some alcohols can be oxidised by acidified sodium dichromate(VI), $Na_2Cr_2O_7$.

(a) Balance the ionic half-equation for the reduction of the dichromate(VI) ion.
Give the colours of all of the species involved, or state colourless if appropriate.

(2)

+12 -14
+6

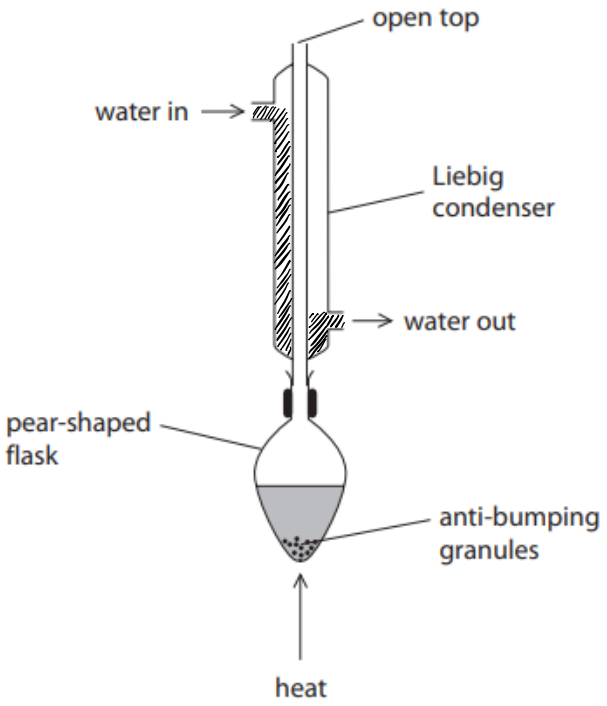
$Cr_2O_7^{2-}$ + 14 H^+ + 6 e^- → 2 Cr^{3+} + 7 H_2O

Colour orange colourless green colourless

(b) Reflux apparatus can be used to carry out the oxidation of alcohols.

(i) This Liebig condenser has been set up incorrectly. Add shading to the diagram to show the water in the condenser, illustrating the effect of the incorrect water flow.

(1)

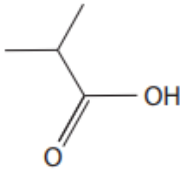


(ii) State how the granules prevent bumping.

(1)

The granule provide a large surface area for bubbles to form on, therefore avoiding the sudden production of large gas bubbles that can lead to bumping.

(c) The carboxylic acid shown can be produced by oxidation of an alcohol under reflux.



Which alcohol would be oxidised under reflux to produce this carboxylic acid?

(1)

☐ **A** 1,1-dimethylethanol

☒ **B** 2-methylpropan-1-ol

☐ **C** 2-methylbutan-1-ol

☐ **D** propan-2-ol

(d) Using the apparatus for distillation instead of reflux is not an efficient way to produce ethanoic acid from ethanol. Explain why.

(2)

Ethanol has a low boiling point thus it evaporates quickly meaning some ethanol may evaporate before being fully oxidised into carboxylic acid. Hence if distillation apparatus is used the product would be likely to be impure containing ethanoic acid, ethanal and ethanol.

(Total for Question 5 = 7 marks)

5 This question is about hydrocarbons.

(a) Which of these molecular formulae represents a non-cyclic, saturated hydrocarbon?

(1)

- ☐ **A** C_6H_6
- ☐ **B** C_6H_{10}
- ☐ **C** C_6H_{12}
- ☒ **D** C_6H_{14}

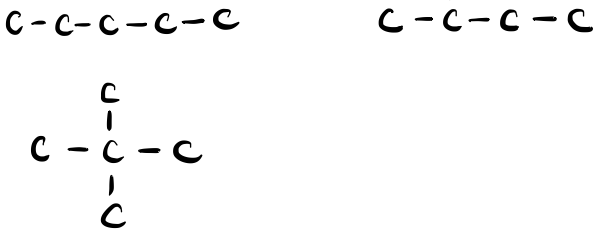
C_nH_{2n+2}

C_6H_{14}

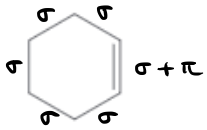
(b) How many **structural** isomers are there with the molecular formula C_5H_{12}?

(1)

- ☐ **A** 2
- ☒ **B** 3
- ☐ **C** 4
- ☐ **D** 5



(c) How many σ bonds and π bonds are there in one molecule of cyclohexene?



(1)

	σ bonds	π bonds
☒ **A**	5	2
☒ **B**	6	1
☒ **C**	15	2
☒ **D**	16	1

(d) When hydrocarbons undergo complete combustion, there is a change in the total volume of gases.

(i) Ethane burns in excess oxygen.

$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$$

All gas volumes are measured at the same temperature and pressure when water is a gas.

What is the **increase** in the total volume when 100 cm^3 of ethane is burned in excess oxygen?

(1)

- ☐ **A** 50 cm^3
- ☐ **B** 100 cm^3
- ☐ **C** 200 cm^3
- ☒ **D** 500 cm^3

start vol: 100 350 0 0

ratio: 2 7 4 6

−100 −350 +200 +300

end vol: 0 0 200 300

(ii) A combustion experiment was carried out using conditions under which water was a liquid.

A cyclic hydrocarbon, C_xH_y, was mixed with excess oxygen and ignited. Under the conditions of the experiment, this hydrocarbon was gaseous and had a volume of 25 cm^3.

The equation for the complete combustion of C_xH_y is

$$C_xH_y(g) + (x + \frac{y}{4})O_2(g) \rightarrow xCO_2(g) + \frac{y}{2}H_2O(l)$$

The total gas volume **decreased** by 75 cm^3.
The remaining gases were shaken with aqueous sodium hydroxide and the total gas volume **decreased** by a further 125 cm^3.

All gas volumes were measured at the same temperature and pressure.

Suggest the identity of the cyclic hydrocarbon by calculating the molecular formula of C_xH_y.
Include the **skeletal formula** of the cyclic hydrocarbon.

(3)

since l

	C_xH_y	O_2	$5CO_2$	~~H_2O~~ 0
initial:	25	175	0	
	−25	−175	+125	
final:	0	0	125	
ratio:	1	7	5	

$x = 5$

$5 + \frac{y}{4} = 7$

$y = 8$

C_5H_8

skeletal formula

cyclopentene

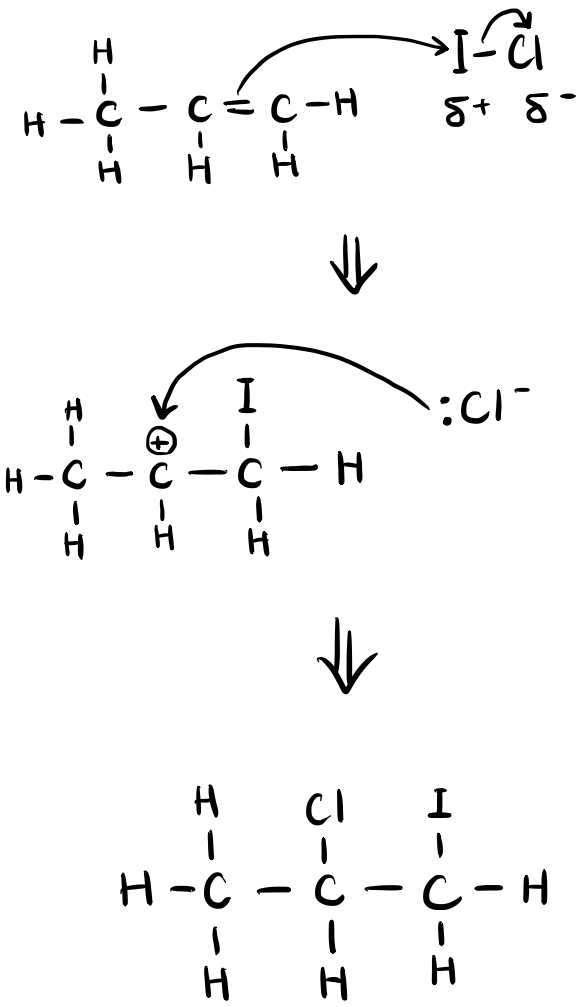
$(25 + O_2) - 125 = 75 \quad O_2 = 175$

(e) Propene reacts with iodine monochloride, ICl, by an electrophilic addition mechanism.

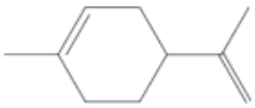
Draw the mechanism for the reaction between propene and iodine monochloride to form the **major** product.

Include the dipole on the ICl molecule, curly arrows and any relevant lone pairs of electrons.

(4)



(f) Limonene is obtained from the oil in lemon peel and it is the only alkene present.



0.500 g of the oil reacted with exactly 30.6 cm^3 of a solution of bromine dissolved in cyclohexane with a concentration of 0.200 mol dm^{-3}.

Calculate the percentage by mass of limonene in the oil.
Give your answer to an appropriate number of significant figures.

Assume that there is nothing else in the oil that reacts with bromine.

(4)

limonene RFM
↳ $12 \times 10 + 1 \times 16$
$= 136$

$Br_2 = \frac{30.6 \times 0.2}{1000}$
$= 6.12 \times 10^{-3}$ mol

limonene = $\frac{0.5}{136} = 3.67 \times 10^{-3}$ mol

$2\,Br_2 = 1$ limonene because two C=C present

$6.12 \times 10^{-3} \div 2 = 3.06 \times 10^{-3}$ mol of limonene used

$(3.67 - 3.06) \times 10^{-3} = 0.61 \times 10^{-3}$ mol left

mass of limonene left = $0.61 \times 10^{-3} \times 136 = 0.08296$ g

percentage of mass = $\frac{0.08296}{0.5} \times 100 = 16.59\%$
$\approx \boxed{16.6\%}$ (3 sf)

(Total for Question 5 = 15 marks)

Total for Test = 40 marks