Alkenes & Polymers

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Alkenes & Polymers
Booklet	Question Paper

Time Allowed: **84 minutes**

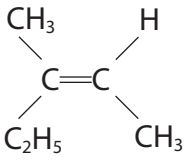
Score: **/70**

Percentage: **/100**

Grade Boundaries:

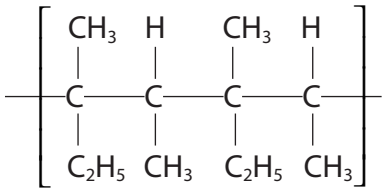
A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 The structure of *Z*-3-methylpent-2-ene is

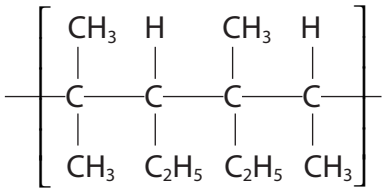


Which of the following shows **two** repeat units of the polymer made from *Z*-3-methylpent-2-ene?

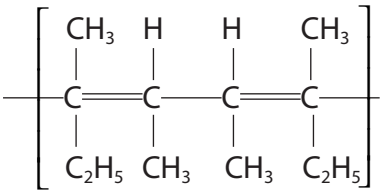
☒ **A**



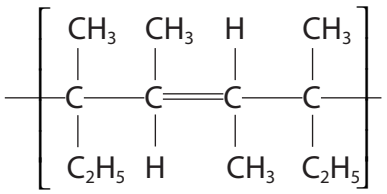
☒ **B**



☒ **C**

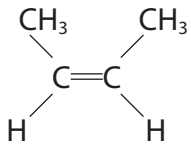


☒ **D**



(Total for Question 1 = 1 mark)

2 One of the isomers with the formula C_4H_8 is



Possible names for this isomer are

☒ **A** *cis*-but-2-ene and *E*-but-2-ene.

☒ **B** *cis*-but-2-ene and *Z*-but-2-ene.

☒ **C** *trans*-but-2-ene and *E*-but-2-ene.

☒ **D** *trans*-but-2-ene and *Z*-but-2-ene.

(Total for Question 2 = 1 mark)

3 An electrophile is a species that

- ☒ **A** can accept a pair of electrons to form a covalent bond.
- ☒ **B** can donate a pair of electrons to form a covalent bond.
- ☒ **C** always has a negative charge.
- ☒ **D** always has a positive charge.

(Total for Question 3 = 1 mark)

4 Alkenes react with hydrogen gas in the presence of a nickel catalyst.

0.2 mol of an alkene reacted completely with 19.2 dm^3 of hydrogen gas at room temperature and pressure.

How many C═C bonds are there in a molecule of this alkene?

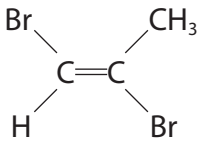
[The molar volume of a gas is 24.0 $dm^3\ mol^{-1}$ at room temperature and pressure]

- ☒ **A** 4
- ☒ **B** 3
- ☒ **C** 2
- ☒ **D** 1

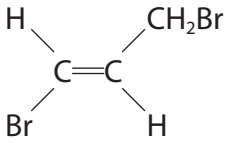
(Total for Question 4 = 1 mark)

5 Which is the structure of *Z*-1,2-dibromoprop-1-ene?

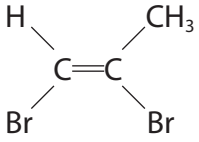
☒ **A**



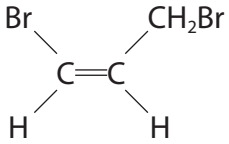
☒ **B**



☒ **C**

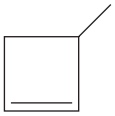


☒ **D**



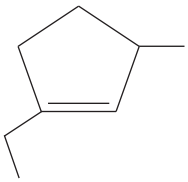
(Total for Question 5 = 1 mark)

6 The skeletal formula of 3-methylcyclobut-1-ene is shown below.

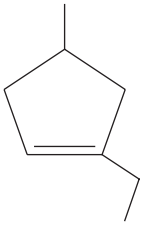


What is the skeletal formula of 1-ethyl-3-methylcyclopent-1-ene?

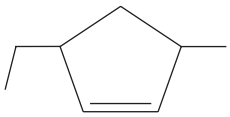
☒ **A**



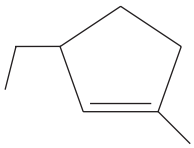
☒ **B**



☒ **C**



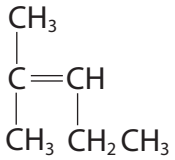
☒ **D**



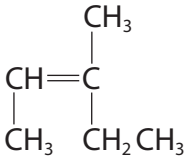
(Total for Question 6 = 1 mark)

7 Which of the following does **not** represent the structure of the compound 2-methylpent-2-ene?

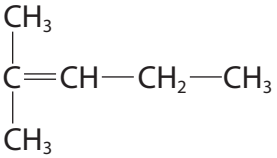
☒ **A**



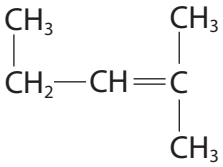
☒ **B**



☒ **C**

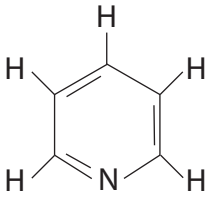


☒ **D**



(Total for Question 7 = 1 mark)

8 A molecule of **Z** has the following structure:



Molecule of **Z**

What are the total numbers of σ-bonds and π-bonds in a molecule of **Z**?

	Number of σ-bonds	Number of π-bonds
☒ **A**	3	11
☒ **B**	8	3
☒ **C**	11	3
☒ **D**	14	6

(Total for Question 8 = 1 mark)

9 Poly(ethene) is a plastic material made by polymerizing the hydrocarbon ethene.
Which of the following is **not** true?

Pure poly(ethene) is

☒ **A** solidified ethene.

☒ **B** composed of carbon and hydrogen only.

☒ **C** a long-chain compound.

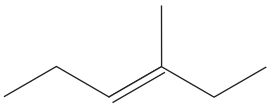
☒ **D** non-biodegradable.

(Total for Question 9 = 1 mark)

10 This question is about alkenes.

(a) (i) Give the molecular formula of this alkene.

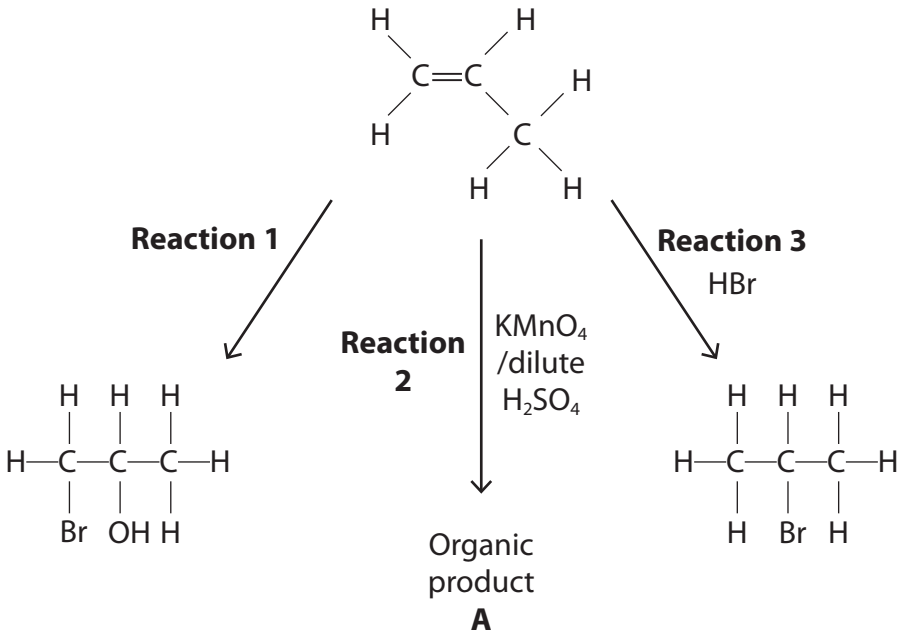
(1)



(ii) Explain why the alkene in (a)(i) exhibits geometric isomerism.

(2)

(b) Propene reacts with three different reagents.



(i) Give the reagent needed for **Reaction 1**.

(1)

(ii) Identify, by name or formula, the organic product **A** formed in **Reaction 2**.

(1)

(iii) State the colour change that you would see when **Reaction 2** is carried out.

(1)

From ..... to .....

(iv) Give the mechanism for **Reaction 3**. Use curly arrows and show any relevant dipoles and lone pairs.

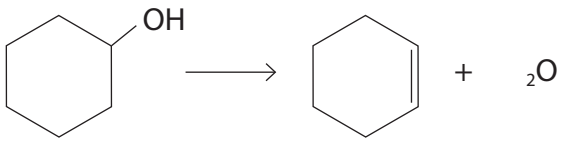
(4)

(c) But-2-ene polymerizes to form poly(but-2-ene).

Draw a section of this polymer, showing **two** repeat units.

(1)

(d) Cyclohexanol forms cyclohexene in the following reaction.



(i) Calculate the percentage atom economy by mass for the production of cyclohexene.

(1)

(ii) Calculate the percentage yield if 10.20 g of cyclohexanol produced 6.15 g of cyclohexene.

(2)

(Total for Question 10 = 14 marks)

11 This question is about alkenes.

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

(1)

(b) Give the **structural** formula of the organic product formed when **ethene**, $CH_2=CH_2$, reacts with

(i) hydrogen

(1)

(ii) chlorine

(1)

(iii) acidified aqueous potassium manganate(VII)

(1)

(iv) bromine **water**

(1)

(c) When **propene**, $CH_3CH=CH_2$, reacts with hydrogen chloride, there are **two** possible products, a major product and a minor product.

(i) Draw the **displayed** formulae of these products.

(2)

Major product	Minor product

(ii) Give the mechanism for the reaction of **propene** with hydrogen chloride which forms the major product.

(3)

(d) Propene can be polymerized.

(i) Write a balanced equation for the polymerization of propene to form poly(propene), drawing the **displayed** formula of the repeat unit of poly(propene).

(3)

(ii) State a problem associated with the disposal of waste poly(propene).

(1)

.....

.....

(e) Standard enthalpy changes of combustion can be used to calculate the standard enthalpy change of formation of propene.

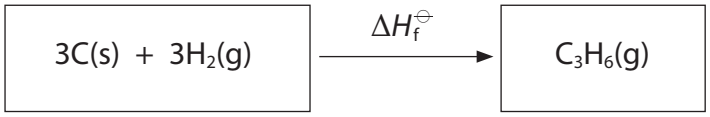
$$3C(s) + 3H_2(g) \longrightarrow C_3H_6(g)$$

Values for some standard enthalpy changes of combustion, $\Delta H_c^{\ominus}$, are shown in the table below.

Substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
C(s)	−394
$H_2(g)$	−286
$C_3H_6(g)$	−2058

(i) Complete the Hess cycle below to enable you to calculate $\Delta H_f^{\ominus}$ from combustion data.

(1)



(ii) alculate $\Delta H_f^{\ominus}$, in kJ mol^{-1}.

(2)

standard enthalpy change of formation of propene = ... kJ mol^{-1}

(Total for Question 11 = 17 marks)

12 Iodine monochloride, ICl, is an interhalogen compound. Molecules of iodine monochloride have a permanent dipole. Alkenes react with ICl, under suitable conditions, in a similar way to the reaction of alkenes with hydrogen chloride, HCl.

(a) Propene reacts with ICl to form two possible organic products. One of these products is 2-chloro-1-iodopropane.

(i) Complete the mechanism below, by adding curly arrows and the intermediate species.

(3)

(ii) Classify the type and mechanism for the reaction in (a)(i).

(2)

.....

(iii) Draw the structure of the other possible organic product of the reaction of propene with ICl.

(1)

(b) Methane reacts with ICl, under suitable conditions, to form many products. Two of these products are iodomethane and hydrogen chloride.
The reaction between methane and ICl is similar to that between methane and chlorine, Cl_2.

(i) Suggest the essential condition needed for this reaction.

(1)

.....

*(ii) The mechanism for the reaction between methane and ICl involves three stages. One of these is the third and final stage, called termination.

Describe the mechanism of the reaction to form iodomethane and hydrogen chloride.

In your answer, include:

- the type of reaction and mechanism
- the type of bond fission occurring
- the name and equation for the **first** stage of the mechanism
- the name and equations for the **second** stage of the mechanism
- one equation for a termination step

Curly (half-) arrows and state symbols are **not** required in your equations.

(7)

Type of reaction and mechanism .....

Type of bond fission occurring .....

.....

.....

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(Total for Question 12 = 14 marks)

13 This question is about the chemistry of alkenes, which are unsaturated hydrocarbons.

(a) State what is meant by the term **unsaturated** as applied to a hydrocarbon.

(1)

.....

.....

(b) An organic compound, **X**, is an unsaturated hydrocarbon with molecular formula C_4H_8.

(i) Draw the displayed formulae and give the names of **two** unbranched molecules with molecular formula C_4H_8 which are *E/Z* isomers.

(3)

Isomer 1	Isomer 2
Name:	Name:

(ii) Both isomers react with a solution of acidified aqueous potassium manganate(VII).

State the colour change that you would observe when this reaction is carried out.

(1)

From ..... to .....

(iii) Draw the structure of the organic product of this reaction with either one of these isomers.

(1)

(iv) Compounds such as C_4H_8 are formed when fractions of crude oil are cracked.

State what is meant by the term **cracking** when applied to processing a fraction obtained from crude oil.

(1)

.....

.....

(v) Write an equation to show the cracking of the hydrocarbon octane into C_4H_8 and a saturated hydrocarbon as the only products.

(1)

(c) Another alkene is propene, C_3H_6.

Describe the mechanism for the addition reaction of propene with bromine, Br_2, to form $C_3H_6Br_2$.

In your answer you should include:

- the name for the type of addition which occurs
- the name of the product
- the mechanism using curly arrows to show the movement of electron pairs.

(5)

Type of addition .....

Name of product .....

Mechanism

(d) Propene can polymerize to form poly(propene).

(i) State, with a reason, the atom economy for this reaction.

(1)

.....

.....

(ii) Draw a section of this polymer, showing **two** repeat units.

(1)

(iii) Poly(propene) is used to make synthetic fibres which are extremely light and act as good insulators.

Comment on the sustainability of this use of poly(propene).

(1)

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(Total for Question 13 = 16 marks)