

GCE AS / A LEVEL – CHEMISTRY UNIT 2 QUESTION PACK

1092-01 (Legacy CH2) · New spec Unit 2 Topic 3 · AS unit, first sat 2016, 80 marks, 1h 30min paper

REVISE.wales

CHEMISTRY – UNIT 2 · ALKENES & M DASH; ADDITION & POLYMERISATION

Topic 2.5 – Alkenes: electrophilic addition, Markovnikov's rule and addition polymerisation

Alkene chemistry: testing with bromine water, electrophilic addition mechanisms (HBr, H₂O, H₂), Markovnikov's rule for unsymmetrical addition, and forming addition polymers (poly(ethene), poly(propene), repeat units).

Legacy 2008 specification

Estimated time for entire question pack: ~1 h 44 min

Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (65 marks over 8 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC CH2 papers (2008 modular spec, Jan 2010 – Jun 2016) that maps onto the new-spec AS Unit 2 Topic 2.5.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. You may need the WJEC Periodic Table / Data Booklet.

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Q	Source	Max	Mark
1	Jun 12 Q7	13	
2	Jan 13 Q12	13	
3	Jun 13 Q7	12	
4	Jan 14 Q5	1	

Q	Source	Max	Mark
5	Jan 14 Q6	1	
6	Jun 14 Q5	2	
7	Jun 14 Q11	12	
8	Jun 15 Q8	11	
Total		65	

Alkenes – Addition & Polymerisation – what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 2: Energy, Rate & Chemistry of Carbon Compounds · Topic 2.5.

Alkenes – basics

- General formula C_nH_{2n} ; unsaturated.
- Reactive C=C double bond; high electron density.
- Decolorise bromine water (test for unsaturation).

Electrophilic addition

- Br_2 : alkene + $Br_2 \rightarrow$ dibromoalkane (no UV needed).
- HBr: alkene + HBr \rightarrow bromoalkane (electrophilic via carbocation).
- H_2O / steam: ethene + $H_2O \rightarrow$ ethanol (H_3PO_4 catalyst, $300^\circ C$, 60 atm).
- H_2 : alkene + $H_2 \rightarrow$ alkane (Ni catalyst).

Markovnikov's rule

- Unsymmetrical alkene + HX: H goes to C with most H's already.
- Major product: more stable carbocation intermediate.
- Tertiary > secondary > primary carbocation stability.

Addition polymerisation

- Monomer (alkene) \rightarrow long-chain polymer; no atoms lost.
- Poly(ethene), poly(propene), poly(chloroethene = PVC).
- Repeat unit shown in brackets [] with bonds extending out.
- Non-biodegradable – recycle, incinerate, or feedstock.

Alkenes – Addition & Polymerisation in one page

Quick-reference notes – revisit before each question.

Bromine water test

Orange $\text{Br}_2(\text{aq}) \rightarrow$ colourless if alkene present. Alkanes do not decolorise.

HBr + propene

Two possible products: 1-bromopropane and 2-bromopropane. Markovnikov \Rightarrow 2-bromopropane is major.

Hydration mechanism

Industrial ethanol: $\text{CH}_2=\text{CH}_2 + \text{H}_2\text{O} \xrightarrow{[\text{H}_3\text{PO}_4, 300^\circ\text{C}, 60 \text{ atm}]} \text{CH}_3\text{CH}_2\text{OH}$.

Hydrogenation

Alkene + $\text{H}_2 \xrightarrow{[\text{Ni}, \sim 150^\circ\text{C}]} \text{alkane}$. Used to harden vegetable oils into margarine.

Polymer drawing

Repeat unit: redraw monomer with the $\text{C}=\text{C}$ opened to single bond; place inside $[\]_n$ with bonds extending out the sides.

Recycling

Addition polymers inert & non-biodegradable. Mechanical recycling, feedstock recycling (back to monomers), or energy recovery via incineration.

SECTION B

Answer **all** questions in the spaces provided.

7. Boron, B, has the atomic number 5 and it forms a fluoride, BF_3 .
- (a) BF_3 is used to initiate certain types of addition polymerisation of unsaturated compounds.
- (i) Ethene is an example of an unsaturated compound. Describe the bonding between the carbon atoms in ethene. You may wish to draw a labelled diagram. [2]

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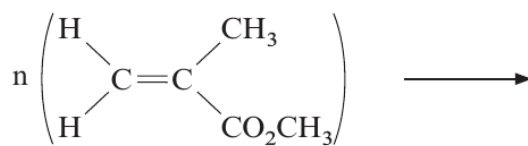
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- (ii) State what is meant by *polymerisation*. [1]

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- (iii) A colourless plastic used to cover lights is made from methyl methacrylate by a process similar to the polymerisation of ethene. Complete the equation by giving the formula of the repeating unit. [1]



- (iv) Addition polymerisation is used to make synthetic rubber. The molecular formula of the monomer used is $\text{C}_4\text{H}_5\text{Cl}$. What is the **empirical** formula of the synthetic rubber polymer? [1]

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- (b) (i) Use the VSEPR theory to deduce the shapes of BF_3 and NH_3 . [2]

Shape of BF_3

Shape of NH_3

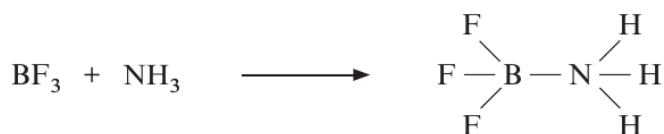
- (ii) Explain the difference in the shapes of BF_3 and NH_3 . [2]
QWC [1]

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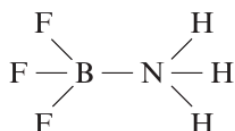
- (c) Boron fluoride reacts with ammonia, NH_3 , to make the compound shown in the following equation.



- (i) Name the type of bond formed between N and B. [1]

.....

- (ii) Suggest a value for the F–B–F bond angle in this molecule.



Bond angle [1]

- (iii) Explain your answer to part (ii). [1]

.....

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Total [13]



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12. But-2-ene is a useful starting material for the production of synthetic rubber.

(a) But-2-ene can be produced from crude oil by fractional distillation and then cracking.

(i) Explain why fractional distillation can be used to separate molecules with different numbers of carbon atoms. [1]

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.....

(ii) Write the equation for a cracking reaction that produces but-2-ene from decane, $C_{10}H_{22}$. [1]

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(b) Bromine solution can be used to distinguish between but-2-ene and butane.

(i) Give the colour **change** that would be expected when bromine solution is added to but-2-ene. [1]

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.....

(ii) In a similar reaction hydrogen bromide reacts with propene.

Draw the mechanism of the reaction of propene with hydrogen bromide indicating clearly all charges and the movement of electrons. [3]



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- (iii) Propene can be produced from the product in part (ii) by using sodium hydroxide. Give the condition(s) required for this reaction. [1]

.....
.....

- (c) But-2-ene can exist as *E*- and *Z*-isomers.
 - (i) Explain why but-2-ene can form *E*- and *Z*-isomers whilst propene and butane cannot. [2]

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- (ii) Draw the **skeletal** formula for *Z*-but-2-ene. [1]

- (d) In industry, butan-2-ol can be produced from but-2-ene. This uses the same reagent(s) and condition(s) as the production of ethanol from ethene.

- (i) Give the reagent(s) and condition(s) used for this reaction. [2]

Reagent(s)

Condition(s)

- (ii) Explain how infrared spectroscopy can be used to distinguish between butan-2-ol and but-2-ene. [1]

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Total [13]

Total Section B [70]

END OF PAPER



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GCE AS/A level

1092/01-A

**CHEMISTRY – DATA SHEET
FOR USE WITH CH2**

A.M. WEDNESDAY, 16 January 2013

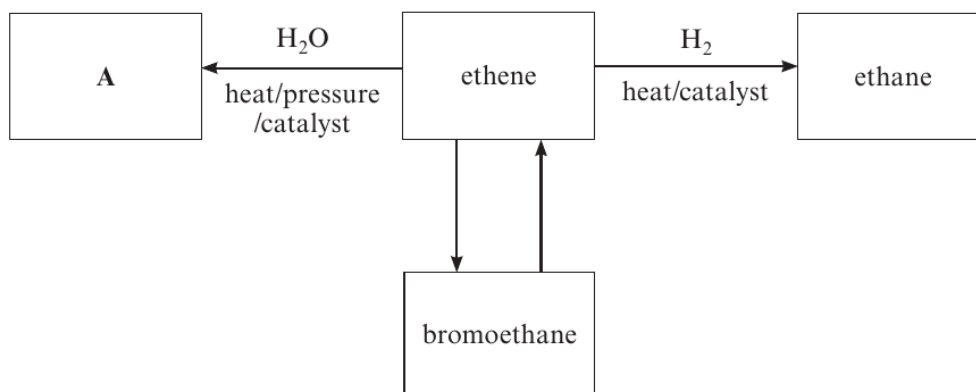
Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm⁻¹
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C=C	1620 to 1670
C=O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

SECTION B

Answer **all** questions in the spaces provided.

7. (a) Ethene can be used to make many useful compounds. Study the reaction scheme shown below then answer the following questions.



- (i) Draw the **displayed** formula of compound A. [1]

- (ii) Name the catalyst used in the conversion of ethene to ethane. [1]

- (iii) Name the reagent(s) and condition(s) necessary to convert bromoethane to ethene. [2]

- (iv) Classify the type of reaction taking place when ethene is formed from bromoethane. [1]



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(b) In the same way that ethene can be polymerised to give the polymer poly(ethene), propene can form poly(propene).

(i) Draw the repeating unit in poly(propene). [1]

(ii) Calculate how many monomer units are joined together to give poly(propene) if it has a relative molecular mass of 1.05×10^6 . [2]

Number of monomer units =

(c) (i) A bromoalkane was shown to contain 22.0% carbon and 73.4% bromine by mass. Calculate the **empirical** formula of the compound. [3]

Empirical formula

(ii) State what other information would be needed to be able to deduce the **molecular** formula of this compound. [1]

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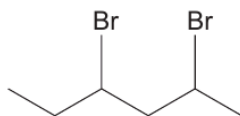
Total [12]

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4. (a) State the **molecular** formula of compound **L** that has the skeletal formula shown.



..... [1]

- (b) Compound **L** reacts with alcoholic sodium hydroxide solution to give hex-1,3-diene as one of the products.

State the type of reaction that has occurred. [1]

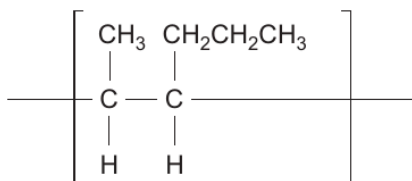
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5. In industry, ethanol is produced by reacting ethene with water / steam.

State the conditions of temperature and pressure used for this reaction. [1]

Temperature°C Pressure atm.

6. A section of an addition polymer is shown below.



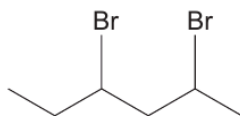
State the **systematic name** of the monomer that gives this polymer. [1]

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4. (a) State the **molecular** formula of compound **L** that has the skeletal formula shown.



..... [1]

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State the type of reaction that has occurred. [1]

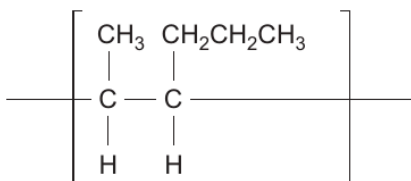
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5. In industry, ethanol is produced by reacting ethene with water / steam.

State the conditions of temperature and pressure used for this reaction. [1]

Temperature°C Pressure atm.

6. A section of an addition polymer is shown below.



State the **systematic name** of the monomer that gives this polymer. [1]

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4. The table below gives the electronegativity values of some elements.

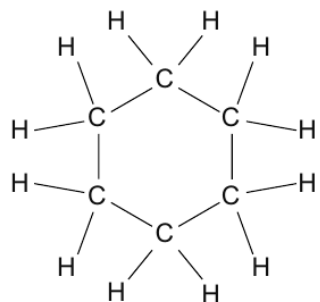
Atom	H	N	O	Al	Cl
Electronegativity value	2.1	3.0	3.5	1.6	3.0

- (a) Use the data in the table to identify any dipoles present in the following bonds. Mark their polarity clearly. [1]

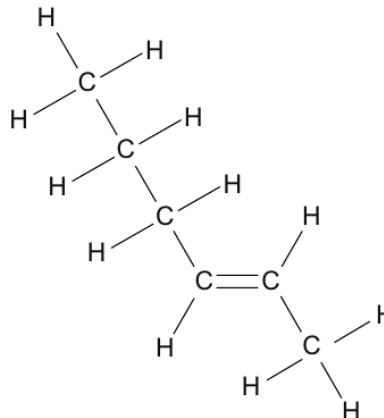


- (b) Use the data to give a reason why aluminium chloride is considered to be a covalent compound, while aluminium oxide is an ionic compound. [1]
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5. Cyclohexane and hex-2-ene are isomers. Give a chemical test to distinguish between these two compounds. [2]



cyclohexane



hex-2-ene

Reagent(s)

Observations

.....



0 3

11. (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]

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1092/01-A

**CHEMISTRY – DATA SHEET
FOR USE WITH CH2**

P.M. TUESDAY, 3 June 2014

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm⁻¹
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C=C	1620 to 1670
C=O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

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5. State the reagent(s) used and the colour change seen when a primary alcohol is oxidised to give a carboxylic acid. [2]

Reagent(s)

Colour change from to

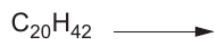
6. State the systematic name of the compound shown below. [1]



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7. On cracking, one molecule of $\text{C}_{20}\text{H}_{42}$ can produce one molecule of pentene, one molecule of hexene and one molecule of another product.

Complete the equation for this reaction. [1]



8. Draw the repeat unit of the polymer formed from the monomer $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$. [1]

Total Section A [10]

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END OF QUESTION PACK

8 questions · 65 marks · ~1 h 44 min

Source: WJEC CH2 (2008 modular spec, Jan 2010 – Jun 2016)

Curated for WJEC Chemistry 2015 spec AS Unit 2 – Topic 3 (2.5)

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