

## GCE AS / A LEVEL – CHEMISTRY UNIT 1 SUPPLEMENTARY QUESTION PACK

Sourced from legacy 1092-02 (CH2) papers · New spec Unit 1 Topic 10 · AS unit, 80 marks, 1h 30min paper

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# CHEMISTRY – UNIT 1 · IMF, ELECTRONEGATIVITY & POLARITY

Topic 1.4 – Intermolecular forces, electronegativity, bond polarity and hydrogen bonding

*Electronegativity values and bond polarity ( $\delta^+/\delta^-$ ), van der Waals forces, permanent dipole-dipole interactions, hydrogen bonding, and how IMF strength determines boiling temperature trends.*

Legacy 2008 specification · CH2 source

**Estimated time for entire question pack: ~40 min***Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (25 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 **supplementary practice question pack** for new-spec Unit 1. It contains every legacy WJEC CH2 question (2008 modular spec, Jun 2009 – Jun 2016) that maps onto 2015 AS Unit 1 Topic 1.4 – bonding, intermolecular forces, solid structures and periodicity were assessed in the old CH2 module but now belong in Unit 1 under the 2015 specification.

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	Jan 10 Q1	1	
2	Jan 10 Q2	1	
3	Jan 10 Q10	13	
4	Jan 11 Q5	3	

Q	Source	Max	Mark
5	Jan 13 Q3	2	
6	Jan 14 Q2	2	
7	Jun 14 Q4	2	
8	Jun 15 Q3	1	
<b>Total</b>		<b>25</b>	

## IMF, Electronegativity & Polarity – what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 1: The Language of Chemistry, Structure of Matter & Simple Reactions · Topic 1.4.

### Electronegativity

- Pauling: ability of an atom to attract bonding e<sup>-</sup> in a covalent bond.
- Increases across a period; decreases down a group.
- F (4.0) most electronegative; Cs/Fr least.
- $\Delta\chi$  small  $\Rightarrow$  non-polar covalent; medium  $\Rightarrow$  polar covalent; large ( $\sim$ >1.7)  $\Rightarrow$  ionic.

### Bond & molecular polarity

- Polar bond: unequal sharing  $\Rightarrow$   $\delta+$  on less electronegative atom.
- Polar molecule: net dipole moment (vector sum).
- Symmetrical molecules (CO<sub>2</sub>, CCl<sub>4</sub>) have polar bonds but no net dipole.
- Bent / pyramidal molecules with polar bonds are polar (H<sub>2</sub>O, NH<sub>3</sub>).

### Van der Waals (London) forces

- Instantaneous & induced dipoles from electron movement.
- Present in *all* molecules; only force in non-polar molecules.
- Strength  $\uparrow$  with M<sub>r</sub> and contact area (long unbranched chains).
- Explains b.p. trend in alkanes and noble gases.

### Dipole-dipole & hydrogen bonding

- Permanent dipole-dipole: weak attractive force between  $\delta+$  and  $\delta-$  ends.
- Hydrogen bond: special case – H bonded to **N, O or F** + lone pair on N/O/F.
- Much stronger than other IMFs; gives H<sub>2</sub>O anomalously high b.p.
- Ice less dense than water due to open H-bonded structure.

# IMF, Electronegativity & Polarity in one page

Quick-reference notes – revisit before each question.

## Electroneg quick

$F > O > Cl \approx N > Br > S \approx C > H$ .  $\Delta\chi > 1.7 \Rightarrow$  ionic-ish; 0.4–1.7 polar covalent;  $< 0.4$  essentially non-polar.

## Three IMFs

**vdW (London):** all molecules.

**Dipole-dipole:** polar molecules.

**H-bond:** H–N, H–O or H–F + lone pair on another N/O/F.

## Boiling point order

Same  $M_r$ : H-bonded  $>$  dipole  $>$  vdW only.

So  $CH_3OH$  (H-bond)  $>$   $CH_3F$  (dipole)  $>$

$CH_3CH_3$  (vdW).

## Branching effect

Branched alkanes pack less well  $\Rightarrow$  smaller vdW contact area  $\Rightarrow$  lower b.p. (n-pentane  $36^\circ C$  vs neopentane  $9^\circ C$ ).

## Anomalous $H_2O$

$H_2O$  b.p.  $100^\circ C$  vs predicted  $\sim -90^\circ C$  from period trend. Cause: extensive 3D H-bonding network.

## Net dipole test

If bond dipoles cancel by symmetry ( $CO_2$ ,  $CCl_4$ ,  $BF_3$ ) molecule is non-polar even with polar bonds.

## SECTION A

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

1. State which **one** of the following bonds is generally the **weakest**. [1]

- A Covalent  
B Hydrogen  
C Ionic  
D Van der Waals

2. State which **one** of the following formulae represents a compound that can show hydrogen bonding. [1]

- A  $\text{CH}_3\text{CH}_3$   
B  $\text{CH}_3\text{OCH}_3$   
C  $\text{HCl}$   
D  $\text{HF}$

3. Complete the table below by inserting the number of bonding pairs of electrons and name the shapes of the molecules involved. [3]

<i>Molecule</i>	<i>Number of bonding pairs of electrons in outer shell</i>	<i>Number of lone pairs of electrons in outer shell</i>	<i>Shape</i>
$\text{BeCl}_2$		0	Linear
$\text{PCl}_3$	3	1	
$\text{CCl}_4$	4	0	

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10. The electronegativities and melting temperatures of some of the elements in Groups 1-7 of the Periodic Table are shown in the table below.  
Some values have been omitted.

		Group						
		1	2	3	4	5	6	7
Period 2	Element	Li	Be	B	C graphite	N	O	F
	Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	Melting temperature / K	453	1550	2600	3730	63	54	53
Period 3	Element	Na	Mg	Al	Si	P	S	Cl
	Electronegativity	0.9	1.2	1.5	1.8	2.1	2.5	3.0
	Melting temperature / K	371	923		1680	317	392	172
Period 4	Element	K						Br
	Electronegativity	0.8						2.8
	Melting temperature / K	337						266

- (a) (i) Explain the meaning of the term *electronegativity*. [1]

.....  
 .....

- (ii) State the trend shown in electronegativity across a period. [1]

.....

- (iii) Explain this trend. [2]

.....  
 .....

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(b) (i) State the trends shown in melting temperature across Period 2. [2]

.....  
.....  
.....

(ii) Suggest a value for the melting temperature of aluminium. [1]

.....

(iii) Explain why the melting temperature of magnesium is higher than that of sodium. [2]

.....  
.....  
.....

(iv) Explain why the melting temperatures of the Group 7 elements increase down the group. [2]

.....  
.....  
.....

(c) Explain, in terms of bonding and structure, why graphite has a very high melting temperature. [2]

.....  
.....  
.....

Total [13]

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5. Use the electronegativity values given in the table below to answer the questions that follow.

Atom	B	H	C	O	Cl
Electronegativity value	2.0	2.1	2.5	3.5	3.0

- (a) Identify any dipoles present in the following bonds, marking their polarity clearly.



- (b) State which of the bonds in (a) will have the largest dipole. [1]
- .....

6. XeF<sub>2</sub> is one of the few noble gas compounds known. It reacts with water in the presence of a base according to the equation below.



Complete the table below to give the initial and final oxidation states of the xenon and oxygen atoms, noting whether oxidation or reduction has occurred. [2]

Element	Initial oxidation state	Final oxidation state	Oxidation or reduction
xenon			
oxygen			

**Total Section A [10]**

## SECTION A

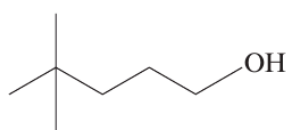
Answer **all** questions in the spaces provided.

1. Calcium and magnesium are essential elements in living things. Give **one** use of each element in biological systems. [1]

*Magnesium* .....

*Calcium* .....

2. Give the **systematic** name of the molecule shown below. [1]



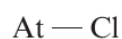
3. The electronegativity values of the halogens are listed below.

Atom	F	Cl	Br	I	At
Electronegativity value	4.0	3.0	2.9	2.6	2.2

- (a) Define the term *electronegativity*. [1]

.....  
.....

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



## SECTION A

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

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only

1. State which **one** of the following is a correct statement.

- A The first ionisation energy of the elements increases down Group 1
- B The melting temperature of the elements decreases down Group 7
- C The first ionisation energy of the elements increases across Period 2
- D The elements in Group 2 become more electronegative down the group

[1]

2. Chlorine monofluoride has the following formula.



(a) Indicate the polarity in the bond shown by use of the symbols  $\delta^+$  and  $\delta^-$ , giving a reason for your answer. [1]

.....

.....

(b) Draw a dot and cross diagram to illustrate the bonding between the two atoms in chlorine monofluoride. Include **all** outer shell electrons. [1]

3. State why a fluoride ion,  $\text{F}^-$ , is more stable than a fluorine atom. [1]

.....

.....

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

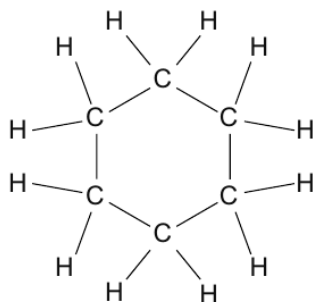
Atom	H	N	O	Al	Cl
Electronegativity value	2.1	3.0	3.5	1.6	3.0

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

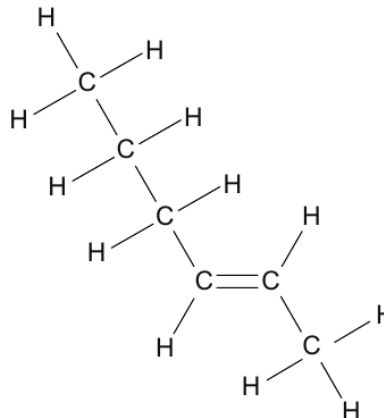


- (b) Use the data to give a reason why aluminium chloride is considered to be a covalent compound, while aluminium oxide is an ionic compound. [1]
- .....
- .....
- .....

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

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only**SECTION A***Answer all questions in the spaces provided.*

1. Complete the electronic structure for the oxide ion present in magnesium oxide. [1]

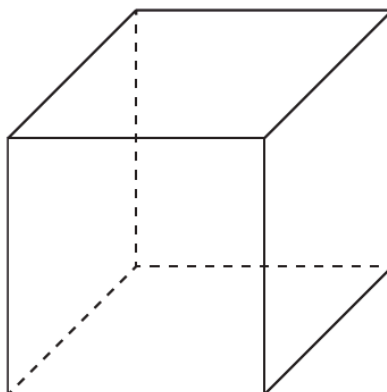
1s<sup>2</sup> .....

2. Draw a dot and cross diagram to show the bonding in calcium fluoride. You should include outer electrons only and give any charges. [2]

3. Give the meaning of the term *electronegativity*. [1]

.....  
.....

4. Complete and label the diagram to show the positions of the ions present in caesium chloride, CsCl. [1]



**END OF QUESTION PACK**

8 questions · 25 marks · ~40 min  
Source: WJEC CH2 (2008 modular spec, Jun 2009 – Jun 2016)  
Curated for WJEC Chemistry 2015 spec AS Unit 1 – Topic 10 (1.4)

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