Higher Chemistry: Unit 1 – Chemical Changes and Structure

REVISION OF PERIODICITY

SUMMARY and Revision Questions

REVISION TOPICS

This revision session will let you revise the following concepts:

1. Bonding and structure in the first 20 elements
2. Covalent Radius
3. Ionisation Energy
4. Electronegativity

Success Criteria

You will have been successful in this lesson if you:

1. Read the summaries below (there is no need to copy/print these)
2. Watch the link provided
3. Try the further reading section if you feel you need more help with this topic.
4. Completed the revision questions

If you have any questions about the content of this lesson, you should ask your class teacher either through your class zoom or via email. The teams will be monitored through the week and someone will get back to you as soon as they can.

Links to Prior Knowledge

You should revise the following to help you understand this summary:

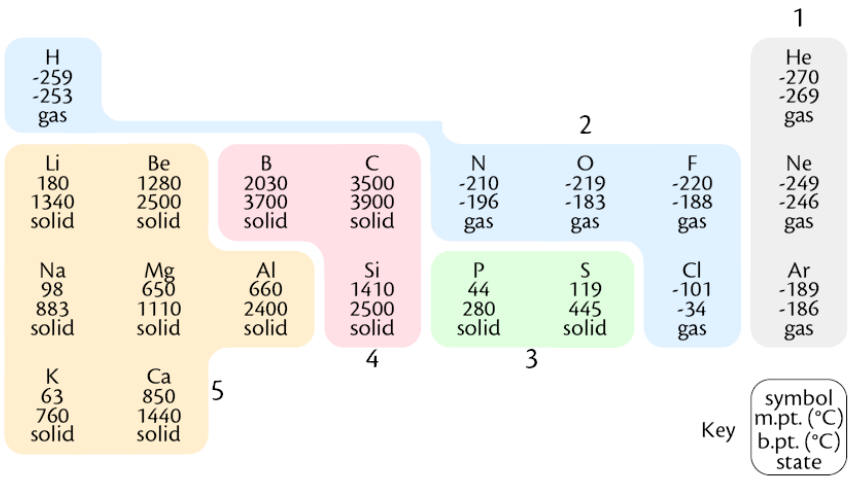
Chemical Changes and Structure Part A – Periodicity

You will need a data booklet for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or from the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

SUMMARY

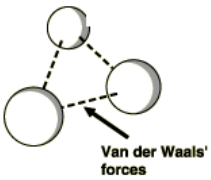
The First 20 Elements – Bonding and Structure

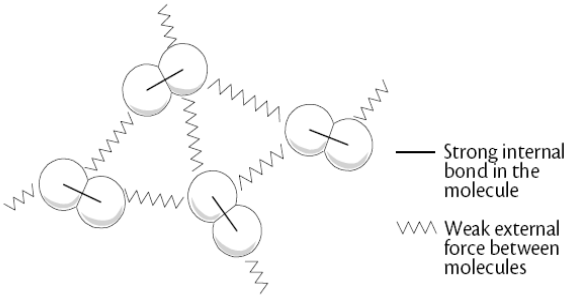
The first 20 elements of the periodic table can be divided into 5 groups based on their bonding and structure, as shown below.



1. Monatomic Gases

These are the Noble gases, Helium, Neon and Argon. They are completely unreactive and exist as single atoms held together only by weak Van der Waals forces.



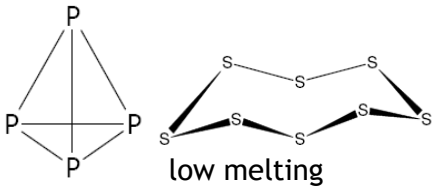


2. Covalent Molecular Gases

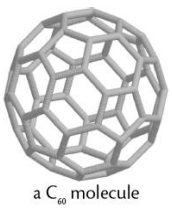
Hydrogen, Nitrogen, Oxygen, Fluorine and Chlorine all exist as diatomic molecules (H_2, N_2 etc) and are all gases at room temperature. Atoms are held to each other by strong covalent bonds, but molecules held together by weak intermolecular forces.

3. Covalent Molecular Solids

Phosphorous, sulfur and carbon (fullerene) exist as molecules but larger than diatomic: P_4, S_8 and C_{60}. All are solid at room temperatures, but will still have relatively points.



low melting



4. Covalent Networks (revision from Nat 5)

5. Metals (revision from Nat 5)

Patterns in the Periodic Table: Periodicity

1. Covalent Radius (Atomic Size)

	Electron arrangement	Covalent radius (pm)
Li	2, 1	123
Na	2, 8, 1	157
K	2, 8, 8, 1	203
Rb	2, 8, 18, 8, 1	216
Ca	2, 8, 18, 18, 8, 1	235

Covalent radius decreases along the period because:

Nuclear charge increases, pulling the electrons closer to the nucleus.

Covalent radius increases down a group because:

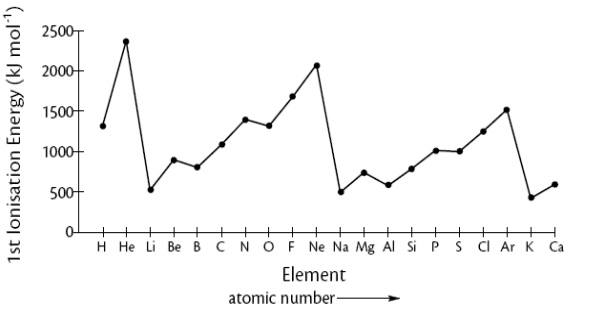
The number of **occupied electrons shells increases**

2. Ionisation Energy

Ionisation energy **increases along the period** because:

- **Nuclear charge increases** and **atomic size decreases** so electrons are held with a **greater force**.

The graph shows the variation of 1st Ionisation Energies with Atomic Number.



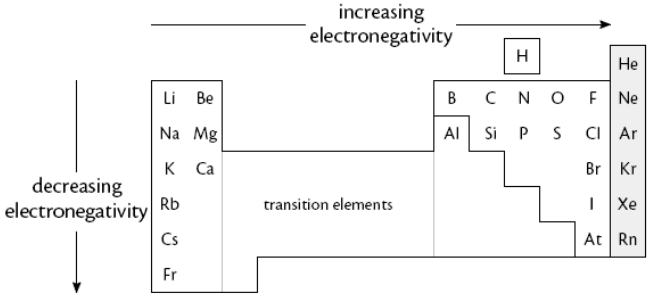
Ionisation energy **decreases down a group** because:

- Outer electrons are **increasingly further away** from nuclear attraction
- **AND** there is a **screening effect** (or shielding effect) due to **electrons on inner shells**.

$Na^{+}_{(g)} \rightarrow Na^{2+}_{(g)} + e^{-}$ requires much more energy because:
It involves removal of an electron from an electron shell which is closer to the nucleus.
AND the electron is less shielded from the nucleus.

3. Electronegativity

Trends for electronegativity are THE SAME AS the trends for ionisation energy.



WATCH - YOUTUBE: Professor Dave Explains: https://youtu.be/hePb00CqvP0

This is an 8 minute summary of what you've learned so far. Some of the content is above Higher level, so feel free to ignore or skip from 4:35 – 6:18

Further Reading

To revise Periodicity even more. Follow the links below:

BBC Bitesize: https://www.bbc.co.uk/bitesize/guides/zxc99j6/revision/1

Read pages 1 to 8 and try the test

Scholar: Log in through GLOW

Higher Chemistry → Chemical changes and structure → look at topics 1-3 and try each of the end of topic tests

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher → Periodicity

Revision Questions

REVISION EXERCISE - PERIODICITY

1. Which of the following reactions refers to the <u>second</u> ionisation energy of Magnesium?

A $Mg_{(s)} \rightarrow Mg^{2+}_{(g)} + 2e^-$
B $Mg_{(g)} \rightarrow Mg^{2+}_{(g)} + 2e^-$
C $Mg^{2+}_{(g)} \rightarrow Mg^{+}_{(g)} + e^-$
D $Mg^{+}_{(g)} \rightarrow Mg^{2+}_{(g)} + e^-$

2. Which of the following atoms has the least attraction for bonding electrons?

A Carbon
B Nitrogen
C Phosphorus
D Silicon

3. As the relative atomic mass in the halogens increases…

A The boiling point increases
B The density decreases
C The first ionisation energy increases
D The atomic size decreases

4. Which of the following equations represents the first ionisation energy of fluorine?

A $F^-_{(g)} \rightarrow F_{(g)} + e^-$
B $F^-_{(g)} \rightarrow \frac{1}{2}F_{2(g)} + e^-$
C $F_{(g)} \rightarrow F^+_{(g)} + e^-$
D $\frac{1}{2}F_{2(g)} \rightarrow F^+_{(g)} + e^-$

5. As the atomic number of the alkali metals increases…

A The first ionisation energy decreases
B The atomic size decreases
C The density decreases
D The melting point increase

6. Which line in the table is likely to be correct for the element francium?

	State at 30°C	First Ionisation Energy / $kJmol^{-1}$
A	Solid	Less than 376
B	Liquid	Less than 376
C	Solid	Greater than 376
D	Liquid	Greater than 376

7. The table shows the first three ionisation energies of aluminium

Ionisation energy / kJmol^{-1}		
1st	2nd	3rd
578	1817	2745

Using this information, what is the enthalpy change, in kJmol^{-1}, for the following reaction?

$$Al^{3+}_{(g)} + 2e^{-} \rightarrow Al^{+}_{(g)}$$

A +2167
B −2167
C +4562
D −4562

8. A potassium atom is larger than a sodium atom because potassium has

A a larger nuclear charge
B a larger nucleus
C more occupied energy levels
D a smaller ionisation energy.

9. Which of the following elements has the greatest attraction for bonding electrons?

A Lithium
B Chlorine
C Sodium
D Bromine

10. Which type of bonding is <u>never</u> found in elements?

A metallic
B covalent
C ionic
D monatomic

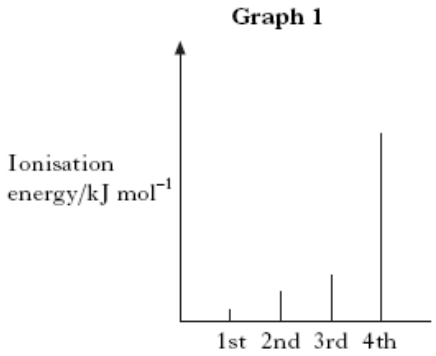
11. Lithium starts the second period of the Periodic Table.

Li	Be	B	C	N	O	F

(a) In general, what is the trend in atomic radius from lithium to fluorine? **(1)**

(b) Explain the trend in question (a) **(1)**

12. Graph 1 shows the first four ionisation energies for aluminium.



(a) Write an equation to represent the fourth ionisation energy of aluminium **(1)**

(b) Explain fully why is the fourth ionisation energy of aluminium so much higher than the third ionisation energy? **(2)**

(c) Suggest why the data booklet has no value for the fourth ionisation energy for Lithium. **(1)**

13. Information about the periodicity can be found in the data booklet, page eleven.

(a) State what is meant be the term *electronegativity*. **(1)**

(b) Which element has the highest electronegativity listed on page 11 of the data booklet? **(1)**

(c) Write an equation, with state symbols, for the first ionisation energy for nitrogen. **(1)**

14. The ability of an atom to form a negative ion is measured by its "Electron Affinity".

The Electron Affinity is defined as the energy change when one mole of gaseous atoms of an element combines with one mole of electrons to form gaseous negative ions.

Write the equation, showing state symbols, that represents the Electron Affinity of chlorine. **(1)**

Total = 20

Answers will be given on Wednesday for you to mark yourself

EXTENSION WORK

If you have already completed the above exercise and would like more practise questions on this topic, you should complete the following questions from you Blue Book:

Bonding and structure in the first twenty elements	page 7 Q3- 11
Covalent and ionic radius	page 10 Q2-4
Ionisation energy and electronegativity	page 12 Q3-10