

IB DP CHEMISTRY

Structure 3 · Classification of Matter

TOPICAL WORKSHEET

S3.1 The Periodic Table: Classification of Elements

S3.2 Functional Groups: Classification of Organic Compounds

Standard and Higher Level · Syllabus 2025

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Section A — Multiple Choice (15 marks)

Circle the letter of the best answer to each question. Each question is worth 1 mark.

1. Electronegativity is best defined as [1]
A the energy required to remove an electron from a gaseous atom
B the relative ability of an atom to attract the shared pair of electrons in a covalent bond
C the energy released when an atom gains an electron
D the number of valence electrons in an atom's outer shell
2. Which of these Period 3 elements has the highest electronegativity? [1]
A Na
B Si
C S
D Cl
3. The reactivity of Group 1 metals with water increases going down the group. This is mainly because [1]
A the atomic radius decreases down the group, making electron loss easier
B the first ionization energy decreases down the group, making electron loss easier
C the number of valence electrons increases down the group
D the melting point increases down the group
4. Across Period 3 from sodium to chlorine, the oxides of the elements change from [1]
A acidic to basic
B basic to acidic
C basic to neutral only
D acidic to neutral only
5. A metalloid (semi-metal) such as silicon is best described as an element that [1]
A conducts electricity as well as a typical metal
B has properties intermediate between metals and non-metals, often behaving as a semiconductor
C only forms ionic compounds
D is always a gas at room temperature
6. A horizontal row of the periodic table is called a [1]
A group
B period
C series
D block

7. Metallic character generally [1]
A increases across a period and increases down a group
B decreases across a period and increases down a group
C increases across a period and decreases down a group
D decreases across a period and decreases down a group
8. Which of the following elements would be classified as a non-metal? [1]
A Magnesium
B Aluminium
C Sulfur
D Sodium
9. The functional group -OH , found in alcohols, is called the [1]
A carbonyl group
B carboxyl group
C hydroxyl group
D amine group
10. A homologous series is best described as a family of compounds that [1]
A all have exactly the same molecular formula but different structures
B share the same functional group and general formula, differing by CH_2 between successive members
C have identical physical properties regardless of chain length
D contain no carbon atoms
11. The general formula for a straight-chain alkane is [1]
A C_nH_{2n}
B $\text{C}_n\text{H}_{2n+2}$
C $\text{C}_n\text{H}_{2n-2}$
D C_nH_n
12. Two compounds with the same molecular formula but different structural arrangements of atoms are called [1]
A isotopes
B isomers
C allotropes
D homologues
13. Which functional group is present in a carboxylic acid? [1]
A -OH only
B -COOH
C -CHO
D -NH_2

14. Within the homologous series of straight-chain alkanes, boiling point increases with increasing chain length mainly because **[1]**

- A the C—C covalent bonds become stronger
- B hydrogen bonding between molecules becomes stronger
- C the strength of London (dispersion) forces between molecules increases with the number of electrons/molar mass
- D the molecules become more polar

15. Propan-1-ol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$) has a considerably higher boiling point than propane ($\text{CH}_3\text{CH}_2\text{CH}_3$) of similar molar mass. This is mainly because **[1]**

- A propan-1-ol molecules can form hydrogen bonds with each other, in addition to London forces
- B propane has stronger covalent bonds
- C propan-1-ol has a smaller molecule
- D propane molecules are ionic

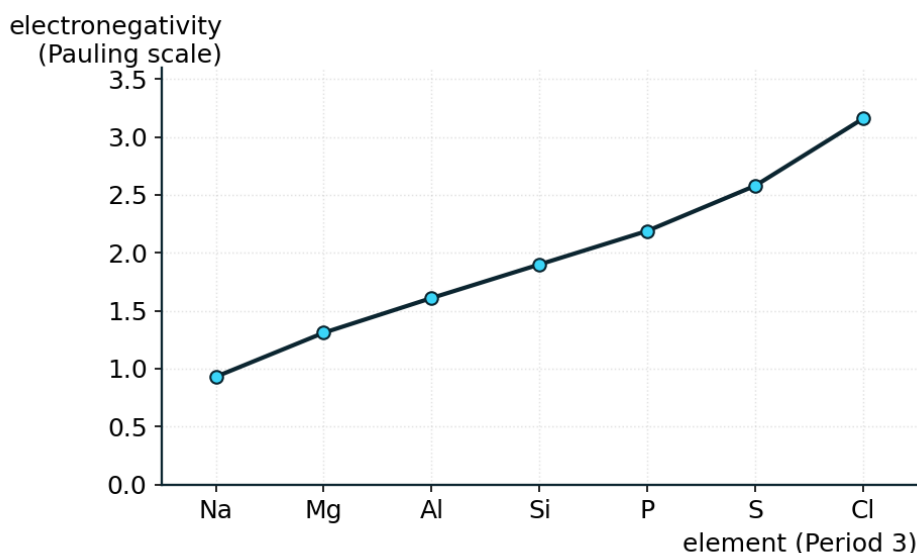
Section B — Structured Questions (65 marks)

Answer all questions in the space provided. Working must be shown for full marks.

S3.1 The Periodic Table

Question 1 [7 marks]

The graph shows the electronegativity (Pauling scale) of the Period 3 elements from sodium to chlorine.



Electronegativity across Period 3 (given data).

(a) Using the graph, identify the elements with the highest and lowest electronegativity shown. [2]

(b) Describe and explain the general trend in electronegativity across Period 3. [3]

(c) Explain why the noble gas argon is usually omitted from electronegativity trends and data tables. [2]

Question 2 [6 marks]

The Group 1 metals (lithium, sodium, potassium) react with water with increasing vigour going down the group.

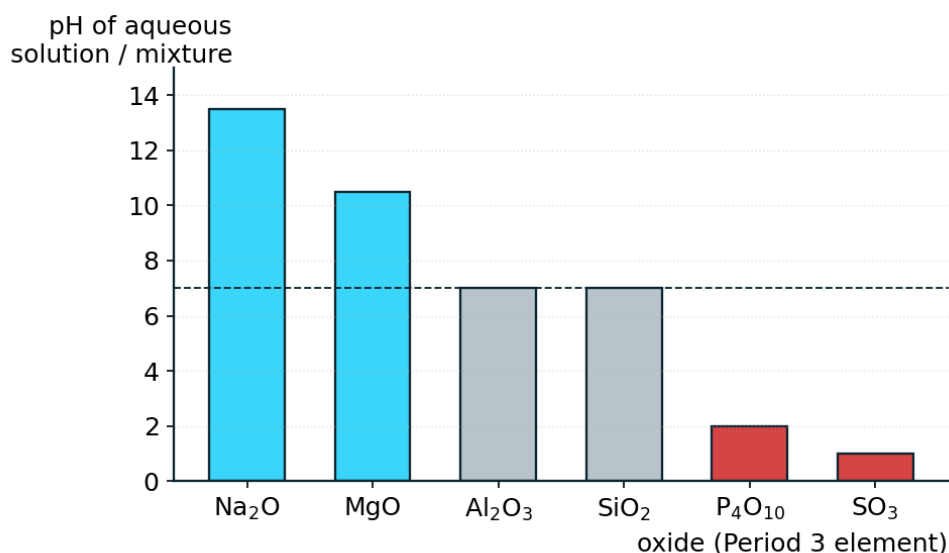
(a) Describe how the reactivity of Group 1 metals with water changes going down the group. [2]

(b) Explain this trend in reactivity in terms of atomic structure.

[4]

Question 3 [7 marks]

The graph shows the approximate pH of the aqueous solutions (or mixtures) formed by the oxides of the Period 3 elements.



Approximate pH of Period 3 oxide solutions/mixtures (given data).

(a) Using the graph, identify one basic oxide and one acidic oxide from Period 3.

[2]

(b) Explain the general trend from basic to acidic oxides across Period 3, in terms of metallic/non-metallic character.

[3]

(c) Al₂O₃ has a pH close to neutral in the graph. Classify its behaviour and explain what this means.

[2]

Question 4 [6 marks]

Silicon (Si, Group 14) lies on the boundary between metals and non-metals in the periodic table.

(a) Classify silicon and state one physical property that justifies this classification. [2]

(b) Describe how metallic character changes (i) across a period and (ii) down a group of the periodic table. [2]

(c) Using the trends in part (b), suggest whether tin (Sn), directly below silicon in Group 14, would be expected to show more or less metallic character than silicon. [2]

Question 5 [6 marks]

The diagram shows a simplified classification of some Period 2 and Period 3 elements as metals, metalloids, or non-metals.

Classification of elements, Periods 2-3 (schematic)

Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

metal
 metalloid
 nonmetal

Classification of elements, Periods 2-3 (schematic).

(a) Using the diagram, identify one metal, one metalloid, and one non-metal from Period 3. [2]

(b) Describe the general position of the metalloids in the periodic table, based on the diagram. [2]

(c) State one physical property that generally differs between a metal and a non-metal element shown in the diagram. [2]

S3.2 Functional Groups

Question 6 [6 marks]

Alkanes form a homologous series of saturated hydrocarbons.

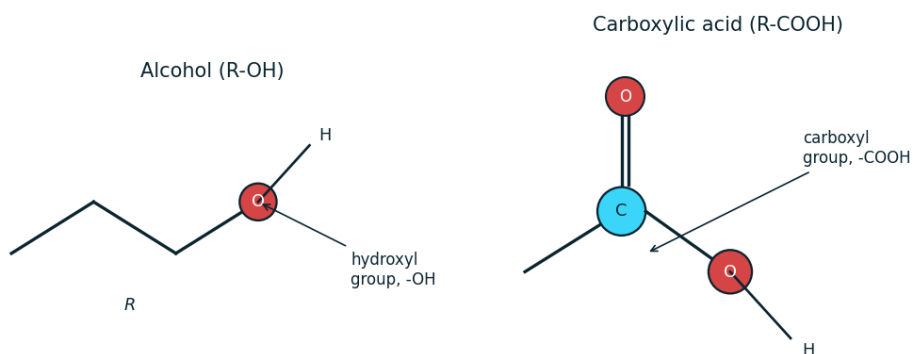
(a) Define the term 'homologous series'. [2]

(b) State the general formula of the alkanes, and use it to deduce the molecular formula of the alkane with 6 carbon atoms. [2]

(c) Identify the functional group present in ethanol, $\text{CH}_3\text{CH}_2\text{OH}$. [2]

Question 7 [7 marks]

The diagrams show the structures of two important functional groups found in organic compounds.



Functional groups: alcohol (hydroxyl) and carboxylic acid (carboxyl), schematic.

(a) Identify the functional group and name the homologous series shown in each diagram. [2]

(b) State the general formula for a straight-chain, saturated carboxylic acid in terms of n (number of carbon atoms). [2]

(c) Describe a simple chemical test that could be used to distinguish a carboxylic acid from an alcohol. [3]

Question 8 [6 marks]

Consider the straight-chain alcohol with the structural formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$.

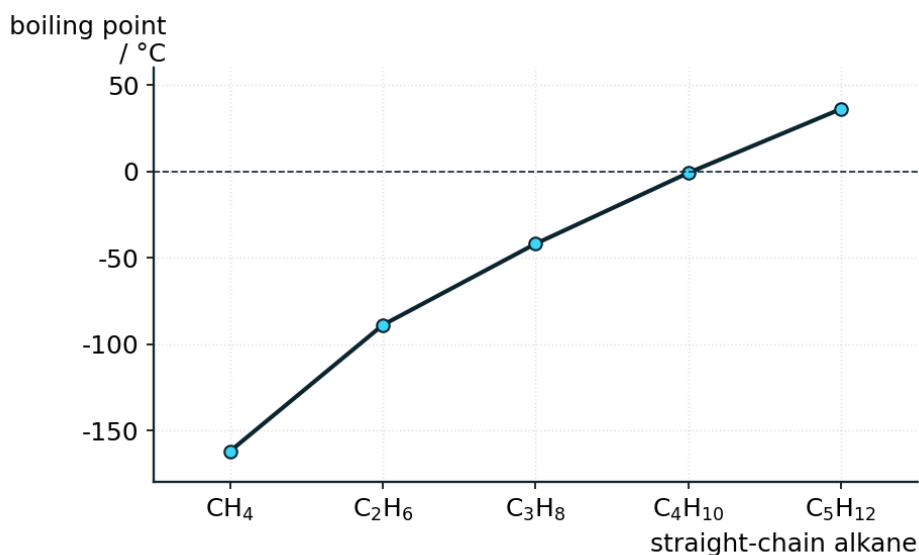
(a) Give the IUPAC name of this compound. [2]

(b) Draw or describe the structure of a structural isomer of this compound that is also an alcohol. [2]

(c) State the type of isomerism shown between propan-1-ol and propan-2-ol. [2]

Question 9 [7 marks]

The graph shows the boiling points of the first five members of the straight-chain alkane homologous series.



Boiling point vs chain length, straight-chain alkanes (given data).

(a) Describe the trend in boiling point shown in the graph as the number of carbon atoms increases. [2]

(b) Explain this trend in terms of intermolecular forces. [3]

(c) Using the trend in the graph, predict the boiling point of hexane, C₆H₁₄ (the next member of the series). [2]

Question 10 [7 marks]

Ethanol (CH₃CH₂OH, boiling point 78°C) and ethane (CH₃CH₃, boiling point -89°C) have similar molar masses but very different boiling points. Ethanoic acid (CH₃COOH, boiling point 118°C) has a functional group related to that of ethanol.

(a) Explain why ethanol has a much higher boiling point than ethane. [3]

(b) Explain why ethanoic acid has an even higher boiling point than ethanol. [2]

(c) State the functional group responsible for the hydrogen-bonding capability of both ethanol and ethanoic acid.

[2]