PERIODIC TABLE OF THE ELEMENTS

Group 1: Alkali Metals

Li  
Na  
K  
Rb  
Cs

1. Each atom has one .................................................................

2. That's why the elements in the group have similar ............................ properties.

3. All atoms in the group can form ion with one positive charge. 
   How?
   ............................................................................................

4. The reactivity of alkali metals increases down the group. Why?
   • Atomic size increases.
   • Distance of valence electron from nucleus is further.
   • Attraction between nucleus and valence electron is weaker.
   • Easier to donate/ release the valence electron.

5. Chemical properties:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Product</th>
<th>Chemical equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>With water.</td>
<td>Alkali and hydrogen gas</td>
<td>2Li + 2H₂O → 2LiOH + H₂</td>
</tr>
<tr>
<td>With oxygen.</td>
<td>Oxide metal / base.</td>
<td>4Li + O₂ → 2Li₂O (white)</td>
</tr>
<tr>
<td>Base dissolves in water.</td>
<td>Alkali</td>
<td>Li₂O + H₂O → 2LiOH</td>
</tr>
<tr>
<td>with halogen (chlorine,</td>
<td>Salt</td>
<td>2Li + Cl₂ → 2LiCl (white)</td>
</tr>
</tbody>
</table>
### Group 18: Noble Gas

<table>
<thead>
<tr>
<th>Element</th>
<th>Electron Configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>2</td>
<td>Stable / duplet electron arrangement</td>
</tr>
<tr>
<td>Ne</td>
<td>2.8</td>
<td>Octet electron arrangement</td>
</tr>
<tr>
<td>Ar</td>
<td>2.8.8</td>
<td></td>
</tr>
<tr>
<td>Kr</td>
<td>2.8.18.8</td>
<td></td>
</tr>
<tr>
<td>Xe</td>
<td>2.8.18.18.8</td>
<td></td>
</tr>
<tr>
<td>Rn</td>
<td>2.8.18.32.18.8</td>
<td></td>
</tr>
</tbody>
</table>

1. Elements in this group are in the form of **monatomic**.

2. They are **chemically inert**, whereas they do not easily ... or ... electrons with others.

3. This is because their outer shell is fully filled with ... electrons (except He).

4. **Physical Properties** :

   i) When going down the group, the atomic radius ... This is because ...

   ii) When going down the group, the melting point and boiling point ... This is because ...

### Group 17: HALOGEN

<table>
<thead>
<tr>
<th>Element</th>
<th>Electron Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>2.7</td>
</tr>
<tr>
<td>Cl</td>
<td>2.8.7</td>
</tr>
<tr>
<td>Br</td>
<td>2.8.18.7</td>
</tr>
<tr>
<td>I</td>
<td>2.8.18.18.7</td>
</tr>
<tr>
<td>As</td>
<td>2.8.18.32.18.7</td>
</tr>
</tbody>
</table>

1. Diatoms at room temperature. (Cl₂, Br₂, I₂)

2. Each atom has seven ... 

3. That’s why the elements in the group have similar ...

4. All atoms in the group can form ion with one ... charge. How?
5. Chemical properties:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Product</th>
<th>Chemical equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>With water. acid</td>
<td>Cl₂  + H₂O → HCl + HOCl</td>
<td></td>
</tr>
<tr>
<td>With alkali. salts</td>
<td>Cl₂  + 2KOH → KCl + KOCl + H₂O</td>
<td></td>
</tr>
<tr>
<td>With metal (iron). salt</td>
<td>2Fe  + 3Cl₂ → 2FeCl₃ (brownish)</td>
<td></td>
</tr>
</tbody>
</table>

6. The Melting Point and Boiling Point increases down Group 17. Why?

- Molecular size increases.
- Forces between molecules become stronger.
- More heat energy is needed to overcome the forces.

Elements across the Period:

1. 

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cl</th>
<th>Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxide</td>
<td>Na₂O</td>
<td>MgO</td>
<td>Al₂O₃</td>
<td>SiO₂</td>
<td>P₂O₅</td>
<td>SO₂</td>
<td>Cl₂O₇</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special characteristic</td>
<td>Earthing</td>
<td>Amphoteric</td>
<td>Acidic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Changes of elements when across the period

- atomic size decreases
- melting point increase then decreases
- electronegativity increases
- from metals to non-metals
- Chemical properties from basic to acidic.

3. Why the atomic size (atomic radius) decreases across the period?

- Proton numbers increase.
- The numbers of electrons in shells increase.
- The positive charges in nucleus increase.
- The force of attraction from nucleus towards all the electrons in the shell increases.
- Thus the atomic size increase.

Transition elements

1. State special characteristic of transition elements and examples.

<table>
<thead>
<tr>
<th>Special characteristic</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form coloured ions.</td>
<td>Cu²⁺ - blue, Cr³⁺ - green, Fe³⁺ - brown</td>
</tr>
</tbody>
</table>
PAPER 2 – STRUCTURE

1. Diagram 1 shows part of the Periodic Table of the Elements A, B, C, D, E and F do not represent the actual symbol of the elements.

```
    A
   C D
 B
 E F
```

Diagram 1

Using the letters in the Periodic Table of the Elements in Diagram 1, answer the following questions.

(a) (i) State the position of element B in the Periodic Table.

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

[2 marks]

(ii) Choose the element which exhibit different oxidation numbers in its compounds.

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

[1 mark]

(b) Element E combines with element A to form a compound.

(i) Write the chemical formula of this compound.

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

[1 mark]

(ii) State one physical property of this compound.

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

[1 mark]

(c) B and E have the same chemical properties.

(i) Which element is more reactive?

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

[1 mark]

(ii) Explain your answer in (c) (i).

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

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

[2 marks]
(d) (i) Which element exists as diatomic molecules?

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

[1 mark]

(ii) Name the chemical bond in these diatomic molecules.

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

[1 mark]

2. Diagram 2 shows part of the Periodic Table of the Elements. P, Q, R, S and T do not represent the actual symbol of the elements.

![Diagram 2]

(a) Using the Periodic Table of the Elements in Diagram 2, answer the following questions.

(i) Choose an element that is a halogen.

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

[1 mark]

(ii) Which element is monoatomic?

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

[1 mark]

(iii) Which element forms an amphotheric oxide?

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

[1 mark]

(b) Arrange P, Q, R, S and T according to increase in size of the atoms.

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

[1 mark]
(c) Write the electron arrangement for an atom of element S.

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

[1 mark]

(d) Write the formula for the ion formed from an atom of element T.

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

[1 mark]

(e) Why are elements P and Q placed in the same period?

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

[1 mark]

(f) When a small piece of element R is put into water, ROH solution is formed and hydrogen gas is released. State one observation when red litmus paper is put into the water.

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

[1 mark]

(g) State the common name of the elements between Group 2 and Group 13.

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

3. The diagram 3 shows part of the Periodic Table of the Elements. A, B, C, D, E, F and G do not represent the actual symbol of the elements.

![Periodic Table Diagram]

**Diagram 3**

Using the letters in the Periodic Table of the Elements in Diagram 3, answer the following questions

(a) Write the formula for the ion formed from an atom of

(i) element D

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

[1 mark]
(ii) element B

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

[1 mark]

(b) F is a reactive metal that is situated in Group 1.

(i) Give the number of electrons in ion F⁺?

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

[1 mark]

(ii) What is the electron arrangement of ion F⁺?

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

[1 mark]

(c) Which of the elements can be used as a catalyst?

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

[1 mark]

(d) Element D reacts with element E to form a compound

(i) Write the chemical formula of this compound

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

[1 mark]

(ii) Draw the diagram of the electron arrangement for the compound formed between D and E.

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

[2 marks]

(iii) State one condition by which the compound in (d) (ii) conducts electricity?

   Explain your answer.

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

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

[2 marks]
4. Diagram 4.1 and 4.2 show the diagrams of the electron arrangement for atoms of two elements from Group 17 in the Periodic Table of the Elements.

(a) Based on Diagram 4.1
(i) Write the electron arrangement for the atom of the element and name the element. [2 marks]
(ii) Write a chemical equation for the reaction between this element and sodium hydroxide. [3 marks]

(b) Compare the attractive forces between the nuclei and the valence electrons in the atoms in Diagram 4.1 and Diagram 4.2 and relate this to their respectively reactivity. [6 marks]

(c) Another element in Group 17 is a black coloured solid. Predict the reactivity of this element in its reaction with sodium hydroxide compared to that of the element in the Diagram 4.2. [1 mark]

(d) Diagram 4.3 shows the set up of the apparatus to investigate the reaction of an element from Group 17 with iron metal.
(i) State two precautions that must be taken while carrying out the experiment. [2 marks]

(ii) Describe and write the chemical equations for the reactions that occur in Part A and Part B. [6 marks]

**PAPER 3 – STRUCTURE**

5. An experiment is carried out to investigate the statement above. Table 5 shows the apparatus set up and the observations for the experiment to determine the reactivity of the Group 1 elements based on their reactions with water.

<table>
<thead>
<tr>
<th>Apparatus set-up</th>
<th>Observation towards the metal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lithium</strong></td>
<td>Lithium moves slowly on the surface of the water with a “hiss” sound.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram of Lithium and water" /></td>
</tr>
<tr>
<td><strong>Potassium</strong></td>
<td>Potassium moves vigorously and randomly on the surface of the water with a “hiss” sound.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram of Potassium and water" /></td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>Sodium moves quickly and randomly on the surface of the water with a “hiss” sound.</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram of Sodium and water" /></td>
</tr>
</tbody>
</table>

**Table 5**

(a) State the variables that are involved in the experiment.

<table>
<thead>
<tr>
<th>Name of variables</th>
<th>Action to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Manipulated variable:</td>
<td>(i) The way to manipulate variable:</td>
</tr>
<tr>
<td>(ii) Responding variable:</td>
<td>(ii) What to observe in the responding variable:</td>
</tr>
<tr>
<td>(iii) Controlled variable:</td>
<td>(iii) The way to maintain the controlled variable:</td>
</tr>
</tbody>
</table>

[6 marks]
(b) State one hypothesis for the experiment.

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

[3 marks]

(c) State the operational definition for the reaction.

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

[3 marks]

(d) Based on the observations in the figure above, arrange lithium, potassium and sodium in the descending order of reactivity of metals towards water.

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

Descending order of reactivity of metals towards water.

[3 marks]

(e) Solution X was produced from the reaction of potassium with water. Classify the ions that exist in solution X into positive ions and negative ions.

<table>
<thead>
<tr>
<th>Positive Ions</th>
<th>Negative Ions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[3 marks]

PAPER 3 – ESSAY

6. The reactivity of the alkali metals increases as you go down the group

Refering to the statement above, plan an experiment to prove it true by using the reactions of lithium, sodium and potassium with water. Your planning must include the following items:

(a) Problem statement
(b) All variables involved
(c) List of materials and apparatus
(d) Experimental procedure
(e) Tabulation of data

[17 marks]
CHEMICAL BONDS

FORMATION OF IONS

Cations

Lithium atom, Li

Releases 1 electron

Lithium ion, Li⁺

Half equation:
Li → Li⁺ + e

Magnesium atom, Mg

Releases 2 electrons

Magnesium ion, Mg²⁺

Half equation:
Mg → Mg²⁺ + 2e

Anions

Fluorine atom, F

Receives 1 electron

Fluoride ion, F⁻

Half equation:
F + e → F⁻

Oxygen atom, O

Receives 2

Oxide ion, O²⁻

Half equation:
O + 2e → O²⁻
FORMATION OF IONIC BONDS

a) Formation of sodium chloride compound, NaCl

Sodium atom + Chlorine atom → [Sodium ion] + [Chloride ion]

Explanation:
- The electron arrangement of sodium atom is 2.8.1 and chlorine atom is 2.8.7
- To achieve octet electron arrangement:
  - Sodium atom releases one electron to form sodium ion, Na⁺.
    
    \[ \text{Half equation: } \text{Na} \rightarrow \text{Na}^+ + e^- \]
  - Chlorine atom receives one electron to form chloride ion, Cl⁻.
    
    \[ \text{Half equation: } \text{Cl} + e^- \rightarrow \text{Cl}^- \]
- Sodium ion and chloride ion are attracted to one another by strong electrostatic force which called an ionic bond
- Ionic compound NaCl is formed

FORMATION OF COVALENT BONDS

Example

Oxygen atom + Oxygen atom → Oxygen molecule, O₂
Explanation

- The electron arrangement of oxygen atom is 2.6
- An oxygen atom contribute 2 electron and attain / achieve the octet electron arrangement.
- Two oxygen atom share 2 pairs of electron to one another to form a double covalent bond
- A covalent molecule, O₂ is formed

PAPER 2 : STRUCTURE

1. Diagram 1 shows the symbols for atom of element X, Y, and Z.

![Diagram 1](image-url)

**Diagram 1**

(a) (i) Write the electron arrangement of atom X.

(ii) Write the electron arrangement of ion X.

(iii) Draw the diagram to show the formation of ion X

(iv) Write the half-equation to show the formation of ion X

(v) Explain the formation of ion X.

(b) (i) What is the proton number of element Y?

(ii) Write the electron arrangement of atom Y.
(iii) Write the electron arrangement of ion Y.

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

(iv) Draw the diagram to show the formation of ion Y.

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

(v) Write the half-equation to show the formation of ion Y.

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

(vi) Explain the formation of ion Y.

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

(c) (i) What is the proton number of element Z?

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

(ii) Atom of element Z has a nucleon number of 35. Calculate the number of neutrons in atom Z.

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

(iii) Write the standard representation of element Z.

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

(d) Element Y and Z are reacted to form a compound T.

(i) Name the type of compound T.

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

(ii) Draw the electron arrangement for the compound T.

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

(iii) State one physical property of compound T.

.............................................................................................................................
(e) Element X can react with carbon to form a compound. [Proton number of C = 6]

(i) Name the type of bond in the compound formed.

(ii) Draw the electron arrangement for the compound formed.

(iii) State one physical property of compound formed.

---

Table 2 shows the proton numbers of elements A, B and C.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Proton Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2

a) (i) Write the electron arrangement for atom A

(ii) Write the electron arrangement for ion A

(iii) Draw the diagram to show the formation of ion A

(iv) Write half-equation to show the formation of ion A

b) (i) Write the electron arrangement for atom B

(ii) Write the electron arrangement for ion B

(iii) Write half-equation to show the formation of ion B
c) A and B react to form a compound
   (i) What type of bond in the compound formed?
   ……………………………………………………………………………………………
   (ii) Draw the electron arrangement of the compound formed in (c)(i)
   ……………………………………………………………………………………………
   (iii) State one physical property of the compound formed
   ……………………………………………………………………………………………

d) C can react with B to form a compound.
   (i) What is the molecular formula of the compound formed?
   ……………………………………………………………………………………………
   (ii) Draw the electron arrangement of the compound formed in (d)(i)
   ……………………………………………………………………………………………
   (iii) What is the relative molecular mass of the compound in d(i).
   \[ \text{Given that relative atomic mass C = 1; B = 16} \]
   ……………………………………………………………………………………………
   (iv) Name another compound that has the same physical properties as the
   compound formed.
   ……………………………………………………………………………………………

3 Diagram 3 shows the position of several elements P, Q, R, S, T, U and W.

```
  P  Q  R
  V   S
  T   U
     W X
```

Diagram 3
Using the symbols P, Q, R, S, T, U and W, answer the following questions.

(a) Write the electron arrangement of

   (i) Atom R: 

   (ii) Ion P: 

(b) Explain the formation of ion U

(c) (i) What is the formula for ion formed by Q

   (ii) Write half-equation for (c) (i)

(d) Atoms of P and U can reacted to form a compound.

   (i) Name the type of bond in the compound formed between atom P and U

   (ii) Draw the electron arrangement for the compound formed.

(e) Atom V and T can also react to form a compound. Draw the electron arrangement for the compound formed.

4. Diagram 4 shows the chemical symbols of element sodium, oxygen, carbon and chlorine.
(a) Write the electron arrangement of

(i) Sodium atom: ..............................................

(ii) Oxide ion: ..................................................

(iii) Carbon atom: ...........................................

(iv) Flouride ion: ...........................................

(b) State the period and the Group for Flourine in Periodic Table of element

(i) Period: ..................................................

(ii) Group: ..................................................

(c) Sodium atom and oxygen atom react to form a compound.

(i) Name the type of bond in the compound formed when sodium react with oxygen.

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

(ii) Draw the electron arrangement for the compound formed.

(d) Carbon atom and Flourine atom can also react to form a compound. Draw the electron arrangement for the compound formed.

(e) Compare one physical property of compound formed (b) and (c). Explain your answer.

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

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PAPER 2 : ESSAY

5 Table 5 shows the proton numbers of three elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Proton Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon, C</td>
<td>6</td>
</tr>
<tr>
<td>Sodium, Na</td>
<td>11</td>
</tr>
<tr>
<td>Chlorine, Cl</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 5

(a) State the valence electron of the
    (i) Sodium atom
    (ii) Chlorine atom.

(b) (i) Select two elements that react to form an ionic compound.
    State your reason.
    (ii) Referring to their proton number, explain how the compound in
    (b) (i) is formed.

(c) (i) Select two elements that react to form a covalent compound.
    State your reason.
    (ii) Referring to their proton number, explain how the compound
    in (c) (i) is formed.

(d) The compound in (b) has higher melting point than in (c). Explain why.