Topic 10: **Answers**
The Periodic Table

SYLLABUS RELEVANCE & TEXTBOOK CHAPTERS		
O-LEVEL PURE (5072)	✓	Chapter 16
O-LEVEL SCIENCE (5116)	✓	Chapter 14
N-LEVEL SCIENCE (5155)	✓	Chapter 12

Lesson Package & Accompanying Slides Designed by Alex Lee (2008)
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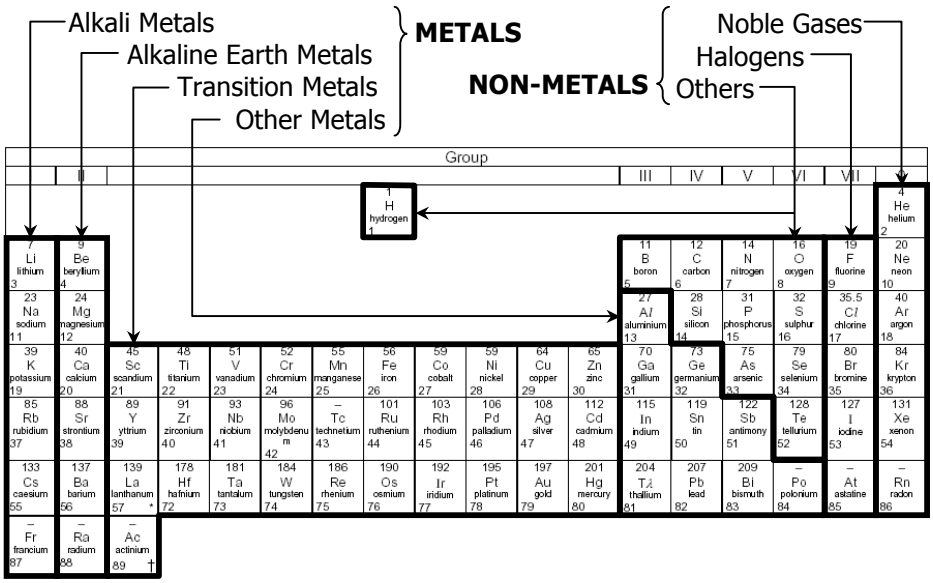
1. The Periodic Table – An Introduction

"The periodic table is a systematic method of classifying all elements, according to **proton** *number and* **electronic** *configuration. There are horizontal rows known as* **periods** *(hence the name 'periodic table'). Elements in the same period have the same* **number of electron shells**. *As such, they also have similar atomic radii. There are also vertical columns known as* **groups**. *Elements in the same group have the same* **number of valence electrons**. *As such, they have similar, but not identical, chemical properties."*

2. Metals Versus Non-Metals

The periodic table can be divided into two main sections – metals and non-metals.



Metals – atoms which **lose** electrons to form **positive ions**.

Non-Metals – atoms which **gain** electrons to form **negative ions** (except noble gases).

Metalloids – elements which exhibit **both metallic and non-metallic** properties. They exist along the boundary line above. Examples include boron and silicon.

3. **Periodic Trends & Group Properties**

Complete the table below to observe some trends across the Periodic Table.

Element	Period Number	Group Number	No. of Electron Shells	No. of Valence Electrons	Ionic Charge	No. of Covalent Bonds
K potassium	4	I	4	1	+	N/A
Ba barium	6	II	6	2	2+	N/A
Al aluminium	3	III	3	3	3+	N/A
C carbon	2	IV	2	4	4+ or 4-	4
As arsenic	4	V	4	5	3-	3
S sulfur	3	VI	3	6	2-	2
I iodine	5	VII	5	7	-	1
Rn radon	6	0 or VIII	6	8	N/A	N/A

Periodic Trends

As we move across a period from left to right,

- the proton number increases consecutively.
- the number of valence electrons increases.
- the number of electron shells remains the same.
- the elements change from metals to non-metals.
- the elements have different chemical properties.

Group Properties

As we move down a group from top to bottom,

- the proton number increases.
- the number of valence electrons remains the same.
- the number of electrons shells increases consecutively.
- the elements have similar chemical properties:
  - they will gain the same ionic charge,
  - they will form the same number of covalent bonds.

4. **Group I Elements: Alkali Metals**

Group I elements have **one valence electron**, and have a tendency to lose one electron to form ions with an ionic charge of 1+.

Period	Element	Electronic Configuration	Melting Point	Boiling Point	Density (g/cm^3)	Reactivity
2	lithium	2, **1**	180 °C	1330 °C	0.53	least
3	sodium	2, 8, **1**	98 °C	890 °C	0.97	
4	potassium	2, 8, 8, **1**	64 °C	760 °C	0.86	
5	rubidium	2, 8, 18, 8, **1**	38 °C	688 °C	1.53	
6	caesium	2, 8, 18, 18, 8, **1**	28 °C	671 °C	1.93	
7	francium	2, 8, 18, 32, 18, 8, **1**	27 °C	677 °C	1.87	most

Physical Properties:

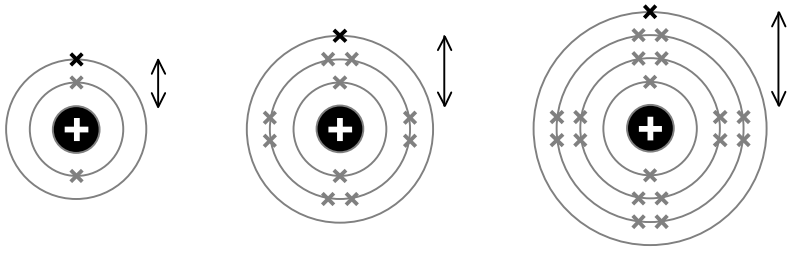
Like most other metals, Group I elements have a shiny, silver appearance and are able to conduct electricity in any state. They are also malleable and ductile, and are cut easily with a knife.

However, unlike most other metals, Group I elements have a low density, with some even being able to float on water; and also low melting and boiling points, with some even readily turning into liquid at room temperature.

Reactivity:

Compared to the other metals, group I metals are the **most reactive** because of the ease of losing one electron. As a result, they seldom exist in element form, and oxidizes (tarnishes) readily when exposed to air. To store a pure sample of a group I metal, e.g. sodium, it has to be kept away from oxygen & moisture, i.e. in container of oil / noble gas.

As we move down the group, the valence electron gets further from the positive nucleus. Thus the ease of giving away the valence electron increases, leading to greater reactivity.



Reaction With Cold Water:

Alkali metals react vigorously with cold water, forming alkalis (hydroxides) and hydrogen gas. The reaction gets **increasing violent** as we move down the group. For example, the reaction between potassium and water:

$$\mathbf{2\ K\ (s) + 2\ H_2O\ (l) \longrightarrow 2\ KOH\ (aq) + H_2\ (g)}$$

In the above reaction, we would observe that the potassium melts into a liquid ball, as the heat produced if sufficient to bring the metal above its melting point. A lilac flame is also observed. The liquid metal 'darts' around the surface of the water, due to its low density allowing it to float. Vigorous effervescence of hydrogen gas is produced.

Complete the table to show the chemical equations for the reaction of alkali metals with water.

Period	Element	Chemical Equation	Observation
2	lithium	$2\ Li + 2\ H_2O \longrightarrow 2\ LiOH + H_2$	moderate effervescence
3	sodium	$2\ Na + 2\ H_2O \longrightarrow 2\ NaOH + H_2$	effervescence, occasional sparks
4	potassium	$2\ K + 2\ H_2O \longrightarrow 2\ KOH + H_2$	effervescence, lilac flame
5	rubidium	$2\ Rb + 2\ H_2O \longrightarrow 2\ RbOH + H_2$	violent reaction
6	caesium	$2\ Cs + 2\ H_2O \longrightarrow 2\ CsOH + H_2$	explosive reaction
7	francium	$2\ Fr + 2\ H_2O \longrightarrow 2\ FrOH + H_2$	explosive reaction

Group Trends:

As we move down the alkali metals group, we observe that:

- number of electron shells ..... increases .....,
- atomic radii ..... increases .....,
- valency ..... remains the same .....,
- melting and boiling points ..... generally decrease .....,
- density ..... generally increases ....., and
- reactivity ..... increases .....

5. **Group VII Elements: Halogens**

Group I elements have **seven valence electrons**, and have a tendency to gain one electron to form ions with an ionic charge of 1-.

Period	Element	Electronic Configuration	State at r.t.p.	Colour	Reactivity
2	fluorine	2, **7**	gaseous	yellow	most
3	chlorine	2, 8, **7**	gaseous	greenish-yellow	
4	bromine	2, 8, 18, **7**	liquid	reddish-brown	
5	iodine	2, 8, 18, 18, **7**	solid	purple	
6	astatine	2, 8, 18, 32, 18, **7**	solid	black	least

Physical Properties:

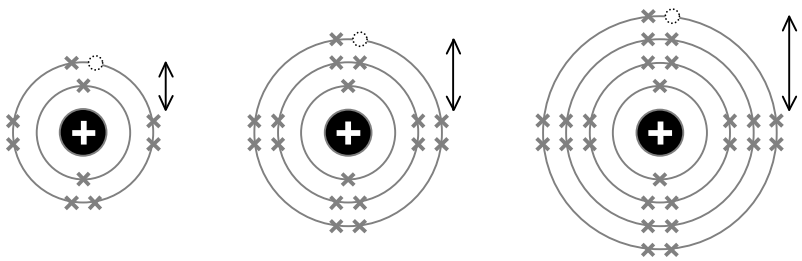
As elements, the halogens typically form only one covalent bond, and thus normally exist as diatomic molecules, i.e. F_2, Cl_2, Br_2, I_2 and At_2. This simple covalent structure leads to properties such as relatively **low melting and boiling points** (compared to ionic compounds and macromolecules), and **poor electrical conductivity** in all states.

In addition, they have **distinctive colours**; such as the reddish-brown colour of liquid bromine, or the purplish colour of iodine. They are also **very soluble in water**.

Reactivity:

Compared to the other non-metals, group VII elements are considered **very reactive** because of the ease of gaining one electron. For example, chlorine has a very strong oxidizing effect.

As we move down the group, the valence shell gets further from the positive nucleus. Thus the ease of taking in an additional electron decreases, leading to lower reactivity.



As we move down the alkali metals group, reactivity increases.

As we move down the halogen group, reactivity decreases.

Displacement Reactions:

Halogens can take part in displacement reactions, where a more reactive halogen can displace a less reactive halogen from its salt. The reverse, however, may not occur. For example, the reaction that occurs when chlorine gas (more reactive halogen) is bubbled through a solution of sodium bromide (a less reactive halogen ion, or halide):

$$\mathbf{2\ NaBr\ (aq) + Cl_2\ (g) \longrightarrow 2\ NaCl\ (aq) + Br_2\ (aq)}$$

What we observe is that a greenish-yellow gas is bubbled through a colourless solution, forming a reddish-brown solution (since the bromine dissolves readily into the water present). It is important to note that while halogens are coloured (i.e. in element form), most halide solutions (i.e. in an ionic compound) are colourless.

Complete the table with the chemical equations for the displacement reactions, if any.

Halogen	Salt	Chemical Equation
bromine	sodium iodide	$2\ NaI + Br_2 \longrightarrow 2\ NaBr + I_2$
chlorine	magnesium astatide	$MgAt_2 + Cl_2 \longrightarrow MgCl_2 + At_2$
iodine	iron(III) fluoride	No reaction.
fluorine	potassium chloride	$2\ KCl + F_2 \longrightarrow 2\ KF + Cl_2$
chlorine	aluminium bromide	$2\ AlBr_3 + 3\ Cl_2 \longrightarrow 2\ AlCl_3 + 3\ Br_2$
bromine	caesium astatide	$2\ CsAt + Br_2 \longrightarrow 2\ CsBr + At_2$

Group Trends:

As we move down the halogens group, we observe that:

- number of electron shells ..... increases .....,
- atomic radii ..... increases .....,
- valency ..... remains the same .....,
- melting and boiling points ..... increase .....,
- colour intensity ..... increases ....., and
- reactivity ..... decreases .....

6. **Group 0 Elements: Noble Gases**

Group 0 elements have ..full.. valence shells, and are hence very unreactive. They do not form ionic or covalent bonds. Instead, they naturally exist as ..monoatomic.. gases.

While they may not form compounds or be used in chemical reactions, noble gases are useful in providing an ..inert.. atmosphere.

Examples of Uses:

Balloons – helium (non-flammable, unlike hydrogen gas)

Light Bulbs – argon and neon (prevent rusting of filament, neon glows when heated)

Manufacture of Steel – argon (prevents clogging in liquid steel)

7. **Review Questions**

(a) Indicate if the following statements are **true** or **false**.

Noble gases all have eight valence electrons. false

Noble gases do not have isotopes. false

Noble gases are non-metals. true

Noble gases form covalent bonds. false

(b) On the right shows the first and seventh group of the periodic table.

(i) Circle the most reactive element in each group.

(ii) Name the three elements that have the most violent reactions when placed in contact with water.

Francium, Caesium, Rubidium

(iii) Name the products formed when **sodium metal reacts with cold water**, and estimate the pH value for the solution.

Sodium Hydroxide & Hydrogen

pH > 12.0

(iv) Construct a balanced chemical equation, including state symbols, for the reaction in (iii).

$2\ Na\ (s) + 2\ H_2O\ (l) \longrightarrow 2\ NaOH\ (aq) + H_2\ (g)$

I	IV
Li lithium	F fluorine
Na sodium	Cl chlorine
K potassium	Br bromine
Rb rubidium	I iodine
Cs caesium	At astatine
Fr francium	

(c) "A **greenish-yellow gas** was bubbled through an aqueous sample of a **potassium salt**. It was observed that the solution slowly turned **purplish-brown**."

(i) Identify the substances as described in the reaction above.

greenish-yellow gas: chlorine gas

purplish-brown solution: iodine solution

aqueous potassium salt: potassium iodide

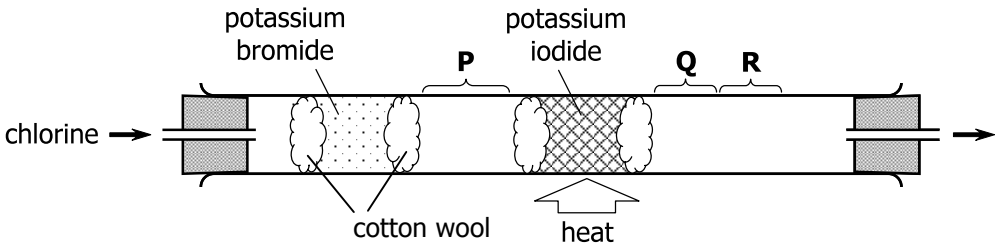
(ii) Construct a chemical equation, including state symbols, for the reaction above.

$Cl_2\ (g) + 2\ KI\ (aq) \longrightarrow 2\ KCl\ (aq) + I_2\ (aq)$

(ii) Construct an ionic equation for the reaction above.

$Cl_2\ (g) + 2\ I^-\ (aq) \longrightarrow 2\ Cl^-\ (aq) + I_2\ (aq)$

(d) In the experimental set-up below, chlorine gas was passed through the tube. It was observed that a red-brown vapour appears at **P**, a violet vapour appears at **Q** and a black solid appears at **R**. *(modified from J97)*



With the aid of a chemical equation, **explain** the observations that occur at

(i) at **P**,

$Cl_2 + 2\ KBr \longrightarrow 2\ KCl + Br_2$

Red-brown bromine vapour is formed when chlorine gas displaces bromide ions.

(ii) at **Q**, and

$Br_2 + 2\ KI \longrightarrow 2\ KBr + I_2$

Violet iodine vapour is formed when bromine vapour displaces iodide ions.

(iii) at **R**.

$I_2\ (g) \longrightarrow I_2\ (s)$

The iodine vapour condenses to become a black (very dark purple) solid.

Self-Designed Summary

Supplementary Questions

1. The elements in the Periodic Table are arranged in order of their
   A atomic size. **B** atomic mass. **C** nucleon number. **D** proton number.

2. A group of elements in the Periodic Table
   A is a horizontal row of elements.
   B is a vertical column of elements.
   C is a list of non-metals.
   D contains elements with the same reactivity.

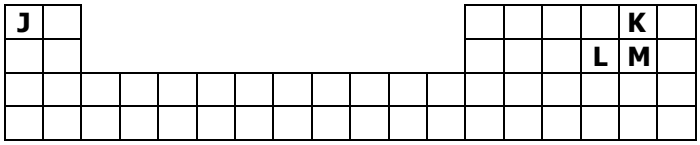
3. A 'period' of elements in the Periodic Table
   A is a vertical column of elements.
   B is a list of non-metals.
   C is a horizontal row of elements.
   D contains elements in the same state.

4. How many periods contain the first eighteen elements?
   A 2 **B** 3 **C** 4 **D** 6

5. Which statement about the Periodic Table is **not** correct?
   A There are more metals than non-metals.
   B The elements with similar chemical properties are in the same vertical group.
   C The most reactive metals are found in the bottom left-hand corner of the table.
   D They are listed in the increasing order of atomic mass.

6. From the following, pick out the correct statement concerning the Periodic Table.
   A In Group I, reactivity decreases with increasing proton number.
   B Elements in a period become more metallic with increasing proton number.
   C In Group VII, the melting point of the elements increases with proton number.
   D Atoms of elements in the same group have the same number of electrons.

7. The elements with the given code letters **J**, **K**, **L**and **M** are placed in the Periodic Table below.



   Which one of the following is correct?
   A The proton numbers increase in the order **J**, **L**, **K**, **M**.
   B **K** and **M** are in the same period of the Periodic Table.
   C The valency of **J** is one but the valency of **K** and of **M** is two.
   D **J** is solid but **K** and **M** are gases under room conditions.

8. Going down Group I in the Periodic Table, the
   A metallic character decreases.
   B melting and boiling points increase.
   C reactivity of the metal increases.
   D number of electrons in the outermost shell increases.

9. Which statement is not true about Group I elements?
   A All the elements form ions by losing one electron.
   B The elements are soft and have relatively low melting points.
   C The elements burn in air with a characteristic coloured flame.
   D The reaction with water becomes less vigorous down the Group.

10. An element **X** in Group VII of the Periodic Table would _____.
    A burn in air.
    B form a hydride of formula **X**H_7.
    C form diatomic molecules.
    D react vigorously with water.

11. For the main groups of the Periodic Table, the properties of the elements show trends down the groups. At which position is the most metallic element found?

I	II	III	IV	V	VI	VII	0
	B				**D**		
A			**C**				

12. Which of the following statements on groups of elements in the Periodic Table is correct?
    A Group VII elements are more metallic then Group II elements.
    B Group I elements form covalent compounds with oxygen.
    C Group VI elements form negative ions.
    D Group 0 elements are unreactive metals.

13. The diagram shows the positions of four elements in the Periodic Table. Which element would form positively charged ions?

I	II	III	IV	V	VI	VII	0
			B				**D**
A						**C**	

14. Element **Y** has the electron configuration: 2, 8, 18, 7. In the Periodic Table, **Y** is most likely in
    A Group II. **B** Group V. **C** Group VI. **D** Group VII.

15. An element in the third period of the Periodic Table is a non-conductor of electricity, burns in air with a blue flame, and forms an acidic oxide. Which of the following could this element be?
    A aluminium **B** argon **C** silicon **D** sulfur

16. Strontium (Sr) is an element in Group II of the Periodic Table. Which one of the following formula is **incorrect**?
    A $SrNO_3$ **B** $SrCl_2$ **C** $SrCO_3$ **D** $Sr(OH)_2$

17. Arsenic (As) is in Group V of the Periodic Table. What is the correct formula for arsenic chloride?
    A $AsCl_3$ **B** $AsCl_5$ **C** As_3Cl_5 **D** As_2Cl_5

18. Phosphorus is in Group V of the Periodic Table. The most likely molecular formula of a hydride of phosphorus is
    A PH. **B** PH_2. **C** PH_3. **D** PH_4.

19. Information for five elements is shown in the table. Which pair of elements are in the same group of the Periodic Table?

	relative atomic mass	*bonding in chloride*
V	39	ionic
W	40	ionic
X	32	covalent
Y	24	ionic
Z	27	covalent

    A **V** and **X** **B** **V** and **Y** **C** **W** and **Y** **D** **W** and **Z**

20. Elements **M** and **X** are in the same period of the Periodic Table and have a valency of 2 and 5 respectively. The compound formed by **M** and **X** would have the formula _____.
    A **MX** **B** $\mathbf{M_2X_3}$ **C** $\mathbf{M_3X_2}$ **D** $\mathbf{M_2X_5}$

21. The oxide of metal **Z** has the formula **Z**O. Which group in the Periodic Table contains metal **Z**?
A II **B** IV **C** VI **D** VII

22. A metal **Y**, in Group I of the Periodic Table, would
A displace hydrogen from cold water.
B form a nitrate of formula **Y**$(NO_3)_2$.
C form an acidic oxide.
D form an insoluble chloride.

23. Caesium, Cs, is an element in Group I of the Periodic Table. Which conclusion can be drawn from this information?
A Many compounds of caesium are coloured.
B Caesium is more reactive than lithium.
C Caesium shows variable valency in its compounds.
D A caesium atom gains an electron when it forms an ion.

24. Which of the following elements will float on water?
A lead **B** iron **C** calcium **D** sodium

25. The table shows the proton (atomic) number of four elements.

Element	**W**	**X**	**Y**	**Z**
Proton Number	9	11	17	19

Which statement is correct?
A **X** is more reactive than **Z**.
B **W** is more reactive than **Y**.
C **W** is a metal.
D **Y** and **Z** are in the same period.

26. Which statement about the halide ions is correct?
A All the ions have seven electrons in the outer shell.
B All the ions contain more protons than neutrons.
C All the ions contain more electrons than protons.
D All the ions contain an odd number of electrons.

27. What is observed when fluorine gas is bubbled through aqueous potassium bromide?
A A silvery coloured solid is formed.
B A green gas is released.
C The solution turns brown.
D The solution turns purple.

28. What is observed when aqueous bromine is added to aqueous potassium chloride?
A A silvery coloured solid is formed.
B A green gas is released.
C A brown vapour forms.
D There is no visible reaction.

29. Fluorine, $^{19}_{9}F$, is a halogen. The table shows some of the properties of other Group VII elements.

element	M_r	*group*	*melting point*	*boiling point*	*vapour colour*
chlorine	71	7	–101 °C	–35 °C	yellow-green
bromine	160	7	–7 °C	59 °C	red-brown
iodine	254	7	114 °C	184 °C	violet

Which one of the statements about fluorine is likely to be correct?
A The boiling point of fluorine is –188 °C.
B At room temperature, fluorine is a black solid.
C The M_r of fluorine is 19.
D The melting point of fluorine is 212 °C.

30. Astatine is a member of the halogens. It has a relative atomic mass greater than iodine. Astatine is expected to
A be a stronger oxidising agent than iodine.
B be a liquid at room temperature.
C be more reactive than iodine.
D have a higher melting point than iodine.

31. As we move across the first eight elements in the Periodic Table,
    A the atomic radii increases steadily.
    B the number of neutrons increases consecutively.
    C the number of valence electrons increases.
    D the relative atomic mass increases.

32. At room temperature and pressure, what states do chlorine, bromine and iodine exist in?

	chlorine	*bromine*	*iodine*
A	gas	liquid	liquid
B	gas	gas	liquid
C	gas	gas	gas
D	gas	liquid	solid

33. Which of the following information most strongly suggests that a solid element **Z** is non-metal?
    A **Z** has a low melting point.
    B **Z** is a conductor of electricity.
    C **Z** reacts vigorously with chlorine.
    D **Z** forms an acidic oxide.

34. The reaction of lithium with water is described as moderately slow. The reaction of rubidium (atomic number 37) with water is likely to be
    A very fast.
    B as slow as that of lithium.
    C marginally faster than lithium.
    D slower than that of lithium.

35. The element astatine (At) is below iodine in Group VII of the Periodic Table. Which of the following is a likely property of astatine?
    A It displaces iodine from potassium iodide.
    B It forms a basic oxide.
    C It bums readily in air.
    D It can be liberated from its salts by chlorine.

36. Which statement about the halogens (Group VII elements) is true?
    A They are diatomic molecules.
    B Chlorine is a colourless gas.
    C Iodine ions are smaller than fluoride ions.
    D Fluorine is less reactive than iodine.

37. The element caesium, Cs, is the same Group of the Periodic Table as sodium and potassium. Which one of the following is a property of caesium?
    A It is a hard, dense metal.
    B It forms a soluble, basic oxide.
    C It forms an ionic chloride of formula $CsCl_2$.
    D It reacts with water giving off oxygen.

38. Rubidium (proton number 37) is in Group I of the Periodic Table. The formula of rubidium carbonate is _____.
    A $Rb(CO_3)_2$ **B** $RbCO_3$ **C** $2RbCO_3$ **D** Rb_2CO_3

39. A new element is discovered. It is a grey metal. One atom of it combines with two atoms of oxygen to form a high melting point oxide. The chloride of the element boils at less than 100 °C. In which group of the Periodic Table does it belong?
    A I **B** II **C** III **D** IV

40. Why are the elements sodium and chlorine placed in the same period of the Periodic Table?
    A Sodium and chlorine combined together to form a compound of formula NaCl.
    B Sodium is a reactive metal and chlorine is a reactive non-metal.
    C The atoms of both elements have only three electrons shell containing electrons.
    D The atoms of both elements have eight electrons in their second electron shell.

Supplementary Questions (Answers)

Multiple-Choice Questions

1 D	2 B	3 C	4 B	5 D	6 C	7 D	8 C
9 D	10 C	11 A	12 C	13 A	14 D	15 D	16 A
17 A	18 C	19 C	20 C	21 A	22 A	23 B	24 D
25 B	26 C	27 C	28 D	29 A	30 D	31 D	32 D
33 D	34 A	35 D	36 A	37 B	38 D	39 D	40 C

Lecture Slides

The Periodic Table

Anglo-Chinese School (Barker Road)

CHEMISTRY
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Chapter Overview

In This Chapter, We Will Learn …

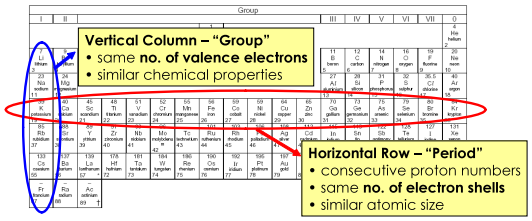
1. Periodic Trends
2. Group Properties
   - Group I: Alkali Metals
   - Group VII: Halogens
   - Group 0: Noble Gases

The Periodic Table

Systematic method of arranging elements, classified by:

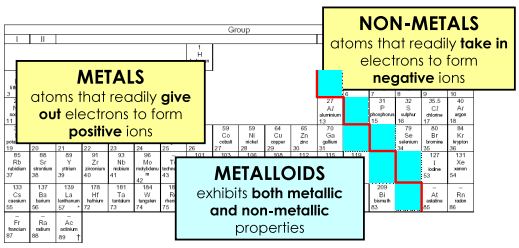
✓ **proton number**

✓ **electronic configuration**



Periodic Trends

- As we go across a period **from left to right, the** metallic character **of the elements decreases.**



Periodic Trends

As we move across a period from left to right,

- the **proton number increases** consecutively
- the **number of valence electrons increases**
- the **number of electron shells remains the same**
- the elements change from **metals to non-metals**
- the elements have **different chemical properties**

$^{23}_{11}Na$	$^{24}_{12}Mg$	$^{27}_{13}Al$	$^{28}_{14}Si$	$^{31}_{15}P$	$^{32}_{16}S$	$^{35.5}_{17}Cl$	$^{40}_{18}Ar$
2,8,1	2,8,2	2,8,3	2,8,4	2,8,5	2,8,6	2,8,7	2,8,8

Group Properties

As we move down a group from top to bottom,

- the **proton number increases** (but not consecutively)
- the **number of valence electrons remains the same**
- the **number of electron shells increases** consecutively
- the elements have **similar chemical properties**:
  - they will gain the **same ionic charge**
  - they will form the **same number of covalent bonds**

$^{7}_{3}Li$	$^{23}_{11}Na$	$^{39}_{19}K$
2,1	2,8,1	2,8,8,1

Group I: Alkali Metals

Group I elements only have **one valence electron**, and tend to **lose an electron** to form ions of **1+ charge**.

Period	Element	Electronic Configuration	m.p. (°C)	b.p. (°C)	Density (g/cm³)	Reactivity
2	lithium	2, **1**	180	1330	0.53	least
3	sodium	2, 8, **1**	98	890	0.97	
4	potassium	2, 8, 8, **1**	64	760	0.86	
5	rubidium	2, 8, 18, 8, **1**	38	688	1.53	
6	caesium	2, 8, 18, 18, 8, **1**	28	671	1.93	
7	francium	2, 8, 18, 32, 18, 8, **1**	27	677	1.87	most

Group I: Alkali Metals

Physical Properties:

- shiny grey appearance
- malleable and ductile
- low density*
- low melting / boiling points*

** unique to alkali metals*

CAN FLOAT ON WATER!

MELTS VERY EASILY!

Group I: Alkali Metals

Chemical Properties:

- very reactive, due to the **ease of losing a single electron**
- needs to be kept away from air and water, e.g. **in oil or a container of noble gas.**

Group I: Alkali Metals

Group Trends:
moving down the group ...

- melting and boiling points *generally* decrease
- density *generally* increases
- reactivity increases

Group I: Alkali Metals

Why do Group I Metals have softer textures and lower melting and boiling points than other metals?

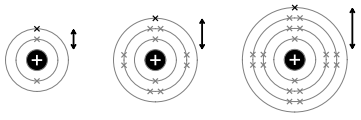
Remember metallic bonding – the lattice of positive ions are held together by delocalised electrons.

Group I metals have a smaller number of delocalised electrons per atom as compared to other metals (as there are fewer valence electrons), hence leading to a 'weaker' structure.

Group I: Alkali Metals

Why does the reactivity on Group I metals increase as we move down the group?

Group I metals form ionic compounds by giving away the valence electron. Moving down the group, the number of shells increases and hence the valence electron gets further from the nucleus, and is more easily removed.



Group I: Alkali Metals

Reaction with Water:

Group I metals are so reactive that they react vigorously with cold water to form hydroxides and hydrogen gas:

$$2\ K\ (s) + 2\ H_2O\ (l) \longrightarrow 2\ KOH\ (aq) + H_2\ (g)$$

Recall:
What other reaction produces hydrogen gas?
How do we test for hydrogen gas in a laboratory?

Group I: Alkali Metals

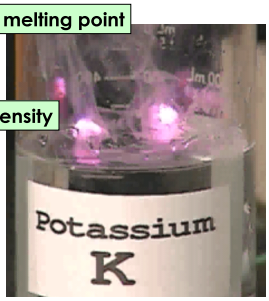
The potassium melts into a liquid ball, and 'darts' around on the surface of the water.

low melting point

low density

A lilac flame is observed.

Effervescence of hydrogen gas is produced.



Group VII: Halogens

Group VII elements have **seven valence electrons**, and tend to **gain an electron** to form ions of **1- charge**.

Period	Element	Electronic Configuration	State at r.t.p.	Colour	Reactivity
2	fluorine	2, **7**	gaseous	yellow	most
3	chlorine	2, 8, **7**	gaseous	green-yellow	⇧
4	bromine	2, 8, 18, **7**	liquid	reddish-brown	
5	iodine	2, 8, 18, 18, **7**	solid	purple	
6	astatine	2, 8, 18, 32, 18, **7**	solid	black	least

Group VII: Halogens

Physical Properties:

- forms diatomic molecules, i.e. F_2, Cl_2, Br_2, I_2, At_2.
- low m.p. and b.p., due to simple covalent structure
- coloured appearance

EACH HALOGEN HAS A DISTINCTIVE COLOUR!

Period	Element	Electronic Configuration	State at r.t.p.	Colour	Reactivity
2	fluorine	2, **7**	gaseous	yellow	most
3	chlorine	2, 8, **7**	gaseous	green-yellow	⇧
4	bromine	2, 8, 18, **7**	liquid	reddish-brown	
5	iodine	2, 8, 18, 18, **7**	solid	purple	
6	astatine	2, 8, 18, 32, 18, **7**	solid	black	least

Group VII: Halogens

Chemical Properties:

- more reactive than most other non-metals
  - due to **ease of gaining just one electron**
  - leads to **oxidising effect**

Period	Element	Electronic Configuration	State at r.t.p.	Colour	Reactivity
2	fluorine	2, **7**	gaseous	yellow	most
3	chlorine	2, 8, **7**	gaseous	green-yellow	⇧
4	bromine	2, 8, 18, **7**	liquid	reddish-brown	
5	iodine	2, 8, 18, 18, **7**	solid	purple	
6	astatine	2, 8, 18, 32, 18, **7**	solid	black	least

Group VII: Halogens

Group Trends:
moving down the group ...

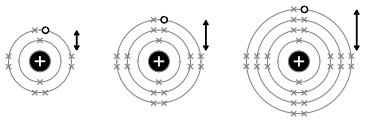
- m.p. and b.p. increase (thus different states at r.t.p.)
- colour intensity increases
- reactivity decreases

Period	Element	Electronic Configuration	State at r.t.p.	Colour	Reactivity
2	fluorine	2, **7**	gaseous	yellow	most
3	chlorine	2, 8, **7**	gaseous	green-yellow	⇧
4	bromine	2, 8, 18, **7**	liquid	reddish-brown	
5	iodine	2, 8, 18, 18, **7**	solid	purple	
6	astatine	2, 8, 18, 32, 18, **7**	solid	black	least

Group VII: Halogens

Why does the reactivity on Group VII elements decrease as we move down the group?

Group VII metals form ionic compounds by gaining one electron. Moving down the group, the number of shells increases and hence the valence shell is further from the nucleus. Hence it is harder to attract the extra electron.



Group VII: Halogens

Displacement Reactions:

A more reactive halogen can displace a less reactive halogen from its salt.

$$2\ NaBr\ (aq) + Cl_2\ (g) \rightarrow 2\ NaCl\ (aq) + Br_2\ (aq)$$

Bromide Ion | Chlorine | Chloride Ion | Bromine

What is the ionic equation for the above reaction?

$2\ Br^-\ (aq) + Cl_2\ (g) \rightarrow 2\ Cl^-\ (aq) + Br_2\ (aq)$

Group 0: Noble Gases

Group 0 (also known as Group VIII) elements have **full valence shells**, and are hence very **stable**.

This stability causes the atom to be **highly unreactive**, and are useful in providing an inert atmosphere.

Because they do not form any ionic nor covalent bonds, they naturally exist as **monoatomic gases**.

Group 0: Noble Gases

Some Uses for Noble Gases:

Filling Balloons –	**helium** (non-flammable, unlike hydrogen)
Filling Light Bulbs –	**argon and neon** (prevent rusting of filament, neon glows when heated)
Manufacture of Steel –	**argon** (prevents clogging in liquid steel)