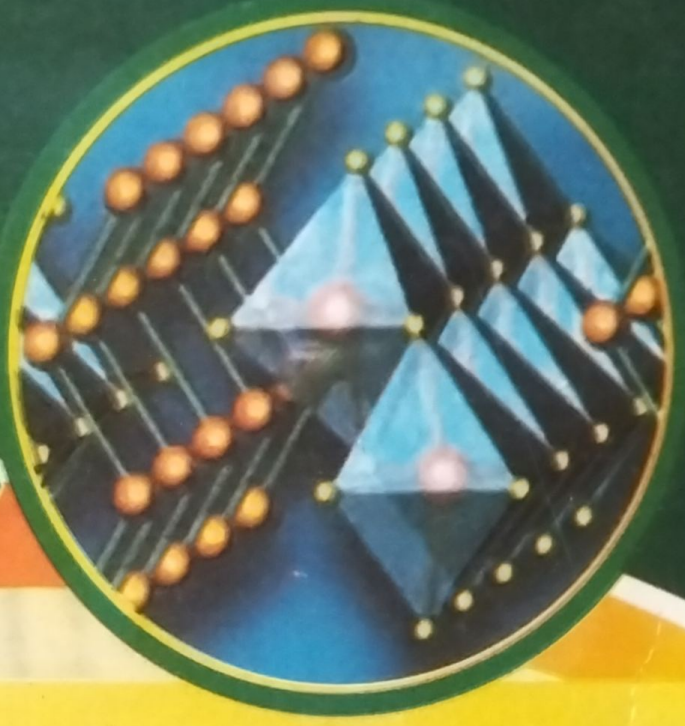

INORGANIC CHEMISTRY 2

THE CHEMISTRY OF GROUP I, II, III, IV AND VII ELEMENTS

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PREFACE

This book is intended to present the chemistry of groups I, II, III, IV and VII to the students of tertiary institution.

Chapters 1 through 3 deal with the group I elements, including the electronic configuration, changes in the corresponding ions of these elements in group one.

Chapters 4 through 7 covered group II elements with emphasis on electronic configuration of group II elements, gradation in properties as shown by elements in group I and II.

Chapter 8 discusses group II and IV elements, their electronic configuration, gradation in the properties of the elements in group III and IV.

Chapters 9 and 10 covered the group VII elements, properties of the halogens, comparison of strength of the halogen, preparation and properties of oxy compounds of halogens, oxyacids of chlorine.

The authors accepts responsibility for any errors, omission and mistakes in the book. Also we acknowledge the various authors whose text were consulted during the preparation of this book.

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CHAPTER ONE

RELATION OF ALKALI AND ALKALINE METALS TO ATOMS

1.1 ALKALI METALS:

The alkali metals are also called the group 1 metals which consist of the following elements: lithium, sodium, potassium, rubidium, caesium and francium.

They belong to the s-block elements in the periodic table. Electrons in outer most shell occupy the S-orbital, hence these elements are also known as 's' block elements.

They have an outer electronic configuration of ns^1 where n is the energy level or period of the element. For example lithium is in the second period. Thus, the written electron configuration for the outer level of this element $2s^1$ where 2 is the second period. Also, sodium that is in the third period and having its outer level as $3s^1$ similarly potassium, Rubidium caesium francium have 4s, 5s, 6s, 7s outer level of configuration respectively. Not much is known about the

last element since it is a radioactive and all its isotopes are exceedingly short lived.

1.2 TABLE 1.1
ELECTRONIC CONFIGURATION OF ALKALI METALS IN TERMS OF S,P,D ORBITALS

ELEMENTS	SYMBOLS	ELECTRONIC CONFIGURATION
Lithium	Li	$Is^2 2s^1$ or (He) $2s^1$
Sodium	Na	$Is^2 2s^2 2s^6 3s^1$ or (Ne) $3s^1$
Potassium	K	$Is^2 2s^2 2p^6 3s^2 3p^6 4s^1$ or (Ar) $4s^1$
Rubidium	Rb	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$ or (kr) $5s^1$
Caesium	Cs	$1s^2 2s^2 2p^6 3S^2 3p^6 3d^{10} 4S^2 4p^6 4d^{10} 5s^2 sp^6 6s^1$ or (xe) $6s^1$
Francium	Fr	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 sp^6 5d^{10} 6s^2 6p^6 7s^1$ or (Rn) $7s^1$

Thus, ignoring the filled inner shells the electronic of the outer shell structures may be written $2S^1$ $3S^1$ $4S^1$ $5S^1$ $6S^1$ & $7S^1$

The single valence electron in a long distance from the nucleus is only weakly held and is readily removed showing a metallic character. This also account for chemical reactivity. The remaining electrons are closer to the nucleus and thus more tightly held and are removed only with great difficulty after attaining duplet or octet state.

1.3 PROPERTIES OF THESE METALS e.g. SOFTNESS, LOW DENSITY AND LOW MELTING POINT ON THEIR ATOMIC SIZES

Table 1.2: Shown below are the atomic Radius(nm), Cohesive energy ($Kjmol^{-1}$) Density (gcm^{-3}), melting point (^{o}c) Boiling point (^{o}c) of group 1 elements:

ELEMENT	ATOMIC RADIUS (nm)	DENSITY (gcm^{-3})	MELTING POINT ^{o}C	BOILING POINT ^{o}C	COHESIVE ENERGY DENSITY ($KJMOl^{-1}$)
Li	0.152	0.54	180	1330	161
Na	0.186	0.97	98	890	108
K	0.231	0.86	64	774	90
Rb	0.244	1.53	39	688	82
Cs	0.262	1.90	29	690	78
Fr	0.270		27	680	

The sizes of the atoms of s-block elements are relatively large as shown above from the atomic Radii. They are the largest in their respective periods. As the effective charge increases across a period the atomic radii decrease because the charges pull the atom together.

Note that group 1, element are larger than group II element in the same period.

Going down both groups the atomic radii increase. This is because the number of completely filled inner shells increases.

1. SOFTNESS:

One important parameter that measures the softness of material is the cohesive energy. The lower the cohesive energy the softer the material.

As could be observed, as atomic Radius increases, the cohesive energy decreases and the softness increases.

The cohesive energy is the force holding the atoms or ions together in the solid (This is the same in magnitude, but the opposite in sign to the enthalpy of atomization, which is the energy required to break the

solid up into gaseous atoms). The cohesive energy of group 1 metals are about half of those for group 2 and one third of those for group 3 element (ie B, A1, Ga, In & T1).

2. LOW DENSITY

Alkali metals i.e. group 1 elements have large atoms. Also they have body centre cubic structures at room temperature when there is 32% empty space in the arrangement. Due to the large nature of the atoms, the computed mass/ volume ratio gave low density to the element of this group, lithium, sodium and potassium are all less dense than water.

3. LOW MELTING POINT:

As we go down the group the atomic size of the elements increase and the cohesive energy decreases. Thus the melting points of the elements decrease. Note that if the energy holding the atoms together is less, the melting points as well as the boiling point will be less as could be seen from the table.