"बेटी बचाओ, बेटी पढ़ाओ"

JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

Faculty of Education & Methodology

Faculty Name	-	JV'n Dr. Mangat Singh (Assistant Professor)
Program	-	V/2023-Semester / Year
Course Name	-	(B.Sc. B.Ed. ZBC/PCM)-V-SEM

Academic Day starts with –

- Greeting with saying **'Namaste'** by joining Hands together following by 2-3 Minutes Happy session, Celebrating birthday of any student of the respective class and **National Anthem**.

Lecture Starts with-

- Topic to be discussed today- **d-BLOCK ELEMENTS**
- Introduction & Brief Discussion about the Topic

The two terms d-block metal and transition metal are often devoted to understanding the properties of middle elements of the periodic table. The term d-block metal refers to the elements having electrons in the d-orbital are known as d-block elements whereby the term transition metals is devoted to the elements having chemical properties that were transitional between those of the s and p blocks elements. However, now, according to the IUPAC definition; an element is termed a transition that has an incomplete d subshell in either the neutral atom or its ions. Thus, the elements; Zn, Cd, and Hg of Group 12 are *considered as the members of the d block but are not counted in transition elements.*

- University Library Reference- *Concise Inorganic Chemistry by J D Lee*
- Questions to check the understanding level of students-
  1. Why Zn, Cd, and Hg are not counted in d-block elements
  2. Why Chromium shows an exceptional electronic configuration
- Small Discussion About Next Topic- ***properties of d-block elements***

d-BLOCK ELEMENTS

Introduction

a) Transition or d-block elements are the elements that lie in between the s-block and p-block elements of the periodic table

b) The transition elements are those having incompletely filled d-orbital. Since Zn, Cd, Hg havecompletely filled (d^{10}) configurations and therefore they are considered asd-block elements but not transition elements

c) The general electronic configuration of transition elements is $(n\text{-}1)d^{1-10}\ ns^{0-2}$

ELECTRONIC CONFIGURATION

3d-Series (Z = 21-30)				
Elements Name	***Element Symbol***	***Atomic Number (Z)***	***Expected Electronic Configuration***	***Observed Electronic Configuration***
Scandium	Sc	21	$[Ar]3d^1\ 4s^2$	$[Ar]3d^1\ 4s^2$
Titanium	Ti	22	$[Ar]3d^2\ 4s^2$	$[Ar]3d^2\ 4s^2$
Vanadium	V	23	$[Ar]3d^3\ 4s^2$	$[Ar]3d^3\ 4s^2$
Chromium	Cr	24	$[Ar]3d^4\ 4s^2$	$[Ar]3d^5 4s^1$
Manganese	Mn	25	$[Ar]3d^5\ 4s^2$	$[Ar]3d^5\ 4s^2$
Iron	Fe	26	$[Ar]3d^6\ 4s^2$	$[Ar]3d^6\ 4s^2$
Cobalt	Co	27	$[Ar]3d^7\ 4s^2$	$[Ar]3d^7\ 4s^2$
Nickle	Ni	28	$[Ar]3d^8\ 4s^2$	$[Ar]3d^8\ 4s^2$
Copper	Cu	29	$[Ar]3d^9\ 4s^2$	$[Ar]3d^{10}\ 4s^1$

Zinc	Zn	30	$[Ar]3d^{10} 4s^{2}$	$[Ar]3d^{10} 4s^{2}$
4d-Series (Z = 39-48)				
Elements Name	***Element Symbol***	***Atomic Number (Z)***	***Expected Electronic Configuration***	***Observed Electronic Configuration***
Yttrium	Y	39	$[Kr]4d^{1} 4s^{2}$	$[Kr]4d^{1}5s^{2}$
Zirconium	Zr	40	$[Kr]4d^{2} 4s^{2}$	$[Kr]4d^{2}5s^{2}$
Niobium	Nb	41	$[Kr]4d^{3} 4s^{2}$	$[Kr]4d^{4} 5s^{1}$
Molybdenum	Mo	42	$[Kr]4d^{4} 4s^{2}$	$[Kr]4d^{5}5s^{1}$
Technetium	Tc	43	$[Kr]4d^{5} 4s^{2}$	$[Kr]4d^{5}5s^{2}$
Ruthenium	Ru	44	$[Kr]4d^{6} 4s^{2}$	$[Kr]4d^{7}5s^{1}$
Rhodium	Rh	45	$[Kr]4d^{7} 4s^{2}$	$[Kr]4d^{8}5s^{1}$
Palladium	Pd	46	$[Kr]4d^{8} 4s^{2}$	$[Kr]4d^{10}5s^{0}$
Silver	Ag	47	$[Kr]4d^{9} 4s^{2}$	$[Kr]4d^{10}5s^{1}$
Cadmium	Cd	48	$[Kr]4d^{10} 4s^{2}$	$[Kr]4d^{10}5s^{2}$
5d-Series (Z = 57-80)				
Elements Name	***Element Symbol***	***Atomic Number (Z)***	***Expected Electronic Configuration***	***Observed Electronic Configuration***
Lanthanum	La	57	$[Xe]\ 5d^{1} 6s^{2}$	$[Xe]\ 5d^{1} 6s^{2}$
Hafnium	Hf	58	$[Xe]\ 5d^{2} 6s^{2}$	$[Xe]\ 5d^{2} 6s^{2}$
Tantalum	Ta	59	$[Xe]\ 5d^{3} 6s^{2}$	$[Xe]\ 5d^{3} 6s^{2}$
Tungsten	W	60	$[Xe]\ 5d^{4} 6s^{2}$	$[Xe]\ 5d^{4} 6s^{2}$
Rhenium	Re	61	$[Xe]\ 5d^{5}6s^{2}$	$[Xe]\ 5d^{5}6s^{2}$
Osmium	Os	62	$[Xe]\ 5d^{6} 6s^{2}$	$[Xe]\ 5d^{6} 6s^{2}$
Iridium	Ir	63	$[Xe]\ 5d^{7} 6s^{2}$	$[Xe]5d7\ 6s^{2}$
Platinum	Pt	64	$[Xe]\ 5d^{8} 6s^{2}$	$[Xe]\ 5d^{8} 6s^{2}$
Gold	Au	65	$[Xe]\ 5d^{9} 6s^{2}$	$[Xe]\ 5d^{10} 6s^{1}$
Mercury	Hg	66	$[Xe]\ 5d^{10} 6s^{2}$	$[Xe]\ 5d^{10} 6s^{2}$

Exceptional Electronic configuration

- The elements of the 3d-series have some exceptions in electronic configurations including Chromium; [Ar]$3d^5 4s^1$) and Copper; [Ar]$3d^{10}$ $4s^1$ due to attaining of exactly half-filled and fully filled stable electronic configuration.
- Variation in the electronic configuration of the 4d-series has been observed in Niobium; [Kr]$4d^4$ $5s^1$, Molybdenum; [Kr]$4d^5$ $5s^1$,Ruthenium; [Kr]$4d^7$ $5s^1$, Rhodium; [Kr]$4d^8$ $5s^1$, Palladium; [Kr]$4d^{10}$ $5s^0$ due to lesser energy difference observed in 4d and 5s orbitals compare to the 3d and 4s orbital of 3d-series
- Variation in the electronic configuration of the 5d-series has not been observed however, only Gold;[Xe] $5d^{10}$ $6s^1$ show exceptional behavior due to acquiring of stable fully filled (d^{10}) electronic configuration

Characteristic properties of d-block elements

- The general electronic configuration of these elements is (n - 1) d^{1-10} ns^{1-2}
- Elements belonging to groups 3 to 12 of the periodic table are known as Transition Elements because the properties of these elements vary between s- Block and p- Block elements.
- Anelement is said to be a transition element only if it should have incompletely filled (n- 1) d orbital either in ionic form or in elemental form
- The elements Zn, Cd, and Hg have fully filled (n- 1) d- orbital in atomic as well in +2 oxidation state,and therefore they are considered Typical Transition Elements or d-
- All elements belonging to d-block metals and theses are less electropositive than s- block elements (Alkali and Alkali earth metals) and more electropositive than p- block elements.
- The atomic radii of elements Sc to Cr decrease gradually due increase in effectivenuclear charge.

- The atomic radii of Fe, Co, and Ni are almost similar in size because the pairing ofelectrons takes place in (n- 1)d orbital causing repulsion i.e. shielding of (n- 1)d electrons.
- The atomic radii of Cu and Zn have a bigger size compared to other elements of the 3d-series due to the strong shielding of a completely filled (n- 1)d orbital.
- The transition elements show a variable oxidation state, this variation occurs due to the participation of both (n- 1)d &ns electrons as there is a small energy difference between these orbitals.
- The highest oxidation state of an element is directly related to the presence of the number of unpaired electrons in (n- 1)d & ns orbital.
- The enthalpy of atomization/sublimation of transition elements is very high this is due to the presence of a large number of unpaired electrons in their atoms, which reveal stronger interatomic interaction,which ultimately causes strong metallic bonding between the atoms.
- Most of the transition elements are paramagnetic due to the presence of unpaired electrons in (n- 1)d orbital.
- Transition elements are typically used as catalystsand this is due to the presence of partially filled (n- 1) d orbital, variation in oxidation state, and ability to change oxidation state frequently.
- Owing to the presence of unpaired electronsin (n- 1) d orbital, most of transition elements form-colored compounds.
- Transition elements form complexes due to their small size, high charge,and presence of vacant d- orbital.
- Transition elements have a lower value of Reduction Potential due to high ionization enthalpy, high heat of sublimation, and low enthalpy of hydration.
- Transition elements form alloys due to negligible differences found in their ionic radii.