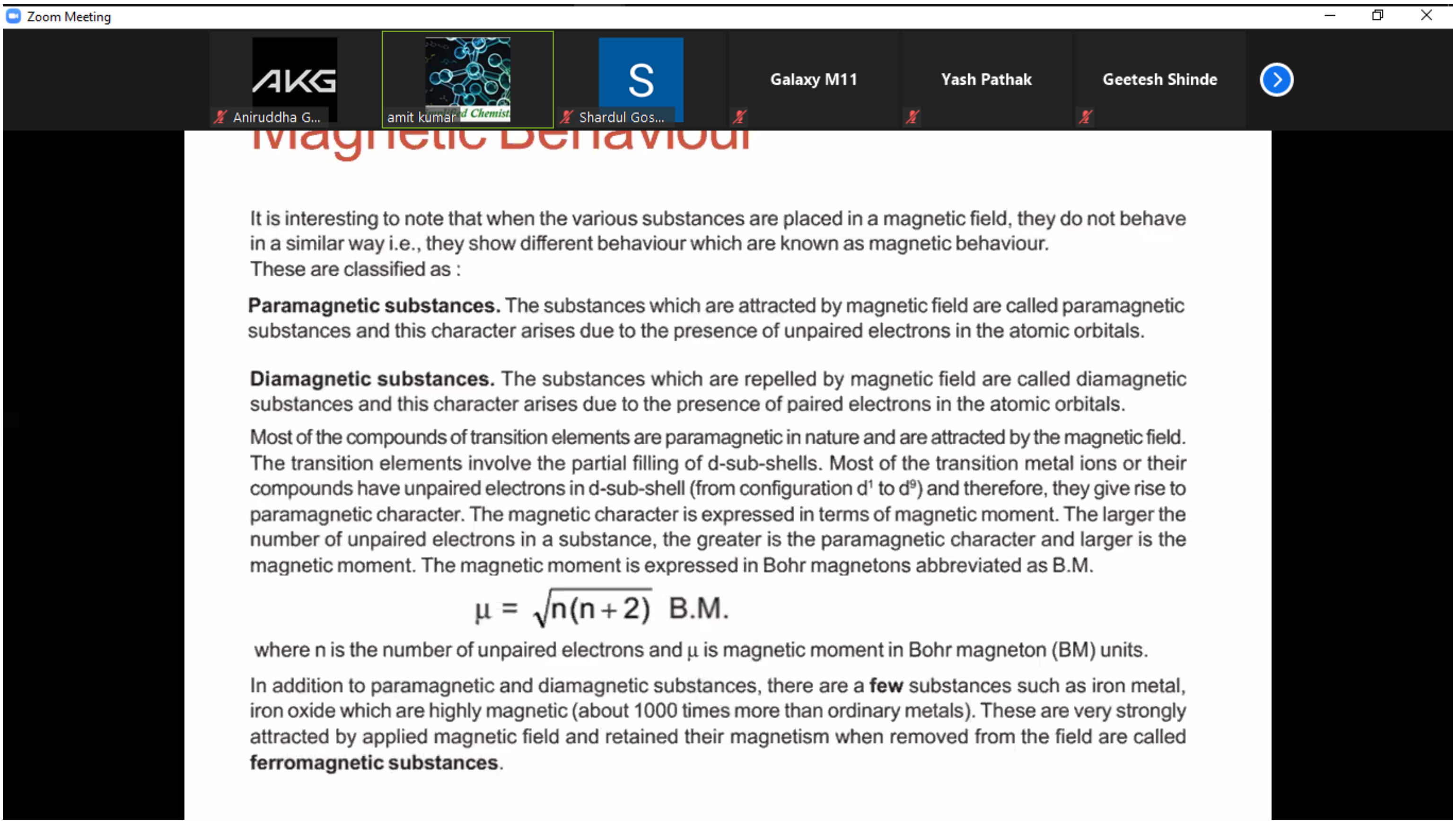


It is interesting to note that when the various substances are placed in a magnetic field, they do not behave in a similar way i.e., they show different behaviour which are known as magnetic behaviour.
These are classified as :

Paramagnetic substances. The substances which are attracted by magnetic field are called paramagnetic substances and this character arises due to the presence of unpaired electrons in the atomic orbitals.

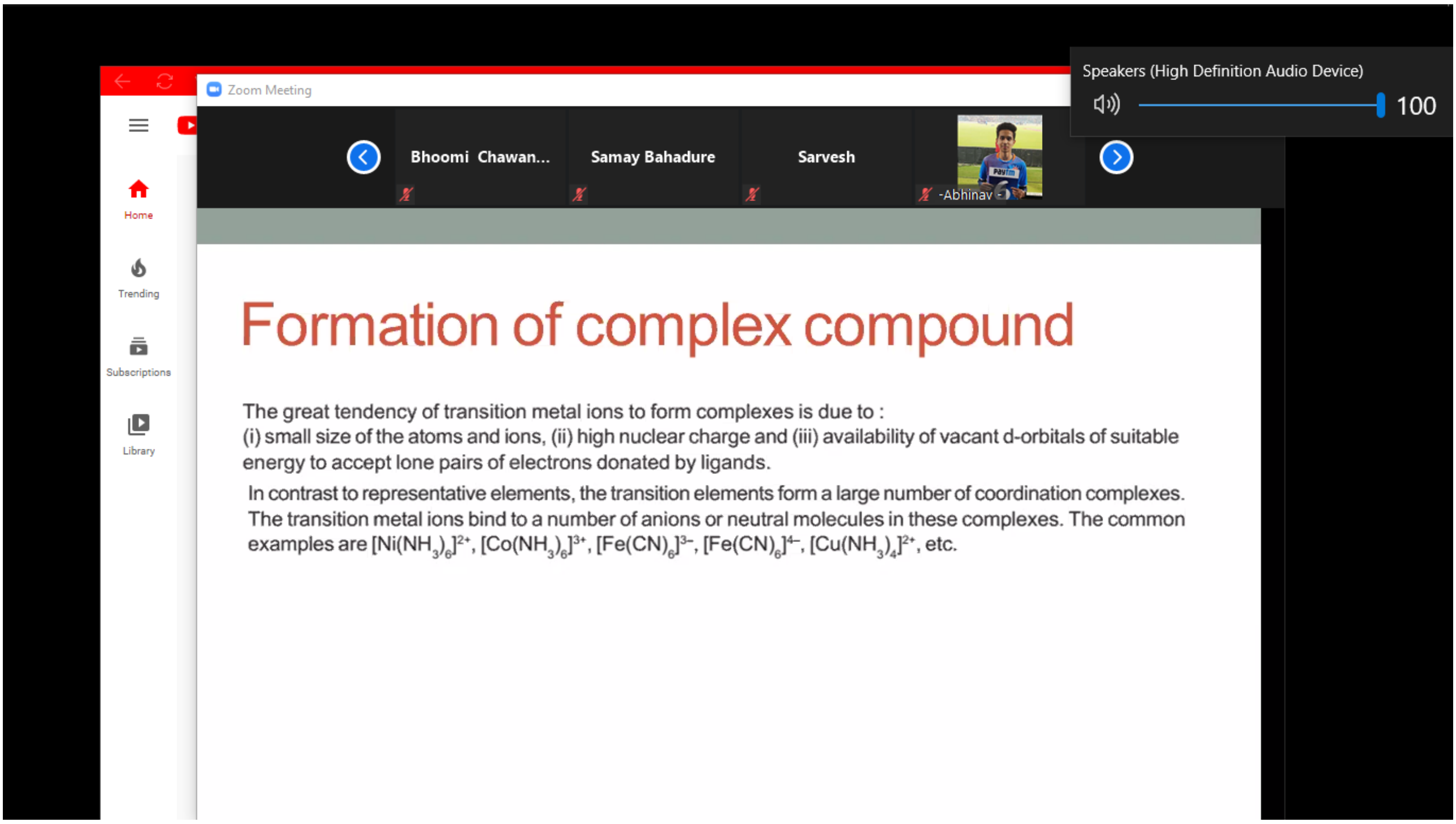
Diamagnetic substances. The substances which are repelled by magnetic field are called diamagnetic substances and this character arises due to the presence of paired electrons in the atomic orbitals.

Most of the compounds of transition elements are paramagnetic in nature and are attracted by the magnetic field. The transition elements involve the partial filling of d-sub-shells. Most of the transition metal ions or their compounds have unpaired electrons in d-sub-shell (from configuration d^1 to d^9) and therefore, they give rise to paramagnetic character. The magnetic character is expressed in terms of magnetic moment. The larger the number of unpaired electrons in a substance, the greater is the paramagnetic character and larger is the magnetic moment. The magnetic moment is expressed in Bohr magnetons abbreviated as B.M.

$$\mu = \sqrt{n(n+2)}\ \text{B.M.}$$

where n is the number of unpaired electrons and μ is magnetic moment in Bohr magneton (BM) units.

In addition to paramagnetic and diamagnetic substances, there are a **few** substances such as iron metal, iron oxide which are highly magnetic (about 1000 times more than ordinary metals). These are very strongly attracted by applied magnetic field and retained their magnetism when removed from the field are called **ferromagnetic substances**.



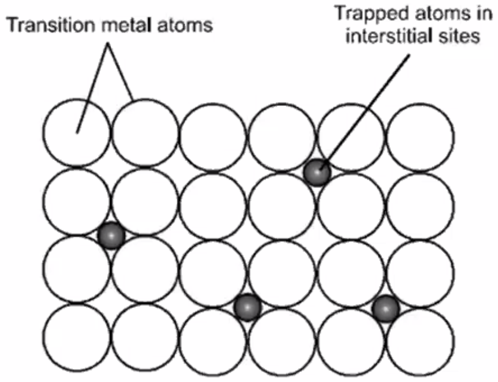
Formation of complex compound

The great tendency of transition metal ions to form complexes is due to :
(i) small size of the atoms and ions, (ii) high nuclear charge and (iii) availability of vacant d-orbitals of suitable energy to accept lone pairs of electrons donated by ligands.

In contrast to representative elements, the transition elements form a large number of coordination complexes. The transition metal ions bind to a number of anions or neutral molecules in these complexes. The common examples are $[Ni(NH_3)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{3-}$, $[Fe(CN)_6]^{4-}$, $[Cu(NH_3)_4]^{2+}$, etc.

Formation of Interstitial compound

Transition metals form interstitial compounds with elements such as hydrogen, boron, carbon and nitrogen. The small atoms of these non-metallic elements (H, B, C, N, etc.) get trapped in vacant spaces of the lattices of the transition metal atoms as shown below.



They are generally non-stoichiometric and are neither typically ionic nor covalent. The common examples of interstitial compounds of transition metals are TiC, Mn_4N, Fe_3H, TiH_2 etc. It may be noted that these formula do not correspond to any normal oxidation state of the metal. Generally, the nonstoichiometric materials are obtained having the composition as $TiH_{1.7}$, $VH_{0.56}$, etc. Because of the nature of their composition, these

Continue..

The general characteristic physical and chemical properties of these compound

(i) They have high melting points which are higher than those of pure metals.

(ii) They retain metallic conductivity i.e. of pure metals.

(iii) They are very hard and some borides have hardness as that of diamond.

(iv) They are chemically inert.

Continue..

The general characteristic physical and chemical properties of these compounds are

(i) They have high melting points which are higher than those of pure metals.

(ii) They retain metallic conductivity i.e. of pure metals.

(iii) They are very hard and some borides have hardness as that of diamond.

(iv) They are chemically inert.

Catalytic properties

Many transition metals and their compounds act as good catalysts for various reactions. Of these, the use of Fe, Co, Ni, V, Cr, Mn, Pt, etc. are very common.

The catalytic property of transition metals is due to their tendency to form reaction intermediates with suitable reactants. These intermediates give reaction paths of lower activation energy and, therefore increase the rate of the reaction.

These reaction intermediates readily decompose yielding the products and regenerating the original substance. The transition metals form these reaction intermediates due to the presence of vacant orbitals or their tendency to form variable oxidation states.

In some cases, the transition metal ions can change their oxidation states and become more effective as catalysts. For example, cobalt salts catalyse decomposition of bleaching powder as cobalt can easily change oxidation state from +2 to +3 as :

$$Co^{2+} + OCl^{-} + H_2O \longrightarrow Co^{3+} + Cl^{-} + 2OH^{-}$$

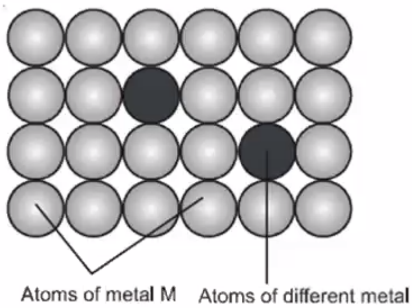
$$2Co^{3+} + 2OH^{-} \longrightarrow 2Co^{2+} + H_2O + \tfrac{1}{2}O_2$$

Iron (III) also catalyses the reaction between iodide and persulphate ions ($S_2O_8^{2-}$).

Alloy Formation

Alloys are homogeneous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other metal. The alloys are generally formed by those atoms which have metallic radii within about 15% of each other. Transition metals form a large number of alloys. The transition metals are quite similar in size and, therefore, the atoms of one metal can substitute the atoms of other metal in its crystal lattice. Thus, on cooling a mixture solution of two or more transition metals, solid alloys are formed. Such alloys are hard, have high melting points and are more resistant to corrosion than parent metals.

For example, the most common known alloys are ferrous alloys. Chromium, manganese, vanadium, tungsten, molybdenum etc. are used to produce variety of steels and stainless steel. Alloys of transition metals with non-transition metals such as bronze (copper-tin), brass (copper-zinc) are also industrially important alloys.



Important Compound

PREPARATIONS AND PROPERTIES OF SOME IMPORTANT d-BLOCK METAL COMPOUNDS

COMPOUNDS OF IRON :

Ferrous Sulphate, $FeSO_4.7H_2O$ (Green vitriol)
It is commonly known as harakasis

- **Preparation**

(i) By iron scrap :

$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2\uparrow$

(ii) From kipp's waste :

$3FeS_2 + 2H_2O + 11O_2 \longrightarrow FeSO_4 + Fe_2(SO_4)_3 + 2H_2SO_4$

$Fe_2(SO_4)_3 + Fe \longrightarrow 3FeSO_4$

(iii) $FeCO_3 + H_2SO_4 \longrightarrow FeSO_4 + H_2O + CO_2$

- **Properties**

(a) Physical : Hydrated ferrous sulphate is a green crystalline compound, effloresces on exposure to air. Anhydrous $FeSO_4$ is colourless.

Colour of Metal ions

Ion	Outer Configuration	Colour of the ion
Sc (III), Ti (IV)	$3d^0$	Colourless
Ti (III)	$3d^1$	Purple
V (IV)	$3d^1$	Blue
V (III)	$3d^2$	Green
Cr (III)	$3d^3$	Green
Mn (III)	$3d^4$	Violet
Cr (II)	$3d^4$	Blue
Mn (II)	$3d^5$	Pink
Fe (III)	$3d^5$	Yellow
Fe (II)	$3d^6$	Green
Co (III)	$3d^6$	Blue
Co (II)	$3d^7$	Pink
Ni (II)	$3d^8$	Green
Cu (II)	$3d^9$	Blue
Cu (I)	$3d^{10}$	Colourless
Zn (II)	$3d^{10}$	Colourless