INORGANIC CHEMISTRY

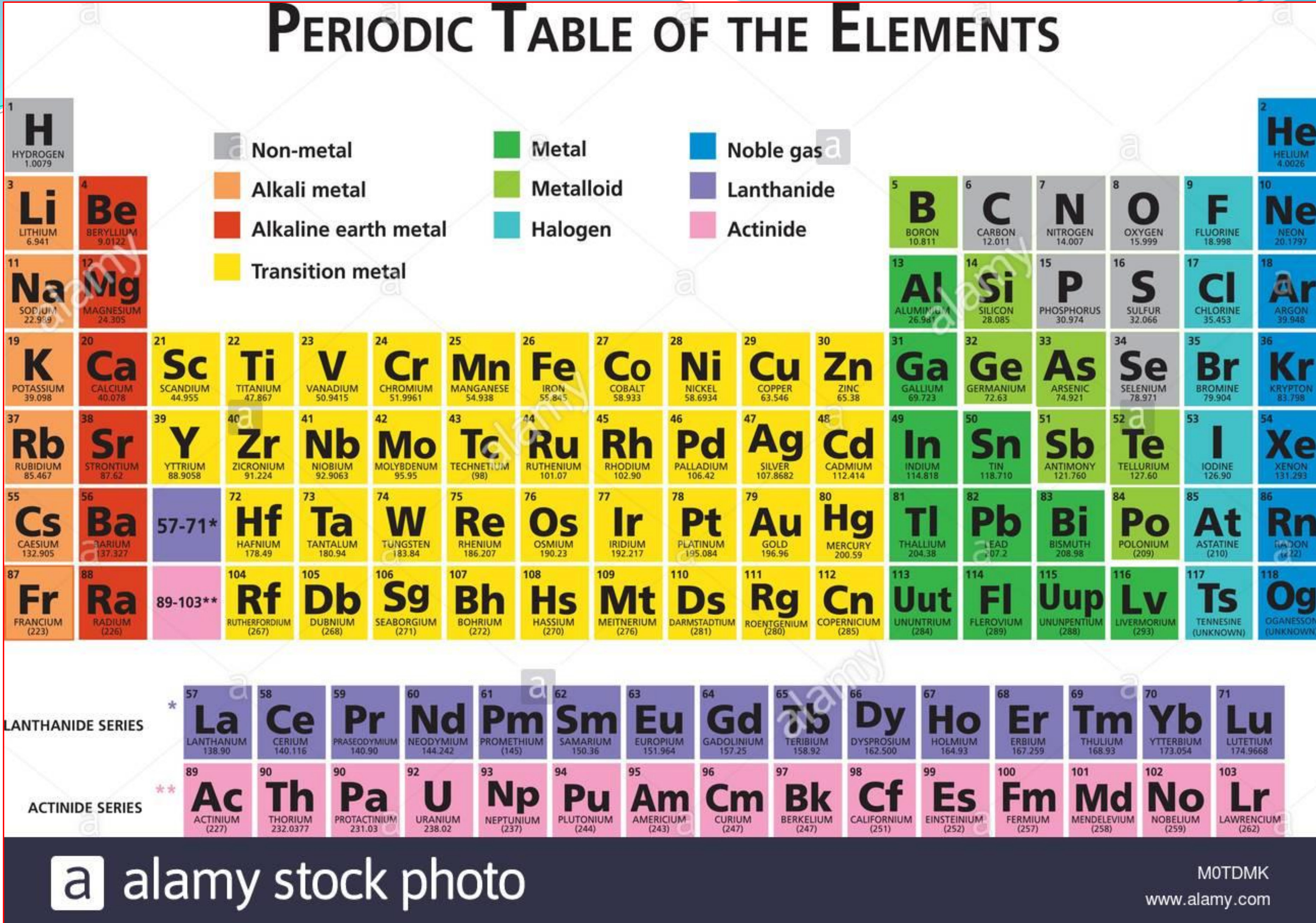
CHAPTER- The d-Block Elements

ONLINE LECTURE

NO. 16

DATE:- 23, OCTOBER 2020

TIME: (9.00A.M.)



PERIODIC TABLE OF THE ELEMENTS
Non-metal
Alkali metal
Alkaline earth metal
Transition metal
Metal
Metalloid
Halogen
Noble gas
Lanthanide
Actinide
1 H HYDROGEN 1.0079
2 He HELIUM 4.0026
3 Li LITHIUM 6.941
4 Be BERYLLIUM 9.0122
5 B BORON 10.811
6 C CARBON 12.011
7 N NITROGEN 14.007
8 O OXYGEN 15.999
9 F FLUORINE 18.998
10 Ne NEON 20.1797
11 Na SODIUM 22.989
12 Mg MAGNESIUM 24.305
13 Al ALUMINIUM 26.981
14 Si SILICON 28.085
15 P PHOSPHORUS 30.974
16 S SULFUR 32.066
17 Cl CHLORINE 35.453
18 Ar ARGON 39.948
19 K POTASSIUM 39.098
20 Ca CALCIUM 40.078
21 Sc SCANDIUM 44.955
22 Ti TITANIUM 47.867
23 V VANADIUM 50.9415
24 Cr CHROMIUM 51.9961
25 Mn MANGANESE 54.938
26 Fe IRON 55.845
27 Co COBALT 58.933
28 Ni NICKEL 58.6934
29 Cu COPPER 63.546
30 Zn ZINC 65.38
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43 Tc TECHNETIUM (98)
44 Ru RUTHENIUM 101.07
45 Rh RHODIUM 102.90
46 Pd PALLADIUM 106.42
47 Ag SILVER 107.8682
48 Cd CADMIUM 112.414
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51 Sb ANTIMONY 121.760
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53 I IODINE 126.90
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86 Rn RADON (222)
87 Fr FRANCIUM (223)
88 Ra RADIUM (226)
89-103**
104 Rf RUTHERFORDIUM (267)
105 Db DUBNIUM (268)
106 Sg SEABORGIUM (271)
107 Bh BOHRIUM (272)
108 Hs HASSIUM (270)
109 Mt MEITNERIUM (276)
110 Ds DARMSTADTIUM (281)
111 Rg ROENTGENIUM (280)
112 Cn COPERNICIUM (285)
113 Uut UNUNTRIUM (284)
114 Fl FLEROVIUM (289)
115 Uup UNUNPENTIUM (288)
116 Lv LIVERMORIUM (293)
117 Ts TENNESINE (UNKNOWN)
118 Og OGANESSON (UNKNOWN)
LANTHANIDE SERIES *
57 La LANTHANUM 138.90
58 Ce CERIUM 140.116
59 Pr PRASEODYMIUM 140.90
60 Nd NEODYMIUM 144.242
61 Pm PROMETHIUM (145)
62 Sm SAMARIUM 150.36
63 Eu EUROPIUM 151.964
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93 Np NEPTUNIUM (237)
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101 Md MENDELEVIUM (258)
102 No NOBELIUM (259)
103 Lr LAWRENCIUM (262)
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PERIODIC TABLE OF ELEMENTS

1 H Hydrogen Nonmetal	Atomic Number Symbol Name Chemical Group Block

1 H Hydrogen Nonmetal																	2 He Helium Noble Gas
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth Metal											5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth Metal											13 Al Aluminum Post-Transition Metal	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth Metal	21 Sc Scandium Transition Metal	22 Ti Titanium Transition Metal	23 V Vanadium Transition Metal	24 Cr Chromium Transition Metal	25 Mn Manganese Transition Metal	26 Fe Iron Transition Metal	27 Co Cobalt Transition Metal	28 Ni Nickel Transition Metal	29 Cu Copper Transition Metal	30 Zn Zinc Transition Metal	31 Ga Gallium Post-Transition Metal	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth Metal	39 Y Yttrium Transition Metal	40 Zr Zirconium Transition Metal	41 Nb Niobium Transition Metal	42 Mo Molybdenum Transition Metal	43 Tc Technetium Transition Metal	44 Ru Ruthenium Transition Metal	45 Rh Rhodium Transition Metal	46 Pd Palladium Transition Metal	47 Ag Silver Transition Metal	48 Cd Cadmium Transition Metal	49 In Indium Post-Transition Metal	50 Sn Tin Post-Transition Metal	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth Metal	*	72 Hf Hafnium Transition Metal	73 Ta Tantalum Transition Metal	74 W Tungsten Transition Metal	75 Re Rhenium Transition Metal	76 Os Osmium Transition Metal	77 Ir Iridium Transition Metal	78 Pt Platinum Transition Metal	79 Au Gold Transition Metal	80 Hg Mercury Transition Metal	81 Tl Thallium Post-Transition Metal	82 Pb Lead Post-Transition Metal	83 Bi Bismuth Post-Transition Metal	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas
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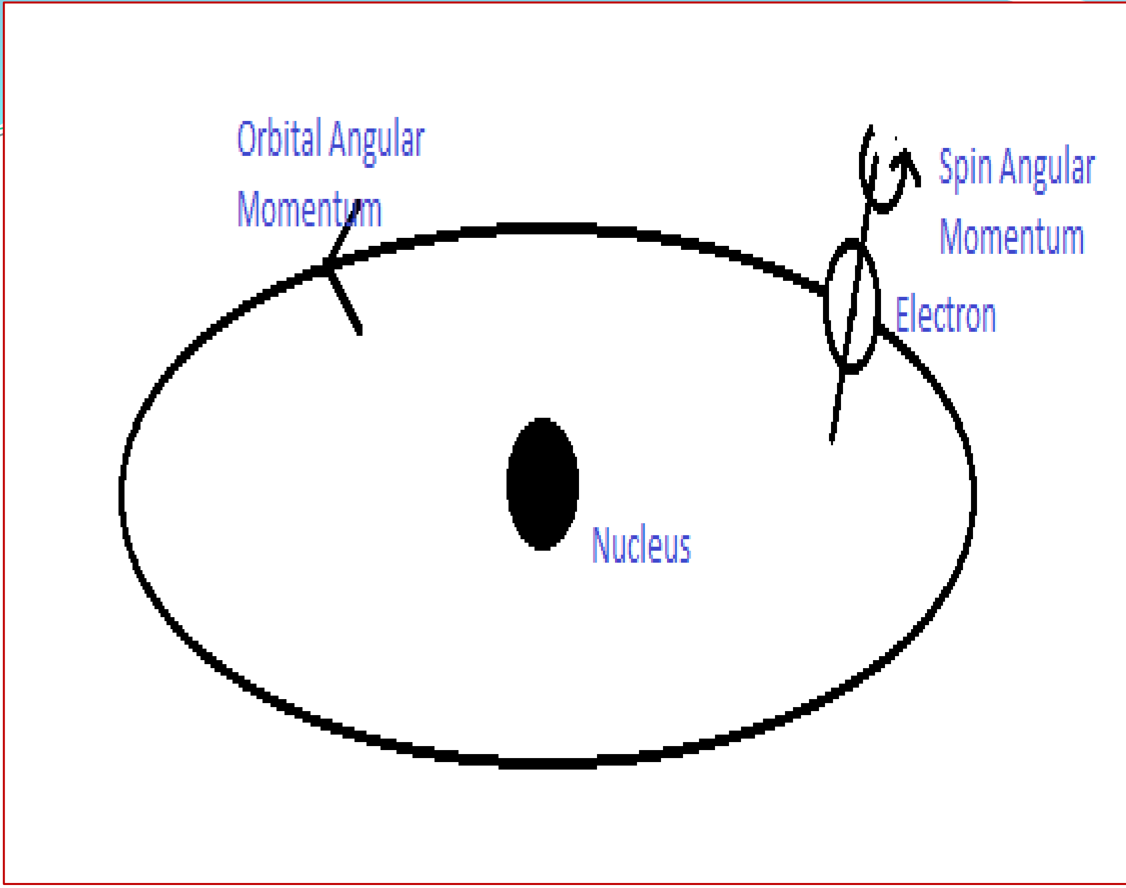
11) Magnetic properties: - The transition metals and their compounds possess magnetic properties. The origin of the magnetic properties of chemical substances is due to the motion of electrons. The electron is treated as a hard negatively charged sphere. There are two types of electron motions. It is spinning on its own axis called spin motion and travelling in a closed orbit about a nucleus, called orbital motion. Each type of motion has a magnetic moment associated with it. The spin motion gives rise to the spin moment and orbital motion gives rise to the orbital moment of the electron. The combination of these two moments gives rise to a magnetic field. Each electron is considered as a micromagnet having a certain value of magnetic moment. The total magnetic moment of a substance is the resultant of the magnetic moments of all the individual electrons.



The total magnetic moment of a substance is the resultant of the magnetic moments of all the individual electrons.

$$\mu_{Total} = \mu_{eff.} = \mu_{orbital} + \mu_{spin}$$

$$\mu_{eff.} \approx \mu_{spin} \approx \sqrt{n(n+2)}$$

Where, n is no. of unpaired electrons.

Spin motion → Spin moment →

Orbital motion → Orbital moment →

} Magnetic field

The magnetic moment of an electron is thus partly due to its spin motion and partly due to its orbital motion. The total or effective magnetic moment ($\mu_{eff.}$) of a substance containing an unpaired electron is due to $\mu_{orbital}$ and μ_{spin}. In transition metal ions, the unpaired electrons are generally present in the outer d-orbitals. As the d-orbitals are more diffused (spread), they get disturbed. The orbital motion of such unpaired electrons is very much disturbed by the electrons of the surrounding ligands which quench the $\mu_{orbital}$ in the transition metal compounds. Therefore, in such cases, the μ_{spin} becomes much more significant than the $\mu_{orbital.}$ Hence, $\mu_{orbital}$ may be neglected. The $\mu_{eff.}$ may be given by the expression,

$$\mu_{eff.} \approx \mu_{spin} \approx \sqrt{n(n+2)}$$

Where, n is the number of unpaired electrons. The magnetic moment is expressed in Bohr magneton (BM), which is given by the equation, BM = eh/4π mc.

Where, h = Planck's constant, e = electronic charge, c = velocity of light and m = mass of electron.

The effective magnetic moment of a substance thus depends mainly on the number of unpaired electrons present in it.

e.g. For one electron, $\mu_{spin} = \sqrt{n(n+2)} = \sqrt{1(1+2)} = \sqrt{3}$

= 1.732 BM

For two electrons, $\mu_{spin} = \sqrt{2(2+2))} = \sqrt{8}$

= 2.83 BM

For three electrons, $\mu_{spin} = \sqrt{3(3+2)} = \sqrt{15}$ = 3.87 BM

The actual magnetic moments may be slightly different from these values. This depends upon the quenching of $\mu_{orbital}$ of the electrons in the ions. This in turn depends upon the arrangement (geometry) of the ligands around the metal ions in their complexes.

The value of magnetic moment is used to find the number of unpaired electrons in the atom or ion.

Types of Magnetic substances: - There are four types of magnetic materials

a) Diamagnetic b) Paramagnetic c) Ferromagnetic and d) Anti-ferromagnetic.

a) Diamagnetic substances: - It is defined as a substance which is repelled by a magnetic field. The diamagnetism is due to the presence of the paired electrons in the substance. The diamagnetic behavior is due to the fact that small magnetic moments are induced into a substance when a magnetic field is brought close to the substance. But, these induced magnetic moments are in opposite direction to the external magnetic field. Thus, the field in the substance is less than the external magnetic field. This causes repulsion of the substance by the magnetic field. e.g. Glass, Cu, Ag, Au.

b) Paramagnetic substances: - It is defined as a substance which is attracted into a magnetic field. Thus, the field in the substance is greater than external field. The paramagnetism is due to the presence of one or more unpaired electrons in atoms, ions or molecules. e.g.Cr, Mn, Pt, $CuSO_4$, etc.

Magnetic substances

Diamagnetic substances

- Paired electrons
- Repelled by mag. field
- Induced Mag. Moment is in opposite to external mag. Field.
- e.g. Glass, Cu, Ag, Au.

Paramagnetic substances

- Unpaired electrons
- Attracted by mag. field
- Field in substance > External field.
- e.g.Cr, Mn, Pt, $CuSO_4$,

Ferromagnetic substances

- Substance which is strongly attracted by a magnet and can be magnetized.
- Mag. Moments Alligned Parallel to external field
- Fe, Co, Ni and their alloys

Anti-ferromagnetic substances

- magnetic moments of adjacent atoms pair and point in opposite directions.
- Fe^{+3}, Mn^{+2} and Gd^{+3}
- Absent in solution

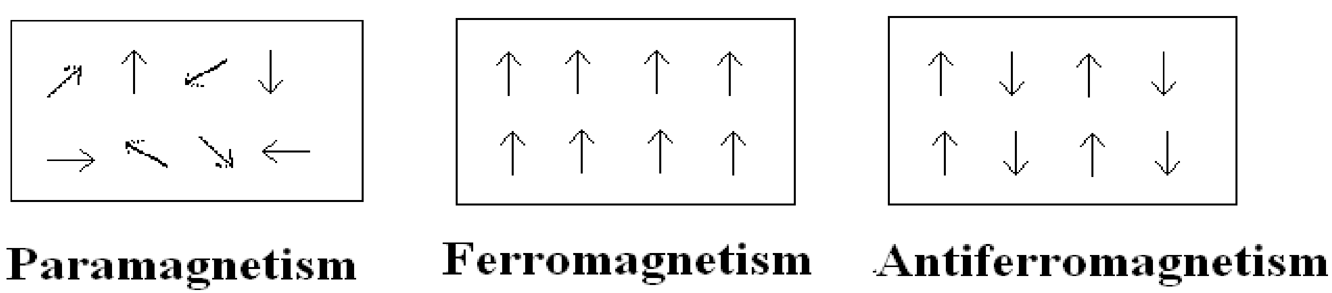


Fig. Arrangements of spins of electrons in different magnetic materials

c) Ferromagnetic substances: - These substances may be considered as a special case of paramagnetism. It is defined as a substance which is strongly attracted by a magnet and can be magnetized.

In these substances, the magnetic moments due to unpaired electron spin are aligned parallel to the external magnetic field. These are strongly paramagnetic substances. e.g. Fe, Co, Ni and their alloys.

d) Anti-ferromagnetic substances: - It is a substance in which the magnetic moments of adjacent atoms pair and point in opposite directions. This gives magnetic moment less than would be expected for any array of independent ions. It occurs in many simple salts of Fe^{+3}, Mn^{+2} and Gd^{+3}.

Anti-ferromagnetism depends on orientation of spins and hence it disappears in solution.

INORGANIC CHEMISTRY

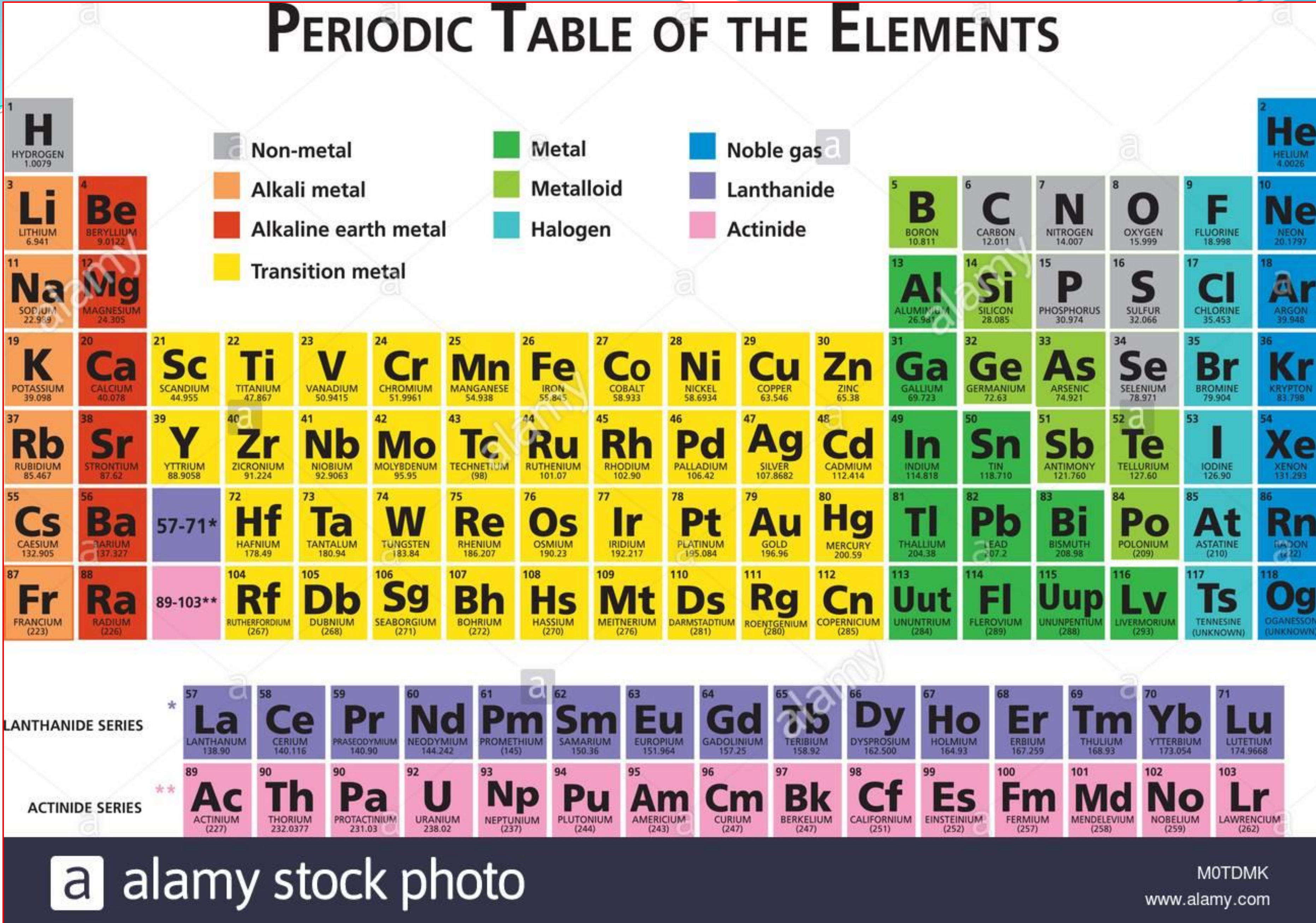
CHAPTER- The d-Block Elements

ONLINE LECTURE

NO. 17

DATE:- 28, OCTOBER 2020

TIME: (10.00A.M.)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12) Catalytic properties: - A catalyst is a substance which alters the rate of a chemical reaction without itself being permanently changed by the reaction. Most of the transition elements and their compounds have good catalytic properties. The transition elements because of their variable valency can very readily form unstable intermediate compounds. These elements can also provide a large surface area for the reactants to be adsorbed and thus come close to one another for the reaction to take place on the surface of the catalyst itself.

According to the theory of catalysis, a catalyst forms an unstable intermediate compound which readily decomposes to give product and regenerate the catalyst.

Step 1) Formation of unstable intermediate compound.

Step 1) Formation of unstable intermediate compound

A + B + Transition metal Catalyst → A—B—Catalyst

Reactant (A + B) unstable intermediate compound (A—B—Catalyst)

Step 2) Formation of product and regeneration of catalyst

A—B—Catalyst → C + Catalyst

Product (C)

There are many examples of transition metals and their compounds acting as catalysts. Pt, Fe, V_2O_5, Ni, Pd etc. Pt is a general catalyst. It is particularly used in the Contact process involving combination of SO_2 and O_2 to form SO_3. For same reaction, V_2O_5 is also good catalyst. Iron is used in Haber's process for combination of N_2 and H_2 to produce NH_3. Ni is good catalyst in the hydrogenation process.

$2SO_2 + O_2 \rightarrow 2SO_3$

$N_2 + 3H_2 \rightarrow 2NH_3$

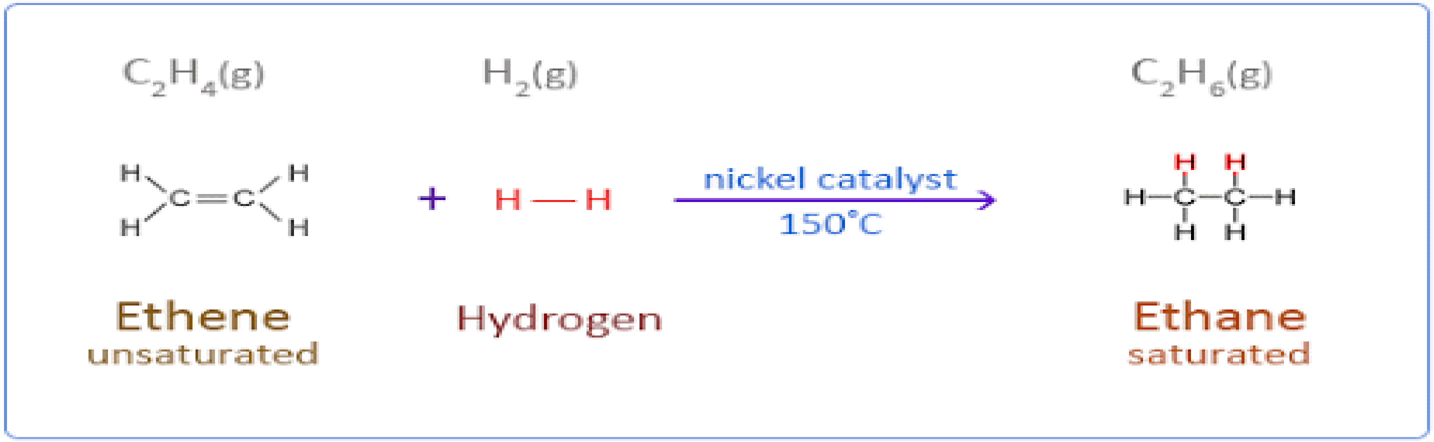
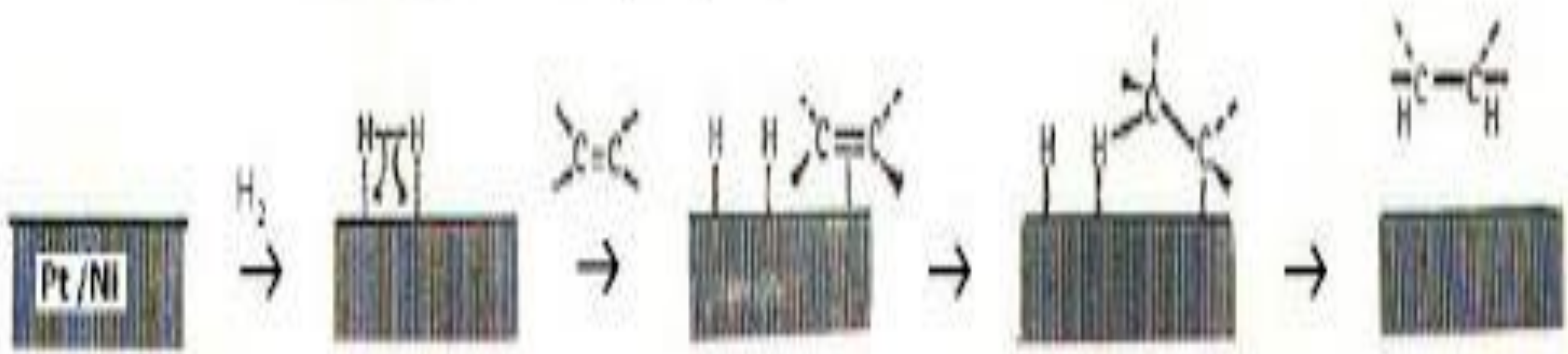
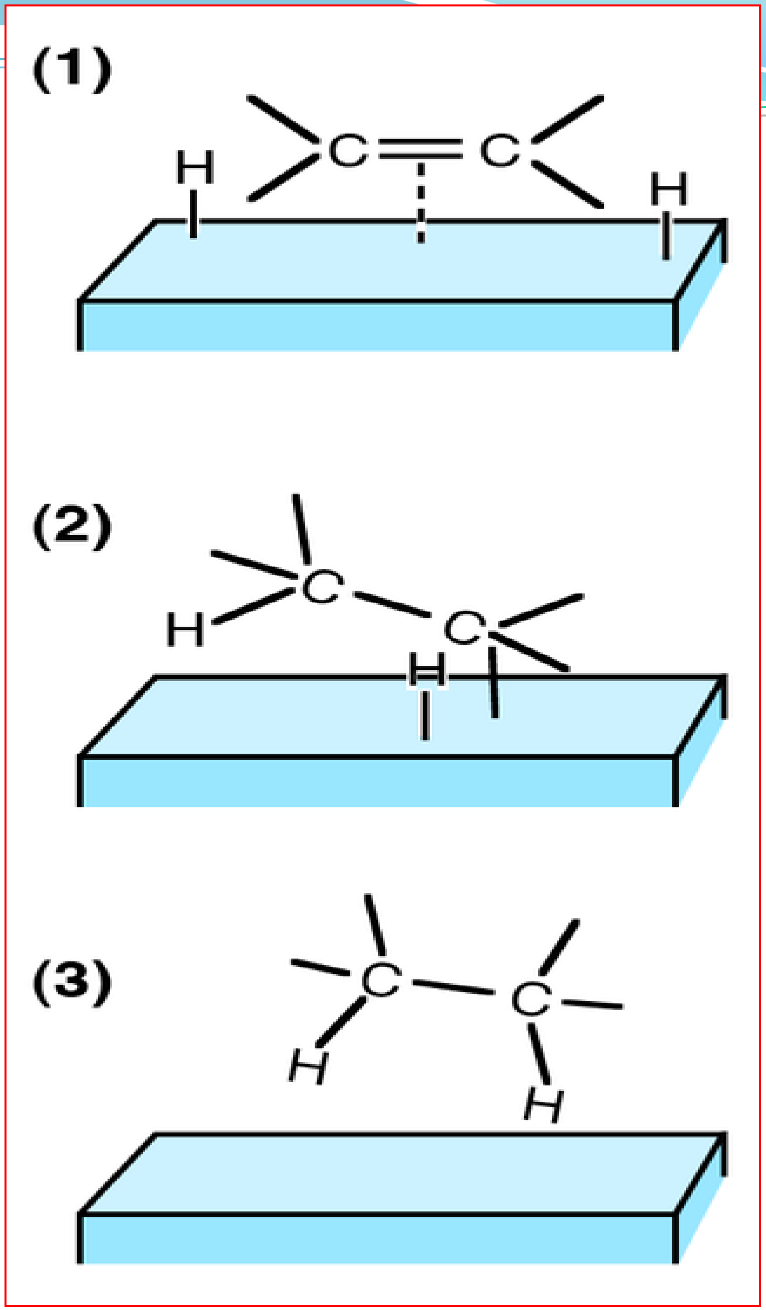


FIG. 9.7. Catalytic hydrogenation of a double bond.



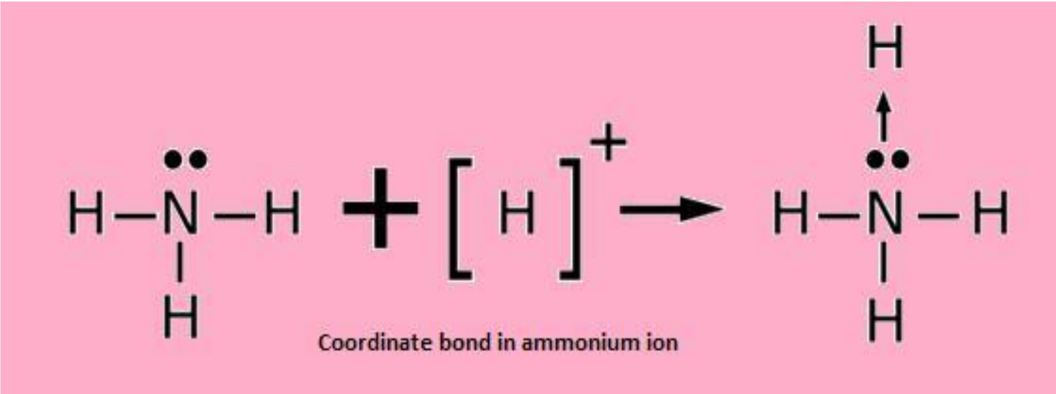

(1)
H
C
C
H
(2)
C
H
C
H
(3)
C
C
H
H

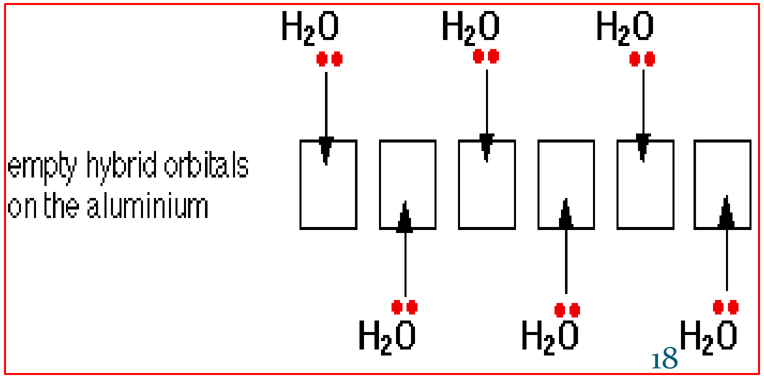
13) Tendency to form complexes: - The transition metals have the peculiar tendency to form coordination complexes. The tendency of cations of transition metals to form complexes is due to two factors:

i) The size of these ions is very small. This gives high positive charge density to the ions. This also helps the acceptance of lone pairs of electrons from other molecules.

2) They have vacant orbitals of suitable energy. The vacant orbitals can easily accept lone pairs of electrons from other molecules.

$N_7 \longrightarrow 1S^2, 2S^2, 2Px^1, 2Py^1, 2Pz^1$





14) Metallic properties: - The metallic or non-metallic character of the element depends upon its electronic configuration. The d-block elements have $ns^{0,1 or 2}$, $(n-1)d^{1-10}$ configuration. The differentiating (last incoming) electron enters in (n-1) d-orbitals of penultimate shell. The number of electrons in the outermost shell are very small i.e. 1 or 2. These outermost few electrons can be easily removed to form positive ions. Thus, all the transition elements are metals.

i) They are good conductors of heat and electricity.

ii) They are malleable (sheets) and ductile (wire).

iii) They form alloys with many other metals.

iv) They are hard and brittle and hence are different from non-transition elements. The Hg is exception.

v) They have high density and low atomic volume.

vi) They form coloured and paramagnetic compounds.

vii) Both covalent and metallic bonding exists amongst the atoms of transition elements. The covalent bonding is due to the overlapping of empty d-orbitals of metal ions. While, the metallic bonding is due to S-electrons.

INORGANIC CHEMISTRY

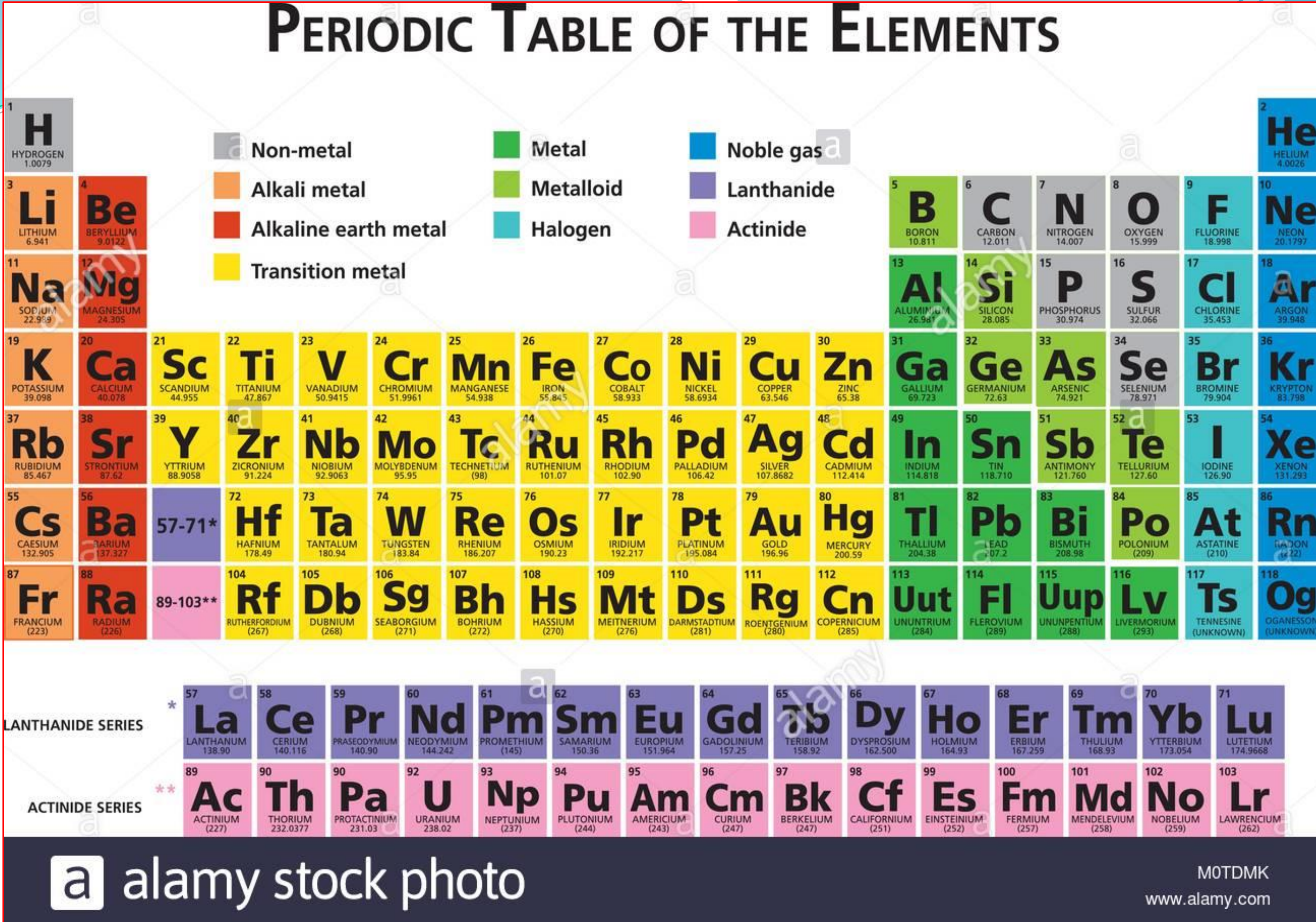
CHAPTER- The d-Block Elements

ONLINE LECTURE

NO. 18

DATE:- 4, NOVEMBER 2020

TIME: (10.00A.M.)


PERIODIC TABLE OF THE ELEMENTS
Non-metal
Alkali metal
Alkaline earth metal
Transition metal
Metal
Metalloid
Halogen
Noble gas
Lanthanide
Actinide
1 H HYDROGEN 1.0079
2 He HELIUM 4.0026
3 Li LITHIUM 6.941
4 Be BERYLLIUM 9.0122
5 B BORON 10.811
6 C CARBON 12.011
7 N NITROGEN 14.007
8 O OXYGEN 15.999
9 F FLUORINE 18.998
10 Ne NEON 20.1797
11 Na SODIUM
12 Mg MAGNESIUM 24.305
13 Al ALUMINIUM
14 Si SILICON 28.085
15 P PHOSPHORUS 30.974
16 S SULFUR 32.066
17 Cl CHLORINE 35.453
18 Ar ARGON 39.948
19 K POTASSIUM 39.098
20 Ca CALCIUM 40.078
21 Sc SCANDIUM 44.955
22 Ti TITANIUM 47.867
23 V VANADIUM 50.9415
24 Cr CHROMIUM 51.9961
25 Mn MANGANESE 54.938
26 Fe IRON 55.845
27 Co COBALT 58.933
28 Ni NICKEL 58.6934
29 Cu COPPER 63.546
30 Zn ZINC 65.38
31 Ga GALLIUM 69.723
32 Ge GERMANIUM 72.63
33 As ARSENIC 74.921
34 Se SELENIUM 78.971
35 Br BROMINE 79.904
36 Kr KRYPTON 83.798
37 Rb RUBIDIUM 85.467
38 Sr STRONTIUM 87.62
39 Y YTTRIUM 88.9058
40 Zr ZIRCONIUM 91.224
41 Nb NIOBIUM 92.9063
42 Mo MOLYBDENUM 95.95
43 Tc TECHNETIUM (98)
44 Ru RUTHENIUM 101.07
45 Rh RHODIUM 102.90
46 Pd PALLADIUM 106.42
47 Ag SILVER 107.8682
48 Cd CADMIUM 112.414
49 In INDIUM 114.818
50 Sn TIN 118.710
51 Sb ANTIMONY 121.760
52 Te TELLURIUM 127.60
53 I IODINE 126.90
54 Xe XENON 131.293
55 Cs CAESIUM 132.905
56 Ba BARIUM 137.327
57-71*
72 Hf HAFNIUM 178.49
73 Ta TANTALUM 180.94
74 W TUNGSTEN 183.84
75 Re RHENIUM 186.207
76 Os OSMIUM 190.23
77 Ir IRIDIUM 192.217
78 Pt PLATINUM 195.084
79 Au GOLD 196.96
80 Hg MERCURY 200.59
81 Tl THALLIUM 204.38
82 Pb LEAD 207.2
83 Bi BISMUTH 208.98
84 Po POLONIUM (209)
85 At ASTATINE (210)
86 Rn RADON
87 Fr FRANCIUM (223)
88 Ra RADIUM (226)
89-103**
104 Rf RUTHERFORDIUM (267)
105 Db DUBNIUM (268)
106 Sg SEABORGIUM (271)
107 Bh BOHRIUM (272)
108 Hs HASSIUM (270)
109 Mt MEITNERIUM (276)
110 Ds DARMSTADTIUM (281)
111 Rg ROENTGENIUM (280)
112 Cn COPERNICIUM (285)
113 Uut UNUNTRIUM (284)
114 Fl FLEROVIUM (289)
115 Uup UNUNPENTIUM (288)
116 Lv LIVERMORIUM (293)
117 Ts TENNESINE (UNKNOWN)
118 Og OGANESSON (UNKNOWN)
LANTHANIDE SERIES *
57 La LANTHANUM 138.90
58 Ce CERIUM 140.116
59 Pr PRASEODYMIUM 140.90
60 Nd NEODYMIUM 144.242
61 Pm PROMETHIUM (145)
62 Sm SAMARIUM 150.36
63 Eu EUROPIUM 151.964
64 Gd GADOLINIUM 157.25
65 Tb TERIBIUM 158.92
66 Dy DYSPROSIUM 162.500
67 Ho HOLMIUM 164.93
68 Er ERBIUM 167.259
69 Tm THULIUM 168.93
70 Yb YTTERBIUM 173.054
71 Lu LUTETIUM 174.9668
ACTINIDE SERIES **
89 Ac ACTINIUM (227)
90 Th THORIUM 232.0377
90 Pa PROTACTINIUM 231.03
92 U URANIUM 238.02
93 Np NEPTUNIUM (237)
94 Pu PLUTONIUM (244)
95 Am AMERICIUM (243)
96 Cm CURIUM (247)
97 Bk BERKELIUM (247)
98 Cf CALIFORNIUM (251)
99 Es EINSTEINIUM (252)
100 Fm FERMIUM (257)
101 Md MENDELEVIUM (258)
102 No NOBELIUM (259)
103 Lr LAWRENCIUM (262)
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PERIODIC TABLE OF ELEMENTS

1 H Hydrogen Nonmetal	Atomic Number Symbol Name Chemical Group Block

1 H Hydrogen Nonmetal																	2 He Helium Noble Gas
3 Li Lithium Alkali Metal	4 Be Beryllium Alkaline Earth Metal											5 B Boron Metalloid	6 C Carbon Nonmetal	7 N Nitrogen Nonmetal	8 O Oxygen Nonmetal	9 F Fluorine Halogen	10 Ne Neon Noble Gas
11 Na Sodium Alkali Metal	12 Mg Magnesium Alkaline Earth Metal											13 Al Aluminum Post-Transition Metal	14 Si Silicon Metalloid	15 P Phosphorus Nonmetal	16 S Sulfur Nonmetal	17 Cl Chlorine Halogen	18 Ar Argon Noble Gas
19 K Potassium Alkali Metal	20 Ca Calcium Alkaline Earth Metal	21 Sc Scandium Transition Metal	22 Ti Titanium Transition Metal	23 V Vanadium Transition Metal	24 Cr Chromium Transition Metal	25 Mn Manganese Transition Metal	26 Fe Iron Transition Metal	27 Co Cobalt Transition Metal	28 Ni Nickel Transition Metal	29 Cu Copper Transition Metal	30 Zn Zinc Transition Metal	31 Ga Gallium Post-Transition Metal	32 Ge Germanium Metalloid	33 As Arsenic Metalloid	34 Se Selenium Nonmetal	35 Br Bromine Halogen	36 Kr Krypton Noble Gas
37 Rb Rubidium Alkali Metal	38 Sr Strontium Alkaline Earth Metal	39 Y Yttrium Transition Metal	40 Zr Zirconium Transition Metal	41 Nb Niobium Transition Metal	42 Mo Molybdenum Transition Metal	43 Tc Technetium Transition Metal	44 Ru Ruthenium Transition Metal	45 Rh Rhodium Transition Metal	46 Pd Palladium Transition Metal	47 Ag Silver Transition Metal	48 Cd Cadmium Transition Metal	49 In Indium Post-Transition Metal	50 Sn Tin Post-Transition Metal	51 Sb Antimony Metalloid	52 Te Tellurium Metalloid	53 I Iodine Halogen	54 Xe Xenon Noble Gas
55 Cs Cesium Alkali Metal	56 Ba Barium Alkaline Earth Metal	*	72 Hf Hafnium Transition Metal	73 Ta Tantalum Transition Metal	74 W Tungsten Transition Metal	75 Re Rhenium Transition Metal	76 Os Osmium Transition Metal	77 Ir Iridium Transition Metal	78 Pt Platinum Transition Metal	79 Au Gold Transition Metal	80 Hg Mercury Transition Metal	81 Tl Thallium Post-Transition Metal	82 Pb Lead Post-Transition Metal	83 Bi Bismuth Post-Transition Metal	84 Po Polonium Metalloid	85 At Astatine Halogen	86 Rn Radon Noble Gas
87 Fr Francium Alkali Metal	88 Ra Radium Alkaline Earth Metal	**	104 Rf Rutherfordium Transition Metal	105 Db Dubnium Transition Metal	106 Sg Seaborgium Transition Metal	107 Bh Bohrium Transition Metal	108 Hs Hassium Transition Metal	109 Mt Meitnerium Transition Metal	110 Ds Darmstadtium Transition Metal	111 Rg Roentgenium Transition Metal	112 Cn Copernicium Transition Metal	113 Nh Nihonium Post-Transition Metal	114 Fl Flerovium Post-Transition Metal	115 Mc Moscovium Post-Transition Metal	116 Lv Livermorium Post-Transition Metal	117 Ts Tennessine Halogen	118 Og Oganesson Noble Gas

*	57 La Lanthanum Lanthanide	58 Ce Cerium Lanthanide	59 Pr Praseodymium Lanthanide	60 Nd Neodymium Lanthanide	61 Pm Promethium Lanthanide	62 Sm Samarium Lanthanide	63 Eu Europium Lanthanide	64 Gd Gadolinium Lanthanide	65 Tb Terbium Lanthanide	66 Dy Dysprosium Lanthanide	67 Ho Holmium Lanthanide	68 Er Erbium Lanthanide	69 Tm Thulium Lanthanide	70 Yb Ytterbium Lanthanide	71 Lu Lutetium Lanthanide
**	89 Ac Actinium Actinide	90 Th Thorium Actinide	91 Pa Protactinium Actinide	92 U Uranium Actinide	93 Np Neptunium Actinide	94 Pu Plutonium Actinide	95 Am Americium Actinide	96 Cm Curium Actinide	97 Bk Berkelium Actinide	98 Cf Californium Actinide	99 Es Einsteinium Actinide	100 Fm Fermium Actinide	101 Md Mendelevium Actinide	102 No Nobelium Actinide	103 Lr Lawrencium Actinide

Problems: 1) Find the spin magnetic moment μ_{spin} of Fe^{+2} in $FeSO_4$? (At. no. of Fe is 26).

Ans:- Fe(26) = $4S^2 3d^6$

$Fe \longrightarrow Fe^{+2} + 2e^-$

Fe^{+2} = 24 electrons = $4S^0\ 3d^6$

↑↓	↑	↑	↑	↑

i.e. n= 4 (no.of unpaired electrons only)

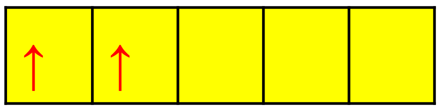
$\mu_{spin} = \sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24}$ = 4.89 BM

Problems: 2) Find the effective magnetic moment μeff. of Ti^{+2} in $(TiO2)^{-2}$? (At. no. of Ti is 22).

Ans:- Ti (22) = $4S^2 3d^2$. In $(TiO2)^{-2}$, the oxidation state of Ti is +2.

$Ti \longrightarrow Ti^{+2} + 2e^-$

Ti^{+2} = 20 electrons = $4S^0\ 3d^2$



i.e. n= 2 (no.of unpaired electrons only)

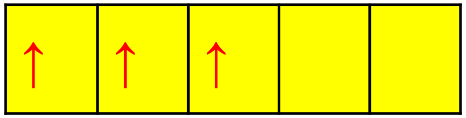
$\mu spin = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} = 2.83$ BM

Problems: 3) Find the effective magnetic moment μeff. of Cr in Cr_2O_3 ? (Given: At. no. of Cr is 24).

Ans:- Cr (24) = $4S^2 3d^4$. In Cr_2O_3, the oxidation state of Cr is +3.

$Cr \longrightarrow Cr^{+3} + 3e^-$

Cr^{+3} = 21 electrons = $4S^0\ 3d^3$



i.e. n= 3 (no.of unpaired electrons only)

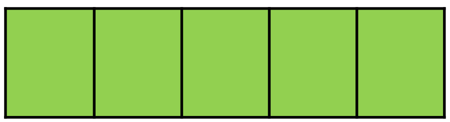
μspin = $\sqrt{n(n+2)}$ = $\sqrt{3(3+2)}$ = $\sqrt{15}$ = 3.87 BM

Problems: 4) Find the effective magnetic moment μeff. of Mn in $MnO4^-$? (Given: At. no. of Mn is 25)

Ans:- Mn (25) = $4S^2 3d^5$. In $MnO4^-$, the oxidation state of Mn is +7.

$Mn \longrightarrow Mn^{+7} + 7e^-$

Mn^{+7} = 18 electrons = $4S^0\ 3d^0$



i.e. n= 0 (There are no unpaired electrons)

μeff. = $\sqrt{n(n+2)} = \sqrt{0(0+2)} = \sqrt{0} = 0.0$ BM