

INORGANIC CHEMISTRY

CHAPTER- The d-Block Elements

ONLINE LECTURE

NO. 6

DATE:- 16, SEPTEMBER 2020

TIME: (9.00A.M.)

PERIODIC TABLE OF THE ELEMENTS

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	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 (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 DARMSTADIUM (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 TERBIUM 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
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ACTINIDE SERIES

89 Ac ACTINIUM (227)	90 Th THORIUM 232.0377	91 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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There are two types of transition elements:

- 1) Main transition elements or d-block elements and
- 2) Inner transition elements or f-block elements

In d-block elements, the penultimate (or last but one) d-subshell is partly filled. While, in f-block elements, the antepenultimate (or last but two) f-subshell is partly filled.

The main transition elements:-

In periodic table, the d-block contains three series of ten elements and a fourth series which is incomplete.

1) The first transition series: - It consists of ten elements from Sc (21) to Zn (30).

The 3d subshell is progressively filled in this series.

2) The second transition series: - It consists of ten elements from Yttrium (39) to Cd (48). The 4d subshell is progressively filled in this series.

3) The third transition series: - It consists of elements from Lanthanum (57) to Hg (80). The 5d subshell is progressively filled in this series.

4) The fourth transition series: - This series starts with Actinium (89) and the 6d subshell is progressively filled in this series, but it is incomplete.

The first transition series: -

Electronic configuration: -

In these elements, the last incoming electron is added in 3d subshell and it is progressively filled step by step.

INORGANIC CHEMISTRY

CHAPTER- The d-Block Elements

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NO. 7

DATE:- 18, SEPTEMBER 2020

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4) The fourth transition series: - This series starts with Actinium (89) and the 6d subshell is progressively filled in this series, but it is incomplete.

The first transition series: -

Electronic configuration: -

In these elements, the last incoming electron is added in 3d subshell and it is progressively filled step by step.

Elements	Symbol	At. number	Electronic configuration
Scandium	Sc	21	$1S^2 2S^2 2P^6 3S^2 3P^6 4S^2 3d^1$ or [Ar] $4S^2 3d^1$
Titanium	Ti	22	[Ar] $4S^2 3d^2$
Vanadium	V	23	[Ar] $4S^2 3d^3$
Chromium	Cr	24	[Ar] $4S^1 3d^5$
Manganese	Mn	25	[Ar] $4S^2 3d^5$
Iron	Fe	26	[Ar] $4S^2 3d^6$
Cobalt	Co	27	[Ar] $4S^2 3d^7$
Nickel	Ni	28	[Ar] $4S^2 3d^8$
Copper	Cu	29	[Ar] $4S^1 3d^{10}$
Zinc	Zn	30	[Ar] $4S^2 3d^{10}$

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NO. 8

DATE:- 23, SEPTEMBER 2020

TIME: (9.00A.M.)

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PERIODIC TABLE OF ELEMENTS



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						

1	Atomic Number
H	Symbol
Hydrogen	Name
Nonmetal	Chemical Group Block

The second transition series: -

Electronic configuration: - In these elements, the last incoming electrons are added in 4d subshell and it is progressively filled step by step.

Elements	Symbol	At. number	Electronic configuration
Yttrium	Y	39	[Kr] 5S ² 4d ¹
Zirconium	Zr	40	[Kr] 5S ² 4d ²
Niobium	Nb	41	[Kr] 5S ¹ 4d ⁴
Molybdenum	Mo	42	[Kr] 5S ¹ 4d ⁵
Technetium	Tc	43	[Kr] 5S ² 4d ⁵
Ruthenium	Ru	44	[Kr] 5S ¹ 4d ⁷
Rhodium	Rh	45	[Kr] 5S ¹ 4d ⁸
Palladium	Pd	46	[Kr] 5S ⁰ 4d ¹⁰
Silver	Ag	47	[Kr] 5S ¹ 4d ¹⁰
Cadmium	Cd	48	[Kr] 5S ² 4d ¹⁰

$\text{CdSO}_4, \text{CdCl}_2, \text{CdS}, \text{Cd}(\text{NO}_3)_2$



The third transition series: -

Electronic configuration: -

In these elements, the last incoming electrons are added in 5d subshell and it is progressively filled step by step

Elements	Symbol	At. number	Electronic configuration
Hafnium	Hf	72	[Xe] 4f ¹⁴ 6s ² 5d ²
Tantalum	Ta	73	[Xe] 4f ¹⁴ 6s ² 5d ³
Tungsten	W	74	[Xe] 4f ¹⁴ 6s ² 5d ⁴
Rhenium	Re	75	[Xe] 4f ¹⁴ 6s ² 5d ⁵
Osmium	Os	76	[Xe] 4f ¹⁴ 6s ² 5d ⁶
Iridium	Ir	77	[Xe] 4f ¹⁴ 6s ² 5d ⁷
Platinum	Pt	78	[Xe] 4f ¹⁴ 6s ⁰ 5d ¹⁰
Gold	Au	79	[Xe] 4f ¹⁴ 6s ¹ 5d ¹⁰
Mercury	Hg	80	[Xe] 4f ¹⁴ 6s ² 5d ¹⁰

Lanthanum ($Z=57$), with outer electronic configuration $5d^16S^2$ is by definition a d-block element and should be member of this series. But, its physical and chemical properties are similar to the series of f-block elements (i.e. Lanthanides) and hence excluded here.

La (57) $\rightarrow 1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^{10}, 4P^6, 5S^2, 4d^{10}, 5P^6, 6S^2, 4f^1$

The fourth transition series: -

This series starts with Actinium (89). In these elements, 6d-subshell is begins to fill and get progressively filled step by step. This series is incomplete.

Ac (89) $\rightarrow 1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^{10}, 4P^6, 5S^2, 4d^{10}, 5P^6, 6S^2, 4f^{14}, 5d^{10}, 6P^6, 7S^2, 5f^1$.

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CHAPTER- The d-Block Elements

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NO. 9

DATE:- 25, SEPTEMBER 2020

TIME: (8.00A.M.)

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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 DARMSTADIUM (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 TERBIUM 158.92	66 Dy DYSPROSIUM 162.500	67 Ho HOLMIUM 164.93	68 Er ERBIUM 167.259	69 Tm THULIUM 168.93	70 Yb YTTERIUM 173.054	71 Lu LUTETIUM 174.9668
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ACTINIDE SERIES

89 Ac ACTINIUM (227)	90 Th THORIUM 232.0377	91 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																	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						
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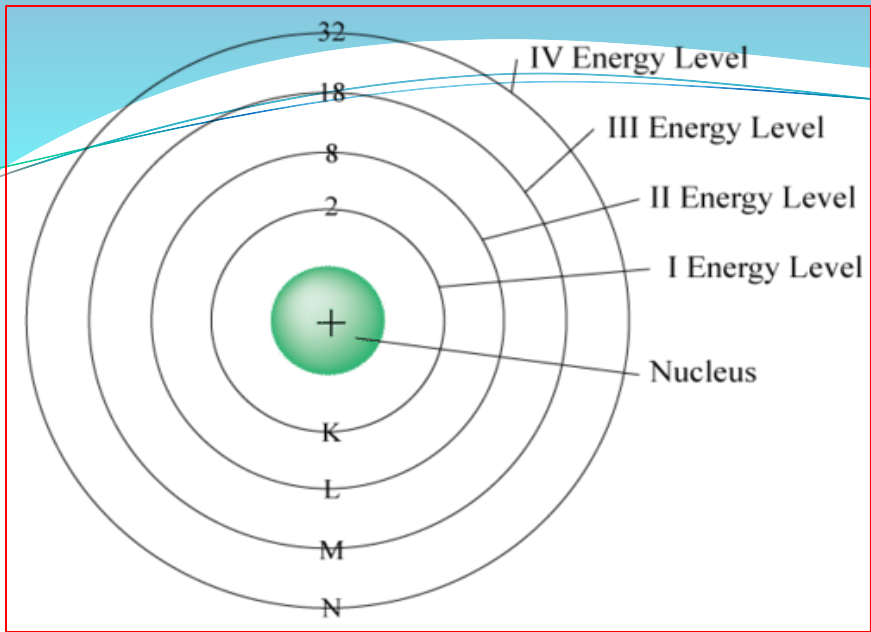
1
H
Hydrogen
Nonmetal

Atomic Number
Symbol
Name
Chemical Group Block

General characteristics of d-block elements: -

- 1) Atomic radii:** - Generally, the atomic radii of the transition elements decreases from left to right with increase in atomic number. This is due to the combined effect of
- Addition of electrons in the inner d-subshell and
 - Increase in the nuclear charge from left to right. The increase in nuclear charge, attracts the electron cloud inwards. However, there are few exceptions.

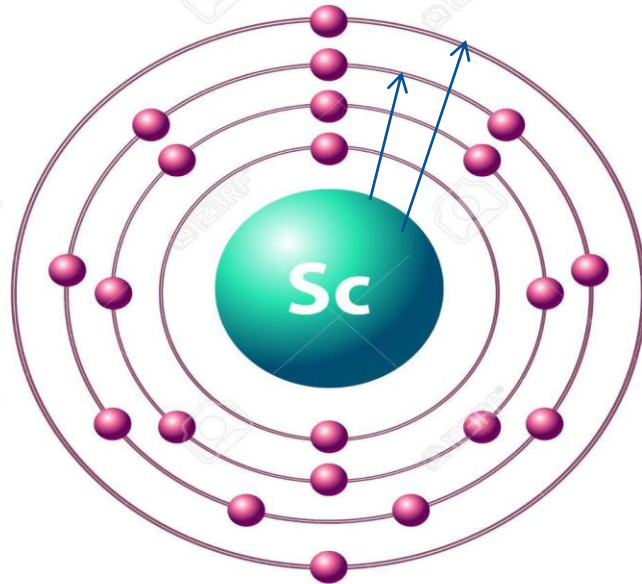
Elements	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic radius(A^0)	1.62	1.47	1.34	1.27	1.26	1.26	1.25	1.24	1.28	1.38



21

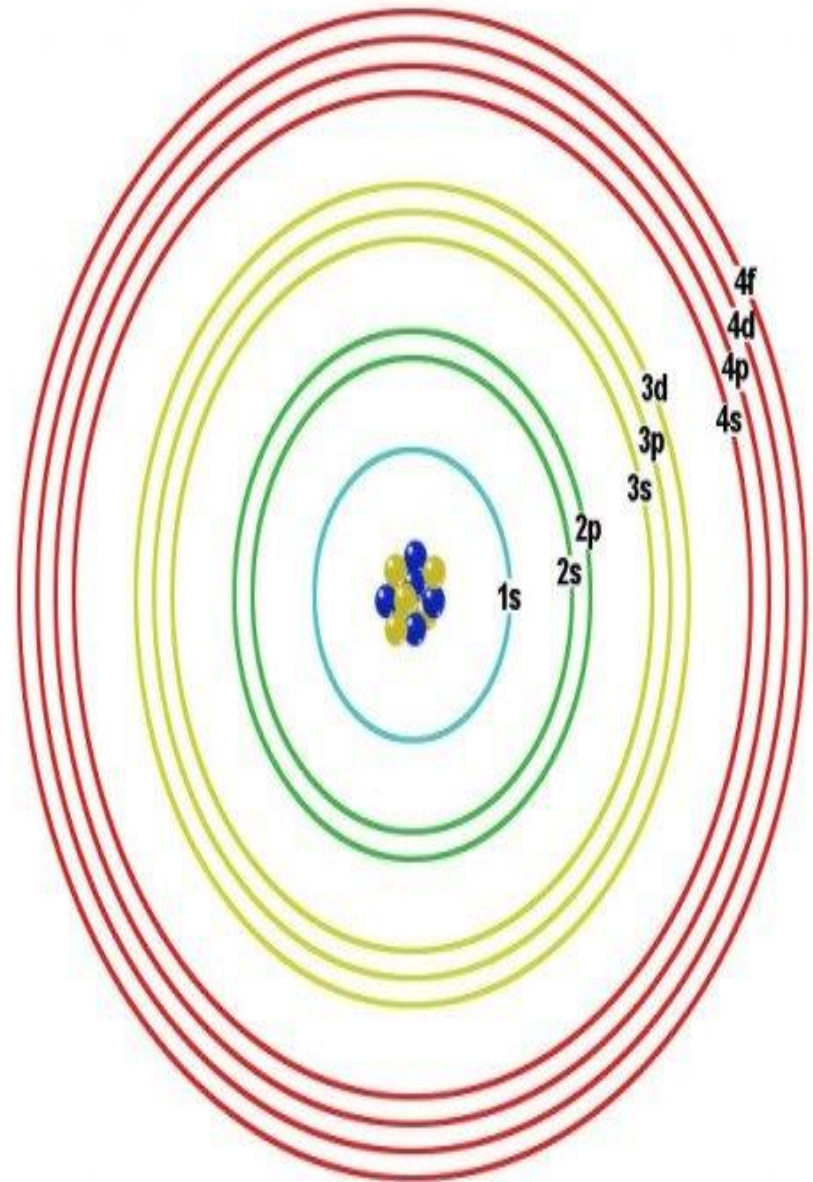
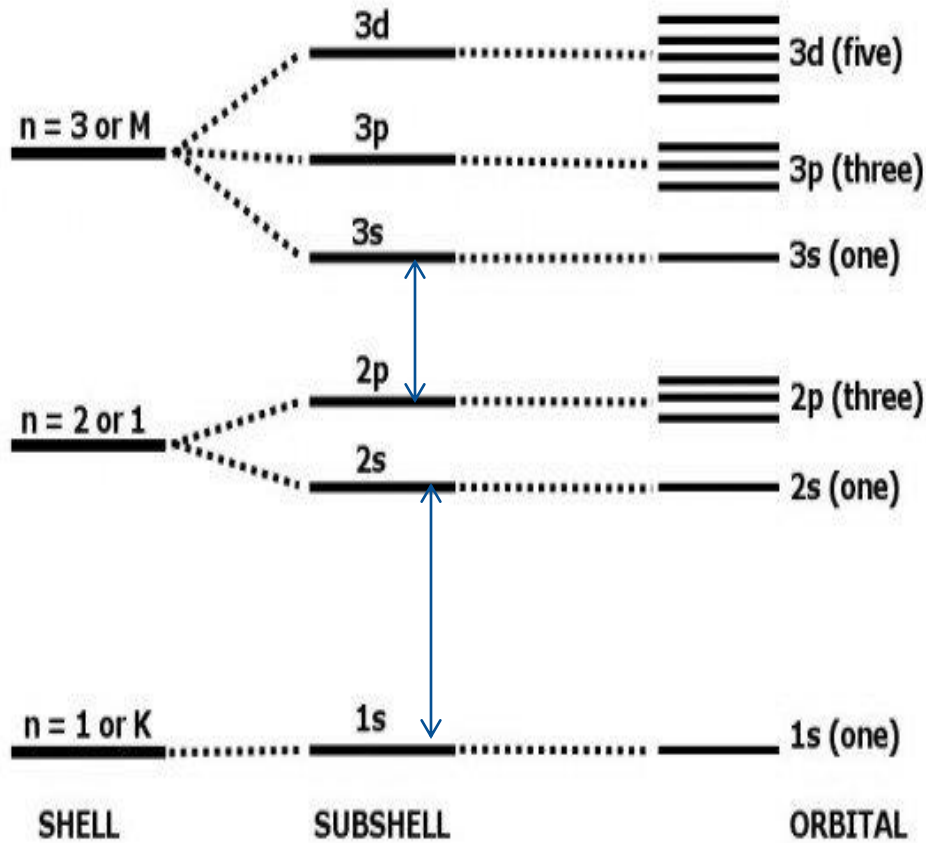
Scandium

Sc



Atomic mass: 44.955

Electron configuration: 2, 8, 9, 2



INORGANIC CHEMISTRY

CHAPTER- The d-Block Elements

ONLINE LECTURE

NO. 10

DATE:- 25, SEPTEMBER 2020

TIME: (8.00A.M.)

PERIODIC TABLE OF THE ELEMENTS

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	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						
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1
H
Hydrogen
Nonmetal

Atomic Number
Symbol
Name
Chemical Group Block

Objective test

<https://forms.gle/wY7W8LFzbF5qmMK38>

Feedback form

<https://forms.gle/rDGKP1Uky5xTuLGW6>

Atomic Size depends upon: -

1) **Number of energy levels:** - Greater the number of energy levels, larger is the size of atoms.

At. Size and no. of energy levels are directly proportional to each other.

i.e. At. Size \propto No. of energy levels

2) **Nuclear charge:** - There is a force of attraction between nucleus (Positively charged) and electrons (Negatively charged) in different energy levels.

Atomic size $\propto \frac{1}{\text{Nuclear charge}}$

i.e. At. Size is inversely proportional to the nuclear charge.

As nuclear charge increases, force of attraction on electrons increases and hence they are attracted towards the nucleus and size decreases.

3) Shielding (Screening) effect: - The inner energy levels acts as screen and these protects the outer electrons from nuclear attraction. i.e. they decreases the force of attraction between outer electrons and nucleus.

Atomic Size \propto Shielding effect

As number of inner energy levels increases, the size of atom also increases and vice versa.

First group elements from top to bottom

Element	At. number	Valence shell Electronic Configuration	Total energy levels
Hydrogen (H)	1	$1S^1$	1
Lithium (Li)	3	$2S^1$	2
Sodium (Na)	11	$3S^1$	3
Potassium (K)	19	$4S^1$	4
Rubidium (Rb)	37	$5S^1$	5
Cesium (Cs)	55	$6S^1$	6
Francium (Fr)	87	$7S^1$	7

Third period from left to right

Element	Na	Mg	Al	Si	P	S	Cl	Ar
At no.	11	12	13	14	15	16	17	18
Congn.	$3S^1$	$3S^2$	$3S^23P^1$	$3S^23P^2$	$3S^23P^3$	$3S^23P^4$	$3S^23P^5$	$3S^23P^6$
Total energy levels	3	3	3	3	3	3	3	3
Nuclear charge	+11	+12	+13	+14	+15	+16	+17	+18

General characteristics of d-block elements: -

1) **Atomic radii:** - Generally, the atomic radii of the transition elements decreases from left to right with increase in atomic number. This is due to the combined effect of addition of electrons in the inner d-subshell and increase in the nuclear charge from left to right. The increase in nuclear charge, attracts the electron cloud inwards. However, there are few exceptions.

Elements	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic radius(\AA)	1.62	1.47	1.34	1.27	1.26	1.26	1.25	1.24	1.28	1.38
Electronic Configuration	$4s^2$ $3d^1$	$4s^2$ $3d^2$	$4s^2$ $3d^3$	$4s^1$ $3d^5$	$4s^2$ $3d^5$	$4s^2$ $3d^6$	$4s^2$ $3d^7$	$4s^2$ $3d^8$	$4s^1$ $3d^{10}$	$4s^2$ $3d^{10}$
Nuclear Charge	+21	+22	+23	+24	+25	+26	+27	+28	+29	+30

2) Ionic radii: - The ionic radii of the transition elements of a given series also decrease with increasing atomic number. For the ions of the given charge, the radius decreases slowly with increase in atomic number. The radii of divalent ions are close with the radius of Ca^{+2} ions.

Ions	Sc^{+2}	Ti^{+2}	V^{+2}	Cr^{+2}	Mn^{+2}	Fe^{+2}	Co^{+2}	Ni^{+2}	Cu^{+2}	Zn^{+2}
Ionic radius(Å^0)	0.81	0.91	0.88	0.84	0.80	0.76	0.74	0.72	0.72	0.74