Set – 1

The First Series of Transition Elements

Element		Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic number		21	22	23	24	25	26	27	28	29	30
Electronic configuration											
	M	$3d^1 4s^2$	$3d^2 4s^2$	$3d^3 4s^2$	$3d^5 4s^1$	$3d^5 4s^2$	$3d^6 4s^2$	$3d^7 4s^2$	$3d^8 4s^2$	$3d^{10} 4s^1$	$3d^{10} 4s^2$
	M^+	$3d^1 4s^1$	$3d^2 4s^1$	$3d^3 4s^1$	$3d^5$	$3d^5 4s^1$	$3d^6 4s^1$	$3d^7 4s^1$	$3d^8 4s^1$	$3d^{10}$	$3d^{10} 4s^1$
	M^{2+}	$3d^1$	$3d^2$	$3d^3$	$3d^4$	$3d^5$	$3d^6$	$3d^7$	$3d^8$	$3d^9$	$3d^{10}$
	M^{3+}	[Ar]	$3d^1$	$3d^2$	$3d^3$	$3d^4$	$3d^5$	$3d^6$	$3d^7$	–	–
Enthalpy of atomisation, $\Delta_a H^\ominus$/kJ mol^{-1}		326	473	515	397	281	416	425	430	339	126
Ionisation enthalpy/$\Delta_i H^\ominus$/kJ mol^{-1}											
$\Delta_i H^\ominus$	I	631	656	650	653	717	762	758	736	745	906
$\Delta_i H^\ominus$	II	1235	1309	1414	1592	1509	1561	1644	1752	1958	1734
$\Delta_i H^\ominus$	III	2393	2657	2833	2990	3260	2962	3243	3402	3556	3837
Metallic/ionic radii/pm	M	164	147	135	129	137	126	125	125	128	137
	M^{2+}	–	–	79	82	82	77	74	70	73	75
	M^{3+}	73	67	64	62	65	65	61	60	–	–
Standard electrode potential $E^\ominus$/V	M^{2+}/M	–	−1.63	−1.18	−0.90	−1.18	−0.44	−0.28	−0.25	+0.34	-0.76
	M^{3+}/M^{2+}	–	−0.37	−0.26	−0.41	+1.57	+0.77	+1.97	–	–	–
Density/g cm^{-3}		3.43	4.1	6.07	7.19	7.21	7.8	8.7	8.9	8.9	7.1

Q1. Which of the following elements has the highest energy of atomization?

A. Zn
B. V
C. Mn
D. Cr

Ans. (B)

Q2. Arrange the elements in the increasing order of their energy of atomization.

A. V
B. Fe
C. Mn
D. Cr

Ans. (C)

Q3. Which of the following is incorrect about the second enthalpy of ionization?

A. Cr < Mn
B. Ni < Cu
C. Co < Ni
D. V < Cr

Ans. (A)

Q4. Select the correct third enthalpy order for the following elements.

A. Mn
B. Co
C. Fe
D. Cr

Ans. (C)

Q5. Which of the following is correct about the ionic radii of the following elements?

A. Sc>Zn>V>Ni
B. Zn>Ni>V>Sc
C. V>Sc>Ni>Zn
D. Sc>V>Ni>Zn

Ans. (A)

Q6. Which of the following has the highest standard reduction potential?

A. Zn^{2+}
B. Ni^{2+}
C. Cu^{2+}
D. Mn^{2+}

Ans. (C)

Q7. Which of the following has the highest density?

A. Fe
B. Co

C. Zn
D. Ni

Ans. (D)

Set – 2

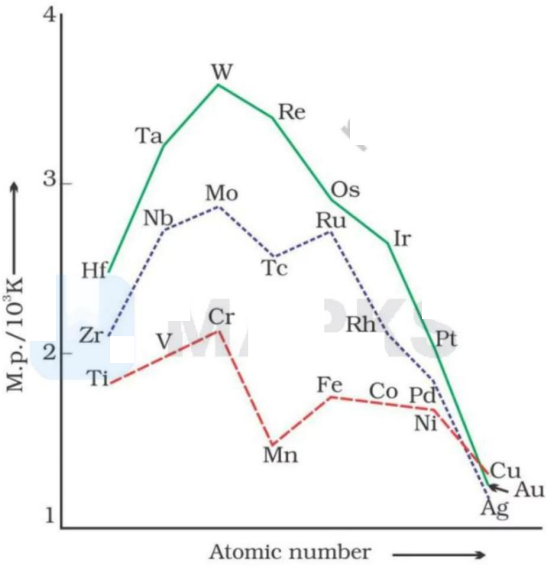


Fig. 8.1: Trends in melting points of transition elements

Q1. Which of the following has the highest melting point?

A. V
B. Cr
C. Mn
D. Fe

Ans. (B)

Q2. Which of the following has the least melting point?

A. Fe
B. Cr
C. V
D. Mn

Ans. (D)

Q3. Which of the following has the least melting point?

A. Mn
B. Ti
C. Cu
D. Pd

Ans. (C)

Q4. Select the correct statement about the melting point of 1strow transition metals?

A. V
B. Mn
C. Mn
D. V

Ans. (B)

Q5. Select the correct order about melting point from the following.

A. T_{Ag}Au T_{Cu}
B. T_{Cu}Ag< T_{Au}
C. T_{Au}AgCu
D. T_{Cu}AuAg

Ans. (A)

Q6. Which of the following option is incorrect about melting point order?

A. T_{Mn}Fe< T_{Cr}
B. T_{Tc}Ru< T_{Mo}
C. T_{Ag}AuCu
D. $T_{W}R_{u}T_{a}$

Ans. (D)

Set – 3

Table 8.1: Electronic Configurations of outer orbitals of the Transition Elements (ground state)

	1st Series									
	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Z	21	22	23	24	25	26	27	28	29	30
$4s$	2	2	2	1	2	2	2	2	1	2
$3d$	1	2	3	5	5	6	7	8	10	10

Q1. 4s13d5is the electronic configuration of which of the following elements?

A. Cr
B. Mn
C. Sc
D. Cu

Ans. (A)

Q2. How many 3d electrons are present in Cu?

A. 8
B. 9
C. 10
D. 11

Ans. (C)

Q3. Which of the elements possess the highest oxidation state?

A. Mn
B. Cr
C. Pt
D.Os

Ans. (D)

Q4. Which of the following is correct electronic configuration of Pd?

A. $5s^1 4d^9$
B. $5s^2 4d^8$

C. $5s^0 4d^{10}$
D. None of the above

Ans. (C)

Q5. Which of the following is correct electronic configuration of Pt?

A. $6s^0 5d^{10}$
B. $6s^2 5d^8$
C. $6s^1 5d^9$
D. None of the above

Ans. (C)

Q6. Choose the correct IUPAC name of Ds(110)?

A. Un-nil-bium
B. Un-nil-ennium
C. Un-un-unium
D. Un-un-nilium

Ans. (D)

Q7. Choose the correct IUPAC name of Rg(111)?

A. Un-un-unium
B. Un-un-nilium
C. Un-un-bium
D. Un-un-trium

Ans. (A)

Set – 4

Table 8.5: Formulas of Halides of 3*d* Metals

Oxidation Number									
+ 6			CrF_6						
+ 5		VF_5	CrF_5						
+ 4	TiX_4	VX_4^{I}	CrX_4	MnF_4					
+ 3	TiX_3	VX_3	CrX_3	MnF_3	FeX_3^{I}	CoF_3			
+ 2	TiX_2^{III}	VX_2	CrX_2	MnX_2	FeX_2	CoX_2	NiX_2	CuX_2^{II}	ZnX_2
+ 1								CuX^{III}	

Q1. Which of the following is the highest oxidation state halide possible in the first row of transition metals?

A. CrF_6
B. MnF_6
C. $CrCl_6$
D. $MnCl_6$

Ans. (A)

Q2. The highest oxidation state of Mn that combines with halogen to form halides is:

A. +7
B. +5
C. +4
D. +6

Ans. (C)

Q3. How many first row transition metals make tetra halides?

A. 4
B. 3
C. 2
D. 1

Ans. (A)

Q4. The only first row transition metals that makes halides in its +1 state is:

A. Sc
B. V
C. Zn
D. Cu

Ans. (D)

Q5. Which of the following elements doesnâ€™t make self mixed oxides?

A. Mn
B. Ni
C. Co
D. Fe

Ans. (B)

Q6. The oxidation state of oxide formed by Scandium is:

A. -2
B. +2
C. 0
D. +3

Ans. (D)

Q7. Select the correct statement about Mn3O4.

A. The oxidation state of Mn is+3.
B. It is a mixed oxide of MnO and MnO_2.
C. It is a mixed oxide of MnO and Mn_2O_3.
D. None of the above.

Ans. (C)

Q8. The oxidation state of Vanadium in V2O5is:

A. +5
B. +4
C. -2
D. -4

Ans. (A)

Q9. The highest oxidation no of iron in its oxide form is:

A. +5
B. +3
C. +2
D. +4

Ans. (B)

Set – 5

Table 8.8: Colours of Some of the First Row (aquated) Transition Metal Ions

Configuration	Example	Colour
$3d^0$	Sc^{3+}	colourless
$3d^0$	Ti^{4+}	colourless
$3d^1$	Ti^{3+}	purple
$3d^1$	V^{4+}	blue
$3d^2$	V^{3+}	green
$3d^3$	V^{2+}	violet
$3d^3$	Cr^{3+}	violet
$3d^4$	Mn^{3+}	violet
$3d^4$	Cr^{2+}	blue
$3d^5$	Mn^{2+}	pink
$3d^5$	Fe^{3+}	yellow
$3d^6$	Fe^{2+}	green
$3d^6 3d^7$	$Co^{3+} Co^{2+}$	bluepink
$3d^8$	Ni^{2+}	green
$3d^9$	Cu^{2+}	blue
$3d^{10}$	Zn^{2+}	colourless

Q1. Vanadium in which oxidation state shows green colour?

A. +1
B. +2
C. +3
D. +4

Ans. (C)

Q2. What is the colour of Ti+4?

A. Blue
B. Green
C. Colourless
D. Pink

Ans. (C)

Q3. Cobalt in which oxidation state shows Blue colour?

A. +3
B. +2
C. 0
D. -1

Ans. (A)

Q4. What is the colour of Fe3+?

A. Blue
B. Yellow
C. Colourless
D. Green

Ans. (B)

Q5. What is the colour of Ni2+?

A. Green
B. Violet
C. Yellow
D. Blue

Ans. (A)

Set – 6

Table 8.9: Electronic Configurations and Radii of Lanthanum and Lanthanoids

Atomic Number	Name	Symbol	Electronic configurations*			Radii/pm		
			Ln	Ln^{2+}	Ln^{3+}	Ln^{4+}	Ln	Ln^{3+}
57	Lanthanum	La	$5d^16s^2$	$5d^1$	$4f^0$		187	106
58	Cerium	Ce	$4f^15d^16s^2$	$4f^2$	$4f^1$	$4f^0$	183	103
59	Praseodymium	Pr	$4f^36s^2$	$4f^3$	$4f^2$	$4f^1$	182	101
60	Neodymium	Nd	$4f^46s^2$	$4f^4$	$4f^3$	$4f^2$	181	99
61	Promethium	Pm	$4f^56s^2$	$4f^5$	$4f^4$		181	98
62	Samarium	Sm	$4f^66s^2$	$4f^6$	$4f^5$		180	96
63	Europium	Eu	$4f^76s^2$	$4f^7$	$4f^6$		199	95
64	Gadolinium	Gd	$4f^75d^16s^2$	$4f^75d^1$	$4f^7$		180	94
65	Terbium	Tb	$4f^96s^2$	$4f^9$	$4f^8$	$4f^7$	178	92
66	Dysprosium	Dy	$4f^{10}6s^2$	$4f^{10}$	$4f^9$	$4f^8$	177	91
67	Holmium	Ho	$4f^{11}6s^2$	$4f^{11}$	$4f^{10}$		176	89
68	Erbium	Er	$4f^{12}6s^2$	$4f^{12}$	$4f^{11}$		175	88
69	Thulium	Tm	$4f^{13}6s^2$	$4f^{13}$	$4f^{12}$		174	87
70	Ytterbium	Yb	$4f^{14}6s^2$	$4f^{14}$	$4f^{13}$		173	86
71	Lutetium	Lu	$4f^{14}5d^16s^2$	$4f^{14}5d^1$	$4f^{14}$	–	–	–

Q1. Which of the following is the correct outermost electronic configuration of Cerium?

A. $4f^15d^16s^2$
B. $4f^25d^06d^2$
C. $5d^16s^2$
D. $4f^36s^2$

Ans. (A)

Q2. Total no. of f electrons in Erbium is:

A. 10
B. 12
C. 11
D. 13

Ans. (B)

Q3. Which of the following is the correct outermost electronic configuration of Gadolinium?

A. $4f^{9}5d^{0}6s^{2}$
B. $4f^{7}5d^{1}6s^{1}$
C. $4f^{7}5d^{1}6s^{2}$
D. $4f^{7}6s^{2}$

Ans. (C)

Q4. Total no. of f electrons in Nd3+?

A. 0
B. 1
C. 2
D. 3

Ans. (D)

Q5. Which of the following is incorrect about radii of lanthanoids?

A. r Ce^{3+}> r Pr^{3+}
B. r Ce^{3+}> r Ce^{4+}
C. r Sm^{2+}>r Sm 3^{+}
D. r Sm^{2+}> r Eu^{2+}

Ans. (C)

Q6. In which oxidation state Lanthanoid halides are stable?

A. +1
B. +2
C. +3
D. +4

Ans. (C)

Set – 7

Table 8.10: Some Properties of Actinium and Actinoids

Atomic Number	Name	Symbol	Electronic configurations*			Radii/pm	
			M	M^{3+}	M^{4+}	M^{3+}	M^{4+}
89	Actinium	Ac	$6d^17s^2$	$5f^0$		111	
90	Thorium	Th	$6d^27s^2$	$5f^1$	$5f^0$		99
91	Protactinium	Pa	$5f^26d^17s^2$	$5f^2$	$5f^1$		96
92	Uranium	U	$5f^36d^17s^2$	$5f^3$	$5f^2$	103	93
93	Neptunium	Np	$5f^46d^17s^2$	$5f^4$	$5f^3$	101	92
94	Plutonium	Pu	$5f^67s^2$	$5f^5$	$5f^4$	100	90
95	Americium	Am	$5f^77s^2$	$5f^6$	$5f^5$	99	89
96	Curium	Cm	$5f^76d^17s^2$	$5f^7$	$5f^6$	99	88
97	Berkelium	Bk	$5f^97s^2$	$5f^8$	$5f^7$	98	87
98	Californium	Cf	$5f^{10}7s^2$	$5f^9$	$5f^8$	98	86
99	Einstenium	Es	$5f^{11}7s^2$	$5f^{10}$	$5f^9$	–	–
100	Fermium	Fm	$5f^{12}7s^2$	$5f^{11}$	$5f^{10}$	–	–
101	Mendelevium	Md	$5f^{13}7s^2$	$5f^{12}$	$5f^{11}$	–	–
102	Nobelium	No	$5f^{14}7s^2$	$5f^{13}$	$5f^{12}$	–	–
103	Lawrencium	Lr	$5f^{14}6d^17s^2$	$5f^{14}$	$5f^{13}$	–	–

Q1. Which of the following represents Cm?

A. Californium
B. Curium
C. Actinium
D. Nobelium

Ans. (B)

Q2. Which of the following is the outer orbital electronic configuration of Uranium?

A. $5f^36d^17s^2$
B. $5f^46d^17s^2$
C. $5f^36d^27s^2$
D. $5f^67s^2$

Ans. (A)

Q3. Total no. of f electrons present in electronic configuration of Neptunium?

A. 18
B. 17
C. 4
D. 3

Ans. (A)

Q4. No. of electrons present in the outermost f-orbital of Plutonium?

A. 4
B. 6
C. 5
D. 7

Ans. (B)

Q5. Which of the following is the outer orbital electronic configuration of Mendelevium?

A. $5f^{11}7s^2$
B. $5f^{12}7s^2$
C. $5f^{13}7s^2$
D. $5f^{14}7s^2$

Ans. (C)

Q6. Atomic no. of Thorium is:

A. 89
B. 90
C. 91
D. 92

Ans. (B)

Set – 8

Lattice Structures of Transition Metals

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
hcp (bcc)	hcp (bcc)	bcc	bcc	X (bcc, ccp)	bcc (hcp)	ccp (hcp)	ccp	ccp	X (hcp)
Y	**Zr**	**Nb**	**Mo**	**Tc**	**Ru**	**Rh**	**Pd**	**Ag**	**Cd**
hcp (bcc)	hcp (bcc)	bcc	bcc	hcp	hcp	ccp	ccp	ccp	X (hcp)
La	**Hf**	**Ta**	**W**	**Re**	**Os**	**Ir**	**Pt**	**Au**	**Hg**
hcp (ccp,bcc)	hcp (bcc)	bcc	bcc	hcp	hcp	ccp	ccp	ccp	X

Q1. Which of the following doesn't exist as hcp?

A. Ti
B. Zr
C. Sc
D. Cr

Ans. (D)

Q2. Pt normally exists as which of the following crystal structures?

A. Hcp
B. Bcc
C. Ccp
D. Simple cubic

Ans. (C)

Q3. Which of the following doesn't exist as ccp?

A. Os
B. Hg
C. Au
D. Ir

Ans. (B)

Q4. Which of the following exist as bcc?

A. W
B. Fe
C. Co
D. Ni

Ans. (A)

Q5. Cu normally exists as which of the following crystal structures?

A. Bcc
B. Ccp
C. Hcp
D. Simple cubic

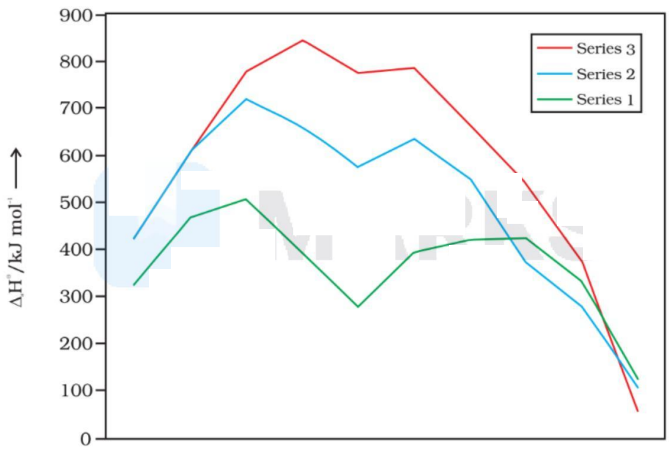
Ans. (B)

Q6. La normally exists as which of the following crystal structures?

A. Ccp
B. Hcp
C. Bcc
D. All of the above

Ans. (D)

Set – 9



Q1. Which of the following has the least enthalpy of atomisation?

A. Mn
B. Cr
C. Fe
D. Co

Ans. (A)

Q2. Which of the following d-block elements has the highest enthalpy of atomisation?

A. Ta
B. W
C. Re
D. Os

Ans. (B)

Q3. Which of the following d-block elements has the highest enthalpy of atomisation?

A. Sc
B. Cr
C. V
D. Fe

Ans. (C)

Q4. Which of the following is the correct order of enthalpy of atomisation of d-block elements?

A. Mn
B. Mn
C. Cr
D. Mn

Ans. (D)

Q5. Which of the following is the correct order of enthalpy of atomisation of d-block elements?

A. Co
B. Fe
C. Ru
D. Os

Ans. (B)

Set – 10

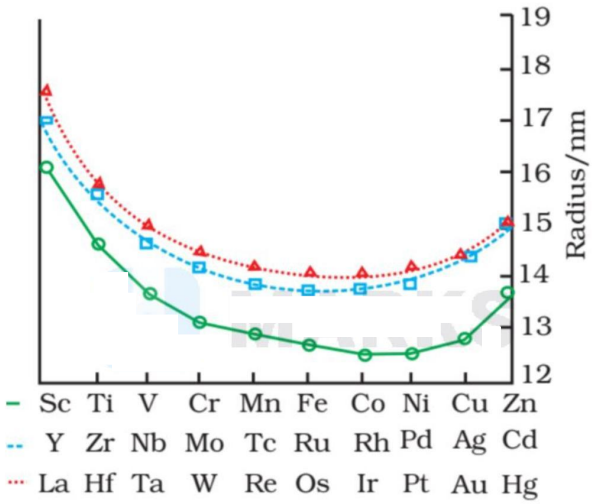


Fig. 8.3: Trends in atomic radii of transition elements

Q1. Which of the following has the least atomic radius?

A. Mn
B. Fe
C. Co
D. Ni

Ans. (C)

Q2. Which of the following D-block elements has the highest atomic radius?

A. Sc
B. Hf

C. La
D. Y

Ans. (C)

Q3. Which of the following is the incorrect order of atomic radii of d-block elements?

A. Ta>Nb>V
B. W>Mo>Cr
C. Ru>Os>Fe
D. Ir>Rh>Co

Ans. (C)

Q4. Which of the following is the correct order of atomic radii of d-block elements?

A. V
B. Mn
C. Cr
D. Ni

Ans. (D)

Q5. Which of the following is the correct order of atomic radii of d-block elements?

A. Nb
B. Pd>Ag>Cd
C. Te>Ru>Rh
D. Te>Mo>Ru

Ans. (A)

Set - 11

Table 8.11: Oxidation States of Actinium and Actinoids

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
3		3	3	3	3	3	3	3	3	3	3	3	3	3
	4	4	4	4	4	4	4	4						
		5	5	5	5	5								
			6	6	6	6								
				7	7									

Q1. Protactinium doesnâ€™t exist in which of the following oxidation states?

A. +3
B. +4
C. +5
D. +6

Ans. (D)

Q2. Which of the following exists in +7 oxidation state?

A. Plutonium
B. Thorium
C. Uranium
D. Nobelium

Ans. (A)

Q3. Thorium general oxidation state is:

A. 3
B. 4
C. 5
D. 6

Ans. (B)

Q4. Which of the following exist in+5 oxidation state?

A. Actinium
B. Americium

C. Fermium
D. Lawrencium

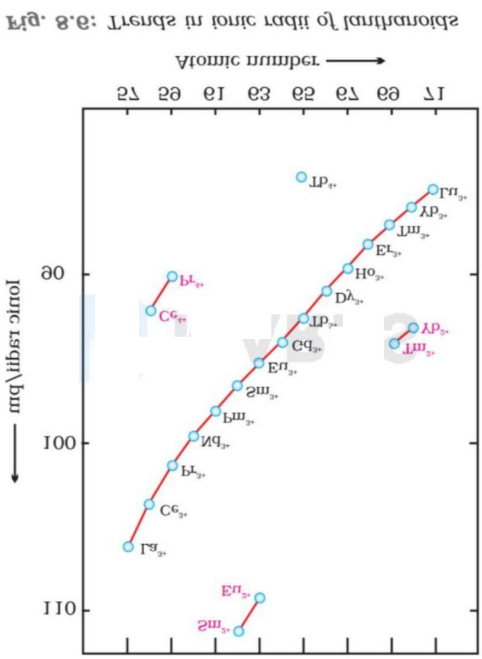
Ans. (B)

Q5. Which of the following can not exist in +4 state?

A. Berkelium
B. Thorium
C. Nobelium
D. Curium

Ans. (C)

Set – 12



Q1. Which of the following has the least ionic radii among lanthanoids?

A. Er^{3+}
B. Tm^{2+}
C. Yb^{2+}
D. Lu^{3+}

Ans. (D)

Q2. Which of the following has the highest ionic radii among lanthanoids?

A. Sm^{3+}
B. Sm^{2+}
C. Eu^{2+}
D. Eu^{3+}

Ans. (B)

Q3. Which of the following options is correct about the ionic radii of lanthanoids?

A. $Ce^{3+}<ce^{4+}$

B. $C^{e3+}<pr^{3+}$

C. $P^{r3+}<pr^{4+}$

D. $P^{m3+}<nd^{3+}$

Ans. (D)

Q4. Which of the following options is incorrect about the ionic radii of lanthanoids?

A. $Yb^{3+}<yb^{2+}$
B. $^{Yb3+}<tm^{3+}$
C. $^{Dy3+}<ho^{3+}$
D. $^{Tb3+}<gd^{3+}$

Ans. (C)

Q5. Which of the following has the least ionic radii?

A. Sm^{2+}
B. Eu^{2+}
C. Ce^{4+}
D. Pr^{4+}

Ans. (D)

Set – 13

Table 8.7: Calculated and Observed Magnetic Moments (BM)

Ion	Configuration	Unpaired electron(s)	Magnetic moment	
			Calculated	Observed
Sc^{3+}	$3d^0$	0	0	0
Ti^{3+}	$3d^1$	1	1.73	1.75
Tl^{2+}	$3d^2$	2	2.84	2.76
V^{2+}	$3d^3$	3	3.87	3.86
Cr^{2+}	$3d^4$	4	4.90	4.80
Mn^{2+}	$3d^5$	5	5.92	5.96
Fe^{2+}	$3d^6$	4	4.90	5.3 – 5.5
Co^{2+}	$3d^7$	3	3.87	4.4 – 5.2
Ni^{2+}	$3d^8$	2	2.84	2.9 – 3. 4
Cu^{2+}	$3d^9$	1	1.73	1.8 – 2.2
Zn^{2+}	$3d^{10}$	0	0	

Q1. Which of the following is the correct magnetic moment of Fe2+?

A. 0
B. 1.73
C. 5.92
D. 4.90

Ans. (D)

Q2. No. of unpaired electrons in Cu2+?

A. 0
B. 1
C. 2
D. 3

Ans. (B)

Q3. Which of the following has the highest no. of unpaired electrons?

A. Ti^{3+}
B. Ti^{2+}

C. V^{2+}

D. Cr^{2+}

Ans. (D)

Q4. Which of the following has the highest Magnetic moment?

A. Mn^{2+}

B. Cr^{2+}

C. Fe^{2+}

D. Co^{2+}

Ans. (A)

Q5. Which of the following is the correct order of Magnetic moments?

A. $Ti^{2+}<ti^{3+}</ti$

B. $C^{u2+}<zn^{2+}</zn$

C. $F^{e2+}<cr^{2+}</cr$

D. $C^{r2+}<mn^{2+}</mn$

Ans. (D)

Q6. Which of the following is a d3system?

A. Sc^{3+}

B. Ti^{3+}

C. V^{2+}

D. Ni^{2+}

Ans. (C)

Set – 14

Table 8.4: Thermochemical data (kJ mol^{-1}) for the first row Transition Elements and the Standard Electrode Potentials for the Reduction of M^{II} to M.

Element (M)	$\Delta_a H^\ominus$ (M)	$\Delta_i H_1^\ominus$	$\Delta_i H_2^\ominus$	$\Delta_{hyd} H^\ominus (M^{2+})$	$E^\ominus$/V
Ti	469	656	1309	-1866	-1.63
V	515	650	1414	-1895	-1.18
Cr	398	653	1592	-1925	-0.90
Mn	279	717	1509	-1862	-1.18
Fe	418	762	1561	-1998	-0.44
Co	427	758	1644	-2079	-0.28
Ni	431	736	1752	-2121	-0.25
Cu	339	745	1958	-2121	0.34
Zn	130	906	1734	-2059	-0.76

Q1. Which of the following has the highest enthalpy of atomisation?

A. Ti
B. V
C. Cr
D. Mn

Ans. (B)

Q2. Which of the following is the correct order of enthalpy of atomisation?

A. Ti
B. Mn
C. Mn
D. Ti

Ans. (C)

Q3. Which of the following has the highest first ionisation enthalpy?

A. Fe
B. Ni
C. Cu
D. Zn

Ans. (D)

Q4. Which of the following has the highest Second ionisation enthalpy?

A. Fe
B. Ni
C. Cu
D. Zn

Ans. (C)

Q5. Which of the following has the highest enthalpy of hydration?

A. Ti
B. V
C. Cr
D. Mn

Ans. (A)

Q6. Which of the following has Standard electrode potential>0?

A. Sc
B. Ti
C. Cu
D. Zn

Ans. (C)