d & f block Elements

SOLUTIONS

Exercise-I (Conceptual Questions)

1. Ans. (2)

Higher I.E. is not the essential condition.

2. Ans. (2)

Elements in the 4d series start from Y(39) to Cd(48).

3. Ans. (1)

$KMnO_4$ on treatment with conc. H_2SO_4 forms a compound which is –

$KMnO_4 + H_2SO_4 \rightarrow H_2O + K_2SO_4 + \underset{(x)}{Mn_2O_7}$

x on heating gives following –

$\underset{(x)}{Mn_2O_7} \xrightarrow{heat} \underset{(y)}{MnO_2}$

4. Ans. (3)

Zn^{+2}, Sc^{+3} are diamagnetic and colourless.

5. Ans. (1)

Cr_2O_3 is green in colour.

6. Ans. (1)

$\underset{(orange)}{Cr_2O_7^{-2}} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} \underset{(yellow)}{2CrO_4^{-2}}$

7. Ans. (1)

Higher oxidation states of transition metals are found with oxygen and fluorine highest fluoride – MnF_4, highest oxide Mn_2O_7

8. Ans. (3)

Atomic number – 26 (Fe)

$Fe \rightarrow [Ar]4s^2\ 3d^6$ ⇅ ⇅ | 1 | 1 | 1 | 1

$Fe^{+2} \rightarrow [Ar]4s^0\ 3d^6$ □ ⇅ | 1 | 1 | 1 | 1

4 unpaired electrons

$X^{n+} \Rightarrow n = 2$

So, magnetic moment $\Rightarrow \sqrt{n(n+2)} \Rightarrow \sqrt{24}$.

9. Ans. (1)

Oxidation of I^- with $KMnO_4$ is given by –

$MnO_4^- + I^- \longrightarrow IO_3^- + Mn^{+2}$

10. Ans. (2)

Chromium (III) oxide is amphoteric in nature.

11. Ans. (3)

Cu^+ is less stable than Cu^{+2} in aqueous solution because Cu^{+2} has greater hydration energy.

12. Ans. (1)

$InCrO_3$ Cr is in (+6) oxidation state which is acidic in nature.

13. Ans. (1)

d^5 configuration will have maximum spin magnetic moment.

14. Ans. (4)

Disproportion is shown by –

MnO_4^{-2} in acidic medium

Cu^+ in aqueous medium

Cl_2 in alkaline medium

15. Ans. (3)

Mn shows maximum oxidation states from +2 to + 7.

16. Ans. (2)

Co^{+3} – $[Ar]\ 4s^0\ 3d^6$

Fe^{+2} – $[Ar]\ 4s^0\ 3d^6$

They will have same value of spin only magnetic moment.

17. Ans. (4)

These metals do not from amalgam with Hg.

18. Ans. (3)

MnF_4 (maximum fluoride)

Mn_2O_7 (maximum oxide)

19. Ans. (4)

Interstitial compounds have high melting point.

20. Ans. (4)

Iodine ions are strong reducing agents therefore Cu (II) iodide reduces to copper (I) iodide.

21. Ans. (3)

Oxidising power refers to how a compound readily accepts electron.

$\underset{+5}{VO_2^+} < \underset{+6}{Cr_2O_7^{-2}}$

22. Ans. (3)
In permagnate titrations $KMnO_4$ will oxidise HCl into Cl_2.
$2KMnO_4+16\ HCl \rightarrow 2KCl+2MnCl_2+8H_2O+5Cl_2$

23. Ans. (3)
$K_2Cr_2O_7$ is prepared from chromite ore ($FeCr_2O_4$)

24. Ans. (4)
$HgCl_2$ does not give chromyl chloride test due to its covalent character.

25. Ans. (4)
Brass – Cu + Zn
Bronze – Cu + Sn
Stainless steel – Cr + Ni

26. Ans. (2)
Cu has positive of (M^{+2}/M) E° in the 3d series due to high enthalpy of atomization.

27. Ans. (4)
$_{103}Lr$ is a transuranic element.

28. Ans. (4)
Europium does not show +4 oxidation state.

29. Ans. (4)
All the options are diamagnetic and colourless.

30. Ans. (4)
General electronic configuration of Lanthanoids are – $[(n-2)f^{1-14}\ (n-1)d^{0-1}ns^2]$

31. Ans. (3)
Ce shows +4 oxidation state due to its tendency to attain noble gas configuration.

32. Ans. (2)
+7 oxidation state is shown by Neptunium and plutonium.

33. Ans. (1)
$[Xe]\ 4f^7\ 5d^1\ 6s^2$ is the configuration of gadolinium

34. Ans. (4)
+6 Oxidation state is not shown by lanthanoids, common O.S. are – +2, +3, +4.

35. Ans. (3)
Eu^{+2} will loose electron hence it acts as a reducing agent.

36. Ans. (2)
Radius 4d ≈ 5d (V B)

37. Ans. (2)
Due to Lanthanoid contraction.

38. Ans. (2)
Lanthanoid element heated with sulphar then Ln_2S_3 is formed.

39. Ans. (1)
Formula of halide of Lanthanoid will become LnX_3 as Lanthanoids generally have +3 (oxidation sate)

40. Ans. (1)
Misch Metal alloy is a mixture of Lanthanoid metal (95%) + Iron (5%).

Exercise-II (Previous Year Questions)

1. Ans. (4)
$\sqrt{n(n+2)}=2.84$
Value of n = 2
So, Ni^{+2}

2. Ans. (2)
$Fe(CO)_5$ from Fe does not involve oxidation of iron.

3. Ans. (2)
Due to lanthanoid contraction
Radius : $\boxed{Zr \approx Hf}$

4. Ans. (4)
When SO_2 is passed through acidified $K_2Cr_2O_7$ solution turns green from orange.
$K_2Cr_2O_7 + 2H_2SO_4 + 3SO_2 \rightarrow$
$2Cr_2(SO_4)_3 + K_2SO_4 + H_2O$

5. Ans. (4)
$_{63}Eu \rightarrow [Xe]4f^7 6s^2$
$_{64}Gd \rightarrow [Xe]4f^7 5d^1 6s^2$
$_{65}Tb \rightarrow [Xe]4f^9 6s^2$

6. Ans. (1)
Some lanthanoids are much more reactive than aluminium.

7. Ans. (1)
SO_2 decolourise $KMnO_4$ from purple to colourless.
$2KMnO_4+2H_2O+5SO_2 \rightarrow$
$K_2SO_4+2MnSO_4+2H_2SO_4$
(purple) (colourless)

8. **Ans. (2)**

$HgCl_2$ and I_2 dissolved in water forms HgI_4^{-2}, I_3^-

$\Rightarrow HgCl_2 + 4I^- \longrightarrow HgI_4^{-2} + 2Cl^-$

$\Rightarrow I_2 + I^- \longrightarrow I_3^-$

9. **Ans. (2)**

5f, 6d and 7s levels having comparable energy. So, actinoids show variable O.S.

10. **Ans. (4)**

MnO_4^{-2} has +6 oxidation state. So, 1d electron is present. So, paramagnetic as well as d-d transition exist.

11. **Ans. (1)**

$Co^{+3} = [Ar]4s^0 3d^6$ = 4 unpaired e^-

$Cr^{+3} = [Ar]4s^0 3d^3$ = 3 unpaired e^-

$Fe^{+3} = [Ar]4s^0 3d^5$ = 5 unpaired e^-

$Ni^{+2} = [Ar]4s^0 3d^8$ = 2 unpaired e^-

12. **Ans. (1)**

1. $\overset{\text{Reduction}}{\overbrace{2Cu^+}} \underbrace{\longrightarrow Cu^{+2}}_{\text{Oxidation}} + Cu^0$

2. $\overset{\text{Reduction}}{\overbrace{3MnO_4^{-2} + 4H^+}} \underbrace{\longrightarrow 2MnO_4^-}_{\text{Oxidation}} + MnO_2 + 2H_2O$

13. **Ans. (1)**

Manganate and permanganate ions are tetrahedral due to formation π bond involving p orbital of oxygen with d orbital of manganese.

14. **Ans. (1)**

$V_2O_5 \rightarrow$ Used in contact process

$TiCl_4 + Al(CH_3)_3 \rightarrow$ Polymerisation of ethylene.

$PdCl_2 \rightarrow$ Oxidation of ethyne to ethanal

Nickel complex $\rightarrow$ Polymerisation of alkynes.

15. **Ans. (3)**

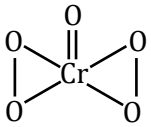
$2KMnO_4 + H_2O + KI \rightarrow 2MnO_2 + 2KOH + KIO_3$

16. **Ans. (3)**

In CrO_5 it has four O atoms as peroxide bearing –1 (charge) and one oxide having –2 (charge) So,

O.S. $\Rightarrow x + 4(-1) + 1 \times (-2) = 0$

$[x = +6]$



17. **Ans. (3)**

$Cr^{+2} = [Ar]4s^0 3d^4 \Rightarrow$ 4 unpaired e^{-1}s

Magnetic moment $= \sqrt{n(n+2)}$

$= \sqrt{4(6)} = \sqrt{24}$ = 4.90 BM

18. **Ans. (1)**

Oxidation state $\Rightarrow$

$CrO_4^{-2} \Rightarrow x + 4(-2) = -2 \Rightarrow [x = +6]$

$Cr_2O_7^{-2} \Rightarrow 2x + 2(-7) = -2 \Rightarrow [x = +6]$

19. **Ans. (1)**

$Cr_2\underline{O} \Rightarrow$ charge $\Rightarrow -2$

Cu atom will have +1

20. **Ans. (2)**

Maximum oxidation states	– Mn
Metal of 3d series not considered transition metal	– Zn
+1 O.S. undergoes disproportionation	– Cu
Does not show variable oxidation state	– Sc

21. **Ans. (2)**

Some trivalent lanthanoids are colourless in the solid state.

Like $\rightarrow$ La^{+3}, Ce^{+3}, Gd^{+3}, Yb^{+3} & Lu^{+3} are colourless rest all are coloured.

22. **Ans. (3)**

Due to lanthanoid contraction Zr and Hf have similar atomic radius.

23. **Ans. (4)**

$Cr^{+2} \rightarrow Cr^{+3}$

$3d^4$ $3d^3$ (t_{2g} Half filled)

(R.A.)

$Mn^{+3} \rightarrow Mn^{+2}$

$3d^4$ $3d^5$ (Half filled 'd' orbital).

(O.A.)

24. **Ans. (2)**

$C \rightarrow \overset{+3}{V_2}O_3 \rightarrow \overset{+4}{V_2}O_4 \rightarrow \overset{+5}{V_2}O_5$

Acidic Nature $\uparrow$

$D \rightarrow V_2O_5$ dissolve in acid to give VO_4^{-3} salts

This doesn't shown by V_2O_4

25. **Ans. (3)**

Reason is the correct explanation of Assertion.

26. Ans. (1)

μ_{spin} only = $\sqrt{n(n+2)}$

where n = no. of unpaired e^-

(A) $Ti^{+3} \rightarrow 3d^1$ n = 1

(B) $Cr^{+2} \rightarrow 3d^4$ n = 4

(C) $Mn^{+2} \rightarrow 3d^5$ n = 5

(D) $Fe^{+2} \rightarrow 3d^6$ n = 4

(E) $Sc^{+3} \rightarrow 3d^0$ n = 0

Since (B) and (D) contain same number of unpaired e^- so they have same spin only magnetic moment.

27. Ans. (3)

Mn^{+3}/Mn^{+2} E° = +ve

$_{25}Mn \rightarrow 3d^5 4s^2$

$Mn^{+2} \rightarrow 3d^5$

$Mn^{+3} \rightarrow 3d^4$

28. Ans. (1)

$Ce^{+4} = {}_{54}[Xe]$

$Yb^{+2} = {}_{54}[Xe]4f^{14}5d^0$

Both species do not contain any unpaired electron. Hence, they are diamagnetic.

29. Ans. (4)

In option (B) and (C), species contain equal number of unpaired electron. Hence will have same value of spin only magnetic moment.

Exercise-III (Analytical Questions)

1. Ans. (3)

Statement-I :- All d block elements except Zn, Cd, Hg & Cn are transition elements.

Statement-II:- Electronic configuration of Ag :– $_{36}[Kr]4d^{10}5s^1$

2. Ans. (2)

Transition metals other than Zn, Cd & Hg are hard and have high m. p. because of unpaired e^- which form metallic bonds.

3. Ans. (2)

Statement-I :- stronger is the metallic bond more will be heat of atomisation.

Statement-II :- More number of unpaired electron will favour the formation of metallic bond.

4. Ans. (4)

Statement-I :- $E^{o}_{Cr^{+2}/Cr^{+3}} \rightarrow +0.41$

$E^{o}_{Mn^{+3}/Mn^{+2}} \rightarrow +1.57$

Statement-II :- Positive only for Cu among 3d elements because hydration energy of Cu^{+2} is not enough to compensate for sublimation energy, IE_1 and IE_2 for Cu.

5. Ans. (3)

Statement-I :- Because Cu^{+2} oxidises I^- to I_2

$2Cu^{+2} + 4I^- \longrightarrow Cu_2I_2(s) + I_2$

Statement-II :- Oxidizing power $\propto$ positive oxidation state of the central metal.

$VO_2^+ \rightarrow +3$

$Cr_2O_7^{-2} \rightarrow +6$

$MnO_4^- \rightarrow +7$

6. Ans. (3)

Statement-I :- Ce^{+4} is a strong oxidant and comes to Ce^{+3}

Eu^{+2} is strong reducing agent changing to common +3 oxidation state.

Statement-II:- La^{+3} & Lu^{+3} ions does not shows any color.

7. Ans. (2)

(i) Ni in the presence of Hydrogen → (c) Vegetable oil to vegetable ghee (Hydrogenation of oil)

(ii) $CuCl_2$ → (d) Decon process (Manufacture of Cl_2)

(iii) V_2O_5 → (b) Contact Process (Manufacture of H_2SO_4)

(iv) $TiCl_4 + Al(CH_3)_3$ → (a) Zieglar-Natta catalyst

8. Ans. (3)

(i) Ce → +4

(ii) Eu → +2

(iii) Promethium is radioactive

(iv) Gd^{+3} :- $_{54}[Xe]4f^7$

9. Ans. (1)

(a) $FeSO_4.7H_2O$ → (p) Green vitriol

(b) $MgSO_4.7H_2O$ → (r) Epsom salt

(c) $ZnSO_4.7H_2O$ → (s) White vitriol

(d) $CuSO_4.5H_2O$ → (q) Blue vitriol

10. Ans. (1)

(a) Cu + Ni → (p) Silver UK coins

(b) Ni+Cu+ Zn → (q) German silver

(c) Cu+ Zn+ Sn → (r) Gun metal

(d) Ln(95%)+Fe → (s) Misch metal

11. Ans. (3)

(i) $K_2MnO_4 \rightarrow Mn^{+6}$ $(3d^1)$ Paramagnetic and green coloured

(ii) $KMnO_4 \rightarrow Mn^{+7}$ $(3d^0)$ Purple colour due to charge transfer

(iii) $K_2Cr_2O_7 \rightarrow Cr^{+6}$ $(3d^0)$ orange colour

(iv) V_2O_5 → Amphoteric (reacts with both acids & bases)

12. Ans. (1)

$K_2Cr_2O_7$ is preferred over $Na_2Cr_2O_7$ because $Na_2Cr_2O_7$ is Hygroscopic in nature.

13. Ans. (1)

Gd :- $_{54}[Xe]4f^75d^16s^2$

Gd^{+3} :- $_{54}[Xe]4f^7$

14. Ans. (1)

Analytical reagent :- A chemical compound of known high standard purity.

Now $E^0_{Ce^{+4}/Ce^{+3}}$ = 1.74V this shows that it has sufficient kinetic stability due to which the reaction rate is very slow hence it is a good analytical agent.

15. Ans. (1)

Eu^{+2} & Yb^{+2} have strong tendency to convert in +3 oxidation state therefore they act as reducing agent.

16. Ans. (2)

V_2O_5 & Cr_2O_3 (Cr^{+3}) is amphoteric in nature.

17. Ans. (3)

(A) Decrease in ionic radii of M^{+3} comparatively more regular.

(B) La :- $[Xe]5d^16s^2$ → d block element

(C) Covalent character of hydroxides increases from lanthanum to Lutetium so basic character decreases.

(D) $\left.\begin{matrix} Ti \\ \wedge \\ Zr \\ \approx \\ Hf \end{matrix}\right]$ due to lanthanoid contraction

18. Ans. (3)

Fe :- $[Ar]3d^64s^2$

Ni :- $[Ar]3d^84s^2$

19. Ans. (1)

(A) $\overset{+2}{Cr}O$ $\overset{+3}{Cr_2}O_3$ $\overset{+6}{Cr}O_3$

As the oxidation number of transition metal in transition metal oxide increases the ionic character decreases.

$$\text{Oxidation Number} \propto \frac{1}{\text{Ionic character}}$$

$$\text{Ionic Character} \propto \text{Melting Point}$$

(B) The oxide in lower oxidation state of a metal is basic and in higher oxidation state of the metal is acidic

$Mn_2O_7 \rightarrow +7$, $Mn_2O_3 \rightarrow +3$, $MnO \rightarrow +2$

(C) In CrO_3 chromium in its higher oxidation state '+6' so it will tend to reduce itself to oxidation state +3 but as we go down the group stability of heavier transition metals in their higher oxidation state increases. So Molybdenum and Tungsten have little tendency to get reduced to lower oxidation state.

20. Ans. (1)

$$MnO_2 + K_2CO_3/KOH \rightarrow K_2MnO_4 \xrightarrow[\text{Oxidation}]{\text{Electrolytic}} KMnO_4$$

K_2MnO_4 $\xrightarrow{Cl_2}$ $KMnO_4 + KCl$

K_2MnO_4 $\xrightarrow{O_3}$ $KMnO_4 + O_2$

K_2MnO_4 $\xrightarrow{H^+/CO_2}$ $KMnO_4 + MnO_2$