DPP - Daily Practice Problems

Chapter-wise Sheets

Date : | Start Time : | End Time :

CHEMISTRY CC22

SYLLABUS : The d- and f-Block Elements

Max. Marks : 180 **Marking Scheme :** + 4 for correct & (–1) for incorrect **Time : 60 min.**

INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. Which one of the elements with the following outer orbital configurations may exhibit the largest number of oxidation states?
(a) $3d^5 4s^1$ (b) $3d^5 4s^2$ (c) $3d^2 4s^2$ (d) $3d^3 4s^2$

2. The addition of excess of aqueous HNO_3 to a solution containing $[Cu(NH_3)_4]^{2+}$ produces
(a) Cu^+ (b) $[Cu(H_2O)_4]^{2+}$
(c) $Cu(OH)_2$ (d) $Cu(NO_3)_2$

3. The "spin-only" magnetic moment [in units of Bohr magneton, (μ_B)] of Ni^{2+} in aqueous solution would be (At. No. Ni = 28)
(a) 6 (b) 1.73 (c) 2.84 (d) 4.90

4. In the form of dichromate, Cr (VI) is a strong oxidising agent in acidic medium but Mo (VI) in MoO_3 and W (VI) in WO_3 are not because _____ .
(i) Cr (VI) is more stable than Mo(VI) and W (VI).
(ii) Mo (VI) and W(VI) are more stable than Cr(VI).
(iii) Higher oxidation states of heavier members of group-6 of transition series are more stable.
(iv) Lower oxidation states of heavier members of group-6 of transition series are more stable.
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i) and (iv) (d) (ii) and (iv)

5. Of the following outer electronic configurations of atoms, the highest oxidation state is achieved by which one of them?
(a) $(n-1)d^3\, ns^2$ (b) $(n-1)d^5\, ns^1$
(c) $(n-1)d^8\, ns^2$ (d) $(n-1)d^5\, ns^2$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

6. $(n-1)d^{10}ns^2$ is the general electronic configuration of
(a) Fe, Co, Ni (b) Cu, Ag, Au
(c) Zn, Cd, Hg (d) Se, Y, La

7. In the following salts the highest value of magnetic moment is observed in
(a) $MnSO_4.4H_2O$ (b) $CuSO_4.5H_2O$
(c) $FeSO_4.6H_2O$ (d) $ZnSO_4.7H_2O$

8. Which one of the following transition metal ions shows magnetic moment of 5.92 BM?
(a) Mn^{2+} (b) Ti^{3+} (c) Cr^{3+} (d) Cu^{2+}

9. Which of the following statements is incorrect?
(a) Zn,Cd and Hg due to presence of completely filled *d*-orbitals $[(n-1)d^{10}ns^2]$ are not studied along with other transition metals.
(b) Zn, Cd and Hg have low m.p and are comparitively softer than other transition metals.
(c) Metallic bond made by elements with d^5 configuration is stronger as compared to metalic bond made by elements with d^3 configuration.
(d) Metals of 5*d* series forms strong metallic bonds as compared with metals of 3*d* series.

10. Super conductors are derived from compounds of
(a) p-Block elements (b) lanthanides
(c) actinides (d) transition elements

11. Which of the following compounds has colour but no unpaired electrons?
(a) $KMnO_4$ (b) K_2MnO_4
(c) $MnSO_4$ (d) $MnCl_2$

12. What is the percentage of lanthanoid metal in mischmetall?
(a) 90% (b) 20% (c) 5% (d) 95%

13. Which of the following in its oxidation state shows the paramagnetism ?
(a) Tb(IV) (b) Lu(III) (c) Ce(IV) (d) La(III)

14. In neutral or faintly alkaline medium, thiosulphate is quantitatively oxidized by $KMnO_4$ to
(a) SO_3^{2-} (b) SO_4^{2-} (c) SO_2 (d) SO_5^{2-}

15. Wrought iron, pig iron and steel differ in properties due to
(a) carbon content (b) malleability
(c) conductivity (d) softness

16. The lanthanide contraction is responsible for the fact that
(a) Zr and Zn have the same oxidation state
(b) Zr and Hf have about the same radius
(c) Zr and Nb have similar oxidation state
(d) Zr and Y have about the same radius

17. $KMnO_4$ can be prepared from K_2MnO_4 as per the reaction:

$$3MnO_4^{2-} + 2H_2O \rightleftharpoons 2MnO_4^{2-} + MnO_2 + 4OH^-$$

The reaction can go to completion by removing OH^- ions by adding.
(a) KOH (b) CO_2 (c) SO_2 (d) HCl

18. On the basis of data given below,

$E^\circ_{Sc^{3+}/Sc^{2+}} = -0.37\ V$, $E^\circ_{Mn^{3+}/Mn^{2+}} = +1.57\ V$

$E^\circ_{Cr^{2+}/Cr} = -0.90\ V$, $E^\circ_{Cu^{2+}/Cu} = 0.34\ V$

Which of the following statements is incorrect?
(a) Sc^{3+} has good stability due of $[Ar]3d^04s^0$ configuration.
(b) Mn^{3+} is more stable than Mn^{2+}.
(c) Cr^{2+} is reducing in nature.
(d) Copper does not give H_2 on reaction with dil. H_2SO_4

19. Green vitriol is
(a) $FeSO_4.7H_2O$ (b) $ZnSO_4.7H_2O$
(c) $CaSO_4.2H_2O$ (d) $CuSO_4.5H_2O$

20. Number of moles of $K_2Cr_2O_7$ reduced by one mole of Sn^{2+} ions is
(a) $\frac{1}{3}$ (b) 3 (c) $\frac{1}{6}$ (d) 6

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ

Space for Rough Work

21. Four successive members of the first series of the transition metals are listed below. For which one of them the standard potential $\left(E^{\circ}_{M^{2+}/M}\right)$ value has a positive sign?
(a) Co(Z=27) (b) Ni(Z=28)
(c) Cu(Z=29) (d) Fe(Z=26)

22. Which of the following factors may be regarded as the main cause of lanthanoide contraction?
(a) Greater shielding of 5*d* electrons by 4*f* electrons
(b) Poorer shielding of 5*d* electrons by 4*f* electrons.
(c) Effective shielding of one of 4*f* electrons by another in the subshell
(d) Poor shielding of one of 4*f* electron by another in the subshell

23. AgCl is soluble in NH_4OH solution. The solubility is due to the formation of
(a) AgOH (b) Ag_2O
(c) $\left[Ag(NH_3)_2\right]^+$ (d) NH_4Cl

24. Oxidation states of the metal in the minerals haematite and magnetite, respectively, are
(a) II, III in haematite and III in magnetite
(b) II, III in haematite and II in magnetite
(c) II in haematite and II, III in magnetite
(d) III in haematite and II, III in magnetite

25. In acidic medium $KMnO_4$ oxidises $FeSO_4$ solution. Which of the following statements is correct?
(a) 10 mL of 1N $KMnO_4$ solution oxidises 10 mL of 5 N $FeSO_4$ solution
(b) 10 mL of 1M $KMnO_4$ solution oxidises 10 mL of 5 N $FeSO_4$ solution
(c) 10 mL of 1M $KMnO_4$ solution oxidises 10 mL of 1M $FeSO_4$ solution
(d) 10 mL of 1N $KMnO_4$ solution oxidises 10 mL of 0.1M $FeSO_4$ solution

26. In which of the following lanthanides oxidation state +2 is most stable?
(a) Ce (b) Eu (c) Tb (d) Dy

27. Acidified solution of chromic acid on treatment with H_2O_2 gives blue colour which is due to
(a) $CrO_3 + H_2O + O_2$ (b) $CrO_5 + H_2O$
(c) $H_2Cr_2O_7 + H_2O + O_2$ (d) None of these

28. Which of the following is used in the preparation of chlorine?
(a) Only MnO_2
(b) Only $KMnO_4$
(c) Both MnO_2 and $KMnO_4$
(d) Either MnO_2 or $KMnO_4$

29. An explosion take place when conc. H_2SO_4 is added to $KMnO_4$. Which of the following is formed?
(a) Mn_2O_7 (b) MnO_2
(c) $MnSO_4$ (d) M_2O_3

30. Which of the following statements are correct ?
(i) Chromium has the highest melting point among the series 1 metals.
(ii) Number of unpaired electrons is greater in Cr than other elements of series 1.
(iii) In any row the melting point of transition metal increases as the atomic number increases.
(a) (i) and (iii) (b) (i) and (ii)
(c) (ii) and (iii) (d) (i), (ii) and (iii)

31. In the laboratory, manganese (II) salt is oxidised to permanganate ion in aqueous solution by
(a) hydrogen peroxide (b) conc. nitric acid
(c) peroxodisulphate (d) dichromate

RESPONSE GRID					
	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ
	31. ⓐⓑⓒⓓ				

Space for Rough Work

32. Which of the following statements about the interstitial compounds is incorrect ?
(a) They are chemically reactive.
(b) They are much harder then the pure metal.
(c) They have higher melting points than the pure metal.
(d) They retain metallic conductivity.

33. Which of the following elements shows maximum number of different oxidation states in its compounds?
(a) Eu (b) Ld (c) Gd (d) Am

34. Identify the product and its colour when MnO_2 is fused with solid KOH in the presence of O_2.
(a) $KMnO_4$, purple (b) K_2MnO_4, dark green
(c) MnO, colourless (d) Mn_2O_3, brown

35. In the extraction of silver from argentite ore. The ore is treated with dil. solution of NaCN in water in the presence of Y, whereby the following reaction takes place :
$Ag_2X + 4NaCN + 2Y \rightarrow 2Na[Ag(CN)_2] + Na_2XO_4 \cdot X$ and Y in this reaction are respectively :
(a) Sb and S (b) S and O_2
(c) O and O_2 (d) O and S

36. Which of the following compound is called Turnbull's blue?
(a) Ferricyanide (b) Ferrous ferricyanide
(c) Ferrous cyanide (d) Ferri-ferrocyanide

37. Which of the following element is responsible for oxidation of water to O_2 in biological process?
(a) Fe (b) Mn (c) Cu (d) Mo

38. Consider the following statements
(i) $La(OH)_3$ is the least basic among hydroxides of lanthanides.
(ii) Zr^{4+} and Hf^{4+} posses almost the same ionic radii.
(iii) Ce^{4+} can act as an oxidizing agent.
Which of the above is/are true ?
(a) (i) and (iii) (b) (ii) and (iii)
(c) (ii) only (d) (i) and (ii)

39. For making Ag from $AgNO_3$, which of the following is used
(a) PH_3 (b) phosphonium iodide
(c) Na_2CO_3 (d) NH_3

40. Which of the following conversions can be carried out by both acidified $K_2Cr_2O_4$ and acidified $KMnO_4$?
(i) $Fe^{2+} \rightarrow Fe^{3+} + e^-$
(ii) $I^- \rightarrow IO_3^-$
(iii) $I^- \rightarrow I_2$ (iv) $H_2S \rightarrow S$
(a) (i)and(iii) (b) (ii)and(iv)
(c) (i), (iii) and (iv) (d) (i), (ii) and (iii)

41. The catalytic activity of transition metals and their compounds is mainly due to :
(a) their magnetic behaviour
(b) their unfilled *d*-orbitals
(c) their ability to adopt variable oxidation state
(d) their chemical reactivity

42. Match the columns

	Column-I		Column -II
A.	Metal of the 3*d*-series which does not form MO type oxide.	I.	Manganese
B.	Metal of the 3*d*-series which forms most covalent oxide.	II.	Vanadium
C.	Metal of the 3*d*-series which forms the amphoteric oxide.	III.	Scandium

(a) A – I; B – III; C – II (b) A – III; B – I; C – II
(c) A – III; B – II; C – I (d) A – II; B – I; C – III

43. The basic character of the transition metal monoxides follows the order
(Atomic Nos., Ti = 22, V = 23, Cr = 24, Fe = 26)
(a) TiO > VO > CrO > FeO (b) VO > CrO > TiO > FeO
(c) CrO > VO > FeO > TiO (d) TiO > FeO > VO > CrO

44. Excited state configuration of Mn^{2+} is
(a) t_{2g}^4 (b) $t_{2g}^3 e_g^2$ (d) $t_{2g}^4 e_g^2$ (d) $t_{2g}^5 e_g^0$

45. What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?
(a) $Cr_2O_7^{2-}$ and H_2O are formed
(b) CrO_4^{2-} is reduced to +3 state of Cr
(c) CrO_4^{2-} is oxidized to +7 state of Cr
(d) Cr^{3+} and $Cr_2O_7^{2-}$ are formed

RESPONSE GRID					
	32.ⓐⓑⓒⓓ	33.ⓐⓑⓒⓓ	34.ⓐⓑⓒⓓ	35.ⓐⓑⓒⓓ	36. ⓐⓑⓒⓓ
	37.ⓐⓑⓒⓓ	38.ⓐⓑⓒⓓ	39.ⓐⓑⓒⓓ	40.ⓐⓑⓒⓓ	41. ⓐⓑⓒⓓ
	42.ⓐⓑⓒⓓ	43.ⓐⓑⓒⓓ	44.ⓐⓑⓒⓓ	45.ⓐⓑⓒⓓ	

Space for Rough Work

1. **(b)** Mn - $3d^5 4s^2$ | 1 | 1 | 1 | 1 | 1 | | ↑↓ |

The no. of various oxidation states possible are +2, +3, +4, +5, +6 and +7.

2. **(b)**

3. **(c)** The number of unpaired electrons in $Ni^{2+}(aq) = 2$

Water is weak ligand hence no pairing will take place

spin magnetic moment

$$= \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} = 2.82$$

4. **(b)**

5. **(d)** $(n-1)d^5ns^2$ attains the maximum O.S. of +7.

6. **(c)**

7. **(a)** $Mn^{2+} = 3d^5$ i.e. no. of unpaired $e^- = 5$

$Cu^{2+} = 3d^9$ i.e. no. of unpaired $e^- = 1$

$Fe^{2+} = 3d^6$ i.e. no. of unpaired $e^- = 4$

$Zn^{2+} = 3d^{10}$ i.e. no. of unpaired $e^- = 0$

$Ni^{2+} = 3d^8$ i.e. no. of unpaired $e^- = 3$

Higher the number of unpaired electrons higher will be the magnetic moment. Hence Mn^{2+} having maximum unpaired electrons will have the maximum magnetic moment.

8. **(a)** Given magnetic moment of transition metal

$$= \sqrt{n(n+2)} = 5.92$$

i.e., n = 5

Number of unpaired electrons in $Mn^{2+} = 5$

Number of unpaired electrons in $Ti^{3+} = 1$

Number of unpaired electrons in $Cr^{3+} = 3$

Number of unpaired electrons in $Cu^{2+} = 1$

Number of unpaired electrons in $Co^{2+} = 3$

Thus Mn^{2+} have magnetic moment = 5.92 BM

9. **(a)** Zn, Cd and Hg due to presence of completely filled *d*-orbitals in ground state as well as in their common oxidation states are not regarded as a transition metals but they are studied along with the transition metals.

10. **(d)** Super conductors are derived from compounds of transition metals.

11. **(a)** Electronic configuration of Mn is $[Ar]3d^5 4s^2$. Being transition metal it bas 7 valence electrons and all are involved in bond formation in MnO_4^-. Hence it has no unpaired electron

12. **(d)** Mischmetall consists of a lanthanoid metal (~95%) and iron (~ 5%) and traces of S,C,Ca and Al.

13. **(a)** $Tb^{4+} = 4f^7$ — 3 unpaired e^-

$Lu^{3+} = 4f^{14}$ — 0 unpaired e^-

$Ce^{4+} = 4f^0$ — 0 unpaired e^-

$La^{3+} = 4f^0$ — 0 unpaired e^-

14. **(b)** In neutral or faintly alkaline medium thiosulphate is quantitatively oxidized by $KMnO_4$ to SO_4^{2-}

$$8KMnO_4 + 3Na_2S_2O_3 + H_2O \longrightarrow 3K_2SO_4 + 8MnO_2 + 3Na_2SO_4 + 2KOH$$

15. **(a)** They contain different percentage of carbon.

16. **(b)** In vertice columns of transition elements, there is an increase in size from first member to second member as expected but from second member to third member, there is very small change in size and some times sizes are same. This is due to lanthanide contraction. This is the reason for Zr and Hf to have same radius.

17. **(b)** HCl and SO_2 are reducing agents and can reduce MnO_4^-. CO_2 which is neither oxidising and nor reducing will provide only acidic medium. It can shift reaction in forward direction and reaction can go to completion.

18. **(b)** Mn^{2+} (d^5) is more stable than Mn^{3+} (d^4), thus

$$E^\circ_{Mn^{3+}/Mn^{2+}} = +ve$$

19. **(a)** Green vitrol is $FeSO_4.7H_2O$.

20. **(a)** $Cr_2O_7^{2-} + 6e^- + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$

$Sn^{2+} \rightarrow Sn^{4+} + 2e^-$

one mole of Sn^{2+} provide 2 mole of e^- which will reduce $1/3Cr_2O_7^{2-}$.

21. **(c)** $E^o_{Cu^{+2}/Cu} = 0.34\,V$

other has – ve $E^o_{R.P.}$

$E^\bullet_{Co^{2+}/Co} = -0.28\,V$

$E^o_{Ni^{2+}/Ni} = -0.25\,V$

$E^o_{Fe^{2+}/Fe} = -0.44\,V$

22. **(b)** In lanthanides, there is poorer shielding of 5*d* electrons by 4*f* electrons resulting in greater attraction of the nucleus over 5*d* electrons and contraction of the atomic radii.

23. **(c)** $AgCl(s) + 2NH_4OH(aq) \rightarrow [Ag(NH_3)_2]Cl(aq) + 2H_2O(l)$

24. **(d)** (i) Haematite is Fe_2O_3 in which Fe is present in III oxidation state.

(ii) Magnetite (Fe_3O_4) is an equimolar mixture of FeO and Fe_2O_3.

Oxidation state of Fe in FeO is II.

Oxidation state of Fe in Fe_2O_3 is III.

25. **(b)** $1M\ KMnO_4 \equiv 5N\ KMnO_4 \equiv 5N\ FeSO_4$

$\therefore 10 \times 1M \equiv 10 \times 5N \equiv 10 \times 5N$

$KMnO_4 \quad KMnO_4 \quad FeSO_4$

26. **(b)** Eu^{2+} has electronic configuration $[Xe]4f^7$ hence stable due to half filled atomic orbitals.

27. **(b)** $H_2Cr_2O_7 + 4O \rightarrow \underset{\text{Blue peroxide of chromium}}{2CrO_5} + H_2O$

28. **(c)** Both MnO_2 and $KMnO_4$ used for the preparation of chlorine by the action of conc. HCl

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

$2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$

Chlorine is not obtained by dil HCl

29. **(a)** $2KMnO_4 + H_2SO_4\,(conc.) \rightarrow K_2SO_4 + \underset{\text{Explosive}}{Mn_2O_7} + H_2O$

30. **(b)** In any row the melting points of transition metals rise to a maximun at d^5 except for anomalous values of Mn and Tc and falls regularly as the atomic number increases.

31. **(c)** In laboratory, manganese (II) ion salt is oxidised to permagnate ion in aqueous solution by peroxodisulphate.

$2Mn^{2+} + \underset{\text{peroxodisulphate ion}}{S_2O_8^{2-}} + 8H_2O \rightarrow 2MnO_4^- + 10SO_4^{2-} + 16H^+$

32. **(a)** In interstitial compounds small atoms like H, B and C enter into the void sites between the packed atoms of crystalline metal. They retain metallic conductivity and are chemically inert.

33. **(d)**

Eu	La	Gd	Am
O.S = +2, +3	+3	+3	+4, +5, +6

34. **(b)** $2MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{dark green}}{2K_2MnO_4} + 2H_2O$

35. **(b)** $Ag_2S + 4NaCN + 2O_2 \longrightarrow 2Na[Ag(CN)_2] + Na_2SO_4$

36. **(b)** Ferrous ferricyanide is known as Turbull's blue.

37. **(b)** Oxidation of water takes place in presence of Mn in biological process.

38. **(b)** As a result of lanthanide contraction Zr^{4+} and Hf^{4+} possess almost the same ionic radii. Ce^{4+} is an oxidising agent. Ce^{4+} gains electron to acquire more stable Ce^{3+} state. $La(OH)_3$ is the most basic among lanthanide hydroxides.

39. **(a)** When $AgNO_3$ reacts with PH_3, then Ag is obtained.

$\underset{\text{silver nitrate}}{6AgNO_3} + \underset{\text{phosphene}}{2PH_3} \longrightarrow 6Ag + \underset{\text{phosphorous acid}}{2H_3PO_3} + 6NO_2$

40. **(c)** I^- is converted to IO_3^- by neutral or faintly alkaline MnO_4^- as shown below.

$2MnO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + 2OH^- + IO_3^-$

41. **(c)** The transition metals and their compounds are used as catalysts. Because of the variable oxidation states they may form intermediate compound with one of the readtants. These intermediate provides a new path with lowe activation energy. $V_2O_5 + SO_2 \rightarrow V_2O_4 + SO_3$

$2V_2O_4 + O_2 \rightarrow 2V_2O_5$

42. **(b)**

43. **(a)** The basic character of the transition metal monoxide is TiO > VO > CrO > FeO because basic character of oxides decrease with increase in atomic number. Oxides of transitional metals in low oxidation state i.e., + 2 and + 3 are generally basic except Cr_2O_3.

44. **(b)** After crystal field spliting, the five d-orbitals. get separated as three t_{2g} and two orbitals. For Mn^{2+}, last shell has 5 e^-s i.e., $3d^5\,4s^0$. So according to Hund's rule of maximun multiplicity the excited state configuration will be $t_{2g}^3 e_g^2$.

45. **(a)** $2K_2CrO_4 + 2HNO_3 \rightarrow K_2Cr_2O_7 + 2KNO_3 + H_2O$

$\Rightarrow 2CrO_4^{2-} \underset{}{\overset{H^\oplus}{\rightleftharpoons}} Cr_2O_7^{2-} + H_2O$