Solution

CET25C4 THE D- AND F- BLOCK ELEMENTS

Class 12 - Chemistry

1\.

(b) [Xe] $4f^7 5d^1 6s^2$

Explanation: Atomic no. 64 Gd: [Xe] $4f^7 5d^1 6s^2$

2\.

(c) Fm

Explanation: In chemistry, a synthetic element is a chemical element that does not occur naturally on earth, and can only be created artificially. So far, 24 synthetic elements have been created (those with atomic numbers 95–118). All are unstable, decaying with half-lives ranging from 15.6 million years to a few hundred microseconds. Fm have an atomic number of 100.

3\.

(c) Variable oxidation states

Explanation: Variable oxidation states is associated with their catalyst activity.

4\.

(b) $KMnO_4$ oxidises HCl into Cl_2 which is also an oxidising agent.

Explanation: HCl is not used to make the medium acidic in oxidation reactions of (potassium permanganate) $KMnO_4$ in acidic medium. The reason is that if HCl is used, the oxygen produced from $KMnO_4$ + HCl is partly utilized in oxidizing HCl to Cl, which itself acts as an oxidizing agent and partly oxidises the reducing agent.

5\.

(c) Mn_2O_7

Explanation: In Mn_2O_7, each Mn is tetrahedrally surrounded by oxygen including Mn-O-Mn bridge.

6\.

(b) 21

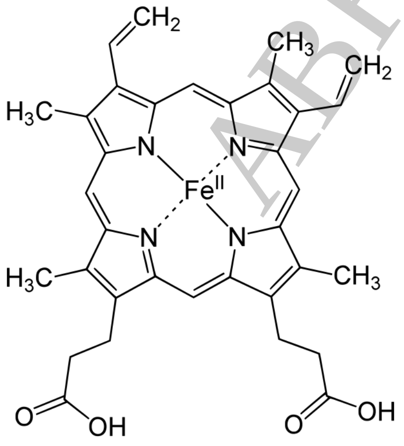
Explanation: M_g= 87.5 and M_m= 100

Carat = $24 \times \left(\frac{M_g}{M_m}\right) = 24 \times \frac{87.5}{100} = 21$

7\.

(b) Fe

Explanation: O_2 is carried in the haemoglobin protein by the heme group. The heme group (a component of the haemoglobin protein) is a metal complex, with iron as the central metal atom, that can bind or release molecular oxygen. The structure of haemoglobin is as given below:



8\.

(c) CuF_2

Explanation: Cu^{2+} has 1 unpaired electron in CuF_2 molecule, hence it is coloured in solid state.

9.

(d) + 3

Explanation: +3 oxidation state is most common for all lanthanoids.

10.

(d) Filling of 4f before 5d

Explanation: This effect is particularly pronounced in the case of lanthanides, as the 4*f* subshell which is filled before 5d is not very effective at shielding the outer shell (n = 5 and n = 6) electrons. Thus the shielding effect is less able to counter the decrease in radius caused by increasing nuclear charge. This leads to "lanthanoid contraction".

11. **(a)** I_2

Explanation: Iodine is liberated from potassium iodide.

$10I^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5I_2$

12. **(a)** harder

Explanation: A number of interstitial compounds are formed by the transition metals. Transition metals react with elements such as hydrogen, carbon, nitrogen, boron etc. to form interstitial compounds. As vacant spaces of the transition metals are filled up by small atoms, these compounds are hard and rigid.

13. **(a)** Fe and Mg

Explanation: Haemoglobin contains Fe and Chlorophyll contains Mg.

14. **(a)** $[Pt(en)_2Cl_2]^{2+}$

Explanation: In $[Pt(en)_2Cl_2]^{2+}$ central atom exhibits the oxidation state of +4

15.

(d) 2

Explanation: Both Zn and Fe can displace Hydrogen from HNO_3.

16. **(a)** Mn (Z = 25)

Explanation: Manganese shows the maximum number of oxidation states because it has 5 unpaired electrons in outer shell 3d and also contains 2 electrons in 4s sub-shell.
+ 2, + 3, + 4, + 5, + 6, + 7.

17.

(c) do not behave like transition metals

Explanation: do not behave like transition metals

18.

(b) the filling of 4f before 5d orbital resulting in a regular decrease in atomic radii.

Explanation: The filling of 4f before 5d orbital results in a regular decrease in atomic radii called Lanthanoid contraction which essentially compensates for the expected increase in atomic size with increasing atomic number. The net result of the lanthanoid contraction is that the second and the third d series exhibit similar radii and have very similar physical and chemical properties much more than that expected on the basis of usual family relationships.

19.

(d) SO_2 and SO_3

Explanation: $FeSO_4$ on heating decomposes to SO_2 and SO_3 along with solid Fe_2O_3 as given below:

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

20. **(a)** Cr^{3+}

Explanation: Cr^{3+}

21.

(c) Ag_2S

Explanation: Ag_2S is least soluble in water. It's K_{sp} (solubility product) in water is 6×10^{-51}. K_{sp} value indicates how soluble a compound is.

22.

(c) Mn^{2+}

Explanation: Mn^{2+} has d^5 configuration so a maximum number of unpaired electrons and hence maximum magnetic moment. This magnetic moment can be calculated by using the spin only formula: $\mu_{so} = \angle n(n+2)$, where n= number of unpaired electrons.

23.

(d) + 3

Explanation: + 3

24.

(b) Mn^{2+}

Explanation: For Manganese, +2 is the most stable oxidation state because of d^5 configuration.

25.

(c) $[Fe(C_2O_4)_3]^{3-}$

Explanation: $[Fe(C_2O_4)_3]^{3-}$ central atom exhibits oxidation State of +3

26. **(a)** $3d^5 4s^2$

Explanation: $3d^5 4s^2$ shows the highest oxidation state

27.

(b) MnO_2

Explanation: In alkaline medium, the reduction of MnO_4^- take place to form MnO_2. The chemical equation for this change is given below as:

$MnO_4^-(aq) + 2H_2O(l) + 3e^- \rightarrow MnO_2(s) + 4OH^-(aq)$

28.

(b) Mn_2O_7

Explanation: $2KMnO_4 + 2H_2SO_4(Conc) \longrightarrow Mn_2O_7 + 2KHSO_4 + H_2O$

29.

(b) Sc

Explanation: In case of scandium the number of electrons in the 3d and 4s orbital is 1 and 2 respectively. By removing three electrons from its d and s orbital it forms a very stable inert gas configuration. Therefore, after that electron removal there is no such oxidation state is possible.

30.

(d) Cu^{2+}

Explanation: Cu^{2+} has an electronic configuration of [Ar] $3d^9$ with the presence of one unpaired electron which is responsible for paramagnetism with a magnetic moment of 1.8 - 2.2. It shows a blue colour due to the d-d transition of this unpaired electron in the visible region.

31. **(a)** Zn

Explanation: Zinc, cadmium, and mercury of group 12 have full d^{10} configuration in their ground state as well as in their common oxidation states and hence, are not regarded as transition metals. However, being the end members of the three transition series, their chemistry is studied along with the chemistry of the transition metals.

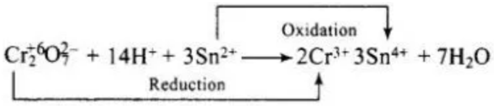
32.

(c) Sn^{4+}

Explanation:

When acidified $K_2Cr_2O_7$ solution is added to the Sn^{2+} salt, Sn^{2+} changes to Sn^{4+} ion

The reaction is given below



33. **(a)** IO_3^-

Explanation: Iodide ion oxidised to IO_3^-

34.

(b) 36%

Explanation: The percentage of nickel in the alloy steel that is used for making pendulum is 36%. it is a single-phase alloy, consisting of around 36% nickel and 64% iron.

35.

(c) Cr

Explanation: Oxygen combines with chromium to create a protective film of chromium oxide (Cr_2O_3) on the surface.

36. **(a)** $Ni(CO)_4$

Explanation: In nickel tetracarbonyl, the oxidation state for nickel is assigned as zero

37.

(b) 3.87 B.M

Explanation: Electronic configuration of Cr^{3+} is $[Ar]3d^3$. The number of electrons that contribute towards spin only magnetic moment is 3. Spin only magnetic moment can be calculated using this formula
$\sqrt{n(n+2)}$

Where n is the number of unpaired electrons. So for Cr^{3+}, the number of unpaired electrons equals 3.
$\sqrt{3(3+2)}$ = 3.87 B.M

38.

(b) effective nuclear charge

Explanation: Lanthanide contraction increase due to effective nuclear charge.

39. **(a)** ZnO

Explanation: ZnO is white in color. This is because Zn is in +2 oxidation state with d^{10} system having no unpaired electrons and hence the absence of d-d transition.

40.

(d) CuI_2

Explanation: CuI_2 is not known

41.

(b) +3

Explanation: +3

42.

(b) $[Ar]\ 3d^5$

Explanation: Atomic number of Fe is 26 and it's electronic configuration is $[Ar]\ 3d^6\ 4s^2$. When we remove 3 electrons, it becomes $[Ar]\ 3d^5$.

43. **(a)** H_2S

Explanation: Silver ornaments turns black coming in contact with H_2S due to formation of Ag_2S. The chemical equation for this change can be represented as given below:
$2Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$

44.

(c) They are chemically reactive.

Explanation: Interstitial compounds are obtained when small atoms like H, B, C, resemble N, etc. fit into the lattice of other elements. They are chemically inert.

45.

(c) Zn

Explanation: Zn metal of 3d series has the lowest melting point.

46.

(d) V^{3+}, V^{2+}, Fe^{3+}

Explanation: V^{3+}, V^{2+}, Fe^{3+} ions exhibit specific colours.

Electronic configuration of V^{2+} - $[Ar]3d^3$.

Electronic configuration of V^{3+} - $[Ar]3d^2$.

Electronic configuration of Fe^{3+} - $[Ar]3d^5$.

Since these ions have partially filled d-subshells, they exhibit colour.

Electronic configuration of Sc^{3+} - $[Ar]3d^0$

Since d subshell is empty, it shows no colour.

Electronic configuration of Ti^{4+} - $[Ar]3d^0$

Since d subshell is empty, it shows no colour.

Electronic configuration of Mn^{2+} $[Ar]3d^4$

Since d subshell is partially filled, it shows colour.

Electronic configuration of Ni^{4+} $[Ar]3d^8$

Since d subshell is partially filled, it shows colour.

Electronic configuration of Zn^{2+} - $[Ar]3d^{10}$

Since d subshell is full, it shows no colour.

47.

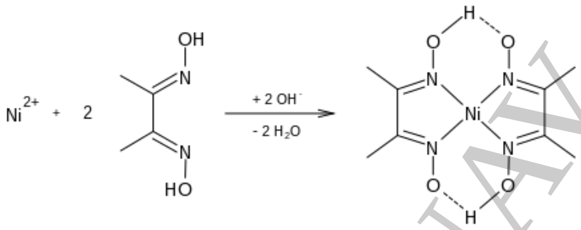
(d) $CuCl_2$

Explanation: $CuCl_2$ is used as a catalyst in Deacon's Process.

48.

(d) Ni

Explanation: Ni^{2+} reacts with DMG to form a red color complex. The reaction can be shown as below:



49. **(a)** 6

Explanation: $N_1V_1 = N_2V_2$

This equation can also be written as:

$N_1 \times$ no. of moles of 1 = $N_2 \times$ no. of moles of

As per the question, N_1 (n factor of $KMnO_4$) = 5 and N_2 (n factor of ferrous oxalate) = 3

Also no. of moles of 2 = 10

Substituting the values we get,

= 5 × no. of moles of 1 = 3 × 10

no. of moles of 1 = 6

Thus, **6 moles** of $KMnO_4$ are required in an acidic medium to oxidise 10 moles of ferric oxalate.

50.

(c) Fe^{3+}

Explanation: Fe^{3+} has maximum number of unpaired electron

51.

(d) Sc^{3+}

Explanation: Sc^{3+} is a diamagnetic ion. Atomic number is 21.

$[Ar]3d^0$ is Sc^{3+} electronic configuration. Since its d subshell is empty it is diamagnetic as it has attained noble gas configuration.

52.

(c) $K_2[HgI_4]$

Explanation: $HgCl_2 + 4KI \rightarrow K_2[HgI_4] + 2KCl$

53.

(c) a, b

Explanation:

$\overset{+1}{Cu^+} \longrightarrow \overset{+2}{Cu^{2+}} + \overset{0}{Cu}$ are disproportionate reaction

$+6 \qquad +2 \qquad +4$

$3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$

54.

(b) 26

Explanation: $[Ar]3d^5$: As X^{3+} is formed by the loss of 3 electrons, the configuration of element X is $[Ar]3d^64s^2$

$\therefore$ Atomic number = 26

55.

(c) Cu

Explanation: Cu typically exhibits the +1 oxidation state. This is due to the fact that Cu (+1) has an electrical configuration of $[Ar]3d_{10}$ It is extremely stable due to the entirely filled d-orbital. Furthermore, Cu has a +2 oxidation state

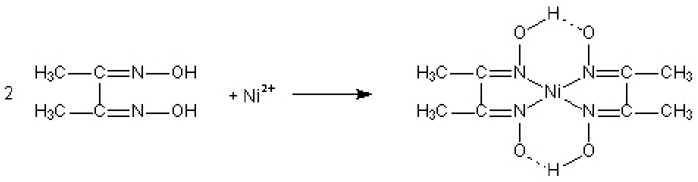
56.

(c) f-block

Explanation: In f-block elements with an increase in atomic number, atomic radii decrease smoothly due to lanthanide contraction.

57. **(a)** Dimethylglyoxime

Explanation: Ni^{2+} forms complex with DMG which is red in colour.



58.

(c) Mn^{2+} acts as autocatalyst

Explanation: When KMnO solution is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes instantaneous after some time because Mn^{2+}acts as an autocatalyst.

Reduction half $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O] \times 2$

Oxidation half $C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-] \times 5$

Overall equation

$2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

End point of this reaction Colourless to light pink

59.

(c) $\frac{2}{5}$

Explanation: The following reaction takes place when KMnO4 reacts with sulphide ions in acidic medium. 2 moles of KMnO4 reacts with 5 moles of sulphide ions, so 2/5 moles of KMnO4 reacts with 1 mole of sulphide ions.

$5S^{2-} + 2MnO^{-4} + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5S$

60.

(d) Cu(II) is more stable

Explanation: Cu(II) has a greater charge density than Cu(l) ion and therefore forms much stronger bonds releasing more energy. That's why Cu(II) is more stable due to nuclear charge of Cu.

61.

(b) Cd^{2+}

Explanation: The atomic number of Ag is 47 with an electronic configuration of [Kr] $4d^{10}$ $5s^1$ whereas for Cd, the atomic number is 48 and electronic configuration is [Kr] $4d^{10}$ $5s^2$. Ag^+ is isoelectronic with Cd^{2+}, since the electronic configuration of both of them is [Kr] $4d^{10}$.

62.

(b) $3d^5$

Explanation: The greater the number of the unpaired electrons, the higher will be its value of the magnetic moment. Since $3d^5$ has 5 unpaired electrons hence highest magnetic moment as compared to others.

$\mu = \sqrt{5(5+2)}$

$= \sqrt{35}$

= 5.95 BM

63.

(c) Variable oxidation states

Explanation: Variable oxidation states

64. **(a)** +3

Explanation: +3 is most common and stable oxidation state

65.

(c) They are chemically very reactive.

Explanation: Interstitial compounds are chemically inert not reactive.

66.

(b) 1

Explanation: In the basic medium, the following reduction reaction takes place for permanganate ion.

$MnO_4^- + e^- \rightarrow MnO_4^{2-}$

Thus 1 e^- is involved.

67.

(b) Tm

Explanation: Tm (Thulium) is a lanthanoid series.

68. **(a)** Poor shielding effect of 4f electron

Explanation: The lanthanoid contraction is due to poor shielding effect of 4f electrons. Thus, the atomic radii decreases as the atomic number increases.

69.

(d) Ce

Explanation: A gas mantle is a device that generates bright white light when heated by a flame. Oxides of Ce are used for making gas mantles.

70.

(b) V_2O_5 and Cr_2O_3

Explanation: V_2O_5, Cr_2O_3 are amphoteric oxides because both react with alkalies as well as acids.

Remember: In lower oxides, the basic character is predominant while in higher oxides, the acidic character is predominant.

71.

(d) Actinoids

Explanation: Actinoids are 5f block elements so in actinoids, 5f orbitals are progressively filled.

72.

(d) Charge transfer

Explanation: The oxidation state of Mn in MnO_4^- is +7. Which means that Mn does not have any unpaired d-electrons left. However, MnO_4^- is deep purple in colour because of charge transfer from the ligand (O^{2-}) to the metal center. This is called a ligand-to-metal charge transfer.

73.

(b) H_2CrO_4

Explanation: H_2CrO_4 is chromic acid. It is actually formed by mixing concentrated sulphuric acid to a dichromate like sodium dichromate which may contain a variety of compounds, including solid chromium trioxide.

74.

(b) Hard and brittle

Explanation: Red hot steel rods on suddenly immersing in water become hard and brittle.

75. **(a)** $Cr_2O_7^{2-}$

Explanation: Chromate ion (CrO_4^{2-}) changes to dichromate ion ($Cr_2O_7^{2-}$) on acidification.

$2\ CrO_4^{2-} + 2\ H^+ \rightarrow Cr_2O_7^{2-} + H_2O$