Additional Problems for Self Practice (APSP)

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Time : 1 Hr. **Max. Marks : 120**

Important Instructions

1. The test is of **1 hour** duration.
2. The Test Booklet consists of **30** questions. The maximum marks are **120.**
3. Each question is allotted **4 (four)** marks for correct response.
4. Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. **¼ (one fourth)** marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

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1. The maximum oxidation state shown by V(Z = 23), Cr(Z = 24), Co(Z = 27), Sc(Z = 21) are respectively :
(1) +5, +6, +3, +3 (2) +3, +4, +5, +2 (3) +5, +3, +2, +1 (4) +4 in each case.

2. Which oxide of manganese is most acidic in nature ?
(1) MnO (2) Mn_2O_7 (3) Mn_2O_3 (4) MnO_2

3. The first ionisation energies of the elements of the first transition series :
(1) generally increases as the atomic numbers increase.
(2) decrease as the atomic number increase.
(3) do not show any change as the addition of electrons takes place in the inner (n – 1) d–orbitals.
(4) increase from Ti to Mn and then decrease from Mn to Cu.

4. The ions from among the following which are colourless are :
(i) Ti^{4+}, (ii) Cu^{+1}, (iii) Co^{3+}, (iv) Fe^{2+} .
(1) (i) and (ii) only (2) (i), (ii) and (iii) (3) (iii) and (iv) (4) (ii) and (iii).

5. Which of the following transition metal ions has least magnetic moment ?
(1) Co^{3+} (2) Fe^{3+} (3) Cr^{2+} (4) V^{3+}

6. If a non metal is added to the interstitial sites of a metal, then the metal becomes :
(1) softer (2) less tensile (3) less malleable (4) more ductile.

7. The pair of the compounds in which both the metals are in the highest possible oxidation state is,
(1) $[Fe(CN)_6]^{3-}$, $[Co(CN)_6]^{3-}$ (2) CrO_2Cl_2, MnO_4^-
(3) TiO_2, MnO_2 (4) $[Co(CN)_6]^{3-}$, Mn_2O_7

8. Among the following statements, the incorrect is :
(1) Calamine and siderite are carbonate ores (2) Argentite and cuprite are oxide ores
(3) Zinc blende and pyrites are sulphide ores (4) Malachite and azurite are ores of copper.

9. A compound of iron exists as a dimer in vapour state. It is hygroscopic in nature and dissolves in water giving brown acidic solution. The compound is :
(1) Fe_3O_4 (2) $FeSO_4$ (3) $FeCl_3$ (4) $FeCl_2$.

10. Iron is rendered passive by treatment with concentrated :
(1) HCl (2) H_2SO_4 (3) HNO_3 (4) both (2) & (3)

11. Which one of the following dissolves in hot concentrated NaOH ?
(1) Fe (2) Zn (3) Cu (4) Ag

12. Hot copper wire reacts with oxygen to produce :
(1) Cu_2O (2) CuO_2 (3) Cu_2O_2 (4) CuO.

13. A compound is yellow when hot and white when cold. The compound is :
(1) Al_2O_3 (2) PbO (3) CaO (4) ZnO

14. At 300ºC, $FeCl_3$(s) :
(1) decomposes into $FeCl_2$ and Cl_2. (2) decomposes into Fe and Cl_2.
(3) sublimes to give liquid $FeCl_3$. (4) sublimes to give gaseous dimer $(FeCl_3)_2$.

15. When $FeSO_4$ is strongly heated, the number of acidic gases produced is :
(1) One (2) Two (3) Three (4) Four

16. On heating $ZnCl_2.2H_2O$, the compound obtained is :
(1) $ZnCl_2$ (2) Zn(OH)Cl (3) $Zn(OH)_2$ (4) Zn

17. On heating $KMnO_4$, one among the following is not formed :
(1) K_2MnO_4 (2) O_2 (3) MnO_2 (4) MnO.

18. Reaction of $KMnO_4$ in neutral or very weakly alkaline solution can be represented as :
(1) $MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$. (2) $2MnO_4^- + 2OH^- \rightarrow 2MnO_4^{2-} + 1/2O_2 + H_2O$.
(3) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$. (4) $MnO_4^- + e^- \rightarrow MnO_4^{2-}$.

19. $KMnO_4$ in excess on treatment with concentrated H_2SO_4 forms a compound (X) which decomposes explosively on heating forming (Y). The (X) and (Y) are respectively :
(1) Mn_2O_7, MnO_2 (2) Mn_2O_7, Mn_2O_3 (3) $MnSO_4$, Mn_2O_3 (4) Mn_2O_3, MnO_2

20. Which of the following statement is wrong ?
(1) An acidified solution of $K_2Cr_2O_7$ liberates iodine from iodides.
(2) In acidic solution dichromate ions are converted to chromate ions.
(3) Ammonium dichromate on heating undergo exothermic decomposition to give Cr_2O_3.
(4) Potassium dichromate is used as a titrant for Fe^{2+}.

21. The image on an exposed and developed photographic film is due to :
(1) AgBr (2) $[Ag(C_2O_3)_2]^{3+}$ (3) Ag (4) Ag_2O.

22. The yellow colour solution of Na_2CrO_4 changes to orange red on passing CO_2 gas due to the formation of :
(1) CrO_5 (2) CrO_3 (3) $Na_2Cr_2O_7$ (4) Na_3CrO_8.

23. What happens when a molten mixture of K_2FeO_4 and K_2CrO_4 is acidified ?
(1) FeO_4^{2-} is converted to H_2FeO_4
(2) CrO_4^{2-} is reduced to Cr^{3+} liberating O_2
(3) CrO_4^{2-} is converted to Cr^{3+}
(4) FeO_4^{2-} is reduced to Fe^{3+} liberating O_2

24. Why silver chloride is used in photochromic spectacles ?
(1) Silver halides darken in light owing to photochemical decomposition
(2) Silver halides produced elemental silver in light.
(3) If the halogen produced is kept in close proximity to finely divided silver chloride, the silver metal is formed.
(4) All of these.

25. In which of the following reactions, reaction of silver with the given acids lead to the formation of compound of silver, along with liberation of gas ?
(1) Ag + dilute HNO_3 (2) Ag + conc. HNO_3 (3) Ag + conc. H_2SO_4 (4) All of these

26. Which of the following can be used for the conversion of potassium manganate to potassium permanganate?
(1) O_3 (2) Cl_2 (3) CO_2 (4) All.

27. Reaction of potassium chromate and $CuSO_4$ in aqueous solution produces :
(1) $CuCrO_4$ only (2) $Cu_5[CrO_4]_2$ only
(3) $CuCr_2O_7$ only (4) both $CuCrO_4$ and $Cu_2Cr_2O_7$.

28. Pick out the correct statements from the following :
1. Cobalt (III) is more stable in octahedral complexes.
2. Zinc forms coloured ions or complexes
3. Most of the d-block elements and their compounds are ferromagnetic
4. Osmium shows (VIII) oxidation state
5. Cobalt (II) is more stable in octahedral complexes.

(1) 1 and 2 (2) 1 and 3 (3) 2 and 4 (4) 1 and 4

29. Transuranic elements begin with
(1) Np (2) Cm (3) Pu (4) U

30. Lanthanide contraction is observed in :
(1) Gd (2) At (3) Xe (4) Ac

Practice Test-1 (IIT-JEE (Main Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.										
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.										
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.										

PART - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

1. The aqueous solution of a salt of a transition metal ion changes colour from pink to blue, when concentrated hydrochloric acid is added to it. The change in colour is due to : **[NSEC-2003]**
(A) evolution of hydrogen that changes the oxidation state of the metal ion
(B) change in the coordination number of the metal ion from 6 to 4 and formation of new species in solution
(C) formation of a coordination complex of the metal ion with hydrochloric acid
(D) protonation of the metal ion.

2. Iron articles get rusted on weathering due to the formation of **[NSEC-2003]**
(A) FeO (B) Fe_2O_3 (C) Fe_3O_4 (D) $Fe(OH)_3$

3. Chromium has the lowest oxidation state in **[NSEC-2003]**
(A) chromium sulphate (B) chromium trioxide
(C) potassium chromate (D) potassium dichromate.

4. Paramagnetism is not exhibited by **[NSEC-2004]**
(A) $CuSO_45H_2O$ (B) $CuCl_25H_2O$ (C) CuI (D) $NiSO_4.6H_2O$.

5. Articles made of copper or bronze slowly tarnish in air and turn green. The green colour is due to the formation of **[NSEC-2005]**
(A) copper sulphide (B) copper oxide
(C) basic copper carbonate (D) copper oxalate.

6. The cation containing maximum number of unpaired electrons is **[NSEC-2005]**
(A) Fe (II) (B) Fe (III) (C) Co (II) (D) Ni (II)

7. Chromium has the lowest oxidation state in **[NSEC-2005]**
(A) potassium chromate (B) chromium sulphate
(C) potassium dichromate (D) chromium oxide.

8. Which of the following statements concerning transition elements is false ? **[NSEC-2006]**
(A) They are all metals.
(B) They easily form coordination compounds.
(C) Their ions are mostly coloured.
(D) They show multiple oxidation states always differing by two units.

9. The magnetic moment of $MnSO_4.4H_2O$ is: **[NSEC-2007]**
(A) 1.73 BM (B) 3.87 BM (C) 4.09 BM (D) 5.92 BM

10. Which two of the following reactions are possible ? **[NSEC-2007]**
(i) $2FeCl_3 + SnCl_2 \longrightarrow 2FeCl_2 + SnCl_4$ (ii) $2FeCl_2 + SnCl_4 \longrightarrow 2FeCl_3 + SnCl_2$
(iii) $PbCl_2 + SnCl_4 \longrightarrow SnCl_2 + PbCl_4$ (iv) $SnCl_2 + PbCL_4 \longrightarrow PbCl_2 + SnCl_4$
(A) i and ii (B) i and iii (C) i and iv (D) ii and iv

11. Europium forms stable Eu^{2+} ions because **[NSEC-2007]**
(A) Europium is a lanthanide. (B) +2 is the common oxidation state of lanthanides.
(C) Eu^{2+} has f^7 valence electronic configuration. (D) All of the above reasons.

12. Which of these ion is expected to be colored in aqueous solution ? **[NSEC-2008]**
[I] Fe^{3+} [II] Zn^{2+} [III] Al^{3+} [IV] Sc^{3+}
(A) [I] only (B) [III] only (C) [I] and [II] only (D) [I], [II] and [III]

13. How many unpaired electrons are in a Fe^{2+} ion in the ground state ? **[NSEC-2008]**
(A) 0 (B) 2 (C) 4 (D) 6

14. In which of the following transition metal ion complexes, the colour in not due to d-d transition ?
(A) $[Ti(H_2O)_6]^{3+}$ and $[CoF_6]^3$ (B) $[Ti(H_2O)_6]^{3+}$ and $[MnO_4]$ **[NSEC-2008]**
(C) $[CoF_6]^3$ and $[CrO_4]^2$ (D) $[MnO_4]$ and $[CrO_4]^2$

15. The compound with the lowest oxidation state of iron is – **[NSEC-2009]**
(A) Fe_2O (B) Fe_3O_4 (C) $K_3Fe(CN)_6$ (D) $K_4Fe(CN)_6$

16. The aqua ion which will be almost colorless is – **[NSEC-2009]**
(A) Cu^{2+} (B) Cr^{2+} (C) Ti^{4+} (D) Mn^{2+}

17. MnO_4^{1-} is of intense pink colour, though Mn is in +VII oxidation state. This is due – **[NSEC-2009]**
(A) d-d transition
(B) charge transfer when Mn gives electron to oxygen
(C) charge transfer when oxygen gives its electrons to Mn making it +VI
(D) absorption of IR frequencies

18. The product formed when chlorine gas is passed over hot iron is **[NSEC-2010]**
(A) Iron(II) chloride is formed.
(B) Iron(III) chloride is formed.
(C) A mixture of iron(II)chloride and iron(III) chloride is formed.
(D) No reactions will take place.

19. The highest magnetic moment is shown by a transition metal ion with the outer electronic configuration **[NSEC-2010]**
(A) $3d^2$ (B) $3d^5$ (C) $3d^7$ (D) $3d^9$

20. The compound in which Mn has oxidation state of +3 is **[NSEC-2011]**
(A) $KMnO_4$ (B) $K_2[Mn(CN)_6]$ (C) $MnSO_4$ (D) $CsMn(SO_4)_2.12H_2O$

21. Lanthanide contraction is caused due to **[NSEC-2012]**
(A) the appreciable shielding on outer electrons by 4f electrons from the nuclear charge
(B) the appreciable shielding on outer electrons by 5d electrons from the nuclear charge
(C) the same effective nuclear charge from Ce to Lu.
(D) the imperfect shielding on outer electrons by 4f electrons from the nuclear charge

22. Which of the following ion is colourless ? **[NSEC-2012]**
(A) Mn^{2+} (B) Cu^+ (C) Cr^3 (D) Fe^{2+}

23. The lanthanide compound which is used as a most powerful liquid laser after dissolving in selenium oxychloride is : **[NSEC-2012]**
(A) Cerium oxide (B) Neodynium oxide
(C) Promethium sulphate (D) Cerium sulphate

24. Which of the following weighs less when weighed in magnetic field ? **[NSEC-2012]**
(A) $ScCl_3$ (B) $FeCl_3$ (C) $TiCl_3$ (D) VCl_3

25. In which of the following compounds is the oxidation number of the transition metal, zero ? **[NSEC-2013]**
(A) $[Fe(H_2O)_3](OH_2)$ (B) $[Co(NH_3)_6]Cl_2$ (C) $[Ni(CO_4)]$ (D) $[Pt(C_2H_4)Cl_3]$

26. One of the constituents of German silver is **[NSEC-2013]**
(A) Ag (B) Mg (C) Cu (D) Al

27. A mixture of acidified $K_2Cr_2O_7$ and 10% KI is titrated against $Na_2S_2O_3$ (Sodium thiosulphate) solution using starch indicator. The colour of the reaction mixture at the end point is **[NSEC-2013]**
(A) Yellow (B) Blue (C) Green (D) Colourless

28. The colourless ion from among the following is **[NSEC-2013]**
(A) Mn^{2+} (B) Cu^{+} (C) Cr^{3+} (D) Fe^{2+}

29. Bell metal is an alloy of copper and **[NSEC-2013]**
(A) Tin (B) Aluminium (C) Zinc (D) Nickel

30. Europium (Eu) and Terbium (Tb) attain stable $4f^7$ configuration by exhibiting oxidation states of **[NSEC-2013]**
(A) +2 and +4 (B) +3 and +4 (C) +2 and +3 (D) +1 and +3

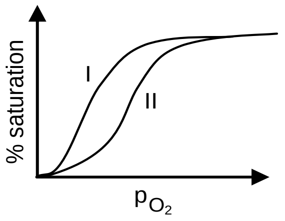
31. The pair of compounds that **will not** react with each other in an aqueous solution, at room temperature is **[NSEC-2014]**
(A) $FeCl_3$, $SnCl_2$ (B) $HgCl_2$, $SnCl_2$ (C) $FeCl_2$, $SnCl_2$ (D) $FeCl_3$, KI

32. Four statements for Cr and Mn are given below. **[NSEC-2015]**
(i) Cr^{2+} and Mn^{3+} have the same electronic configuration.
(II) Cr^{2+} is a reducing agent while Mn^{3+} is an oxidizing agent.
(III) Cr^{2+} is an oxidizing agent while Mn^{3+} is a reducing agent
(IV) both Cr and Mn are oxidizing agents.
The correct statements are
(A) I, III, IV (B) I, II (C) I, II, IV (D) I, IV

33. The incorrect statement for lanthanides among the following statements is **[NSEC-2015]**
(A) 4f and 5d orbitals are so close in energyythat it is very difficult to locate the exact position of electrons in lanthanides
(B) most common stable oxidation state is +3
(C) tripositive lanthanide ions have characteristic color depending on nature of group with which they combine to form compounds
(D) some lanthanide ions absorb either in infrared or ultraviolet region of electromagnetic spectrum

34. Which of the following statements is not true for Ce^{3+} and Yb^{3+} ? **[NSEC-2016]**
(A) Both absorb in UV region (B) Both show f-f transition
(C) Both show 4f to 5d transition (D) Both ions are colorless

35. Haemoglobin is a Fe containing protein responsible for oxygen transport in the blood. The curves given below indicate the percentage saturation of haemoglobin by O_2 as a function of partial pressure of O_2. **[NSEC-2017]**
Which of the following statement/s is /are correct for the given curves?



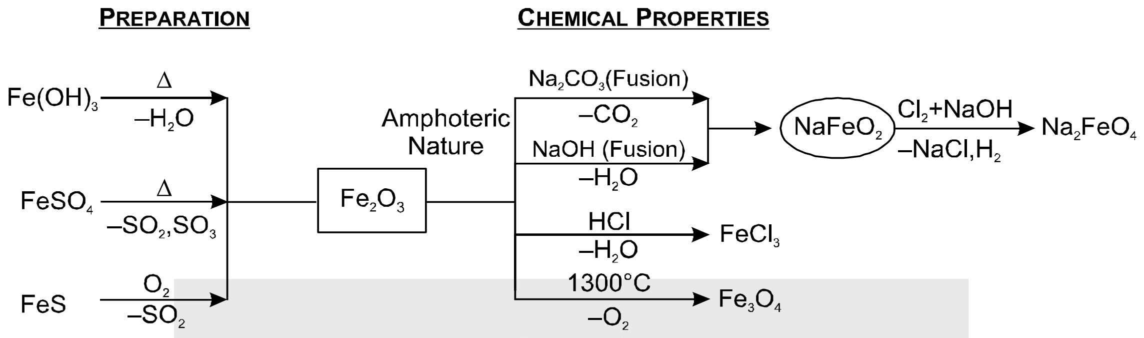
I. In presence of CO_2, higher P_{O_2} is needed for a given percentage saturation.
II. In presence of CO_2, lower P_{O_2} is needed for a given percentage saturation.
III. The maximum percentage saturation is not affected by the presence of CO_2
IV. In the absence of CO_2, maximum saturation of haemoglobin occurs at lower p_{O_2}
(A) I and IV (B) II and IV (C) I, III and IV (D) II and III

PART - III : HIGH LEVEL PROBLEMS (HLP)

THEORY

1. Ferric Oxide, Fe_2O_3

Physical Properties :
Deep red coloured powder and insoluble in water.

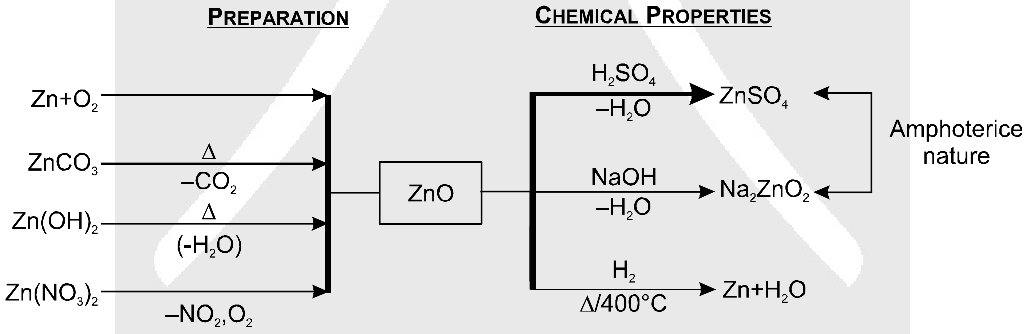


Uses : It is used
(i) as red pigment.
(ii) an abrasive polishing powder.
(iii) as a catalyst.

2. ZnO, Zinc oxide (Chinese white or Philosopher's wool)

It is found in nature as zincite or red zinc ore.

Physical Properties :
(i) White powder which becomes yellow on heating due to change in the structure of latlice again turns white on cooling.
(ii) Insoluble in water and sublimes at 400°C.



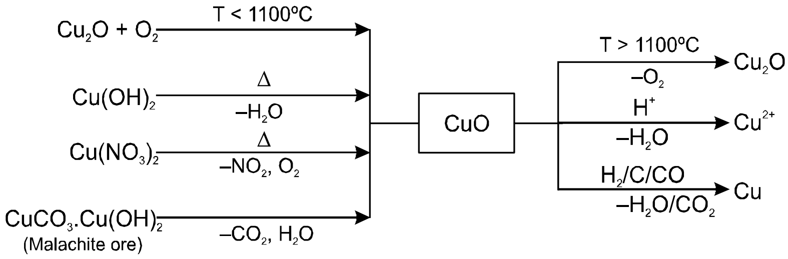
Uses : It is used
(i) as a white paint. It does not get tarnished even in presence of H_2S because ZnS is also white.
(ii) for preparing Rinmann's green (green paint $ZnCoO_2$).
(iii) as a catalyst for preparation of methyl alchol.
(iv) for making soft rubber.

3. Cupric oxide, (CuO) :

It is called black oxide of copper and is found in nature as tenorite.

Physical properties : Black powder, insoluble in water and stable to moderate heating.

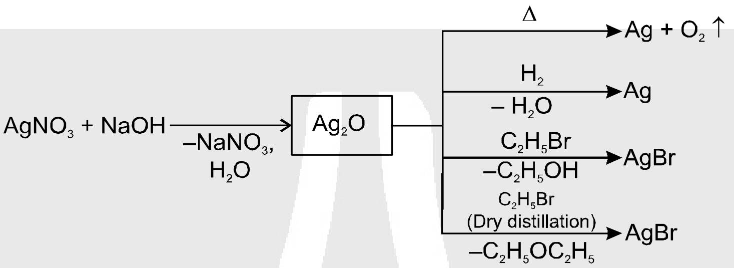
PREPARATION **CHEMICAL PROPERTIES**



4. Silver oxide (Ag_2O) :

Physical properties : Brown solid sparingly soluble in water properties.

PREPARATION **CHEMICAL PROPERTIES**



Uses : It is used

(i) as Tollen's reagent for detection of aldehydes, formic acid, and terminal alkynes.

(ii) in the manufacturing of mirrors.

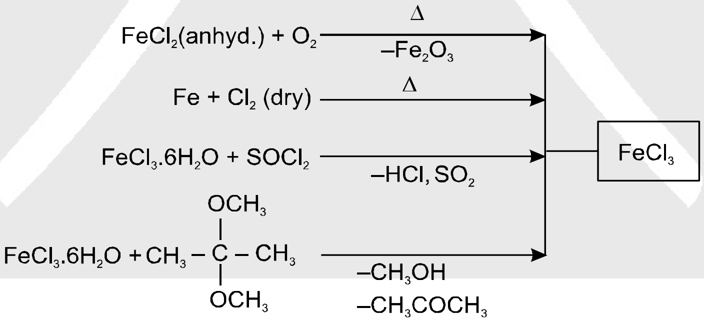
Chlorides (Cl^-) of Fe^{2+}, Zn^{2+} and Cu^{2+}

5. Ferric Chloride, $FeCl_3$

Prepration

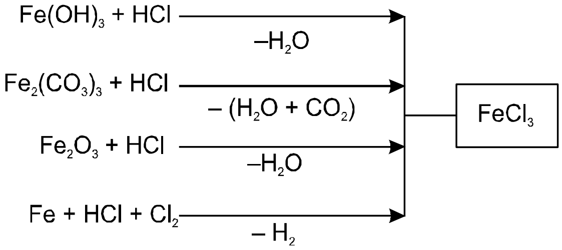
(a) Anhydrous $FeCl_3$

Preparation



(b) Hydrated $FeCl_3$

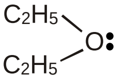
Preparation



Properties :

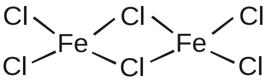
- Anhydrous $FeCl_3$ is dark black solid, while hydrated salt. $FeCl_3.6H_2O$ is yellowish-brown deliquescent crystalline liquid.
- Both hydrous $FeCl_3$ and hydrated $FeCl_3$, are soluble in water as well as ether forming solvated species.

$[Fe(H_2O)_4Cl_2]Cl.2H_2O$ and



$\rightarrow FeCl_3$ respectively

- It sublimes at 300ºC giving a dimeric gas.



Chemical Properties :

(i) Action of heat :

$FeCl_3(\text{anhydrous}) \xrightarrow{\Delta} 2FeCl_2 + Cl_2$

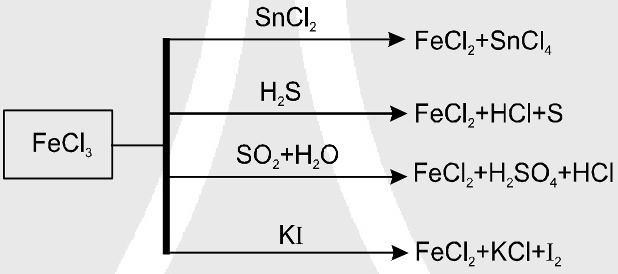
$2FeCl_3.6H_2O \xrightarrow{\Delta} Fe_2O_3+6HCl+9H_2O$

(ii) Aqueous solution is acidic due to hydrolysis.

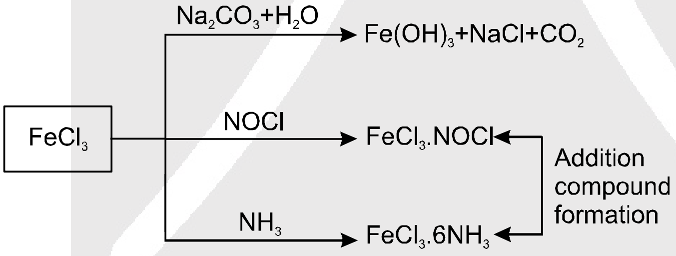
$$\underset{\text{Acid}}{[Fe(H_2O)_6]^{3+}} + \underset{\text{Base}}{H_2O} \rightleftharpoons \underset{\text{Base}}{[Fe(H_2O)_5(OH)]^{2+}} + \underset{\text{Acid}}{H_3O^{\oplus}}$$

(iii) As an oxidising agent.

$$Fe^{3+} \xrightarrow{\text{reducing agent}} Fe^{2+}$$



(iv)

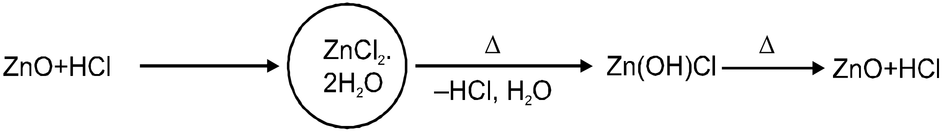


Uses : It is used

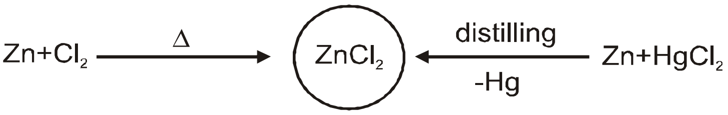
(i) as a medicine.
(ii) for detection of phenols.
(iii) for making Prussian blue dyes.
(iv) as an oxidising agent.

6. <u>Zinc Chloride</u>

Prepration of Hydrated $ZnCl_2$ ($ZnCl_2.2H_2O$)



Anhydrous $ZnCl_2$



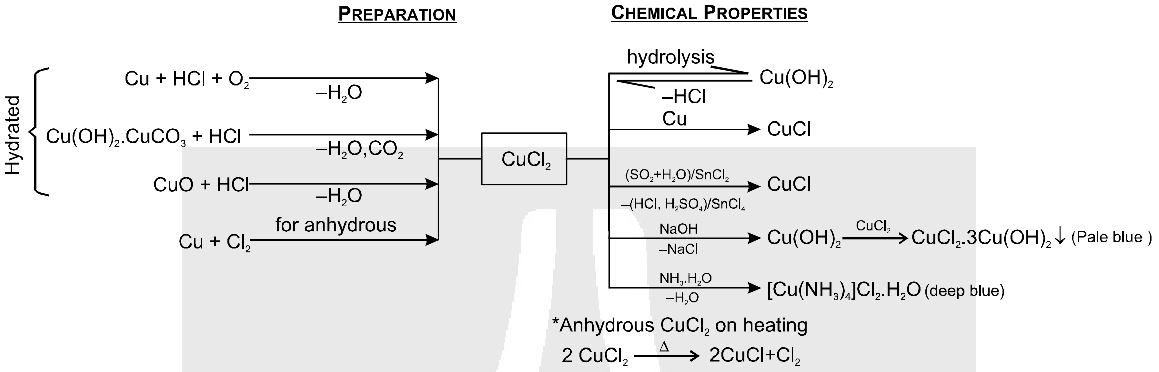
Properties

White crystalline solid, deliquescent and soluble in water.
Its concentrated solution sets to a hard mass when mixed with ZnO and product is used as a dental filling.

7. Cupric chloride, $CuCl_2.2H_2O$

Physical Properties

It is deliquescent compound. readily soluble in water.
Dilute & solution is blue but concentrated solutions is green.
It changes to yellow when concentrated HCl is added.
Blue colour is due to complex cation $[Cu(H_2O)_4]^{2+}$ and yellow colour due to complex axion $[CuCl_4]^{2-}$ and green when both are present.



Heating effect : $CuCl_2.2H_2O \xrightarrow[\text{HCl gas}]{150^{\circ}C} CuCl_2 + 2H_2O$

SUBJECTIVE QUESTIONS

1. K_2PtCl_6 compound whereas corresponding Ni compound is not known. Explain.

2. What is meant by disproportionation of an oxidation state ? Give an example.

3. Most of transition metals can displace hydrogen from dilute acids. Why ?

4. Why do Mn(II) show maximum paramagnetic character amongst the bivalent ions of the Ist transition series?

5. Explain why transition metals and their many compounds act as good catalyst.

6. A transition metal forms alloys with other transition elements. Explain.

7. What happens when $CuSO_4$ solution is treated with
(i) excess of ammonia solution and (ii) KI solution ?

8. What happens when silver nitrate solution is added to $Na_2S_2O_3$ solution and then content is allowed to keep for a longer period ?

9. What reaction will take place if a silver coin is put in dilute HNO_3 ?

10. What happens when :
(a) $FeSO_4$ reacts with potassium ferricyanide.
(b) Fe_2O_3 is fused with soda ash.
(c) Salts of iron (III) reacts with NH_4SCN.
(d) Zinc oxide and cobalt oxide is fused.

ONLY ONE OPTION CORRECT TYPE

11. Which ore contains both iron and copper ?
(A) Cuprite (B) Chalcocite (C) Chalcopyrite (D) malachite

12.✍ Atoms of the transition elements are smaller than those of the s-block elements, because :
(A) there is increase in the nuclear charge along the period.
(B) orbital electrons are added to the penultimate d–subshell rather than to the outer shell of the atom.
(C) the shielding effect of d-electrons is small.
(D) All of these

13. Which of the following statements is correct ?
(A) The lesser number of oxidation states in 3d-series in the beginning of the series is due to the presence of too few electrons to loose or share
(B) The lesser number of oxidation states in 3d-series towards the end of the series is due to the presence of too many electrons and thus fewer empty orbitals to share electrons with the ligands
(C) (A) and (B) both
(D) None is correct

14.✍ $E^{\ominus}$ values for the couples Cr^{3+}/Cr^{2+} and Mn^{3+}/Mn^{2+} are – 0.41 and + 1.51 volts respectively. Considering these values select the correct option from the following statements.
(A) Cr^{2+} acts as a reducing agent and Mn^{3+} acts as an oxidising agent in their aqueous solutions.
(B) Cr^{2+} (aq.) is more stable than Cr^{3+} (aq.).
(C) Mn^{3+} (aq.) is more stable than Mn^{2+} (aq).
(D) None of these.

15. A metal ion from the first transition series has a magnetic moment (calculated) of 3.87 B.M. How many unpaired electrons are expected to be present in the ion ?
(A) 1 (B) 2 (C) 3 (D) 4

16. Which one of the ionic species will impart colour to an aqueous solution ?
(A) Ti^{4+} (B) Cu^{+} (C) Zn^{2+} (D) Cr^{3+}

17. $CuSO_4.5H_2O$ is blue in colour because
(A) It contains water of crystallization
(B) SO_4^{2-} ions absorb red light
(C) Cu^{2+} ions absorb red light
(D) Cu^{2+} ions absorb all colours except red from the white light

18. When $AgNO_3$ (aq) reacts with excess of iodine, we get :
(A) $AgIO_3$ (B) HIO_3 (C) AgO (D) HI

19. When $K_4[Fe(CN)_6]$ is added to $FeCl_3$, the complex compound formed is :
(A) $Fe_3[Fe(CN)_6]_4$ (B) $Fe_4[Fe(CN)_6]_3$ (C) $K_2Fe[Fe(CN)_6]$ (D) $K_2Fe_3[Fe(CN)_6]_2$

20. $FeCl_3.6H_2O$ is actually :
(A) $[Fe(H_2O)_6]Cl_3$ (B) $[Fe(H_2O)_5Cl]Cl_2.H_2O$
(C) $[Fe(H_2O)_4Cl_2]Cl.2H_2O$ (D) $[Fe(H_2O)_3Cl_3].3H_2O$

21. Aqueous solution of which of the following ions is green ?
(A) V^{2+} (B) V^{3+} (C) VO^{2+} (D) VO_2^{+}

22. Aqueous solutions of (P) and (Q) are violet. (P) turns green on oxidation while (Q) turns green on reduction. They may respectively be :
(A) VCl_2, CrO_3 (B) VCl_3, $KMnO_4$ (C) VSO_4, $KMnO_4$ (D) $VOSO_4$, K_2MnO_4

23.✍ In the reaction, $2CuCl_2 + 2H_2O + SO_2 \rightarrow A + H_2SO_4 + 2HCl$; A is
(A) CuCl (B) Cu (C) $CuSO_4$ (D) CuS

24. German silver is an alloy of copper and :
(A) Zn + Ni (B) Al + Ag (C) Zn + Ag (D) Sn + Zn

25. When copper is placed in the atmosphere for sufficient time, a green crust is formed on its surface. The composition of the green crust is :
(A) $Cu(OH)_2$ (B) CuO (C) $CuCO_3$ (D) $CuCO_3.Cu(OH)_2$

26. $FeCl_3$ dissolves in :
(A) water (B) ether (C) ammonia (D) (A) and (B) both

27. When $AgNO_3$ (aq) reacts with excess of iodine, we get :
(A) $AgIO_3$ (B) HIO_3 (C) AgO (D) HI

28. $ZnO + CoO \xrightarrow{\Delta} X$; Product 'X' colour is :
(A) Green (B) Blue (C) Pink (D) Bluish green

29. The compound that gets oxidised even on exposure to atmosphere is :
(A) $Co_2(SO_4)_3$ (B) $NiSO_4$ (C) $KMnO_4$ (D) $FeSO_4$

30. The +3 ion of which one of the following has half filled 4f subshell ?
(A) La (B) Lu (C) Gd (D) Ac

SINGLE AND DOUBLE VALUE INTEGER TYPE

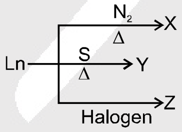
31. $FeC_2O_4 \xrightarrow{\Delta}$ products
Number of diamagnetic products= x
Number of unpaired electrons in paramagnetic product = y
Report your answer as (x + y).

32. No. of following reagents in which ppt A is soluble is :
$AgNO_3 + NaCl \longrightarrow A\downarrow$
(i) aq NH_3 (ii) aq. KCN (iii) $Na_2S_2O_3$
(iv) Conc. HCl (v) aq. NaOH (iv) aq. KI

33.✍ The number of water molecule(s) directly bonded to the metal centre in $CuSO_4.5H_2O$ is–

34. How many of the following statements are correct for green vitriol?
1. It can be used for the preparation of Mohr's salt.
2. It is a hydrated salt and its anhydrous form is white in colour.
3. The decomposition reaction of its anhydrous form is redox in nature.
4. It is used for making Fenton's reagent used as a catalyst in organic chemistry
5. It can be used for the preparation of Potassium ferrocyanide.
6. It has same number of molecules of water of crystallization as white vitriol or blue vitriol.
7. It turns brownish-yellow on exposure to atmosphere.
8. Its aqueous solution is acidic in nature due to hydrolysis.
9. Out of the decomposition products of its anhydrous form, only one can turn acidified $K_2Cr_2O_7$ solution green.

35. The heavier members of lanthanoid series metal react with following non-metal.



The summation of atomicity of compound X, Y and Z is :

ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

36.✍ The less stable oxidation states of Cr are :
(A) Cr^{2+} (B) Cr^{3+} (C) Cr^{4+} (D) Cr^{5+}

37.✍ Which of the following is/are soluble is excess of NaOH.
(A) $Al(OH)_3$ (B) $Cr(OH)_3$ (C) $Fe(OH)_3$ (D) $Zn(OH)_2$

38. What are the characteristics of products obtained when green vitriol is strongly heated ?
(A) Basic oxide (B) Neutral oxide (C) acidic oxide (D) Reducing agent

39. Which of the following reaction(s) is/are used for the preparation of anhydrous $FeCl_3$?
(A) $FeCl_3\,6H_2O + 6SOCl_2 \longrightarrow FeCl_3 + 12HCl + 6SO_2$
(B) $Fe(OH)_3\downarrow + 3HCl \longrightarrow FeCl_3 + 3H_2O$
(C) $2Fe + 4HCl\ (aq.) + Cl_2 \longrightarrow 2FeCl_3 + 2H_2$
(D) $2Fe + 3Cl_2(dry) \longrightarrow 2FeCl_3$

40.✍ Cuprous chloride can be prepared :
(A) by passing SO_2 through the solution containing $CuSO_4$ and NaCl.
(B) by heating excess of copper with concentrated HCl in presence of a little $KClO_3$.
(C) by boiling copper sulphate solution with excess of copper turnings in presence of hydrochloric acid.
(D) by dissolving cupric oxide or copper carbonate in concentrated HCl.

PART - IV : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr. **Max. Marks : 66**

Important Instructions

A. General :

1. The test is of 1 hour duration.
2. The Test Booklet consists of 22 questions. The maximum marks are 66.

B. Question Paper Format

3. Each part consists of five sections.
4. Section-1 contains 7 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
5. Section-2 contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
6. Section-3 contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
7. Section-4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a partcular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
8. Section-5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

C. Marking Scheme

9. For each question in Section-1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (– 1) mark will be awarded.
10. For each question in Section-2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
11. For each question in Section-3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

SECTION-1 : (Only One option correct Type)

This section contains 7 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

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1. Among the following series of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is ;
(A) Ti^{3+}, V^{2+}, Cr^{3+}, Mn^{4+} (B) Ti^{+}, V^{4+}, Cr^{6+}, Mn^{7+}
(C) Ti^{2+}, V^{3+}, Cr^{2+}, Mn^{3+} (D) Ti^{2+}, V^{3+}, Cr^{4+}, Mn^{5+}

2. The pair of the compounds in which both the metals are in the highest possible oxidation state is,
(A) $[Fe(CN)_6]^{3-}$, $[Co(CN)_6]^{3-}$ (B) CrO_2Cl_2, MnO_4^{-}
(C) TiO_2, MnO_2 (D) $[Co(CN)_6]^{3-}$, Mn_2O_7

3. VO_2 is an amphoteric oxide and in acidic medium it forms :
(A) VO^{2+} (B) VO_2^{+} (C) V^{3+} (D) VO_2^{2+}

4. **S_1 :** Mn^{2+} compounds are more stable than Fe^{2+} towards oxidation to their +3 state.
S_2 : Titanium and copper both in the first series of transition metals exhibits +1 oxidation state most frequently.
S_3 : Cu^{+} ion is stable in aqueous solutions.
S_4 : The E^{θ} value for the Mn^{3+} / Mn^{2+} couple is much more positive than that for Cr^{3+} /Cr^{2+} or Fe^{3+}/Fe^{2+}.
(A) T T F T (B) T F F T (C) T F T T (D) F F T F

5. Identify the incorrect statement.
(A) $CuSO_4$ reacts with KCl in aqueous solution to give Cu_2Cl_2.
(B) $CuSO_4$ reacts with KI in aqueous solution to give Cu_2I_2.
(C) $CuSO_4$ reacts with NaOH and glucose in aqueous medium to give Cu_2O.
(D) $CuSO_4$ on strong heating gives CuO.

6. $CuFeS_2 + O_2$ (excess) $\xrightarrow{\Delta}$ X(s) + Y(s)
Note : Correspondings sulphates of copper and iron are formed respectively.
Which is correct choice for (X) and (Y) ?
(A) (X) liberates iodine from soluble iodides like KI
(B) (Y) on heating liberates SO_3 only
(C) (X) forms bluish white precipitate with sodium hydroxide which redissolves in excess of sodium hydroxide.
(D) (Y) on reaction with potassium ferricyanide gives brown precipitate.

7. $FeCr_2O_4 + Na_2CO_3 + O_2 \xrightarrow{\text{Fusion}} [X] \xrightarrow[H_2O]{H^+} [Y] \xrightarrow[H_2O_2]{H^+} [Z]$
Which of the following statement is true for the compounds [X], [Y] and [Z] ?
(A) In all three compounds, the chromium is in + 6 oxidation state.
(B) [Z] is a deep blue–violet coloured compound which decomposes rapidly in aqueous solution into Cr^{3+} and dioxygen.
(C) Saturated solution of [Y] gives bright orange compound, chromic anhydride, with cold and concentrated H_2SO_4.
(D) All of these.

Section-2 : (One or More than one options correct Type)
This section contains 5 multipole choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

8. Select the correct statement(s) with respect to oxides and oxoanions of transition metals.
(A) Among oxides of chromium, CrO is basic, Cr_2O_3 is amphoteric and CrO_3 is acidic.
(B) No higher oxides of iron above Fe_2O_3 are found.
(C)Ti,V,Cr and Mn form oxides MO and their correct increasing order of acidic character is MnO<CrO<VO<TiO.
(D) Vandium(V) oxide does not react with acids but reacts with alkalies only.

9. Fenton's reagent is X + H_2O_2. X combines readily with Y and H_2O to form crystals of Mohr salt. X can be made in laboratory from Kipp's waste. When Kipp's waste is heated in the presence of O_2 and water, Z is also produced along with X. The reaction of X with $KMnO_4$ in the presence of H_2SO_4 also gives Z. Identify the correct match.
(A) X = $FeSO_4$ (B) X = $Fe_2(SO_4)_3$ (C) Y = $(NH_4)_2SO_4$ (D) Z = $FeSO_4$

10. Cuprous chloride can be prepared :
(A) by passing SO_2 through the solution containing $CuSO_4$ and NaCl.
(B) by heating excess of copper with concentrated HCl in presence of a little $KClO_3$.
(C) by boiling copper sulphate solution with excess of copper turnings in presence of hydrochloric acid.
(D) by dissolving cupric oxide or copper carbonate in concentrated HCl.

11. Potassium manganate (K_2MnO_4) is formed when :
(A) potassium permanganate reacts with formaldehyde in acidic medium.
(B) manganese dioxide is fused with potassium hydroxide in air.
(C) manganese hydroxide reacts with K_2O_2 in alkaline medium.
(D) potassium permanganate is heated at 750K.

12. Select the incorrect statement(s) :
(A) In K_2MnO_4 and CrO_2Cl_2, the central transition metals/ions have same oxidation state.
(B) Both sodium and potassium dichromate can be used as primary standard in volumetric estimations.
(C) Potassium dichromate on strong heating evolves oxygen gas and forms green powder.
(D) Potassium permanganate on heating with solid KOH evolves oxygen gas and forms a black powder.

Section-3 : (One Integer Value Correct Type.)

This section contains 6 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

13. How many of the following are coloured or paramagnetic or coloured and paramagnetic both.
NO_2, $Cu^{+1,}$ O_2, O_3, Hg_2^{+2}, Cd^{+2}, Al, C(graphite), Sc^{+3}

14. How many of the following ions have spin maganetic moment more than four B.M.
Ti^{3+}, Cu^{+}, Ni^{2+}, Fe^{3+}, Mn^{2+}, Co^{2+}

15. In how many of the following reactions, colored precipitate is obtained ?

(a) $CuSO_4$ + NaOH(excess) $\longrightarrow$ (b) $CuCl_2$ + NH_3 (excess) $\longrightarrow$

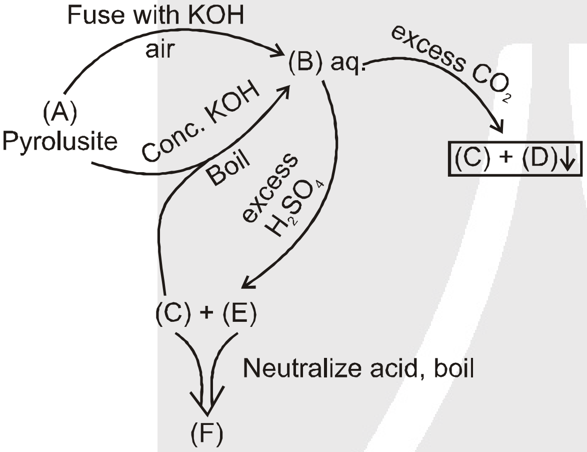
(c) $ZnSO_4$ + NaOH(excess) $\longrightarrow$ (d) $ZnSO_4$ + NH_3 (excess) $\longrightarrow$

(e) $FeSO_4$ + NaOH(excess) $\xrightarrow[\text{air}]{\text{in}}$ (f) $FeCl_3$ + NaOH(excess) $\longrightarrow$

(g) $CuSO_4$ + KI (excess) $\longrightarrow$ (h) $ZnSO_4$ + $NaHCO_3$ $\longrightarrow$

(i) $CuCl_2$ + $NaNO_3$ $\longrightarrow$

16.



In the above reaction scheme, MnO_2 appears more than once. From (A)–(F), How many of them contain MnO_2 ?

17. How many of the following compounds are diamagnetic and colored ?
K_2MnO_4, Cu_2Cl_2, Hg_2I_2, Ag_2S, HgI_2, K_2CrO_4, Cr_2O_3, AgCl, Ag_2O, $CuSO_4$, HgS, AgF, CrO_5, Mn_2O_7, MnO_2

18. How many of given statements are true for lanthanums ?
(1) The common oxidation state of all lanthanides is +3.
(2) All lantanides belongs to group III of modern periodic table.
(3) All lanthanides belongs to seventh period of periodic table.
(4) The radius for all lanthanides cations(M^{+3}) decrease from Ce^{+3} to Lu^{+3}.
(5) The basic character of hydroxide increases on moving from $Ce(OH)_3$ to $Lu(OH)_3$.
(6) All lanthanides are metals.
(7) The reducing power of lanthanides decreases from Ce to Lu.
(8) Lanthanides reacts with cold water to liberate H_2.

SECTION-4 : Comprehension Type (Only One options correct)

This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D)

Paragraph for Questions 19 to 21

(i) A powdered substance (A) on treatment with fusion mixture gives a green coloured compound (B).
(ii) The solution of (B) in boiling water on acidification with dilute H_2SO_4 gives a pink coloured compound (C) and brown colour compound (D).
(iii) The aqueous solution of (A) on treatment with NaOH and Br_2–water gives the compound (D).

(iv) A solution of (D) in concentrated HNO_3 on treatment with lead peroxide at boiling temperature produced a compound (E) which was of the same colour at that of (C).

(v) A solution of (A) on treatment with a solution of barium chloride gave a white precipitate of compound (F) which was insoluble in concentrated HNO_3 and concentrated HCl.

19. Which of the following is true for compound (C) ?
(A) It oxidises ammonia to nitrogen dioxide in neutral medium.
(B) It's pink colour is due to d-d transition.
(C) It can be oxidised by ozone.
(D) It is obtained by alkaline fusion of pyrolusite followed by electrolytic oxidation.

20 The oxidation state of central metal ions of (A), (B) and (C) compounds are respectively :
(A) +II , + VI and + VII (B) +II , + VI and + VI (C) +II , + VII and + VII (D) +VI , + VII and + VII

21. Consider the following statements ;
(I) anions of both (B) and (C) are diamagnetic and have tetrahedral geometry.
(II) anions of both (B) and (C) are paramagnetic and have tetrahedral geometry.
(III) anion of (B) is paramagnetic and that of (C) is diamagnetic but both have tetrahedral geometry.
(IV) green coloured compound (B) in a neutral or acidic medium disproportionates to give (C) and (D).
of these select the correct one from the codes given :
(A) I and III only (B) II and III only (C) II and IV only (D) III and IV only

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SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

---

22. Match the reactions in **Column I** with the types of products / the use of products in **Column II**.

Column - I	**Column - II**
(P)  + AgBr(s) $\rightarrow$	(1) Turn bull's blue pigment
(Q) $BaCl_2 + K_2Cr_2O_7 + H_2SO_4 \rightarrow$	(2) Rinmann's green pigment
(R) $FeSO_4 + K_3[Fe(CN)_6] \rightarrow$	(3) Chromyl chloride test
(S) $ZnO + Co(NO_3)_2 \xrightarrow{\Delta}$	(4) Photography

Code :

	P	Q	R	S		P	Q	R	S
(A)	1	3	2	4	(B)	3	2	4	1
(C)	4	3	1	2	(D)	4	1	2	3

Practice Test-2 ((IIT-JEE (ADVANCED Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.										
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.										
Que.	**21**	**22**								
Ans.										

APSP Answers

PART – I

1.	(1)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(4)
6.	(3)	**7.**	(2)	**8.**	(2)	**9.**	(3)	**10.**	(4)
11.	(2)	**12.**	(4)	**13.**	(4)	**14.**	(4)	**15.**	(2)
16.	(2)	**17.**	(4)	**18.**	(1)	**19.**	(1)	**20.**	(2)
21.	(3)	**22.**	(3)	**23.**	(4)	**24.**	(4)	**25.**	(4)
26.	(4)	**27.**	(4)	**28.**	(4)	**29.**	(1)	**30.**	(1)

PART - II

1.	(C)	**2.**	(B)	**3.**	(A)	**4.**	(C)	**5.**	(C)
6.	(B)	**7.**	(B)	**8.**	(D)	**9.**	(D)	**10.**	(D)
11.	(C)	**12.**	(A)	**13.**	(C)	**14.**	(D)	**15.**	(A)
16.	(C)	**17.**	(C)	**18.**	(B)	**19.**	(B)	**20.**	(D)
21.	(D)	**22.**	(B)	**23.**	(B)	**24.**	(A)	**25.**	(C)
26.	(C)	**27.**	(C)	**28.**	(B)	**29.**	(A)	**30.**	(A)
31.	(C)	**32.**	(B)	**33.**	(C)	**34.**	(B)	**35.**	(C)

PART - III

1. This is because Pt^{4+} is more stable than Ni^{4+} as the sum of four ionisation energies of Pt is less than those of Ni.

2. When a particular oxidation state becomes less stable relative to other oxidation states, one lower, one higher. It is said to undergo disproportionation,
e.g., $3Mn^{VI}O_4^{2-} + 4H^+ \longrightarrow 2Mn^{VII}O_4^- + Mn^{IV}O_2 + 2H_2O$
Mn (VI) is unstable relative to Mn (VII) and Mn (IV).

3. Because most of the transition metals have negative oxidation potential and lie above hydrogen in electrochemical series.

4. Mn^{2+} has maximum number of unpaired electrons i.e. $3d^5$.

5. The transition metals form reaction intermediates due to the presence of vacant orbitals or their tendency to form variable oxidation states. These intermediates give reaction paths of lower activation energy and, therefore, increase the rate of the reaction. These reaction intermediates readily decompose yielding the products and regenerating the original substance.

6. Transition metals form a large number of alloys. The transition metals are quite similar in size and, therefore, the atoms of one metal can substitute the atoms of other metal in its crystal lattice. Thus, on cooling a mixture solution of two or more transition metals, solid alloys are formed.

7. (i) $CuSO_4 + 4NH_4OH \longrightarrow [Cu(NH_3)_4]\,SO_4$ (blue colour complex) + $4H_2O$
(ii) $CuSO_4 + 2KI \longrightarrow Cu\,I_2 + K_2SO_4$
$2CuI_2 \longrightarrow Cu_2I_2$ (white) + I_2 (violet vapours)

8. White precipitate of $Ag_2S_2O_3$ is obtained which turns yellow, brown and finally black on keeping.
$2AgNO_3 + Na_2S_2O_3 \longrightarrow Ag_2S_2O_3 \downarrow$ (white) + $2NaNO_3$
$Ag_2S_2O_3 + H_2O \longrightarrow Ag_2S \downarrow$ (black) H_2SO_4

9. $3Ag + 4HNO_3 \longrightarrow 3AgNO_3 + NO + 2H_2O$

10. (a) $3FeSO_4 + 2K_3[Fe(CN)_6] \longrightarrow Fe_3[Fe(CN)_6]_2 + 3K_2SO_4$
(b) $Fe_2O_3 + Na_2CO_3 \longrightarrow 2NaFeO_2 + CO_2$
(c) $Fe(III) + 3NH_4SCN \longrightarrow [Fe(SCN)_3] + 3NH_4^+$
(d) $ZnO + CoO \longrightarrow CoZnO_2$ (Rinmann's green)

11.	(C)	**12.**	(D)	**13.**	(C)	**14.**	(A)	**15.**	(C)
16.	(D)	**17.**	(C)	**18.**	(B)	**19.**	(B)	**20.**	(C)
21.	(B)	**22.**	(C)	**23.**	(A)	**24.**	(A)	**25.**	(D)
26.	(D)	**27.**	(B)	**28.**	(A)	**29.**	(D)	**30.**	(C)
31.	6	**32.**	4 (I, ii, iii, iv)	**33.**	4	**34.**	8	**35.**	11
36.	(ACD)	**37.**	(ABD)	**38.**	(ABCD)	**39.**	(AD)	**40.**	(ABC)

PART - IV

1.	(D)	**2.**	(B)	**3.**	(A)	**4.**	(B)	**5.**	(A)
6.	(A)	**7.**	(D)	**8.**	(AB)	**9.**	(AC)	**10.**	(ABC)
11.	(BCD)	**12.**	(BD)	**13.**	5	**14.**	2	**15.**	3
16.	3	**17.**	9	**18.**	6	**19.**	(D)	**20**	(A)
21.	(D)	**22.**	(C)						

APSP Solutions

PART - I

1. (1) Electron configuration of V is [Ar] $3d^3\ 4s^2$ and thus maximum 5 electrons participate in bonding.
(2) Electron configuration of Cr is [Ar] $3d^5\ 4s^1$ and thus maximum 6 electrons participate in bonding.
(3) Electron configuration of Co is [Ar] $3d^7\ 4s^2$. In octahedral splitting in presence of ligands, half filled t_{2g}^6 has higher CFSE and thus +3 oxidation state is most stable.
(4) Electron configuration of Sc is [Ar] $3d^1\ 4s^2$ and thus maximum 3 electrons participate in bonding.

2. Transition metal oxide with highest oxidation states is most acidic in character because of the very less difference in the values of electronegativity between Mn^{7+} and O^{2-}, and the decreasing order of acidic character is $\overset{+7}{Mn_2O_7} > \overset{+4}{MnO_2} > \overset{+3}{Mn_2O_3} > \overset{+2}{MnO}$.

3. First ionisation energies of 3d-series (first transition series) increase with increase in atomic number due to (1) increase in nuclear charge (2) decrease in atomic size.

4. (i) Valence shell electron configuration of Ti^{4+} is $3d^{10}\ 4s^0$. As there is no unpaired electrons for d–d transition, the solution of ions will be colourless.
(ii) Valence shell electron configuration of Cu^+ is $3d^{10}\ 4s^0$. As all electrons are paired, there is no d–d transition, so the solution of ions will be colourless.
(iii) Valence shell electron configuration of Co^{3+} is $3d^6\ 4s^0$. As there are 4 unpaired electrons, there is d–d transition of electron, so the solution of ions will be coloured.
(iv) Valence shell electron configuration of Fe^{2+} is $3d^6\ 4s^0$. As there are 4 unpaired electrons, there is d–d transition of electron, so the solution of ions will be coloured.

5. (1) Valence shell electron configuration of Co^{3+} is $3d^6\,4s^0$. So has 4 unpaired electrons.
(2) Valence shell electron configuration of Fe^{3+} is $3d^5\,4s^0$. So has 5 unpaired electrons.
(3) Valence shell electron configuration of Cr^{2+} is $3d^4\,4s^0$. So has 4 unpaired electrons.
(4) Valence shell electron configuration of V^{3+} is $3d^2\,4s^0$. So has 2 unpaired electrons.
It has least number of unpaired electrons, so it has least magnetic moment.

6. If a non-metal occupies interstitial sites of a metal, the metal becomes less malleable. This is because the non-metal atom forms covalent bonds with metal atoms and covalent bond is rigid and directional.

7. (1) Oxidation state of iron is +3 but it can exceed to a maximum of +6. Oxidation state of cobalt is +3 but it can exceed to a maximum of +4.
(2) Highest oxidation state of Cr in CrO_2Cl_2 is + 6 and highest oxidation state of Mn in MnO_4^- is + 7.
(3) Oxidation state of titanium is +2 but it can exceed to a maximum of +4. Oxidation state of Mn is +4 but it can exceed to a maximum of +7.
(4) Oxidation state of cobalt is +3 but it can exceed to a maximum of +4. Oxidation state of Mn is +7 which is its highest oxidation state.

9. (3) $FeCl_3$ exists as Fe_2Cl_6 (a dimer) in vapour state.The solution is acidic due to the formation of HCl and brown due to the formation of $Fe(OH)_3$.

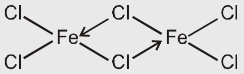
$$FeCl_3 + 3H_2O \rightarrow Fe(OH)_3\ (\text{Brown}) + 3HCl$$

11. $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

12. $2Cu(\text{hot}) + O_2(g) \rightarrow 2CuO$.

13. It is a white powder which becomes yellow on heating due to change in the structure of lattice (due to cation excess defect) but again turns white on cooling.

14. $2FeCl_3 \longrightarrow$



(gas)

15. SO_2 and SO_3
$FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2\uparrow + SO_3\uparrow + O_2\uparrow$
The acidic gases produced are SO_2 and SO_3

16. $ZnCl_2 \,.\, 2H_2O \xrightarrow{\Delta} Zn(OH)Cl + HCl + H_2O$.

17. $2KMnO_4 \xrightarrow{750K} K_2MnO_4 + MnO_2 + O_2$.

18. $MnO_4^- + 3e^- + 2H_2O \longrightarrow MnO_2 + 4OH^-$ (neutral / weak alkaline medium)

19. $2KMnO_4 + 3H_2SO_4 \longrightarrow 2KHSO_4 + (MnO_3)_2SO_4 + 2H_2O$
$(MnO_3)_2SO_4 + H_2O \longrightarrow Mn_2O_7 + H_2SO_4$
$Mn_2O_7 \xrightarrow{\Delta} 2MnO_2 + \frac{3}{2}O_2$

20. (1) $Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$.
(2) In acidic solution, actually chromate is converted to dichromate.

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

(3) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$.
(4) $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$.

21. Quinol developer (a reducing agent) reduces AgBr to Ag.
$2AgBr^*(s) + 2OH^-\,(aq) + C_6H_5(OH)_2\,(aq) \longrightarrow 2Ag(s) + 2H_2O + C_6H_4O_2\,(aq) + 2Br^-\,(aq)$
Where AgBr* represents a molecules of AgBr exposed to light.

22. $CO_2 + H_2O \longrightarrow H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$; $CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-}$ (orange red) $+ H_2O$

23. In FeO_4^{2-}, Fe is in very high oxidation state (+6) and hence unstable, so it gets reduced to Fe^{3+} liberating O_2. CrO_4^{2-} in acidic medium converted to $Cr_2O_7^{2-}$.

24. AgCl $\xrightarrow{h\nu}$ Ag↓ + 1/2 Cl_2
(black)
If souce of light is removed, we get back Agce and blacknem due to Ag removed.

25. Ag + dilute $HNO_3 \rightarrow AgNO_3$ + NO (g)
Ag + conc. $HNO_3 \rightarrow AgNO_3 + NO_2$ (g)
Ag + conc. $H_2SO_4 \rightarrow Ag_2SO_4 + SO_2$ (g)

26. $2K_2MnO_4 + Cl_2 \rightarrow 2KMnO_4 + 2KCl$; $2K_2MnO_4 + H_2O + O_3 \rightarrow 2KMnO_4 + 2KOH + O_2$
$3K_2MnO_4 + 2CO_2 \rightarrow 2KMnO_4 + MnO_2 + 2K_2CO_3$

27. Aqueous solution of $CuSO_4$ is acidic in nature, it converts some $CuCrO_4$ to $CuCr_2O_7$.

28. In Co^{+3} ion, electronic configuration $|Ar|_{18}\ 3d^6 4s^0$. For octahedral complex 4 unpaired electron get paired and in configuration become $t_{2g}^6\ eg^0$ and hybridization d^2sp^3.
Os has maximam VIII oxidation state.

29. After uranium all elements are transuranic element.

PART - III

12. The atomic radii of the transition metals lie in-between those of s- and p-block elements. In the begining, the atomic radius decreases with the increase in nuclear charge (as atomic number increases), whereas the shielding effect of d-electrons is small and orbital electrons are added to the penultimate d–subshell rather than to the outer shell of the atom.

13. The lesser number of oxidation states in the begining of series can be due to the presence of smaller number of electrons to lose or share (Sc, Ti). On the other hand, at the extreme right hand side end (Cu, Zn), lesser number of oxidation state is due to large number of d electrons so that only a fewer orbitals are available in which the electron can share with other for higher valence.

14. $Cr^{3+} + e^- \longrightarrow Cr^{2+}$, $E^\ominus = -0.41$ volts and $Mn^{3+} + e^- \longrightarrow Mn^{2+}$, $E^\ominus = +1.51$ volts
This shows that Cr^{2+} is unstable and has a tendency to acquire more stable Cr^{3+} state by acting as a reducing agent. On the other hand Mn^{3+} is unstable and is reduced to more stable Mn^{2+} state.

15. $3.87 = \sqrt{n\ \ (n+2)}$; n = number of unpaired electrons. So n = 3.

16. In Ti^{4+}, Cu^+ and Zn^{2+}, all have electrons paired so all are diamagnetic. Cr^{3+} with electron configuration $[Ar]^{18}\ 3d^3$ has three unpaired electrons. So it undergoes d-d transition of electrons in presence of ligands according to CFT and thus it is coloured.

17. Cu^{2+} ion ($3d^9$) absorbs red light from the visible region, for the promotion of 3d electrons, the ions reflect blue light and appear blue.

18. $5AgNO_3 + 3I_2$ (excess) $+ 3H_2O \longrightarrow HIO_3 + 5AgI + 5HNO_3$.

19. $Fe^{3+} + [Fe(CN)_6]^{4-} \longrightarrow Fe_4[Fe(CN)_6]_3$ (prussian blue)

20. Hydrated $FeCl_3$ exists as $[Fe(H_2O)_4Cl_2]Cl.H_2O$; it is factual.

21.

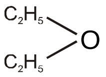
(A) V^{2+}	violet	(B) V^{3+}	green
(C) VO^{2+}	blue	(D) VO_2^+	yellow

23. $2CuCl_2 + SO_2 + 2H_2O \longrightarrow 2CuCl + 2HCl + H_2SO_4$.

24. German silver contains Cu = 60% ; Zn = 20% ; and Ni = 20%.

25. $Cu + H_2O + CO_2 \longrightarrow CuCO_3.Cu(OH)_2$.
Green crust of basic copper carbonate is formed.

26. Dissolves in both ether and water forming solvated/ hydrated monomeric species,



$(C_2H_5)_2O \longrightarrow FeCl_3$ $[Fe(H_2O)_4Cl_2]Cl\ .\ 2H_2O$

solvated $FeCl_3$ hydrated $FeCl_3$

27. $5AgNO_3 + 3I_2$ (excess) $+ 3H_2O \longrightarrow HIO_3 + 5AgI + 5HNO_3$.

28. $ZnO + CoO \longrightarrow ZnOCoO$ (Rinmanns green)

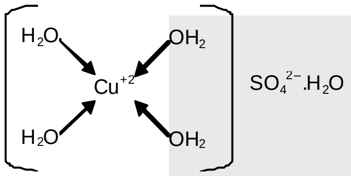
29. $4FeSO_4 + 2H_2O + O_2 \longrightarrow 4Fe(OH).SO_4$ (basic ferric sulphate)

30. **Gd^{3+} :** [Xe] $4f^7$

31. $FeC_2O_4 \xrightarrow{\Delta} FeO + CO + CO_2$
Number of diamagnetic products = 2 (CO & CO_2) = x ; (CO & CO_2)
and Number of unpaired electrons in paramagnetic products FeO = 4 ($3d^6$) = y ; ($3d^6$)

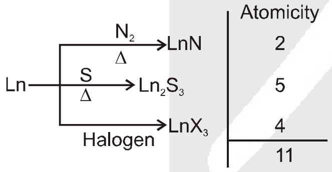
32. $AgCl$ + aq. $NH_3 \longrightarrow [Ag(NH_3)_2]^+Cl^-$
$AgCl + KCN \longrightarrow K^+[Ag(CN)_2]^-$
$AgCl + Na_2S_2O_3$ (excess) $\longrightarrow Na_3[Ag(S_2O_3)_2]$
$AgCl$ + conc. $HCl \longrightarrow [AgCl_2]^-$
$AgCl$ + aq. $NaOH \longrightarrow Ag_2O\downarrow$

33.



34.
1. $FeSO_4 + (NH_4)_2SO_4 + 6H_2O \longrightarrow FeSO_4.(NH_4)_2\,SO_4.6H_2O$ (Mohr salt)
2. Green vitriol is $FeSO_4.7H_2O$ & its anhydrous form ($FeSO_4$) is white.
3. $2\,\overset{(+2)}{Fe}\,\overset{(+6)}{S}O_4 \xrightarrow{\Delta} \overset{(+3)}{Fe_2}\,O_3 + \overset{(+4)}{S}O_4 + SO_3$ (Redox)
4. Fact (Fenton's reagent = $FeSO_4 + H_2O_2$)
5. $\underset{(aq)}{FeSO_4} + \underset{(aq)}{6KCN} \longrightarrow K_4\,[Fe(CN)_6]$
6. White vitriol is $ZnSO_4.7H_2O$ & Blue vitriol is $CuSO_4.5\,H_2O$
7. Due to its oxidation to Fe^{3+}.
8. $Fe^{2+} + 2H_2O \rightleftharpoons Fe(OH)_2\downarrow + 2H^+$ (acidic solution)
9. Only SO_2 can turn acidified $K_2Cr_2O_7$ solution green.

35.



36. Cr^{3+} is most stable because in aqueous solution it has higher CFSE on account of half filled t^3_{2g} energy level of 3d orbitals in octahedral spliting.

38. $$FeSO_4.7H_2O\ (\text{Green vitriol}) \xrightarrow{\Delta} \underset{\text{Basic oxide}}{Fe_2O_3} + \underset{\text{Neutral oxide}}{H_2O} + \underbrace{\underset{\text{Reducing agent}}{SO_2} + SO_3}_{\text{acidic oxide}}$$

39. (A) Anhydrous ; (B) Hydrated ; (C) Hydrated ; (D) Anhydrous

40. (A) $2CuSO_4 + 2NaCl + 2H_2O + SO_2 \longrightarrow Cu_2Cl_2 + Na_2SO_4 + 2H_2SO_4$

(B) $Cu + HCl + [O] \longrightarrow CuCl_2 + H_2O$; $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(C) $CuSO_4 + 2HCl \longrightarrow CuCl_2 + H_2SO_4$; $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(D) $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$; Cu_2Cl_2 is not formed.

PART - IV

1. $_{22}Ti = 3d^2 4s^2$, $Ti^{2+} = 3d^2$; $_{23}V = 3d^3 4s^2$, $V^{3+} = 3d^2$.
$_{24}Cr = 3d^5 4s^1$, $Cr^{4+} = 3d^2$; $_{25}Mn = 3d^5 4s^2$, $Mn^{5+} = 3d^2$.

2. (A) Oxidation state of iron is +3 but it can exceed to a maximum of +6. Oxidation state of cobalt is +3 but it can exceed to a maximum of +4.
(B) Highest oxidation state of Cr in CrO_2Cl_2 is + 6 and highest oxidation state of Mn in MnO_4^- is + 7.
(C) Oxidation state of titanium is +2 but it can exceed to a maximum of +4. Oxidation state of Mn is +4 but it can exceed to a maximum of +7.
(D) Oxidation state of cobalt is +3 but it can exceed to a maximum of +4. Oxidation state of Mn is +7 which is its highest oxidation state.

3. It is an amphoteric in nature and it reacts with alkalies as well as with acids to give $V_4O_9^{2-}$ and VO^{2+} respectively.

4. **S_1 :** It is because Mn^{2+} has $3d^5$ configuration which has extra stability.
S_2 : Not titanium but Copper, because with +1 oxidation state an extra stable configuration, $3d^{10}$ results.
S_3 : It is not stable as it undergoes disproportionation ; $2Cu^+(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$. The E° value for this is favourable.
S_4 : Much larger third ionisation energy of Mn (where the required change is d^5 to d^4) is mainly responsible for this.

5. (A) $CuSO_4$ reacts with KI to give Cu_2I_2 (white precipitate) but not with KCl.
(B) $2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2\uparrow$.
(C) Fehling's solution mainly contains $CuSO_4$ and NaOH. When warmed with glucose (with – CHO group) gives red precipitate of Cu_2O. Glucose reduces the Cu^{2+} to Cu_2O (red).
(D) $CuSO_4$ on heating gives CuO.

$$CuSO_4 \xrightarrow{1000K} CuO + SO_2 + \frac{1}{2} O_2.$$

6. $CuFeS_2 + 4O_2 \xrightarrow{\Delta} CuSO_4\,(s) + FeSO_4\,(s)$
(A) $CuSO_4 + 4KI \longrightarrow Cu_2I_2 + I_2 + 2K_2SO_4$
(B) $2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$
(C) $CuSO_4 + 2NaOH \rightarrow Na_2SO_4 + Cu(OH)_2\downarrow$ (insoluble in excess NaOH)
(D) $Fe^{2+} + 2K_3\,[Fe(CN)_6] \longrightarrow Fe_3\,[Fe(CN)_6]_2$ (deep blue)

7. $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \xrightarrow{\text{Fusion}} \overset{+VI}{Na_2CrO_4} \xrightarrow[H_2O]{H^+} \overset{+VI}{Na_2Cr_2O_7} \xrightarrow[H_2O_2]{H^+} \overset{+VI}{Cr}O(O_2)_2$ (deep blue violet) $\xrightarrow{H_2O} O_2 + H_2O + Cr^{3+}$.
(X) (Y) (Z)
$Na_2Cr_2O_7 + H_2SO_4 \rightarrow 2CrO_3$ (bright orange/red- chromic anhydride) $+ Na_2SO_4 + H_2O$.

8. (A) and (B) statements are correct. These statements are factual.
(C) Along the period, the electronegativity of metals decreases and therefore the difference of electronegativities between metal and oxygen decreases. Hence, the acidic character increases, so the correct order is TiO < VO < CrO < MnO.
(D) V_2O_5 reacts with alkalies as well as acids to give VO_4^{3-} and VO_2^+ respectively.

9. Fenton's reagent is $FeSO_4 + H_2O$
$FeSO_4 + (NH_4)_2\,SO_4 + 6\,H_2O \longrightarrow FeSO_4\,.\,(NH_4)_2SO_4\,.\,6\,H_2O$
(Y)
$FeS_2 + O_2 + H_2O \longrightarrow FeSO_4 + Fe_2\,(SO_4)_3 + H_2SO_4$
(Z)
$FeSO_4 + KMnO_4 + H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + MnSO_4 + K_2SO_4 + H_2O$
(X) (Z).

10. (A) $2CuSO_4 + 2NaCl + 2H_2O + SO_2 \longrightarrow Cu_2Cl_2 + Na_2SO_4 + 2H_2SO_4$

(B) $Cu + HCl + [O] \longrightarrow CuCl_2 + H_2O$; $CuCl_2 + Cu \longrightarrow Cu_2\,Cl_2$

(C) $CuSO_4 + 2HCl \;\; CuCl_2 + H_2SO_4$; $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(D) $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$; Cu_2Cl_2 is not formed.

11. (A) $5HCHO + MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5HCOOH + 3H_2O$.
(B) $4KOH + 2MnO_2$ (manganese dioxide) $+ O_2 \rightarrow 2K_2MnO_4$ (potassium mangnate) $+ 2H_2O$.
(C) $Mn(OH)_2 + O_2^{2-} \rightarrow MnO_4^{2-}$ (mangnate) $+ 2OH^-$.
(D) $2KMnO_4 \xrightarrow{750K} K_2MnO_4$ (potassium mangnate) $+ MnO_2 + O_2$.

12. (A) In both compounds central metals have + 6 oxidation states.
MnO_4^{2-} ; $x + 4(-2) = -2$, So, $x = 6$. ; CrO_2Cl_2 ; $x + 2(-2) + 2(-1) = 0$, So, $x = 6$.
(B) Sodium dichromate is $Na_2Cr_2O_7.2H_2O$, so it can not be weighed correctly for the preparation of standard solution.

(C) $2K_2Cr_2O_7 \xrightarrow{\Delta} 2K_2CrO_4 + Cr_2O_3$ (green) $+ 3/2\ O_2$.

(D) $4KMnO_4 + 4KOH \xrightarrow{\Delta} 4K_2MnO_4$ (green) $+ 2H_2O + O_2$

13.

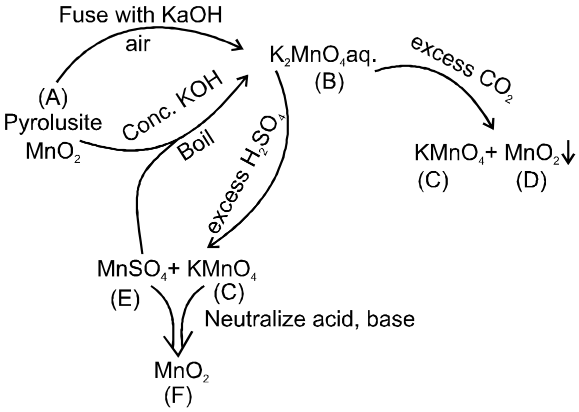
*NO_2	Coloured & paramagnetic
Cu^{+1}	Colourless & diamagnetic
*O_2	Colourless & paramagnetic
O_3	Coloured & diamagnetic
Hg_2^{+2}	Colourless & diamagnetic
Cd^{+2}	Colourless & diamagnetic
*Al	Coloured & paramagnetic
*C(graphite)	Coloured & diamagnetic
Sc^{+3}	Colourless and diamagnetic

14.

Ions	Outer configuration	Number of unpaired electron (s)	$m_s = \sqrt{n(n+2)}$
Ti^{3+}	$3d^1$	1	$\sqrt{2}$
Cu^+	$3d^{10}$	0	0
Ni^{2+}	$3d^8$	2	$\sqrt{8}$
Fe^{3+}	$3d^5$	5	$\sqrt{35}$
Mn^{2+}	$3d^5$	5	$\sqrt{35}$
Co^{2+}	$3d^7$	3	$\sqrt{15}$

15. (a) $Cu(OH)_2\downarrow$ (blue)
(b) $[Cu(NH_3)_4]^{2+}$ (aq.)
(c) $Na_2[Zn(OH)_4]$ (aq.)
(d) $[Zn(NH_3)_4]^{2+}$ (aq.)
(e) $Fe(OH)_2\downarrow$ (greenish)
(f) $Fe(OH)_3\downarrow$ (reddish brown)
(g) CuI (white)
(h) $ZnCO_3\downarrow$ (white)
(i) $Cu(NO_3)_2\downarrow$ (aq.)

16.



17. Paramagetic – K_2MnO_4, Cr_2O_3, AgO, $CuSO_4$, MnO_2

Diamagnetic and Colored –Hg_2I_2, Ag_2S, HgI_2, K_2CrO_4

(black) (Red) (yellow)

Ag_2O (brown), H_gS (black), A_gF (yellow)

CrO_5 (deep blue), Mn_2O_7 (dark red oil)

18. (1) All lanthanides exhibits +3 O.N. but few also exhibit +2 and +4 O.N. (2) Correct

(3) Incorrect as all belongs to 6th period. (4) True due to lanthanide contraction.

(5) Incorrect as basicing decreases from $Ce(OH)_3$ to $Lu(OH)_3$ becomes of fazans rule.

(6) Correct

(7) Correct

(8) All lanthanides have –ve S.R.P. hence all releases hydrogen.

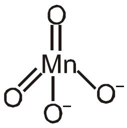
19. (A) $2MnO_4^- + 2NH_3 \longrightarrow 2MnO_2 + N_2 + 2OH^- + 2H_2O$

(B) It is due to charge transfer from O^{2-} to empty d-orbital of Mn(VII).

(C) MnO_4^- is in highest oxidation state i.e. +VII and thus can not be oxidised further.

(D) $MnO_2 + OH \longrightarrow MnO_2^{2-} \xrightarrow{[e^-]} MnO_4^-$

20 (A) In $MnSO_4$, = +II ; (B) MnO_4^{2-} = +VI ; (C) MnO_4^- = +VII

21. 

(III) Electron configuration of Mn(VI) in MnO_4^{2-} is $[Ar]^{18}\ 3d^1$. So it is paramagnetic and tetrahedral. Electron configuration of Mn(VII) in MnO_4^- is $[Ar]^{18}\ 3d^0$. So it is diamagnetic and tetrahedral.

(IV) $3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$. **(Solution : 19 to 21)**

A = $MnSO_4$, B = K_2MnO_4 , C = $KMnO_4$, D = MnO_2 , E = $HMnO_4$, F = $BaSO_4$.

$MnSO_4(A) + 2KNO_3 + K_2CO_3 \longrightarrow K_2MnO_4(B) + 2KNO_2 + 2CO_2 + K_2SO_4$

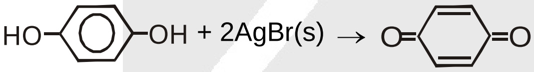
$2MnO_4^{2-} + 4H^+ \longrightarrow MnO_4^-\ (C) + MnO_2 + 2H_2O$.

$Mn^{2+} + 2OH^- \longrightarrow Mn(OH)_2\downarrow$; $Mn(OH)_2 + Br_2 + 2NaOH \longrightarrow MnO_2(D) + 2NaBr + 2H_2O$

$MnO_2 + 4HNO_3 \longrightarrow 2Mn(NO_3)_2 + 2H_2O + O_2$

$Mn(NO_3)_2 + 5PbO_2 + 6HNO_3\ \ 2HMnO_4(E) + 5Pb(NO_3)_2 + 2H_2O$

$SO_4^{2-} + Ba^{2+} \longrightarrow BaSO_4\downarrow$ (white) (F)

22. (P) 

+ 2HBr + 2Ag(black silver particles)

Hydroquinone acts as developer

(Q) $BaCl_2 + K_2Cr_2O_7 + 3H_2SO_4 \rightarrow K_2SO_4 + 2CrO_2Cl_2 + 2BaSO_4 + 3H_2O$

(R) $FeSO_4 + K_3[Fe(CN)_6] \rightarrow KFe^{II}\ [Fe^{III}(CN)_6] + K_2SO_4$

(S) $Co(NO_3)_2 + ZnO \xrightarrow{\Delta} CoZnO_2$ or CoO. ZnO