1. Which of the following options are correct for the reaction?

$2[Au(CN)_2]^-\left(aq\right) + Zn\left(s\right) \rightarrow 2\,Au\left(s\right) + [Zn(CN)_4]^{2-}\left(aq\right)$

A. Redox reaction

B. Displacement reaction

C. Decomposition reaction

D. Combination reaction

Choose the correct answer from the options given below:

[2023 (06 Apr Shift 1)]

(1) A only

(2) A and D only

(3) A and B only

(4) C and D only

2. Strong reducing and oxidizing agents among the following , respectively, are

[2023 (06 Apr Shift 1)]

(1) Ce^{3+} and Ce^{4+}

(2) Ce^{4+} and Tb^{4+}

(3) $Ce^{4+}$and Eu^{2+}

(4) Eu^{2+} and Ce^{4+}

3. During the reaction of permanganate with thiosulphate, the change in oxidation of manganese occurs by value of 3. Identify which of the below medium will favour the reaction.

[2023 (06 Apr Shift 2)]

(1) Both aqueous acidic and neutral

(2) Aqueous neutral

(3) Both aqueous acidic and faintly alkaline

(4) Aqueous acidic

4. The volume of 0.02 M aqueous HBr required to neutralize 10.0 mL of 0.01 M aqueous $Ba(OH)_2$ is (Assume complete neutralization)

[2023 (06 Apr Shift 2)]

(1) 2.5 mL

(2) 5.0 mL

(3) 10.0 mL

(4) 7.5 mL

5. $2\,IO_3^- + xI^- + 12H^+ \rightarrow 6I_2 + 6H_2$ What is the value of x?

[2023 (08 Apr Shift 1)]

(1) 2

(2) 12

(3) 10

(4) 6

6. Given below are two statements:

Statement I: In redox titration, the indicators used are sensitive to change in pH of the solution.

Statement II: In acid-base titration, the indicators used are sensitive to change in oxidation potential.

In the light of the above statements, choose the **most appropriate** answer from the options given below

[2023 (08 Apr Shift 2)]

(1) **Statement I** is correct but **Statement II** is incorrect

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is incorrect but **Statement II** is correct

(4) Both **Statement I** and **Statement II** are correct

7. In alkaline medium, the reduction of permanganate anion involves a gain of _____ electrons.

[2023 (10 Apr Shift 2)]

8. $KMnO_4$ is titrated with ferrous ammonium sulphate hexahydrate in presence of dilute H_2SO_4. Number of water molecules produced for 2 molecules of $KMnO_4$ is _____

[2023 (13 Apr Shift 1)]

9. 20 mL of calcium hydroxide was consumed when it was reacted with 10 mL of unknown solution of H_2SO_4. Also 20 mL standard solution of 0.5 M HCl containing 2 drops of phenolphthalein was titrated with calcium hydroxide, the mixture showed pink colour when burette displayed the value of 35.5 mL whereas the burette showed 25.5 mL initially. The concentration of H_2SO_4 is _____M. (Nearest integer)
[2023 (13 Apr Shift 1)]

10. See the following chemical reaction:
$Cr_2O_7^{2-} + XH^+ + 6Fe^{2+} \rightarrow YCr^{3+} + 6Fe^{3+} + ZH_2O$
The sum of X, Y and Z is
[2023 (13 Apr Shift 2)]

11. The total change in the oxidation state of manganese involved in the reaction of $KMnO_4$ and potassium iodide in the acidic medium is _____.
[2023 (15 Apr Shift 1)]

ANSWER KEYS

1. (3)	**2.** (4)	**3.** (2)	**4.** (3)	**5.** (3)	**6.** (2)	**7.** (3)	**8.** (68)
9. (1)	**10.** (23)	**11.** (5)					

1. (3)

Gold is then extracted from this complex by displacement technique by using a more electropositive zinc metal.

In this method, zinc (Zn) acts as a reducing agent and it reduces Au^{+} to Au and itself gets oxidized from Zn to Zn^{+2} ions which combine with CN^{-} ions and form soluble complex, sodium tetracyanozincate (II).

$2[Au(CN)_2]^{-}(aq) + Zn(s) \rightarrow 2\,Au(s) + [Zn(CN)_4]^{2-}(aq)$

2. (4)

$E_{Ce^{4+}/Ce^{3+}} = +1.74\ V$

Lanthanoids have $+3$ oxidation state as stable oxidation state. Hence, in their $+4$ oxidation state, they act as an oxidising agents and $+2$ oxidation state, they act as reducing agents.

3. (2)

In neutral or weakly alkaline solution oxidation state of Mn changes by 3 unit. The reaction between permanganate and thiosulfate is a redox reaction, in which permanganate acts as an oxidizing agent and thiosulfate acts as a reducing agent.

$MnO_4^{\ominus} + S_2O_3^{-2} \rightarrow MnO_2 + SO_4^{-2}$

This ionic mechanism is favoured in neutral aqueous medium.

4. (3)

The balanced chemical equation for the reaction between HBr and $Ba(OH)_2$ is:

$2HBr + Ba(OH)_2 \rightarrow BaBr_2 + 2H_2O$

From this equation, we can see that 2 moles of HBr react with 1 mole of $Ba(OH)_2$.

Equal equivalents will react.

Number of equivalents = Normality $\times$ Volume

So,

$N_1V_1 = N_2V_2$

$0.02 \times V_1 = 0.02 \times 10$

$V_1 = 10\ ml$

5. (3)

Assign the oxidation number to all the elements in the reaction,

$2\overset{+5}{I}O_3^{-} + x\overset{-1}{I^{-}} + 12\overset{+1}{H^{+}} \rightarrow 6\overset{0}{I_2} + 6H_2O$

$2\,IO_3^{-} + 10e^{-} \rightarrow I_2$

$[2I^{-} \rightarrow I_2 + 2e^{-}] \times 5$

$2\,IO_3^{-} + 10I^{-} + 12H^{+} \rightarrow 6I_2 + 6H_2O$

Therefore, the value of $x = 10$ in the reaction.

6. (2)

In redox titrations, the indicator changes color when the titration reaches the equivalence point, which corresponds to the point at which the reducing agent has been completely oxidized or the oxidizing agent has been completely reduced. So these are used to change in oxidation potential and not change in pH.

In acid base titration, the indicators are sensitive to change in pH and not change in oxidation potential.

$\therefore$ Both the statements are incorrect.

7. (3)

In Faintly alkaline medium potassium permanganate changes to manganese dioxide in its oxidising action.

$MnO_4^{-} + 2H_2O + 3e^{-} \rightarrow MnO_2 + 4\,OH^{-}$

The oxidation state of manganese in MnO_4^{-} is +7 and in MnO_2 is +4.

Hence, it transfers 3 electrons during the oxidising action in alkaline medium.

8. (68)

By balancing redox reaction:

$10[FeSO_4.(NH_4)_2SO_4.6H_2O] + 2KMNO_4 + 8H_2SO_4 \rightarrow 5Fe_2(SO_4)_3 + 2MnSO_4 + 10(NH_4)_2SO_4 + K_2SO_4 + 68H_2O$

$8H^+ + MnO_4^- + 5Fe^{+2} \longrightarrow 5Fe^{+3} + Mn^{+2} + 4H_2O$

For 2 moles of MnO_4^-, 8 moles of H_2O. are released 5 moles of Mohr's salt contain 30 moles of H_2O. So, 10 moles of Mohr's salt contain 60 moles of H_2O So, total moles of H_2O produced$= 68$

9. (1)

Titration principle is $N_1V_1 = N_2V_2$

N = Normality

V = Volume of solution

$M_1V_1n_1 = M_2V_2n_2$

M = molarity

n = Valence factor of acid or base

As pink colour is obtained on consumption of 10 ml of $Ca(OH)_2$, we have

$20 \times 0.5 \times 1 = 10 \times M \times 2$

Molarity of $Ca\left(OH\right)_2 = \frac{10}{20} = \frac{1}{2}M$

Also, moles of $Ca(OH)_2 =$ mm of H_2SO_4

$\frac{1}{2} \times 20 = 10 \times M$

Molarity of $H_2SO_4 = 1M$

10. (23)

The given equation can be balanced using ion-electron method as shown below.

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ -oxidation Half reaction

$6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$ -Reduction Half reaction

The overall reaction is

$6Fe^{2+} + 14H^+ + Cr_2O_7^{2-} \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

The values $X = 14, Y = 2$ and $Z = 7$

$(X + Y + Z) = 14 + 2 + 7$

$= 23$

11. (5)

In the reaction of $KMnO_4$ and potassium iodide (KI) in an acidic medium, the $KMnO_4$ acts as an oxidizing agent, and the iodide ions (I^-) in KI act as reducing agents.

$KMnO_4 + KI + H^+ \longrightarrow Mn^{+2} + I_2 + H_2O$

In $KMnO_4$, the oxidation state of manganese is $+7$, which is the highest possible oxidation state for manganese in this compound.

In the final product, $MnSO_4$, the oxidation state of manganese is $+2$.

Therefore, the total change in the oxidation state of manganese is:

$+7$ (initial) $-$ $+2$ (final) $= 5$

Hence the change in O. S. of Mn is (5).