JEE Advanced

Single Correct Answer Type

1. The oxidation number of C in CH_2O is
   a. −2 **b.** +2 **c.** 0 **d.** +4
   (IIT-JEE 1983)

2. The brown ring complex compound is formed as $[Fe(H_2O)_5NO]SO_4$. The oxidation state of Fe is
   a. 1 **b.** 2 **c.** 3 **d.** 0
   (IIT-JEE 1987)

3. The equivalent weight of $MnSO_4$ is half its molecular weight when it is converted to
   a. Mn_2O_3 **b.** MnO_2 **c.** MnO_4^- **d.** MnO_4^{2-}
   (IIT-JEE 1988)

4. The oxidation number of phosphorus in $Ba(H_2PO_2)_2$ is:
   a. +3 **b.** +2 **c.** +1 **d.** −1
   (IIT-JEE 1990)

5. The oxidation states of the most electronegative elements in the products of the reaction between BaO_2 and H_2SO_4 are

a. 0 and –1 **b.** –1 and –2
c. –2 and 0 **d.** –2 and +1

(IIT-JEE 1991)

6. For the redox reaction
$xMnO_4^{\ominus} + yC_2O_4^{2-} + zH^{\ominus} \longrightarrow Mn^{2+} + CO_2 + H_2O$
the coefficient x, y, and z are

a. 2, 5, 16, **b.** 16, 5, 2 **c.** 5, 16, 2 **d.** 2, 16, 5

(IIT-JEE 1992)

7. In the compound $YBa_2Cu_3O_7$ which shows superconductivity, what is the oxidation state of Cu? Assume that the rare earth element yttrium is in its usual +3 oxidation state.

a. $+\frac{7}{3}$ **b.** $-\frac{7}{3}$ **c.** $\frac{5}{3}$ **d.** $-\frac{5}{3}$

(IIT-JEE 1994)

8. In the reaction
$3Br_2 + 6CO_3^{2-} + 3H_2O \longrightarrow 5Br^{\ominus} + BrO_3^{\ominus} + 6HCO_3^{\ominus}$

a. Br_2 is oxidised and CO_3^{2-} is reduced.
b. Br_2 is reduced and H_2O is oxidised.
c. Br_2 is neither reduced nor oxidised.
d. Br_2 is both reduced and oxidised. **(IIT-JEE 1996)**

9. The number of moles of $KMnO_4$ that will be needed to react with 1 mol of sulphite ion in acidic solution is

a. $\frac{2}{5}$ **b.** $\frac{3}{5}$ **c.** $\frac{4}{5}$ **d.** 1

(IIT-JEE 1997)

10. The oxidation number of S in S_8, S_2F_2, H_2S respectively, are:

a. 0, +1 and –2 **b.** +2, +1 and –2
c. 0, +1 and +2 **d.** –2, +1 and –2

(IIT-JEE 1999)

11. Among the following, identify the species with an atom in +6 oxidation state.

a. $MnO_4^{\ominus}$ **b.** $[Cr(CN)_6]^{3-}$
c. $[Ni\,F_6]^{2-}$ **d.** CrO_2Cl_2

(IIT-JEE 2000)

12. In the neutralisation of $Na_2S_2O_3$ using $K_2Cr_2O_7$ by iodometry, the equivalent weight of $K_2Cr_2O_7$ is

a. $M/2$ **b.** $M/6$ **c.** $M/3$ **d.** M

(IIT-JEE 2001)

13. The reaction
$3ClO^{\ominus}(aq) \longrightarrow ClO_3(aq) + 2Cl^{\ominus}(aq)$ is an example

a. Oxidation **b.** Reduction
c. Disproportionation **d.** Decomposition

(IIT-JEE 2001)

14. Maximum oxidation state is present in

a. CrO_2Cl_2 and $MnO_4^{\ominus}$
b. MnO_2
c. $[Fe(CN)_6]^{3-}$ and $[Co(CN)_6]^{3-}$
d. MnO **(IIT-JEE 2004)**

15. Which of the following will not be oxidised by O_3?

a. KI **b.** $FeSO_4$ **c.** $KMnO_4$ **d.** K_2MnO_4

(IIT-JEE 2005)

16. 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 is haematite and II, III in magnetite

(IIT-JEE 2011)

Multiple Correct Answers Type

1. For the reaction
$I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$
The correct statement(s) in the balanced equation is/are

a. Stoichiometric coefficient of HSO_4^- is 6
b. Iodide is oxidized
c. Sulphur is reduced
d. H_2O is one of the products

(JEE Advanced 2014)

Matching Column Type

1. Match the reactions in column I with the nature of the reactions/type of the products listed in column II.

(IIT-JEE 2007)

Column I	Column II
a. $O_2^{\ominus} \rightarrow O_2 + O_2^{2-}$	**p.** Redox reaction
b. $CrO_4^{2-} + H^{\oplus} \rightarrow$	**q.** One of the products has trigonal planar structure
c. $MnO_4^{\ominus} + NO_2^{\ominus} + H^{\oplus} \rightarrow$	**r.** Dimeric bridged tetrahedral metal ion
d. $NO_3^{\ominus} + H_2SO_4 + Fe^{\oplus} \rightarrow$	**s.** Disproportionation

IntegerAnswer Type

1. Among the following , the number of elements showing only one non-zero oxidation state is O, Cl, F, N, P, Sn, Tl, Na, Ti **(IIT-JEE 2010)**
2. The difference in the oxidation numbers of two types of sulphur atoms in $Na_2S_4O_6$ is ..... **(IIT-JEE 2011)**

Subjective Type

1. **a.** Give the oxidation number (with sign) of the element underlined in the following equations.
   i. $K\underline{Cl}O_3 + 24HCl \longrightarrow 8\,KCl + 12\,H_2O + 9Cl_2 + 6\underline{Cl}O_2$
   ii. $3I_2 + 6NaOH \longrightarrow Na\underline{I}O_3 + 5Na\underline{I} + 3H_2O$
   b. Calculate equivalent weight of $Na_2S_2O_3 \cdot 5H_2O$ and $KBrO_3$ in the following reactions
   i. $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$
   ii. $BrO_3^- + 6H^+ + 6e^- \longrightarrow Br^- + 3H_2O$

(IIT-JEE, 1979)

2. Complete and balance the following equations

i. $KNO_3 + FeSO_4 + H_2SO_{4\,(Conc)} \longrightarrow$

ii. $H_2S + K_2CrO_4 + H_2SO_4 \longrightarrow$

iii. $KI + H_2SO_4\,(Conc) \xrightarrow{\Delta}$

iv. $Mg_3N_2 + H_2O \longrightarrow$

v. $Al + KMnO_4 + H_2SO_4 \longrightarrow$

(IIT-JEE, 1980)

3. Balance the following equations.

i. $Cu_2O + H^+ + NO_3^- = Cu^{2+} + NO + H_2O$

ii. $K_4[Fe(CN)_6] + H_2SO_4 + H_2O = K_2SO_4 + FeSO_4 + (NH_4)_2SO_4 + CO$

iii. $C_2H_5OH + I_2OH^- = CHI_3 + HCO_3^- + I^- + H_2O$

(IIT-JEE, 1981)

4. Complete and balance the following reactions:

i. $Zn + NO_3^- = Zn^{2+} + NH_4^+$

ii. $Cr_2O_7^{2-} + C_2H_4O = C_2H_4O_2 + Cr^{3+}$

iii. $HNO_3 + HCl = NO + Cl_2$

iv. $Ce^{3+} + S_2O_8^{2-} = SO_4^{2-} + Ce^{4+}$

v. $Cl_2 + OH^- = Cl^- + ClO^-$ (IIT-JEE, 1983)

5. a Complete and balance the following reactions :

i. $Mn^{2+} + PbO_2 \longrightarrow MnO_4^- + H_2O$

ii. $S + OH^- \longrightarrow S^{2-} + S_2O_3^{2-}$

iii. $ClO_3^- + I^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^-$

iv. $Ag^+ + AsH_3 \longrightarrow H_3AsO_3 + H^+$

(IIT-JEE,1986)

6. Arrange the following in increasing oxidation number of iodine.

I_2, HI, HIO_4, ICl **(IIT-JEE, 1986)**

Answer Key

JEE Advanced

Single Correct Answer Type

1. c.	**2.** a.	**3.** b.	**4.** c.	**5.** b.
6. a.	**7.** a.	**8.** d.	**9.** a.	**10.** a.
11. d.	**12.** b.	**13.** c.	**14.** a.	**15.** c.
16. d.				

Multiple Correct Answers Type

1. a., b., d.

Matching Column Type

1. (a) → (p), (s); (b) → (r); (c) → (p), (q); (d) → (p)

Integer Answer Type

1. (2) **2.** (5)

Hints And Solutions

JEE Advaced

Single Correct Answer Type

1. c. CH_2O: $x + 2 - 2 = 0 \Rightarrow x = 0$

2. a. $\left[\overset{+1}{Fe}(\overset{0}{H_2O})_5\ \overset{+1}{NO}\right]^{2+} SO_4^{2-}$

Oxidation state of Fe = +1

3. b. $\overset{+2}{Mn}SO_4^{2-} \longrightarrow \overset{+4}{Mn}O_2 + 2e^-$

$\therefore$ Equivalent weight = $M/2$

4. c. $Ba(H_2PO_2)_2$

Let the oxidation number of P is x

$\therefore \quad (+2) + (+1 \times 4) + (x + 2) + (-2 \times 4) = 0$

or $\quad 2 + 4 + 2x - 8 = 0$

or $\quad 3x - 2 = 0$

or $\quad 2x = +2$

$\therefore \quad x = \dfrac{2}{2} - = +1$

5. b. $BaO_2 + H_2SO_4$ (dil) $\longrightarrow BaSO_4 + H_2O_2$

Oxidation state of O in $H_2O_2 = -1$

Oxidation state of O in $BaSO_4 = -2$

6. a. $MnO_4^- \longrightarrow Mn^{2+} + 5e^-$ (1)

$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$ (2)

Multiply eqn. (1) $\times$ 2 + eqn. (2) $\times$ 5

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

$\therefore \quad x$, y and z are 2, 5, 16

7. a. $(YBa_2Cu_3O_7)$

$3 + (2 \times 2) + 3x - 14 = 0$

$\therefore \quad x = +\dfrac{7}{3}$

8. d. It is a disproportionation reaction in which Br_2 is both reduced and oxidised. The oxidation state of C in both CO_3^{2-} and $HCO_3^{\ominus}$ does not change.

9. a. In acidic medium

$MnO_4^- + 5e^- \longrightarrow Mn^{2+}$ (1)

$SO_3^{2-} - \longrightarrow SO_4^{2-} + 2e^-$ (2)

eqn. (1) $\times$ 2 + eqn. (2) $\times$ 5 we get

$2MnO_4^{2-} + 5SO_3^{2-} \longrightarrow$

$\Rightarrow$ 2 moles 5 moles

$\dfrac{2}{5}$ moles 1 mole

10. a. Oxidation no. of S in $S_8 = 0$

Oxidation no. of S in S_2F_2

$S_2F_2 \Rightarrow 2x + 2x \times -1 = 0 \Rightarrow 2x = 2 \Rightarrow x = 1$

Oxidation no. of S in H_2S

$H_2S \Rightarrow 2 \times 1 + x = 0 \qquad x = -2$

11. d.

a. MNO_4^- $\quad x + 4x - 2 = -1$ $\quad x = 7$

b. $[Cr(CN)_6]^{3-}$ $\quad x + 6x - 1 = -3$ $\quad x = 3$

c. $[NiF6]^{2-}$ $\quad x + 6x - 1 = -2$ $\quad x = 4$

d. CrO_2Cl_2 $\quad x + 2x - 2 + 2x - 1 = 0$ $\quad x = 6$

12. b. $Cr_2O_7^{2-} + 6e^- \longrightarrow 2Cr^{3+}$ (1)

$2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2e^-$ (2)

eqn. (2) $\times$ 3 + eqn. (1)

$6S_2O_3^{2-} + Cr_2O_7^{2-} \longrightarrow$

Equivalent of $Cr_2O_7^{2-} \longrightarrow \dfrac{M}{6}$

13. c

reduction

$3ClO^- \longrightarrow ClO_3^- + 2Cl^-$

+1 +5 −1

oxidation

Hence, disproportionation.

14. a.

a. $\overset{+6}{Cr}\ \overset{-2\times2}{O_2}\ \overset{-1\times2}{Cl_2}$ and $\overset{+7}{Mn}O_4^{\ominus}$ (+6 and +7) **b.** $\overset{+4}{Mn}\ \overset{-2\times2}{O_2}$

c. $\left[\overset{+3}{Fe}\ \overset{-1\times6}{(CN)_6}\right]$ and $\left[\overset{+3}{Co}\ \overset{-1\times6}{(CN)_6}\right]^{3-}$ **d.** $\overset{+2}{Mn}\ \overset{-2}{O}$

15. c. Since in $KMnO_4$, the highest oxidation state of Mn is +7, so it will not be oxidised.

16. d. Haematite: $Fe_2O_3 \Rightarrow$ Oxidation state of Fe = III

Magnetite: $Fe_3O_4 \equiv FeO.\ Fe_2O_3$

Oxidation state of Fe = II, III

Multiple Correct Answers Type

1. a., b., d.

$I^-_{-1} \longrightarrow I^2_0$ Oxidization Step I: $2I \rightarrow I_2$ Step II: Balance e^{-1}s $2I^- \longrightarrow I_2 + 2e^-$ (i)	$\underset{+5}{ClO_3^-} \longrightarrow \underset{-1}{Cl^-}$ Reduction Step I: $ClO_3^- + 6e^- \longrightarrow Cl^-$ Step II: Charge −7 −1 L.H.S R.H.S. Balance change by H^+ as reaction is in acidic medium $ClO_3^- + 6e^- + 6H^+ \rightarrow Cl^-$
Step III: Balance charges L.H.S R.H.S −2 −2 Equation balanced	Step III: Balance oxygen by adding H_2O 0 = 3 0 = 0 L.H.S R.H.S $ClO_3^- + 6e^- + 6H^+ \rightarrow Cl^- + 3H_2O$ (ii)

Multiply eqn. (i) $\times$ 3 and add eqn. (ii)

$6I^- \rightarrow 3I_2 + 6e^-$

$\underline{ClO_3^- + 6e^- + 6H^+ \rightarrow Cl^- + 3H_2O}$

$ClO_3^- + 6I^- + 6H^+ \rightarrow 3I_2 + Cl^- + 3H_2O$

$ClO_3^- + 6I^- + 6H_2SO_4 \rightarrow 3I_2 + Cl^- + 3H_2O + 6HSO_4^-$

Matching Column Type

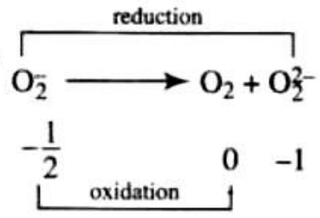
(a → p, s; b → r; c → p, q; d → p)

1. **(a) → (p), (s)**

$O_2^{\ominus} \longrightarrow O_2^0 + e^-$ (Oxidation) or

$e^- + O_2^{\ominus} \longrightarrow O_2^{2-}$ (Reduction)

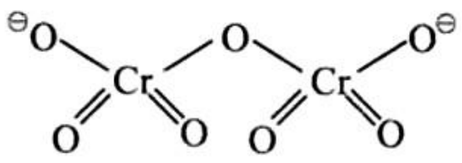
So redox and disproportionation.



(b) → (r)

$2\overset{+6}{Cr}O_4^{2-} + H^{\oplus} \longrightarrow \overset{+6}{Cr_2}O_7^{2-} + H_2O$ (no change in +6 oxidation state of Cr)

Structure is:



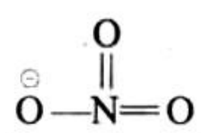
It is a dimeric bridged tetrahedral metal ion with sp^3 hybridisation at Cr.

(c) → (p), (q)

$[5e^- + MnO_4^{\ominus} \longrightarrow Mn^{2+}]$ (Reduction)

$[NO_2^{\ominus} \longrightarrow NO_3^{\ominus} + e^-]$ (Oxidation)

Structure of $NO_3^{\ominus}$:



[sp^2 hybridisation and hence trigonal planar in shape]

(d) → (p)

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ (Oxidation)

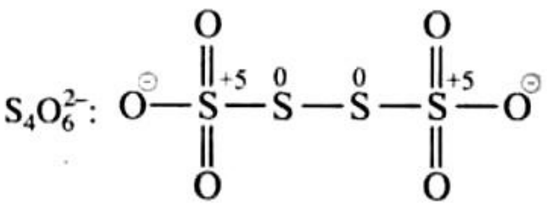
$3e^- + NO_3^{\ominus} \longrightarrow NO$ (Reduction)

$x = 5 \qquad x = 2$

Integer Answer Type

1. (2) Na, F show only one non-zero oxidation state.

2. (5) $S_4O_6^{2-}$:



So difference in oxidation numbers of two types of S = (5 – 0) = 5

Subjective Type

1. Sum of oxidation state of all atoms is compound is zero.

a. i. Let oxidation state of Cl in $KClO_3 = x$

$+1 + x + (-2 \times 3) = 0$

$\Rightarrow \quad x = +5$

Oxidation state of Cl in $Cl_2 = \mathbf{0}$

Let oxidation state of Cl in $ClO_2 = x$

$\therefore \quad x + (-2 \times 2) = 0$

$\Rightarrow \quad x = +4$

ii. Oxidation state of I in $I_2 = \mathbf{0}$

Let oxidation state of I in $NaIO_3 = x$

$+1 + x + (-2 \times 3) = 0 \Rightarrow x = +5$

Let oxidation state of I in NaI = x

$\therefore \quad +1 + x = 0 \Rightarrow x = -1$

b. i. Molecualr wt. of $Na_2S_2O_3 \cdot 5H_2O$

$= 23 \times 2 + 32 \times 2 + 16 \times 3 + 5 \times 18 = 248$

$\because$ Two $2S_2O_3^{2-}$ give up two e^- to form $S_4O_6^{2-}$

$\therefore$ One $S_2O_3^{2-}$ give up one e^- to form $S_4O_6^{2-}$

$$\text{Eq. wt.} = \frac{\text{Mol. wt.}}{\text{no. of } e^- \text{ involved in reaction}}$$

ii. Molecular weight of $KBrO_3 = 39 + 79.9 + 3 \times 6 = 166.9$

$$\text{Eq. wt.} = \frac{\text{Mol. wt.}}{\text{no. of } e^- \text{ involved in reaction}}$$

$$= \frac{166.9}{6} = 27.81$$

2. **i.** $2KNO_3 + 8FeSO_4 + 4H_2SO_{4(conc)} \longrightarrow 2(FeSO_4 \cdot NO) + K_2SO_4 + 3Fe_2(SO_4)_3 + 4H_2O$

ii. $3H_2S + 2K_2CrO_4 + 5H_2SO_4 \longrightarrow 2K_2SO_4 + Cr_2(SO_4)_3 + 3S + 8H_2O$

iii. $2KI + 2H_2SO_{4(conc)} \xrightarrow{\Delta} I_2 + SO_2 + K_2SO_4 + 2H_2O$

iv. $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$

v. Al is covered by layer of Al_2O_3

3. **i.** $Cu_2O + 2H^+ \longrightarrow 2Cu^{2+} + H_2O + 2e^-] \times 3$ (i)

$NO_3^- + 4H^+ + 3e^- \longrightarrow NO + 2H_2O] \times 2$ (ii)

$3CU_2O + 14H^+ + 2NO_3^- \longrightarrow 6Cu^{2+} + 2BO + 7H_2O$

ii. $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \longrightarrow 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$

iii. $C_2H_5OH + 4I_2 + 8OH^- \longrightarrow CHI_3 + HCO_3^- + 5I^- + 6H_2O$

4. Balance the atoms as well as charges by ion electron/oxidation number method.

While balancing the equations, both the charges and atoms must balance.

i. $4Zn + NO_3^- + 10H^+ \longrightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$

ii. $Cr_2O_7^{2-} + 3C_2H_4O + 8H^+ \longrightarrow 3C_2H_4O_2 + 2Cr^{3+} + 4H_2O$

iii. $2HNO_3 + 6HCl \longrightarrow 2NO + 3Cl_2 + 4H_2O$

iv. $2Ce^{3+} + S_2O_8^{2-} \longrightarrow 2SO_4^{2-} + 2Ce^{4+}$

v. $Cl_2 + 2OH^- \longrightarrow Cl^-ClO^- + H_2O$

5. Balance the atoms as well as charges by ion electron/oxidation number method.

While balancing the equations, both the charges and atoms must balance.

i. $2Mn^{2+} + 5PbO_2 + 4H^+ \longrightarrow 2MnO_4^- + 2H_2O + 5Pb^{2+}$

ii. $4S + 6OH^- \longrightarrow 2S^{2-} + S_2O_3^{2-} + 3H_2O$

iii. $ClO_3^- + 6I^- + 6H_2SO_4 \longrightarrow Cl^- + 6HSO_4^- + 3I_2 + 3H_2O$

iv. $6Ag^+ + AsH_3 + 3H_2O \longrightarrow 6Ag + H_3AsO_3 + 6H^+$

6. $HI < I_2$, $ICl < HIO_4$; O.N. of I in $I_2 = 0$, $HI = -1$, $ICl = +1$, $HIO_4 = +7$.