



Attempt all questions before checking the answer key. Balance both atoms and charge. Specify acidic or basic medium and identify oxidising/reducing agents.

A. Very short answers - 1 mark each

1. Define oxidation in terms of electron transfer.
2. Find oxidation number of Mn in KMnO_4 .
3. Find oxidation number of Cr in $\text{Cr}_2\text{O}_7^{2-}$.
4. What is a reducing agent?
5. Give one example of a disproportionation reaction.

B. Short answers / practice - 2 marks each

6. Find oxidation numbers of sulphur in H_2SO_4 , SO_2 and H_2S .
7. Identify oxidant and reductant in $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$.
8. Explain why H_2O_2 can act as both oxidising and reducing agent.
9. Distinguish oxidation number from an actual ionic charge, using a covalent molecule.
10. Show by oxidation numbers that $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$ is a redox reaction.
11. Find oxidation number of oxygen in H_2O_2 .
12. Find oxidation number of nitrogen in NH_4^+ .
13. Find oxidation number of sulphur in SO_4^{2-} .
14. Is oxidation possible without simultaneous reduction in an overall redox reaction?
15. Identify oxidising agent in $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$.
16. Find electrons gained when Fe^{3+} becomes Fe^{2+} .
17. Balance $\text{Al} + \text{Cu}^{2+} \rightarrow \text{Al}^{3+} + \text{Cu}$.
18. Find average oxidation number of sulphur in $\text{S}_2\text{O}_3^{2-}$.
19. Can fluorine have a positive oxidation number in ordinary compounds?
20. Identify oxidation and reduction in $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$.

C. Short answers - 3 marks each

21. Balance $\text{MnO}_4^- + \text{Fe}^{2+} \rightarrow \text{Mn}^{2+} + \text{Fe}^{3+}$ in acidic medium by half-reactions.
22. Balance $\text{Cr}_2\text{O}_7^{2-} + \text{I}^- \rightarrow \text{Cr}^{3+} + \text{I}_2$ in acidic medium.
23. Balance $\text{Cl}_2 + \text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$ in basic medium. Identify the atoms undergoing both changes.

24. Balance $\text{H}_2\text{O}_2 + \text{MnO}_4^- \rightarrow \text{O}_2 + \text{Mn}^{2+}$ in acidic medium and identify both agents.

25. Distinguish combination, decomposition, displacement and disproportionation redox reactions with one balanced example each.

D. Long answers - 5 marks each

26. Explain the ion-electron balancing method for acidic and basic media. Apply it to $\text{MnO}_4^- + \text{SO}_3^{2-} \rightarrow \text{MnO}_2 + \text{SO}_4^{2-}$ in basic medium.

27. Balance $\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} \rightarrow \text{Mn}^{2+} + \text{CO}_2$ in acidic medium. State electron change per species and calculate moles of oxalate required per mole of permanganate.

28. Balance $\text{Cr}_2\text{O}_7^{2-} + \text{Fe}^{2+} \rightarrow \text{Cr}^{3+} + \text{Fe}^{3+}$ in acidic medium. Determine moles of Fe^{2+} oxidised by 25 mL of 0.020 M dichromate solution.

29. Explain redox reactions as simultaneous electron-transfer processes. Write half-reactions for a Zn/Cu^{2+} reaction and describe electron flow, oxidation and reduction when the half-reactions occur in separate connected compartments.

30. Balance $\text{Cl}_2 + \text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$ and $\text{Cl}_2 + \text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}_3^- + \text{H}_2\text{O}$. Identify oxidised and reduced fractions of chlorine in each and explain why both are disproportionation reactions.

ANSWER KEY - Numerical / short answers

2) +7. 3) +6. 6) +6, +4, -2. 10) Cl +5 $\rightarrow$ -1; O -2 $\rightarrow$ 0. 11) -1. 12) -3. 13) +6. 14) No. 15) O_2 . 16) One electron per ion. 17) $2\text{Al} + 3\text{Cu}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Cu}$. 18) +2. 19) No; it is -1 in its compounds. 20) H: 0 $\rightarrow$ +1 oxidised; Cl: 0 $\rightarrow$ -1 reduced. 21) $\text{MnO}_4^- + 5\text{Fe}^{2+} + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 5\text{Fe}^{3+} + 4\text{H}_2\text{O}$. 22) $\text{Cr}_2\text{O}_7^{2-} + 6\text{I}^- + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 7\text{H}_2\text{O}$. 23) $\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$. 24) $2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{O}_2 + 8\text{H}_2\text{O}$. 26) $2\text{MnO}_4^- + 3\text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow 2\text{MnO}_2 + 3\text{SO}_4^{2-} + 2\text{OH}^-$. 27) $2\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$; 2.5 mol oxalate per mol permanganate. 28) $\text{Cr}_2\text{O}_7^{2-} + 6\text{Fe}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 6\text{Fe}^{3+} + 7\text{H}_2\text{O}$; 0.0030 mol Fe^{2+} . 30) Cold: $\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$, fractions oxidised/reduced = 1/2, 1/2. Hot: $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$, fractions = 1/6, 5/6.