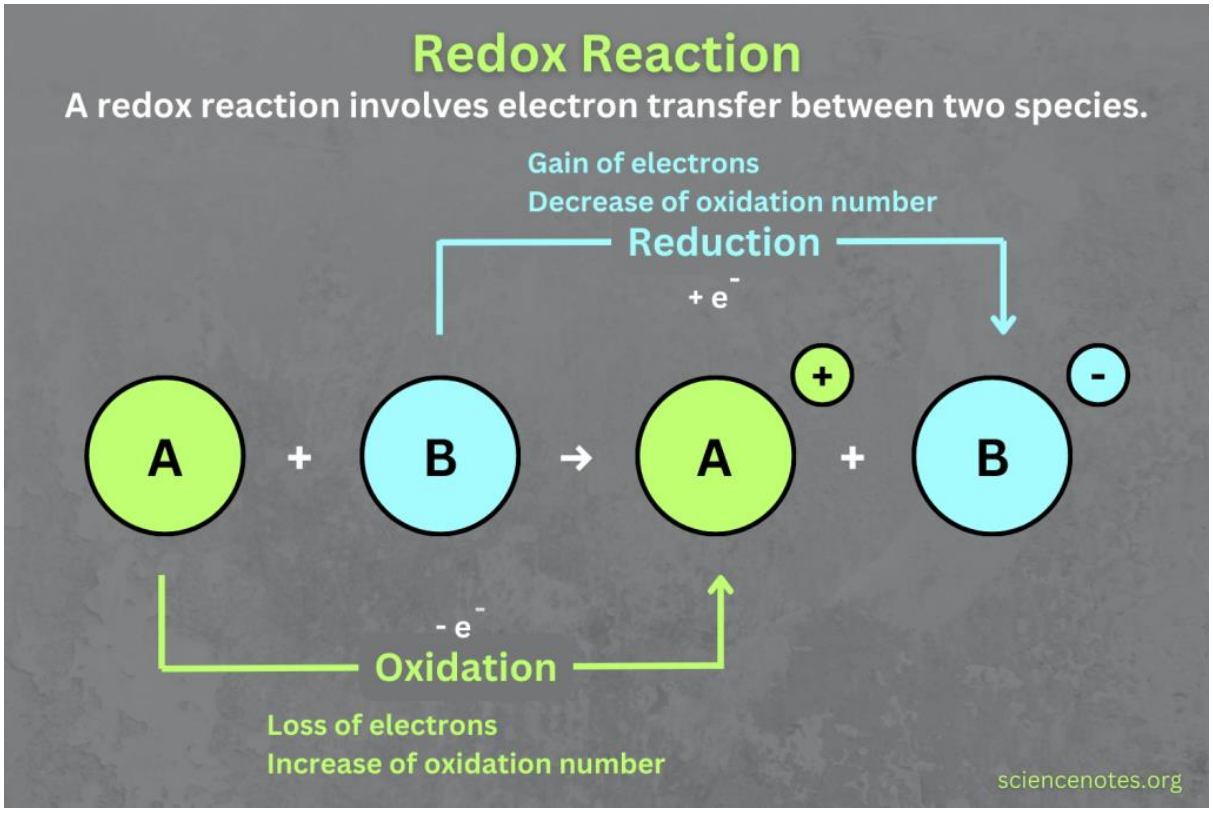
SNS COLLEGE OF PHARMACY AND HEALTH SCIENCES, COIMBATORE

CASE STUDY BASED PUZZLE

UNIT-IV: CONCEPTS OF OXIDATION AND REDUCTION (REDOX REACTIONS) AND TYPES OF REDOX TITRATIONS.

1. Forensic Detection of Poisoning with Cyanide.

In a suspected murder case, forensic experts analyze blood and tissue samples for cyanide poisoning. Cyanide inhibits cellular respiration by binding to iron in cytochrome oxidase, but detection often involves a redox-based test where cyanide is converted to cyanogen chloride and reacts with a reagent to form a colored complex. Oxidation is loss of electrons (increase in oxidation state), while reduction is gain of electrons (decrease in oxidation state). In many detection methods, a reducing agent helps liberate cyanide, followed by oxidation steps for visualization.

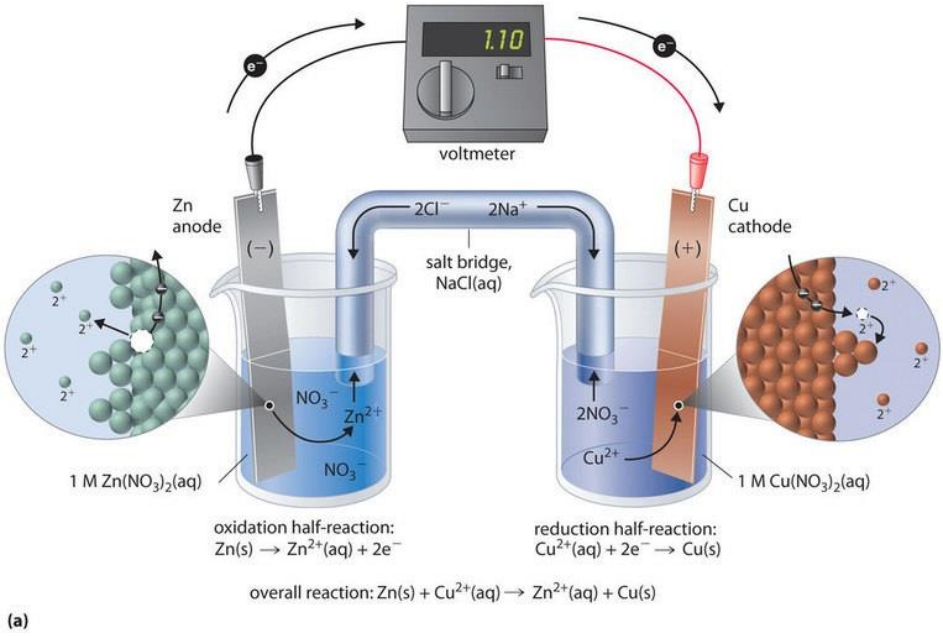


Puzzle Questions:

1. In the reaction $CN^- + Fe^{3+} \rightarrow Fe^{2+} + SCN^-$ (simplified), identify which species is oxidized and which is reduced. Explain using change in oxidation states.
2. If a sample turns deep red upon adding benzidine-pyridine reagent (indicating oxidation), but a control does not, what does this suggest about the presence of cyanide? Why are redox indicators preferred over simple pH tests in forensics?
3. Propose why cyanide acts as a poison by interfering with redox processes in the electron transport chain. Hypothesize how an antidote like hydroxocobalamin works via redox complexation.

2. Battery Design and Quality Control in Pharmaceutical Devices

A pharmaceutical company develops portable insulin pumps powered by zinc-carbon batteries. The battery uses a zinc anode and manganese dioxide cathode. During quality testing, they measure cell potential and discharge curves. In a galvanic cell, spontaneous redox reaction generates electricity: zinc is oxidized at anode, MnO_2 is reduced at cathode.

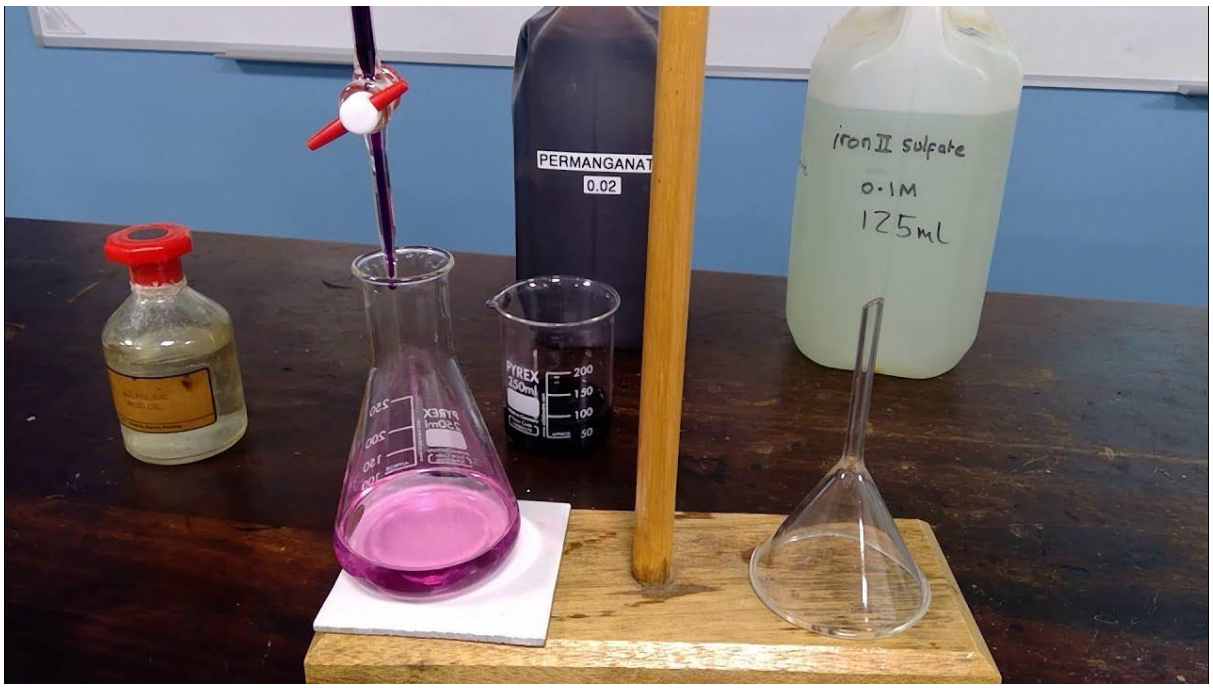


Puzzle Questions:

1. Write the half-reactions for Zn/Zn^{2+} and MnO_2/Mn_2O_3 in acidic medium. Explain why zinc is the anode (oxidized) based on standard reduction potentials.
2. If the cell potential drops rapidly in a faulty batch, calculate the theoretical voltage using $E°_{cell} = E°_{cathode} - E°_{anode}$ (assume $E° Zn^{2+}/Zn = -0.76$ V, $E° MnO_2/Mn^{2+} \approx +1.23$ V). What factors like salt bridge inefficiency affect it?
3. In scaling production, corrosion causes self-discharge. Suggest troubleshooting: adding inhibitors or changing electrolyte, and predict outcomes on shelf life.

3. Redox Titration for Assay of Vitamin C Tablets

In pharmaceutical quality control, analysts perform redox titration to determine ascorbic acid (vitamin C) content in tablets using iodine or 2,6-dichlorophenolindophenol (DCPIP). Ascorbic acid is oxidized to dehydroascorbic acid, reducing the titrant. The endpoint is sharp color change due to self-indicating nature.



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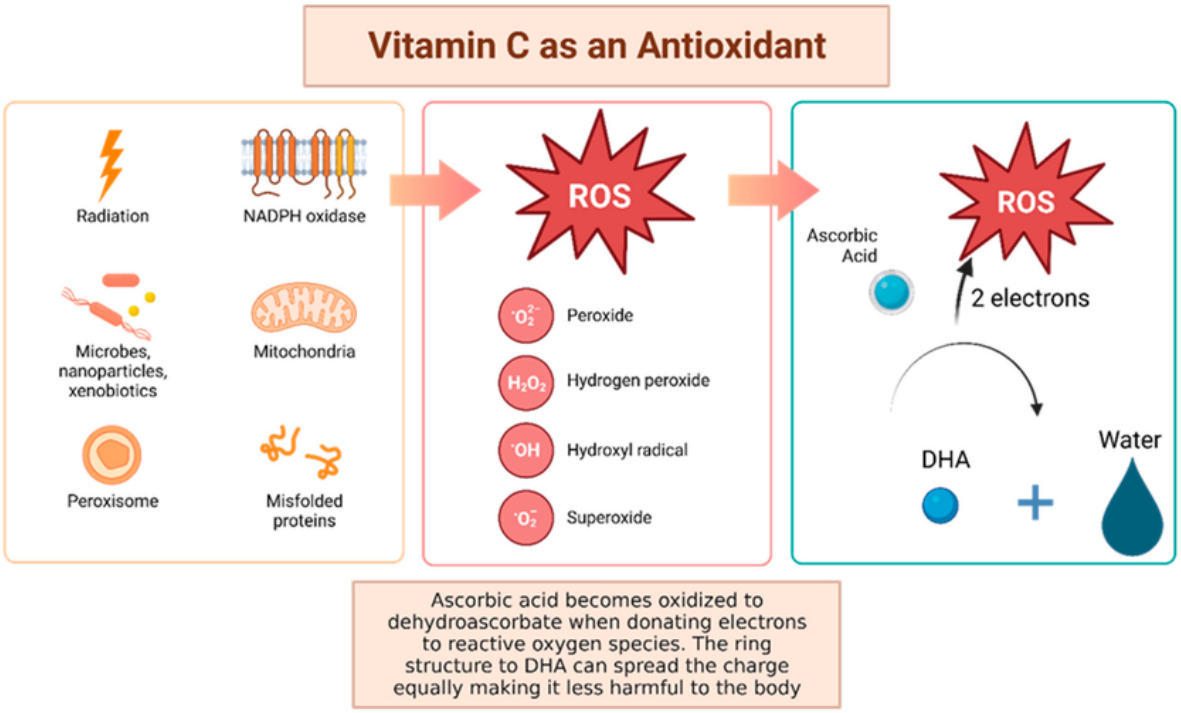

Puzzle Questions:

1. In the reaction $C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2I^- + 2H^+$, identify oxidation and reduction. Why does excess vitamin C decolorize blue DCPIP?
2. If 25 mL of 0.01 M iodine titrates a tablet extract, calculate mg of ascorbic acid (molar mass 176 g/mol) using n-factor = 2 for ascorbic acid.
3. Humidity causes premature oxidation and low assay results. Explain why air oxidation occurs and propose controls like inert atmosphere or stabilizers.