



Molten NaCl

Na^+ & Cl^- only.

**Products of
Electrolysis —
Who Actually Gets
Discharged?**



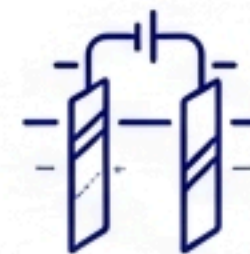
Aqueous NaCl

**Na^+ , Cl^- ,
 H^+ , & OH^-**



Material State

Is the electrolyte molten (pure) or an aqueous solution (water competes)?



Electrode Type

Is the electrode inert (Pt, Graphite) or active/attackable (Cu, Ag)?



Standard Potentials (E°)

Higher reduction potential wins at the cathode. Lower reduction potential wins at the anode.



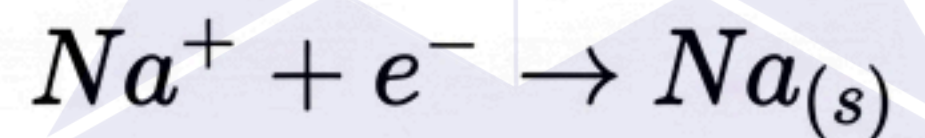
Overpotential (Kinetics)

Some thermodynamically feasible reactions are too slow and require extra voltage to proceed.

Molten NaCl: No Competition

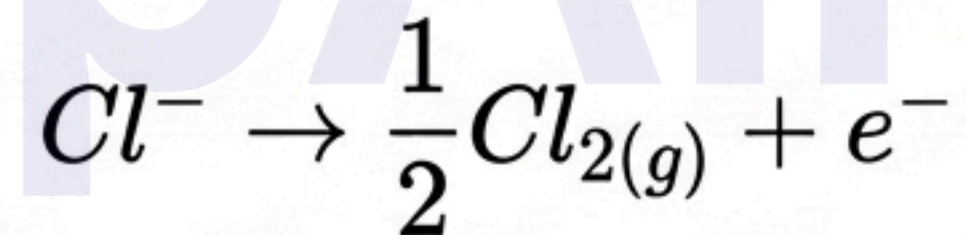
Only two ions exist in the melt. They have nowhere else to go.

REDUCTION AT CATHODE (NEGATIVE)



Sodium metal deposited.

OXIDATION AT ANODE (POSITIVE)



Chlorine gas evolved.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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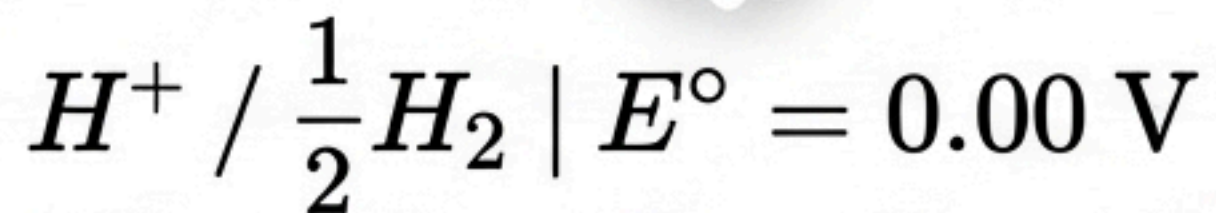


Aqueous NaCl: The Cathode Battle

Water introduces H^+ into the solution. Who gets reduced?



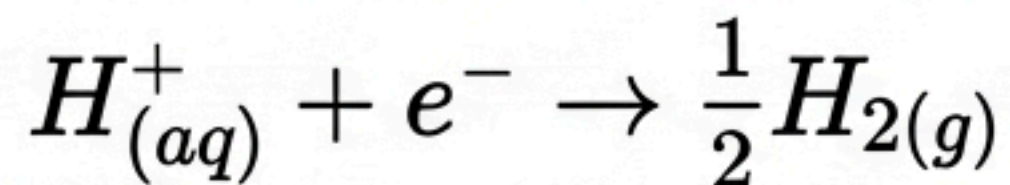
VS



Rule: The reaction with the higher (more positive) E° is preferred at the cathode.

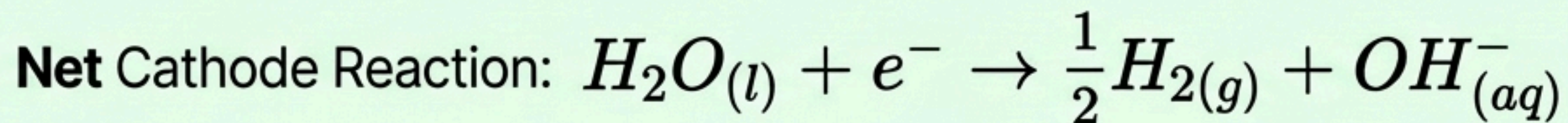
The True Source of Hydrogen

Step 1: The Preferred Reduction



+

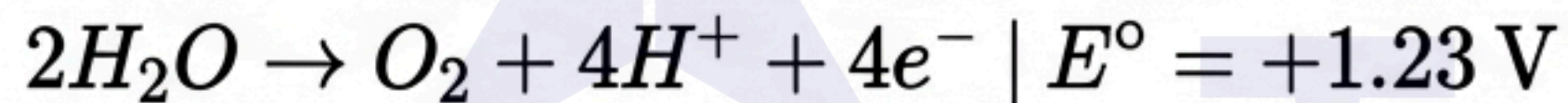
Step 2: Where does H^{+} actually come from?



i Hydroxide ions (OH^{-}) are left behind in the solution.

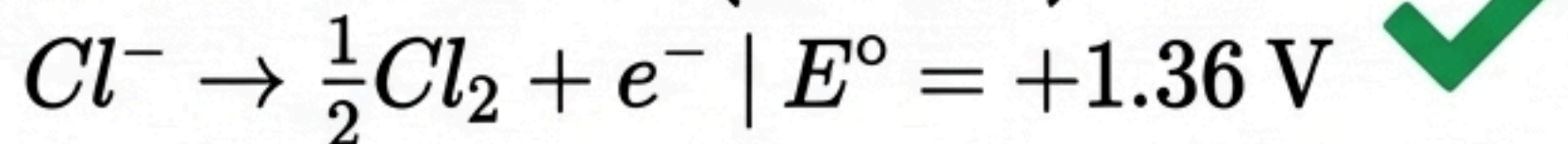
Aqueous NaCl: The Anode Anomaly

Top Contender (Water):



VS

Bottom Contender (Chloride):



Thermodynamic expectation: Lower E° should win at the anode. Water *should* oxidize.



OVERPOTENTIAL OF OXYGEN

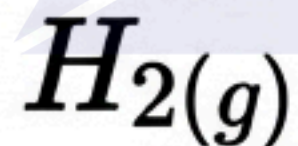
Kinetically, O_2 formation is incredibly slow. It requires an extra voltage (overpotential) to proceed, making its effective potential much higher than 1.23 V.

Therefore, Chloride wins.

The Final Scoreboard: Aqueous NaCl



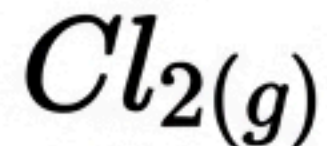
At the Cathode



Hydrogen gas evolves.



At the Anode



Chlorine gas evolves.



Left in Solution



The undischarged Na^+ and newly formed OH^- remain, making the solution highly alkaline.

Final Review

THE EXAM TRAP

Never assume 'NaCl electrolysis' means Molten.

Examiners will intentionally omit the state in tricky options. Always look for aqueous vs molten keywords.

Aqueous = H_2 & Cl_2
Molten = Na & Cl_2

-  Cathode winners have higher reduction potentials (E°).
-  Anode winners have lower reduction potentials (E°) — usually.
-  Oxygen overpotential forces Cl^- to discharge instead of water at the anode.



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