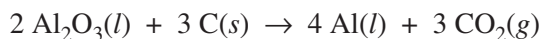


2013 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

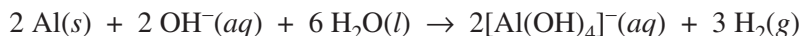
2. Answer the following questions involving the stoichiometry and thermodynamics of reactions containing aluminum species.



An electrolytic cell produces 235 g of Al(l) according to the equation above.

- (a) Calculate the number of moles of electrons that must be transferred in the cell to produce the 235 g of Al(l).
- (b) A steady current of 152 amp was used during the process. Determine the amount of time, in seconds, that was needed to produce the Al(l).
- (c) Calculate the volume of CO₂(g), measured at 301 K and 0.952 atm, that is produced in the process.
- (d) For the electrolytic cell to operate, the Al₂O₃ must be in the liquid state rather than in the solid state. Explain.

When Al(s) is placed in a concentrated solution of KOH at 25°C, the reaction represented below occurs.



Half-reaction	E° (V)
$[\text{Al}(\text{OH})_4]^-(aq) + 3 e^- \rightarrow \text{Al}(s) + 4 \text{OH}^-(aq)$	-2.35
$2 \text{H}_2\text{O}(l) + 2 e^- \rightarrow \text{H}_2(g) + 2 \text{OH}^-(aq)$	-0.83

- (e) Using the table of standard reduction potentials shown above, calculate the following.
- (i) E° , in volts, for the formation of $[\text{Al}(\text{OH})_4]^-(aq)$ and $\text{H}_2(g)$ at 25°C
- (ii) ΔG° , in kJ/mol_{rxn}, for the formation of $[\text{Al}(\text{OH})_4]^-(aq)$ and $\text{H}_2(g)$ at 25°C