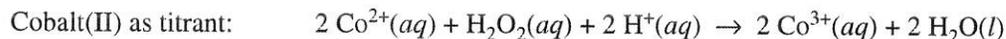
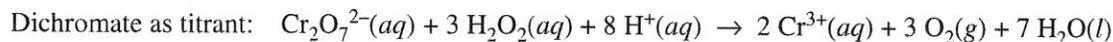


2017 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

7. A student wants to determine the concentration of H_2O_2 in a solution of $\text{H}_2\text{O}_2(\text{aq})$. The student can use one of two titrants, either dichromate ion, $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$, or cobalt(II) ion, $\text{Co}^{2+}(\text{aq})$. The balanced chemical equations for the two titration reactions are shown below.



The half-reactions and the E° values for the systems related to the titrations above are given in the following table.

Half-Reaction	E° (V) at 298 K
$\text{Co}^{3+}(\text{aq}) + e^- \rightarrow \text{Co}^{2+}(\text{aq})$	1.84
$\text{H}_2\text{O}_2(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 e^- \rightarrow 2 \text{H}_2\text{O}(\text{l})$	1.77
$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14 \text{H}^+(\text{aq}) + 6 e^- \rightarrow 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$	1.33
$\text{O}_2(\text{g}) + 2 \text{H}^+(\text{aq}) + 2 e^- \rightarrow \text{H}_2\text{O}_2(\text{aq})$	0.70

- (a) Use the information in the table to calculate the following.
- E° for the reaction between $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ and $\text{H}_2\text{O}_2(\text{aq})$ at 298 K
 - E° for the reaction between $\text{Co}^{2+}(\text{aq})$ and $\text{H}_2\text{O}_2(\text{aq})$ at 298 K
- (b) Based on the calculated values of E° , the student must choose the titrant for which the titration reaction is thermodynamically favorable at 298 K.
- Which titrant should the student choose? Explain your reasoning.
 - Calculate the value of ΔG° , in $\text{kJ/mol}_{\text{rxn}}$, for the reaction between the chosen titrant and $\text{H}_2\text{O}_2(\text{aq})$.

STOP

END OF EXAM