UV-Vis Spectroscopy

\[ \Delta E = h \nu \text{(photon)} = h(c/\lambda) = h c \bar{\nu} = E(\text{LUMO}) - E(\text{HOMO}) \]

LUMO \equiv \text{Lowest Unoccupied Molecular Orbital}
HOMO \equiv \text{Highest Occupied Molecular Orbital}

Examples: \(\pi\text{-to-}\pi^*\) \(n\text{-to-}\pi^*\) \(d\text{-to-}d\) (transition metals)

1. What transition(s) is(are) expected in the following molecules between the HOMO and LUMO?
   A. N\(_2\)
   B. HF
   C. C\(_6\)H\(_6\)
   D. CH\(_3\)COOH
   E. CH\(_2\)NH

2. Use the information on the next page on \(d\text{-to-}d\) transitions and the information given below to identify the solutions labeled 1 to 6. The maximum wavelength of absorption for the following coordination complexes are:

\[
\begin{align*}
[\text{Co(H}_2\text{O})_6]^{3+} \quad &\lambda_{\text{max}} = 540 \text{ nm} \\
[\text{Co(en)}_3]^{3+} \quad &\lambda_{\text{max}} \approx 415 \text{ nm} \\
[\text{Co(CN)}_6]^{3-} \quad &\lambda_{\text{max}} = 295 \text{ nm} \\
[\text{CoF}_6]^{3-} \quad &\lambda_{\text{max}} \approx 600 \text{ nm} \\
[\text{CoCl}_6]^{3-} \quad &\lambda_{\text{max}} \approx 700 \text{ nm} \\
[\text{Co(NH}_3)_6]^{3+} \quad &\lambda_{\text{max}} = 435 \text{ nm}
\end{align*}
\]

If one of the solutions cannot be identified, propose a possible ligand that may account for the color of the solution.

**Note:** There are two bidentate ligands on the list,
   en \equiv \text{ethylenediamine} (NH\(_2\)CH\(_2\)CH\(_2\)NH\(_2\)) and
   ox \equiv \text{oxalate anion} (C\(_2\)O\(_4^{2-}\))
The effect of changing the ligands in octahedral cobalt(III) complexes in aqueous solution. The ligand field strengths increase from left to right. Weak-field ligands form complexes that absorb red light, so the complexes are green. Strong-field ligands form complexes that absorb blue and violet light, so the complexes are orange and yellow.