Infrared spectra in the C-H stretch region are reported for the allyl \((\text{CH}_2\text{CHCH}_2)\) and allyl peroxy \((\text{CH}_2=\text{CH-CH}_2\text{OO})\) radicals solvated in superfluid helium nanodroplets. Nine bands in the spectrum of the allyl radical have resolved rotational substructure. We have assigned three of these to the \(\nu_1 (a_1)\), \(\nu_3 (a_1)\), and \(\nu_{13} (b_2)\) C-H stretch bands and four others to the \(\nu_{14}(\nu_{15}+2\nu_{11}) (b_2)\) and \(\nu_2(\nu_{14}+2\nu_{11}) (a_1)\) Fermi dyads, and an unassigned resonant polyad is observed in the vicinity of the \(\nu_1\) band. Experimental coupling constants associated with Fermi dyads are consistent with quartic force constants obtained from density functional theory computations. The peroxy radical was formed within the He droplet via the reaction between allyl and \(\text{O}_2\) following the sequential pick-up of the reactants. Five stable conformers are predicted for the allyl peroxy radical, and a computed two-dimensional potential surface for rotation about the CC-OO and CC-CO bonds reveals multiple isomerization barriers greater than 300 \(\text{cm}^{-1}\). Nevertheless, the C-H stretch infrared spectrum is consistent with the presence of a single conformation following the allyl + \(\text{O}_2\) reaction within helium droplets.