PS 45: Problem 4.24

The relative probability without normalization/partition function is given by

$$P_{rel} = e^{-\beta E_s} \tag{1}$$

The energy difference between the two conformations is $\Delta E/k = 4180$ K, with the trans isomer lower than the cis isomer. The relative abundance is given by

$$P_{rel} = e^{-\Delta E/kT} \tag{2}$$

At $T = 300$ K, the relative abundance between the two isomers is

$$\boxed{P_{rel}\Big|_{T=300} = e^{-4180/300} \approx 8.89 \times 10^{-7}} \tag{3}$$

At $T = 1000$ K,

$$\boxed{P_{rel}\Big|_{T=1000} = e^{-4180/1000} \approx 1.53 \times 10^{-2}} \tag{4}$$

This indicates that at low temperatures, the relative abundance between the cis and trans conformations is negligible. At higher temperatures, the cis isomer is more abundant.