1) In class we showed that, for the “particle in a box” potential with infinite walls at $x = \pm a$, the eigenfunctions are $u_n(x) = \frac{1}{\sqrt{a}} \cos\left(\frac{n\pi x}{2a}\right)$ for $n = 1, 3, \ldots$ and $u_n(x) = \frac{1}{\sqrt{a}} \sin\left(\frac{n\pi x}{2a}\right)$ for $n = 2, 4, \ldots$. Show by direct integration that these are orthonormal, that is $\int_{-\infty}^{\infty} u_m^* u_n dx = \delta_{mn}$.

2) The ammonia molecule undergoes its tunneling transition at a frequency $\nu = 23870$ MHz. What is the energy splitting between the two, otherwise degenerate states between which the nitrogen atom oscillates?