# V25.0109: General Chemistry I (Honors)

## Practice problems for midterm II

1. The spin part of the valence bond wave function for two electrons is

$$\psi_{\text{spin}}(s_{z,1}, s_{z,2}) = \frac{1}{\sqrt{2}} \left[\psi_\uparrow(s_{z,1})\psi_\downarrow(s_{z,2}) - \psi_\uparrow(s_{z,2})\psi_\downarrow(s_{z,1})\right]$$

   Show that this wave function is properly normalized. In order to show this, you need to sum the square of the wave function over the allowed values of $s_{z,1}$ and $s_{z,2}$.

2. The allowed energies (in Rydbergs) of an electron in a hydrogen atom are given by the formula

$$E_n = -\frac{1}{n^2}$$

   Suppose a photon of frequency $2.7\times10^{15}$ Hz strikes the electron hydrogen atom's electron. The electron is ejected a strikes a photosensitive detector with a velocity of $2.113\times10^6$ m/s. In what energy level was the electron before it was struck by the photon? The conversion from Rydbergs to Joules is 1 Ry = $2.18\times10^{-18}$ J. Planck's constant is $h = 6.626 \times 10^{-34}$J·s, and the mass of an electron is $9.109\times10^{-31}$ kg.

3. Consider the molecule cyclobutadiene $C_4H_4$. Determine the Lewis structure of the molecule, including resonant structures.