9.20: Numerical Solutions for the Three-Dimensional Harmonic Oscillator

Reduced mass: μ = 1

Angular momentum: L = 0

Integration limit: r_{max} = 6

Force constant: k = 1

Solve Schrödinger's equation numerically. Use Mathcad's ODE solve block:

Given

$$\frac{-1}{2\mu}\frac{d^2}{dr^2}\psi(r)-\frac{1}{r\mu}\frac{d}{dr}\psi(r)+\left[\frac{L(L+1)}{2\mu r^2}+\frac{1}{2}kr^2\right]\psi(r)=E\psi(r) \quad \psi(.001)=1 \quad \psi'(.001)=0.1$$

$$\psi=Odesolve(r,r_{max})$$

$$\psi(r)=\left(\int_0^{r_{max}}\psi(r)^2 4\pi r^2\,dr\right)^{\frac{-1}{2}}\psi(r)$$

Energy guess: E = 7.5