5.3 Part 3:

$$A_{\ell,m}(y) = y^{m/2} e^{-y/2} \alpha_{\ell,m}(y)$$

$$y\alpha''_{\ell,m}(y) + (1+m-y)\alpha''_{\ell,m}(y) - \frac{1}{2}\left[m+1+i\mu_\ell \hat{\sigma}_x\left(\mu_\ell - \frac{\Delta V}{2\rho} - \frac{1}{\mu_\ell^2}\right)\right]\alpha_{\ell,m}(y)=0$$

eigenvalue must satisfy:

$$\mu_\ell^2\left(\mu_\ell - \frac{\Delta V}{2\rho}\right) - 1 = \frac{i\mu_\ell}{\hat{\sigma}_x}(2\ell+m+1), \text{ for } \ell \geq 0, \ell \in \mathbb{Z}, m \in \mathbb{Z}$$

eigenvalues given by:

$$\mu^2\left(\mu_\ell - \frac{\Delta V}{2\rho}\right) - 1 = \frac{i\mu_\ell}{\hat{\sigma}_x}(2\ell+1)$$

$$\text{if } \sigma_x \to \infty \Rightarrow \boxed{\mu_\ell^2 = \frac{1}{\mu_\ell - \frac{\Delta V}{2\rho}}}$$

$$A_{\ell,0}(\hat{r}) = L_\ell^0\left(\frac{i\hat{r}^2}{\mu\hat{\sigma}_x}\right)\exp\left(\frac{-i\hat{r}^2}{2\mu_\ell\hat{\sigma}_x}\right)$$

$$L=0 \Rightarrow A_{00}(\hat{r}) = \exp\left(-i\hat{r}^2/2\sigma_x^2\right)$$