

The operator  $\hat{L}_z$  that represents the  $z$ -component of angular momentum, the operator  $\hat{L}^2$  that represents the total angular momentum, and the operator  $\hat{H}$  that represents the energy for the rigid rotor (a particle confined to the unit sphere) have eigenvalues given by

$$\hat{L}_z |\ell, m\rangle = m\hbar |\ell, m\rangle \quad (1)$$

$$\hat{L}^2 |\ell, m\rangle = \ell(\ell + 1)\hbar^2 |\ell, m\rangle \quad (2)$$

$$\hat{H} |\ell, m\rangle = \frac{\hbar^2}{2I} \ell(\ell + 1) |\ell, m\rangle \quad (3)$$

Find the matrix representations for these operators.