1. The Pauli spin matrices form a 3-vector of $2 \times 2$ matrices:

$$\vec{\sigma} = (\sigma_x, \sigma_y, \sigma_z)$$

with

$$\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad \sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

Show that they satisfy

$$\sigma_x \sigma_y = -\sigma_y \sigma_x = i\sigma_z \quad \sigma_y \sigma_z = -\sigma_z \sigma_y = i\sigma_x \quad \sigma_z \sigma_x = -\sigma_x \sigma_z = i\sigma_y$$

and

$$\sigma_x \sigma_x = \sigma_y \sigma_y = \sigma_z \sigma_z = I$$

where $I$ is the $2 \times 2$ identity matrix.

2. The spin operator for a spin $1/2$ particle is

$$\vec{S} = \frac{\hbar}{2} \vec{\sigma}$$

For two spin $1/2$ particles the total spin is $\vec{S} = \vec{S}_1 + \vec{S}_2$. Find the eigenvalues of the operator $\vec{S}_1 \cdot \vec{S}_2$ that appears in a typical nucleon-nucleon potential.

3. Chapter 1, problem 16
4. Chapter 1, problem 17
5. Chapter 2, problem 1
6. Chapter 2, problem 2