Problem 1

A particle of mass m and charge q is moving in the x-direction under the influence of a uniform electric field $\vec{E} = \mathcal{E}_0 \hat{x}$.
Calculate the average acceleration

$$\frac{d^2 \langle X \rangle}{dt^2}$$

and compare your result with the one expected from classical mechanics.

Problem 2

A spin-1/2 particle of magnetic moment $\vec{\mu} = \gamma \vec{S}$, where

$$S_x = \frac{\hbar}{2} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad , \quad S_y = \frac{\hbar}{2} \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad , \quad S_z = \frac{\hbar}{2} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

is placed in a uniform magnetic field

$$\vec{B} = B_0 \begin{pmatrix} 0 \\ 3/5 \\ 4/5 \end{pmatrix}$$

At $t = 0$ the z component of its spin is measured and found to be $+\hbar/2$.
If the x component of the spin is measured at time $t > 0$, what are the possible outcomes and with what probability will each occur?