5.73
Quiz 19 ANSWERS

1. $$|\psi\rangle = N\left[\alpha|1\rangle + \beta|2\rangle + \gamma|3\rangle\right]$$

Express the 3×3 density matrix $\boldsymbol{\rho} = |\psi\rangle\langle\psi|$ in terms of N, α, β, and γ.

$$\rho = N^2 \begin{pmatrix} |\alpha|^2 & \alpha\beta^* & \alpha\gamma^* \\ \beta\alpha^* & |\beta|^2 & \beta\gamma^* \\ \gamma\alpha^* & \gamma\beta^* & |\gamma|^2 \end{pmatrix}$$

2. $$\boldsymbol{\rho} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

What is an example of a $|\psi\rangle$ that corresponds to this ρ?

$$\psi = |2\rangle$$

3. $$\boldsymbol{\rho} = \begin{pmatrix} 1/2 & 1/4 \\ 1/4 & 1/2 \end{pmatrix}$$

Is the system in a pure state? A coherent superposition state? Or a statistical mixture state? What does $\boldsymbol{\rho}^2$ tell you?

$\rho = \rho^2$ for coherent superposition
$\rho \neq \rho^2$ for statistical mixture

$$\rho^2 = \begin{pmatrix} 5/16 & 3/8 \\ 3/8 & 5/16 \end{pmatrix} \neq \rho$$

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