

Phys 443. Second Midterm

Solutions

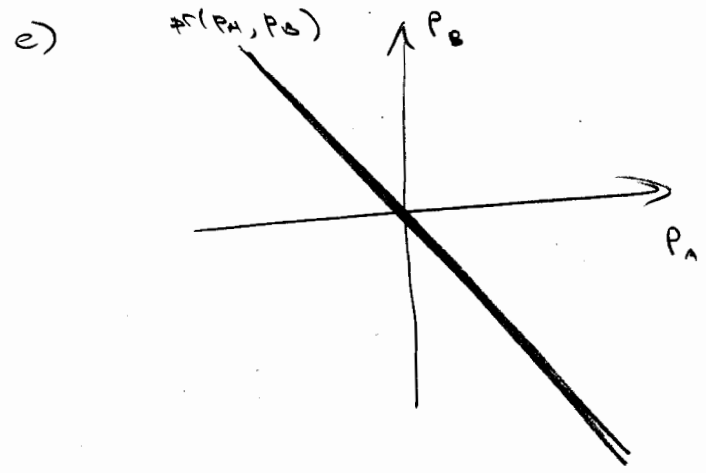
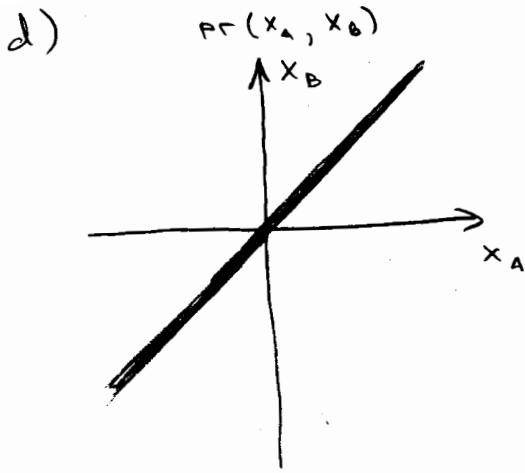
$$\boxed{1} \quad a) \quad \langle \Phi^+ | \Psi_{ABC} \rangle = \frac{1}{6} \left(\frac{1}{\sqrt{2}} |H\rangle - \frac{3i}{\sqrt{2}} |V\rangle + 4i \cdot 0 - 4 \cdot 0 + \frac{3}{\sqrt{2}} |H\rangle \right) \\ = \frac{1}{6} \left(\frac{4}{\sqrt{2}} |H\rangle - \frac{3i}{\sqrt{2}} |V\rangle \right) = \frac{\sqrt{2}}{3} |H\rangle - \frac{\sqrt{2}}{4} |V\rangle$$

$$b) \quad \text{Pr}(\Phi^+) = \|\langle \Phi^+ | \Psi_{ABC} \rangle\|^2 = \left(\frac{\sqrt{2}}{3}\right)^2 + \left(\frac{\sqrt{2}}{4}\right)^2 = \frac{2}{9} + \frac{2}{16} = \frac{25}{72}$$

$$\boxed{2} \quad a) \quad |\Psi_{AB}\rangle = \iint \delta(x_A - x_B) |x_A x_B\rangle dx_A dx_B = \\ = \iiint \delta(x_A - x_B) \langle p_A | x_A \rangle \langle p_B | x_B \rangle |p_A p_B\rangle dp_A dp_B dx_A dx_B \\ = \iiint \langle p_A | x \rangle \langle p_B | x \rangle |p_A p_B\rangle dp_A dp_B dx = \\ = \iiint \frac{1}{2\pi\hbar} e^{i\frac{x}{\hbar}(p_A + p_B)} |p_A p_B\rangle dp_A dp_B dx = \\ = \frac{1}{2\pi\hbar} \iint 2\pi \delta(p_A + p_B) |p_A p_B\rangle dp_A dp_B$$

$$b) \quad \langle X_{0_A} | \Psi_{AB} \rangle = \iint \delta(x_A - x_B) \langle X_{0_A} | x_A x_B \rangle dx_A dx_B = \\ = \iint \delta(x_A - x_B) \delta(x_0 - x_A) |x_B\rangle dx_A dx_B = |x_0\rangle_B$$

c) Similarly, $| -p_0 \rangle_B$



- e) - Uncertainty principle: a state with a definite position cannot be the same as a state with a definite momentum (different, incompatible physical reality)
- By choosing to measure either \hat{x} or \hat{p} , Alice can prepare two incompatible physical realities (a position eigenstate or a momentum eigenstate) at Bob's location.