Quiz 3: Non-local Games

Recall that the CHSH game is the non-local game where Alice and Bob are given uniformly random questions $x, y \in \{0, 1\}$, respectively, and they produce answers $a, b \in \{0, 1\}$. They win if $x \cdot y = a + b \mod 2$.

Question 1. Which of the following statements is true?

(a) Randomized strategies are better than deterministic strategies.
(b) Quantum strategies are better than randomized strategies.

Question 2. Suppose that Alice and Bob share a 2-party state ρ_{AB}. Upon receiving questions, they perform measurements μ_A^x and μ_B^y, respectively. Which of the following statements are true?

(a) The order in which Alice and Bob perform their measurments does not affect their probabilities.
(b) The outcomes of Alice's and Bob's measurements are independent if ρ_{AB} is not entangled.

Question 3. Suppose that Alice and Bob share a quantum state of the form

$$\rho_{AB} = \sum_{\lambda} p_\lambda \rho_{A,\lambda} \otimes \rho_{B,\lambda},$$

where $\rho_{A,\lambda}$ and $\rho_{B,\lambda}$ are quantum states for all λ and $\{p_\lambda\}_\lambda \in \Lambda$ is a probability distribution. What is the optimal winning probability?

(a) $\frac{1}{2}$
(b) $\frac{3}{4}$
(c) $\frac{1}{2} + \frac{1}{2\sqrt{2}}$
(d) 1

Question 4. Suppose that Alice and Bob share the pure quantum state

$$|\psi_{AB}\rangle = \frac{1}{2}|0\rangle \otimes (|0\rangle + |1\rangle) + \frac{1}{2}|1\rangle \otimes (|0\rangle - |1\rangle).$$

What is the optimal winning probability?

(a) $\frac{1}{2}$
(b) $\frac{3}{4}$
(c) $\frac{1}{2} + \frac{1}{2\sqrt{2}}$
(d) 1