Reflective Homework

(1) Consider the following statements from two people:
Person 1: Given the Hamiltonian $\hat{H}$ of the system and the initial wave function at time $t = 0$, we can find the wave function at all future times by solving the Time-Dependent Schroedinger Equation (TDSE).
Person 2: If the wave function can be determined with certainty at all future times, we should be able to determine the different physical observables such as position, momentum, energy etc. at all future times with certainty.
Explain why you agree or disagree with each person.

(2) Consider the following statement: "A wave function that is zero everywhere in the classically forbidden region cannot be a possible wave function for an electron interacting with a finite square well even if this wave function is single valued, continuous and smooth. This is because there should be a non-zero probability of finding the particle in the classically forbidden region if it is interacting with a finite square well." Explain why you agree or disagree with the statement.

(3) Consider the following statement: "For an infinite square well and a finite square well both between $0 \leq x \leq a$, some possible wave functions for the infinite square well can also be possible wave functions for the finite square well". Explain why you agree or disagree with the statement.

(4) How does the number of bound states change as the width of a finite square well is increased keeping the depth V_0 fixed? Why? You must provide a reasoning.

(5) Two systems are identically prepared. In both systems, a free particle is in the same generic state $\phi(x)$ when momentum is measured for each. You measure the momentum in one of these systems and your friend measures the momentum in the other identically prepared system. You obtain a value P_0 for the momentum. What can you conclude about your friend's measurement? You must justify your answer.

(6) A free particle is in a generic state $\phi(x)$ when you measure its momentum. After the first measurement, you wait for a long time before measuring its momentum again. Do you expect the same outcome for momentum both times? You must justify your answer.