Quantum Mechanics I - Module 1

1. Consider each of the following situations:
   (a) An electron and a proton have the same kinetic energy.
   (b) An electron and a proton have the same momentum.
   (c) An electron and a proton have the same speed.

In each case, which particle has the shorter de Broglie wavelength?

2. Normalization of a wave function is done so that:
   (a) The probability can be made into a real quantity.
   (b) The total probability of finding the particle somewhere is one.
   (c) The wave function can be made into a real quantity.
   (d) The uncertainty principle is satisfied.

3. Let $f(x)$ be an odd function and let $g(x)$ be an even function. Which of the following statements are true?

   (a) $\int_{-\infty}^{\infty} f(x)\,dx = 0$

   (b) $\int_{-\infty}^{\infty} g(x)\,dx = 0$

   (c) $\int_{-\infty}^{\infty} f(x)\,dx = 2\int_{0}^{\infty} f(x)\,dx$

   (d) $\int_{-\infty}^{\infty} g(x)\,dx = 2\int_{0}^{\infty} g(x)\,dx$

4. For each of the following, describe how classical physics was challenged.
   (a) Blackbody radiation
   (b) The photoelectric effect
   (c) The Compton effect

5. Discuss one of the following models. What are the major features of each model, and point out where, if anywhere, the model fails.
   (a) Thomson's model
   (b) Rutherford's model
   (c) Bohr's model
   (d) Sommerfeld's model