Sample Exam Questions - Module 10

1) In another landmark paper of 1905 Einstein boldly suggested the hypothesis of light quanta or what would later be called photons. Was this just a restatement of Planck's hypothesis of 1900, or did Einstein go further? How did he suggest that the hypothesis might be tested experimentally? Millikan's famous experiment of 1916 apparently settled the matter - or did it? How was the photon hypothesis received in the physics community ca. 1905-1925?

2) How did Bohr in 1913 explain the Balmer series of the hydrogen spectrum? The explanation was empirically successful but rested on a basis (his two postulates) which was widely considered strange and even inconsistent. From the point of view of physicists at about 1913, what were these strange and objectionable features of Bohr's theory? The Balmer series was known at the time, and Bohr's explanation was therefore of a known phenomenon (post hoc or a "postdiction"). Did he also come up with genuine predictions, that is, claims of novel phenomena?

3) Heisenberg starts his 1925 *Umdeutung* paper with a lengthy discussion of what has been called the "observability criterion." What is this and what is his point in introducing his paper with these methodological remarks? Would you say that the observability criterion is generally a valid principle for theory construction, or can it be criticized?

4) In his Nobel Lecture of 1933, Heisenberg states that "quantum mechanics is in no way concerned with the objective determination of space-time phenomena" (p. 296). Taken at face value this sounds astonishing, even provocative. What has Heisenberg in mind? Try to explain his (and Bohr's) view concerning the observability of atomic particles and the role played by the observer and his/her measuring apparatus.

5) In his seminal paper of April 1926, in which wave mechanics was introduced, Schrödinger stated the eigenvalue wave equation in the form used today. But this was not his original quantum wave equation. Why did he state only the non-relativistic version when he already had the more general, relativistic version? And how is it that he started with the latter rather than the simpler version without relativity?

6) By the spring of 1926 there existed basically two theories of quantum mechanics, the Heisenberg-Born-Jordan matrix mechanics and Schrödinger's wave mechanics. In which respects did the two theories or formulations differ? Did Schrödinger's theory lead to experimental results that the other theory could not account for, or vice versa? Why did wave mechanics soon become the favoured language of the quantum physicists?