MODERN PHYSICS (351 PHYS)

PROBLEM SET 4

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PROBLEM (1)

Answer the following questions:

1. An electron and a proton are accelerated from rest through the same potential difference. Which particle has the longer wavelength?
2. In what ways does BohrâĂŹs model of the hydrogen atom violate the uncertainty principle?

PROBLEM (2)

In order to simplify the calculations, and keep using the Hight-Energy units at all time. We need to find the numerical value of $\hbar$ in continent high energy units, particularly $MeV/\times$Åor $KeV/c\times$ Å.
Find that numerical values, starting from dimensional analysis of the relation $\Lambda = p \times \lambda_{db}$. (*Hint*: Recall that p is measured in MeV/c and λ in Å).

PROBLEM (3)

Calculate the de Broglie wavelength for a proton moving with a speed of 10^5 m/s

PROBLEM (4)

Calculate the de Broglie wavelength for an electron with kinetic energy (a) 60 eV (b) $60KeV$.

PROBLEM (5)

An electron and a photon each have kinetic energy equal to 100 keV. What are their de Broglie wavelengths?

PROBLEM (6)

A proton has a kinetic energy of $1.0MeV$. If its momentum is measured with an uncertainty of 5.0%, what is the minimum uncertainty in its position?

BONUS PROBLEM

Typical measurements of the mass of a subatomic delta Δ particle $(m \sim 1230MeV/c^2)$ are shown in Figure Although the lifetime of the delta is much too short to measure directly, it can be calculated from the energy-time uncertainty principle. Estimate the lifetime from the full width at half-maximum of the mass measurement distribution shown.