Modern Physics Revision

Question 1: A laser produces light of wavelength 520 nm in an ultrashort pulse.
- (a) What is the energy of the photon in this laser pulse?
- (b) If the uncertainty is 1.0% of the photon energy, what is the value of ΔE?
- (c) What is the minimum duration of the pulse Δt?

Question 2: A horizontal beam of laser light of wavelength 650 nm passes through a narrow slit that has width 0.0620 mm. The intensity of the light is measured on a vertical screen that is 2.00 m from the slit.
- (a) What is the minimum uncertainty in the vertical component of the momentum of each photon in the beam after the photon has passed through the slit?
- (b) Use the result of part (a) to estimate the width of the central diffraction maximum that is observed on the screen.

Question 3: A hydrogen atom initially in the ground level absorbs a photon, which excites it to the level n = 4. Determine the wavelength and frequency of the photon.

Question 4: The wave function $\psi(x, t) = Ae^{i(k_1 x - \omega_1 t)} + Ae^{i(k_2 x - \omega_2 t)}$ is a superposition of two free-particle wave functions. Both k_1 and k_2 are positive. Find the probability distribution function for $\psi(x, t)$.

Question 5: A spacecraft of the Trade Federation flies past the planet Coruscant at a speed of 0.700c. A scientist on Coruscant measures the length of the moving spacecraft to be $l_0 =$75.0 m. The spacecraft later lands on Coruscant, and the same scientist measures the length of the now stationary spacecraft.

- (a) What is the Lorentz factor γ at that speed?
- (b) What length l does she get?

Question 6: Define

- (a) Doppler effect
- (b) De Broglie wavelength
- (c) Heisenberg uncertainty principle