**PHYS301 HW 3 Dr. Amir**

**Uncertainty Principle**

**6.** (I) The lifetime of a typical excited state in an atom is about 10ns. Suppose an atom falls from one such excited state and emits a photon of wavelength about 500 nm. Find the fractional energy uncertainty $ΔE/E$ and wavelength uncertainty $∆λ/λ$ of this photon.

 **7.** (I) A radioactive element undergoes an alpha decay with a lifetime of  If alpha particles are emitted with 5.5-keV kinetic energy, find the uncertainty $ΔE/E$ in the particle energy.

 **8.** (II) A 12-g bullet leaves a rifle horizontally at a speed of  (*a*) What is the wavelength of this bullet? (*b*) If the position of the bullet is known to a precision of 0.65 cm (radius of the barrel), what is the minimum uncertainty in its vertical momentum?

**10.** (II) What is the uncertainty in the mass of a muon  specified in  given its lifetime of 2.20μs

 **11.** (II) A free neutron (m=1.67$×10^{-27}kg)$ has a mean life of 900s. What is the uncertainty in its mass (in kg)?

**14.** (II) How accurately can the position of a 3.50-keV electron be measured assuming its energy is known to 1.00*%*?

**Free Particles; Plane Waves; Wave Packets**

**18.** (I) A free electron has a wave function$ ψ\left(x\right)=Asin(2.0×10^{10}x)$ where *x* is given in meters. Determine the electron’s (*a*) wavelength, (*b*) momentum, (*c*) speed, and (*d*) kinetic energy.

 **19.** (I) Write the wave function for (*a*) a free electron and (*b*) a free proton, each having a constant velocity $v=3.0×\frac{10^{8}m}{s}.$ The general equation for a free particle ca be written as

$$ψ\left(x\right)=Asinkx+Bcoskx$$