
**Problem 3:**
Calculate the de Broglie wavelength, $\lambda$, for:

(a) An electron with kinetic energy $E_k$ of (i) 1.0 eV, and (ii) 100 eV
(Hint: it may be tempting to use $c$ (the speed of light for the electron velocity. But we know better, $c$ is the speed of light, not the speed of electron)

(b) A singly ionized tungsten atom with kinetic energy $E_k$ of 1.0 eV.
(c) A 2000-kg truck traveling at 20 m/s.
(d) A photon having energy 2 eV
(Hint: please pay attention here, we do not use the mass of photon in this class, we know nothing about the mass of photon in this class, so you should NOT try to use $p=m\upsilon$ or $E_k=mv^2/2$).

**Problem 4:**
Formulate the Heisenberg uncertainty principle for the energy $E$ (in class, we considered the uncertainty in the momentum $p$). Try to find an example of this principle (for the energy).

**Problem 5:**
When the uncertainty principle is considered, it is not possible to locate a photon in space more precisely than about one wavelength. Consider a photon with wavelength $\lambda=1$ μm. What is the uncertainty in the photon’s (a) momentum and (b) energy.

**Problem 6:**
The solution to Schrodinger’s wave equation for a particular one dimensional situation is given by:
$$\psi(x) = \sqrt{2/a_0} e^{-x/a_0}$$
(1) Determine the probability of finding the particle between the following limits: $0 \leq x \leq a_0/4$
(2) Determine the probability density of finding the particle exactly at $x=0$, if $a_0=2$

**Problem 7:**
An electron in free space is described by a plane wave given by $\Psi(x,t)=A e^{i(kx-\omega t)}$, where $k=1.5\times10^9$ m$^{-1}$ and $\omega=1.5\times10^{13}$ rad/s.
Considering the wave and particle properties of electron (wave-particle duality), calculate the wavelength, momentum, and kinetic energy (in eV) of this particular electron.