PHYS 1512: Week 12

Connor Feltman

University of Iowa

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Equations

$$E = hf = \frac{hc}{\lambda} \quad \text{(Energy of a photon)} \tag{1}$$

$$KE_{max} = hf - \phi_o \quad \text{(Photoelectric effect)} \tag{2}$$

$$\lambda = \frac{h}{p} \quad \text{(De Broglie)} \tag{3}$$

$$(\Delta p_x)(\Delta x) \geq \frac{h}{4\pi} \quad \text{(Uncertainly Principle)} \tag{4}$$

$$(\Delta E)(\Delta t) \geq \frac{h}{4\pi} \quad \text{(Uncertainly Principle)} \tag{5}$$

Some notes

$h = 6.626\text{E-}34\ Js$

$1J = 6.242\text{E}18\ eV$

Question #1

Discrete Energy

An AM radio station broadcasts an electromagnetic wave with a frequency of 665kHz, whereas an FM station broadcasts an electromagnetic wave with a frequency of 91.9MHz. How many AM photons are needed to have a total energy equal to that of one FM photon?

Question #2

Einstein's Victory

The maximum wavelength that an electromagnetic wave can have and still eject electrons from a metal surface is 485nm. What is the work function ϕ_o of this metal? Express your answer in electron volts.

Question #3

Faster than a speeding proton

An electron and proton have the same speed. Ignore relativistic effects and determine the ratio $\frac{\lambda_{electron}}{\lambda_{proton}}$ of their De Broglie wavelengths.

$m_{electron} = 9.11 * 10^{-31} kg$
$m_{proton} = 1.67 * 10^{-27} kg$

Question #4

What's really down in an atom?

A proton is confined to a nucleus that has a diameter of $5.5 * 10^{-15}$m. If this distance is considered to be the uncertainty in the position of the proton, what is the minimum uncertainty in its momentum?

Question # 5

Electric potential energy in motion

An electron, starting from rest, accelerates through a potential difference of 418V. What is the final de Broglie wavelength of the electron, assuming that its final speed is much less than the speed of light?