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1. The light intensity incident on a metallic surface with a work function of 4 eV produces photoelectrons with a maximum kinetic energy of 2 eV. The frequency of the light is then doubled. Determine the new maximum kinetic energy of the resulting photoelectrons, in eV. (5 points)

\[ k \cdot E_1 = h \cdot f_1 - 4 \text{ eV} = 2 \text{ eV} \implies h \cdot f_1 = 6 \text{ eV} \]

Then \( h \cdot f_2 : 2 \cdot h \cdot f_1 \implies \)

\[ k \cdot E_2 = 12 - 4 = 8 \text{ eV} \]

2. A photon whose energy is \( 4 \times 10^{-15} \text{J} \) is scattered off an electron at an angle of 90°. What is the wavelength of the scattered wave? (5 points)

\[ \lambda' - \lambda = (1 - \cos \theta) \frac{h}{m_e c} \]

\[ \lambda' = \frac{h}{m_e c} + \lambda \]

\[ = 2.43 \times 10^{-12} + 4.95 \times 10^{-11} \]

\[ = 5.19 \times 10^{-11} \text{[m]} \]
3. A spaceship moves at a speed of 0.95c away from the earth. It shoots a torpedo toward the earth at a speed of 0.9c relative to the ship. What is the velocity, in terms of c, of the torpedo relative to the earth? (5 points)

\[ u = \frac{0.9c - 0.95c}{1 - (0.95)(0.9)} = -0.345c \]

4. Electrons are accelerated through a voltage, V, towards a collection of hydrogen atoms all in the ground state. What is the minimum value of V in order to excite the hydrogen atoms to the n=2 state? (5 points)

\[ eV_{\text{min}} = 13.6 \, eV \left( \frac{1}{1^2} - \frac{1}{2^2} \right) = 10.2 \, [eV] \]

\[ V_{\text{min}} = 10.2 \, [\text{Vols}] \]