1) The work function of silver is 4.73 eV. To break free from the surface, Wally must absorb a photon with at least this much energy. The wavelength of a photon with this energy is

\[ E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{1240 \text{ eV nm}}{4.73 \text{ eV}} = 262 \text{ nm} \]

2) \( E = h\nu = 571 \text{ keV} \)

\[ \text{incident \ photon \ to \ electron} \]

\[ \theta = 110^\circ \]

a) \( \lambda = \frac{hc}{E} \) where photon energy \( E = mc^2 \)

\[ = \frac{hc}{mc^2} = \frac{h}{mc} = \lambda_c \]

The photon wavelength is the Compton wavelength.

b) Use the Compton scattering formula:

\[ \lambda_2 - \lambda_1 = \frac{h}{mc} (1 - \cos \theta) \]

\[ \lambda_2 + \lambda_c = \lambda_c (1 - (-0.342)) \]

\[ \lambda_2 = \lambda_c + \lambda_c (1.342) = 2.342 \lambda_c \]
c) By conservation of energy, the loss of energy by the photon is the gain of energy by Wally (with all of it going to kinetic):

\[\Delta E = \frac{hc}{\lambda} - \frac{hc}{\lambda_c} = mc^2 \frac{hc}{2.342\lambda_c} = mc^2 \left(1 - \frac{1}{2.342}\right)\]

so Wally gains \[\Delta E = 0.573 \, mc^2\]

d) Since the kinetic energy is a sizeable fraction of the rest mass, we must use relativity:

\[E = pc + mc^2 \implies pc = (E - mc^2)^{1/2}\]

\[pc = \left((1.573mc^2) - mc^2\right)^{1/2} = (2.474 - 1.) \, mc\]

\[p = 1.21 \, mc\]

e) \[\lambda = \frac{h}{p} = \frac{h}{1.21mc} = \frac{\lambda_c}{1.21} = 0.826 \lambda_c\]
3) \( a) \) 

\[ \lambda_1 = 2L \]
\[ \lambda_2 = L \]
\[ \lambda_3 = \frac{3}{2} L \] 

\[ \Rightarrow \lambda_n = \frac{2L}{n} \]

c) each state has a momentum \( p = \frac{\hbar}{\lambda} \)

\[ p_n = \frac{n\hbar}{2L} \]

d) \( p = mv \) and \( E = \frac{1}{2}mv^2 \), so \( E = \frac{p^2}{2m} \)

\[ E_n = \frac{n^2\hbar^2}{4L^2m} = n^2 \frac{\hbar^2}{8mL^2} \]

e) Change in energy from state \( n=2 \) to \( n=1 \) corresponds to

\[ \Delta E = E_2 - E_1 = (2^2 - 1^2) \frac{\hbar^2}{8mL^2} = \frac{3}{8} \frac{\hbar^2}{mL^2} \]

f) wavelength of emitted photon with this energy

\[ \lambda = \frac{hc}{E} = \frac{8}{3} \frac{hc}{\hbar^2} = \frac{8}{3} \frac{mc^2}{h} \lambda_0 = \frac{8}{3} \frac{1}{\lambda_0} \]
H)

\[ V = 0.2c \quad \therefore \quad V = 0.2c \]

a) The collision must conserve energy and momentum. Since the net momentum in this frame is initially zero, it must remain zero afterwards: the outgoing photons must have equal and opposite momentum, and hence equal energy.

b) Initial energy \( E = 2(\gamma mc^2) \)

so final energy must be \( 2(\gamma mc^2) \)

and each photon has \( E = \gamma mc^2 \)

where \( \gamma = (1 - 0.2^2)^{-\frac{1}{2}} = 1.0206 \)

\[ E_{\text{ph}} = 1.0206 \ mc^2 = 1.0206 \times 511 \text{ keV} = 521 \text{ keV} \]

c) \[ A = \frac{h\nu}{E} = \frac{hc}{1.0206mc^2} = 0.9798 \ \frac{h}{mc} = 0.9798 \ \frac{\text{Å}}{\text{nm}} \]

\[ = \frac{1240 \text{ eV\cdotÅ}}{1.0206 \times 511,000 \text{ eV}} = 2.38 \times 10^{-3} \text{ nm} \]