Solution to Sample Exam 1

1. $v' = \frac{v - u_m}{1 - u_m v/c^2} = \frac{\mu c - \delta c}{1 - \mu\delta} = \frac{(\mu - \delta)c}{1 - \mu\delta}$ Messenger Rest Frame (S_m)

a) **Length of Armada**: $L = \frac{L_0}{\gamma} = \Lambda\sqrt{1 - \frac{(\mu-\delta)^2}{(1-\mu\delta)^2}}$

Time of trip: $t' = \frac{L}{v'} = \frac{1-\mu\delta}{(\mu-\delta)c} \cdot \Lambda\sqrt{1 - \frac{(\mu-\delta)^2}{(1-\mu\delta)^2}}$

b.) Armada's Rest Frame (S_a)

$v' = \frac{v - v_a}{1 - \frac{v v_a}{c^2}} = \frac{\delta c - \mu c}{1 - \mu\delta} = \frac{(\delta - \mu)c}{1 - \mu\delta}$ velocity of messenger

Length of Trip: $t' = \frac{L_0}{v'} = \frac{(1-\mu\delta)}{(\delta-\mu)c} \cdot \Lambda$

c.) System S

Length of armada: $L = \frac{L_0}{\gamma} = \Lambda\sqrt{1-\mu^2}$

Length of trip: $t = \frac{L}{u_m - v_a} = \frac{\Lambda\sqrt{1-\mu^2}}{\delta c - \mu c} = \frac{\Lambda\sqrt{1-\mu^2}}{(\delta-\mu)c}$

2a.) $\Delta E = E_2 - E_0 = \frac{hc}{\lambda} = \frac{1240\,\text{eV}\cdot\text{nm}}{\lambda} \Rightarrow \frac{1240\,\text{eV}\cdot\text{nm}}{E_2 - E_0} = \lambda$

$\lambda = \frac{1240\,\text{eV}\cdot\text{nm}}{0.289\,\text{eV}} = \boxed{4.29\,\mu\text{m}}$

2b.) $\Delta E' = E_2 - E_1 = \frac{hc}{\lambda'} \Rightarrow \lambda' = \frac{1240\ eV \cdot nm}{E_2 - E_1}$

$\lambda' = \frac{1240\ eV \cdot nm}{(0.289 - 0.165)} = \boxed{10\ \mu m}$

c.) $4.29\ \mu m \leftrightarrow 4290\ nm$ $\quad 10\ \mu m \leftrightarrow 10{,}000\ nm$

Visible Light: 700-400 nm $\quad \lambda > 700\ nm \Rightarrow$ InfraRed (IR)

λ, λ' are in IR Region

3a.) $\Delta t = \frac{\Delta t_0}{\sqrt{1 - u^2/c^2}} = \frac{\sigma}{\sqrt{1 - \frac{\tau^2 c^2}{c^2}}} = \boxed{\frac{\sigma}{\sqrt{1-\tau^2}}}$

b.) Photons are the carriers of Electromagnetic Radiation, having both wave and particle properties. Photons have Energy pc yet are massless.
Momentum of photon = $\frac{\text{Energy}}{c}$

c.) The Stopping Potential is found by making the potential of the anode relative to the cathode negative enough so that current stops. The work function, φ, represents the minimum amount of Energy necessary for an electron to escape from the surface.

d.) An ideal blackbody denotes an ideal surface that absorbs all wavelengths of the EM Spectrum. The Stefan-Boltzmann Law tells us that $I = \sigma T^4$ so Intensity is proportional to T^4.

e.) N/A.