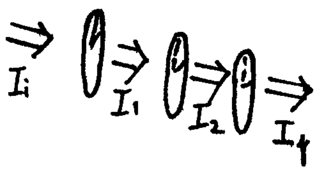
38-36) $\theta = 8.15^\circ$, $\lambda = 0.129\,nm$, $m = 1$

$$2d\sin\theta = m\lambda \Rightarrow \boxed{d = \frac{m\lambda}{2\sin\theta} \simeq 0.455\,nm}$$

38-42) a) $\theta_1 = 20.0^\circ$, $\theta_2 = 40.0^\circ$, $\theta_3 = 60.0^\circ$

The axis of each successive polarizing disk is oriented at a 20° angle w/respect to the previous one.

$I_{max} = 10$

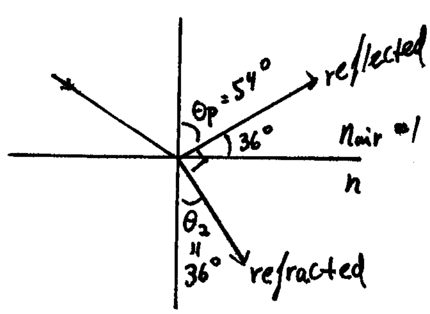


$$I_1 = I_{max}\cos^2(20^\circ)$$
$$I_2 = I_1\cos^2(20^\circ) = I_{max}(\cos^2(20^\circ))^2$$
$$I_f = I_2\cos^2(20^\circ) = I_{max}(\cos^2(20^\circ))^3$$
$$\Rightarrow \boxed{I_f \simeq 6.89}$$

38-42) b) $\theta_1 = 0^\circ$, $\theta_2 = 30^\circ$, $\theta_3 = 60^\circ$

$$I_1 = I_{max}\cos^2(0^\circ) = I_{max}$$
$$I_2 = I_{max}\cos^2(30^\circ)$$
$$I_3 = I_f = I_2\cos^2(30^\circ) = I_{max}(\cos^2(30^\circ))^2 \Rightarrow \boxed{I_f = 5.625}$$

38-55)



This problem is poorly written... in order for $n > 1$, we must take the statement "completely polarized at 36°" to mean that the incident angle is 54°.

This gives $\theta_p = 54^\circ \Rightarrow n = \tan\theta_p \simeq 1.376$

$$\lambda_n = \frac{\lambda}{n} = \frac{750\,nm}{1.376} \Rightarrow \boxed{\lambda_n \simeq 544.9\,nm}$$

39-8) a) The time interval for travel is measured in Earth's frame to be: $\Delta t = \frac{d_p}{v} = \frac{20.0\ ly}{0.8c} = \boxed{25 \text{ years}}$

39-8) b) The Eigenzeit (proper time) is therefore: $\Delta t_p = \frac{\Delta t}{\gamma} = \sqrt{1-\left(\frac{v}{c}\right)^2}\,\Delta t$

$$\Rightarrow \Delta t_p = \sqrt{1-(0.8)^2}\,(25 \text{ years}) = \boxed{15 \text{ years}}$$

39-8) c) $d = \frac{d_p}{\gamma} = \sqrt{1-(0.8)^2}\,(20\ ly) = \boxed{12\ ly}$

39-23) a)
$$L_{p,x} = \gamma L_x = \gamma L\cos\theta$$
$$L_{p,y} = L_y = L\sin\theta$$
$$L_p = \sqrt{L_{p,x}^2 + L_{p,y}^2} = L\sqrt{\gamma^2\cos^2\theta + \sin^2\theta}$$

$v = 0.995c$

$\theta = 30^\circ$

$$\Rightarrow \boxed{L_p \simeq 17.37\,\text{m}}$$

39-23) b)
$$\frac{L_{p,y}}{L_{p,x}} = \tan\theta_p = \frac{\tan\theta}{\gamma} \Rightarrow \theta_p = \underbrace{\tan^{-1}}_{\text{arc tan}}\left[\frac{\tan\theta}{\gamma}\right] \simeq \boxed{3.30^\circ}$$

39-42) a) First, we begin by finding the mass of the composite object, then we'll find the speed.

<u>Note</u>: $c = 1$ in these calculations! $\underset{A}{\bullet} \xrightarrow{\vec{v}_A} \underset{B}{\bullet} \Rightarrow \underset{C}{\bullet}\ \vec{v}_c \rightarrow$

So, $K_i = (\gamma_A - 1)m_A c^2$ or $K_i = (\gamma_A - 1)m_A$ for $c=1$ units!, where $\gamma_A = \left[1-\left(\frac{v_A}{c}\right)^2\right]^{-1/2}$

Using $E^2 = m^2 + p^2 \Rightarrow -m_A^2 + E_A^2 = p_A^2$, where $E_A = m_A + K_i$

$p_i = p_A$ & $p_f = p_c \Rightarrow p_A^2 = (m_A + K_i)^2 - m_A^2 = 2m_A K_i + K_i^2 = p_c^2$ by momentum conservation!

$\Rightarrow p_c^2 = E_c^2 - m_c^2 = 2m_A K_i + K_i^2 \Rightarrow m_c^2 = E_c^2 - 2m_A K_i - K_i^2$

Conservation of Energy entails: $E_i = K_i + (m_A + m_B) = E_f = E_c \Rightarrow E_c^2 = K_i^2 + 2(m_A + m_B)K_i + (m_A+m_B)^2$

$$\Rightarrow m_c^2 = 2m_B K_i + (m_A + m_B)^2 \qquad (1)$$

39-42) a) With c, Eqn. (1) looks like:

$$m_c^2 c^4 = 2 m_B K_i c^2 + (m_A + m_B)^2 c^4 \quad (2)$$

(Note: same derivation as the problem discussed in section!)

*Now let us solve for the velocity of the composite object, v_c!

Consider: $E_c^2 - m_c^2 c^4 = p_c^2 c^2$

$$E_c = \gamma_c m_c c^2 \Rightarrow (\gamma_c^2 - 1) m_c c^4 = p_c^2 c^2 \Rightarrow \gamma_c^2 - 1 = \left(\frac{p_c}{m_c c}\right)^2$$

$$\Rightarrow 1 - \left(\frac{v_c}{c}\right)^2 = \frac{1}{1 + \left(\frac{p_c}{m_c c}\right)^2} \Rightarrow v_c = \frac{c}{\sqrt{1 + \left(\frac{m_c c}{p_c}\right)^2}}$$

or for $c=1$ units: $v_c = \frac{1}{\sqrt{1 + \left(\frac{m_c}{p_c}\right)^2}}$, I used this eqn!

With $m_B = 1400$ kg, $m_A = 900$ kg & $v_A = 0.85c$,

I find $\boxed{v_c = 0.467\ c}$

39-42) b) Using Eqn. (1): $\boxed{m_c \simeq 2748.41\ \text{kg}}$

Please Note: This method of solving the problem is somewhat abstract... there are easier ways!!!

39-63) a) $u_x' = 0.8c$, $v = 0.6c$

$$\Rightarrow u_x = \frac{(0.8 + 0.6)c}{1 + (0.8)(0.6)} \simeq \boxed{0.946c}$$

39-63) b) $L = \frac{L_p}{\gamma} = (0.2\ ly)(1 - (0.6)^2)^{1/2} \simeq \boxed{0.160\ ly}$

39-63) c) As observed by aliens on mother ship:

$$\Delta t_{lander} = \frac{0.160\ ly}{0.8c + 0.6c} \simeq \boxed{0.114\ \text{years}}$$

39-63) d) $K = (\gamma_{u_x} - 1) mc^2$

$m = 4 \times 10^5$ kg

$$\gamma_{u_x} = \frac{1}{\sqrt{1 - \left(\frac{u_x}{c}\right)^2}}$$

$u_x = 0.946c$

$$\Rightarrow \boxed{K \simeq 7.51 \times 10^{22}\ \text{J}}$$