T3-17

$$\lambda_{min} = 400 \, nm$$

$$\lambda_{max} = 700 \, nm$$

$$n_{vesi} = 1,33$$

$$n_{ilma} = 1,00$$

$$\frac{\sin a_1}{\sin a_2} = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2} = n_{12}$$
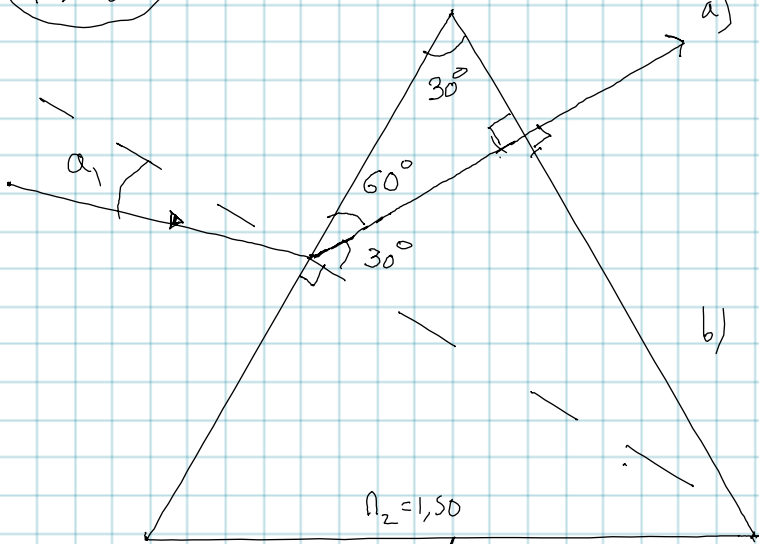
$$\lambda_2 \cdot n_2 = \lambda_1 \cdot n_1$$

$$\lambda_2 = \frac{\lambda_1 \cdot n_1}{n_2}$$

$$\lambda_3 = \frac{\lambda_{max} \cdot n_1}{n_2} = \frac{700 \, nm \cdot 1,00}{1,33}$$

$$\lambda_2 = \frac{\lambda_{min} \cdot 1,00}{1,33} = \frac{400 \, nm \cdot 1,00}{1,33}$$

$$\lambda_3 \approx 526 \, nm$$

$$\lambda_2 \approx 301 \, nm$$

Vastaus: Aallonpituus on välillä 300–530 nm.

T3-18

a) $$\frac{\sin a_1}{\sin 30°} = \frac{1,50}{1,00}$$

$$\sin a_1 = 1,50 \cdot \sin 30°$$

$$a_1 \approx 49°$$

b) $$\frac{\sin a_1}{\sin 30°} = \frac{1,50}{1,30}$$

$$\sin a_1 = \frac{1,50}{1,30} \cdot \sin 30°$$

$$a_1 \approx 35°$$

T3-19

$$\frac{\sin a_1}{\sin a_2} = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2} = \frac{c_1}{c_2}$$

$$\sin a_2 = \frac{n_1 \sin a_1}{n_2}$$

Suunnan muutos

$$\sin a_2 = \frac{1,00 \cdot \sin 30°}{1,5}$$

$$30° - 19,47° \approx 11°$$

$$a_2 \approx 19,47°$$

$$c_{lasi} = \frac{c}{n_{lasi}} = \frac{2,998 \cdot 10^8 \, m/s}{1,5} \approx 2,0 \cdot 10^8 \, m/s$$

$$f_{lasi} = f_{ilma} = \frac{c}{\lambda_{ilma}} = \frac{2,998 \cdot 10^8 \, m/s}{450 \cdot 10^{-9} \, m} \approx 0,67 \, PHz$$