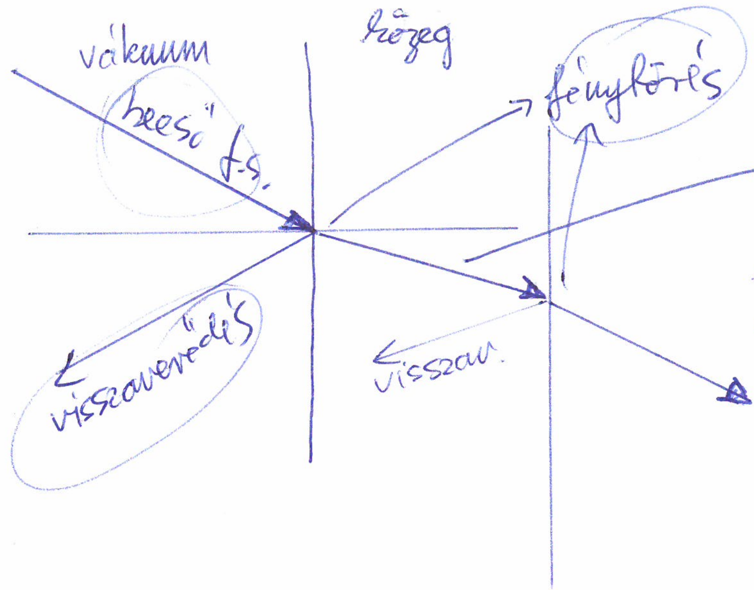
Fény kölcsönhatása közeggel

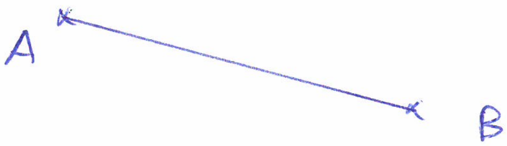


intenzitás gyengülés
- elnyelődés abszorpció
- szóródás
  - rugalmas
    - Mie!
    - Rayleigh
  - rugalmatlan
    - Raman

Fermat-elv: legkevesebb idő elve

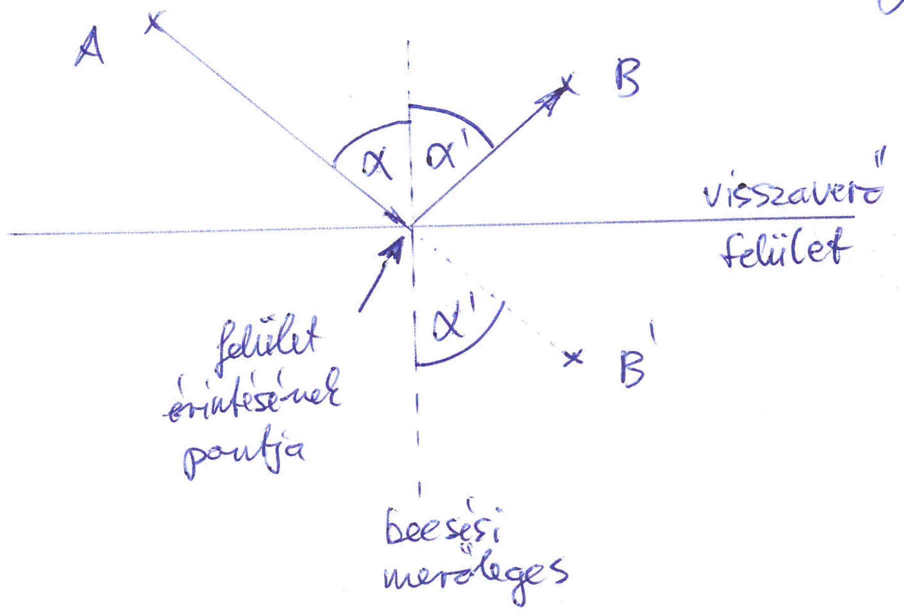
1.) terjedés egy adott közegben: egyenes vonalú terjedés

legkevesebb idő = legrövidebb út

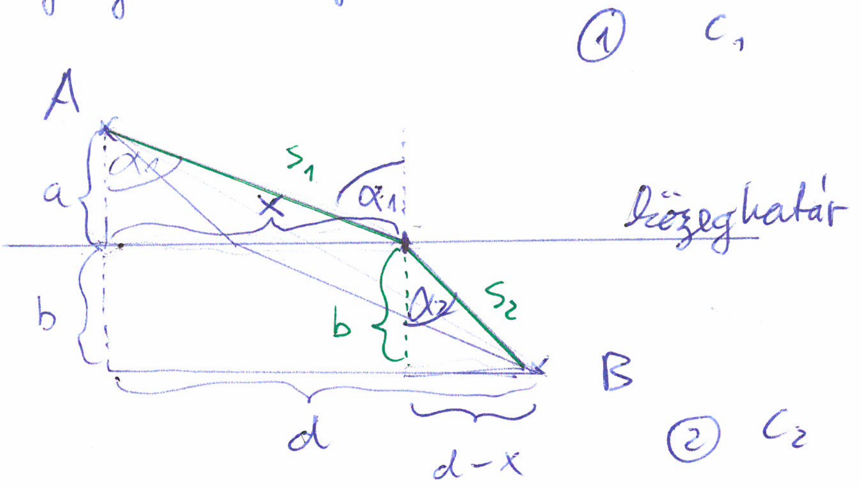


2.) visszaverődés (reflexió)

beesési szög → $\alpha = \alpha'$ ← visszaverődési szög



3, fénytörés (refrakció)



$$a^2 + x^2 = s_1^2$$

$$s_1 = \sqrt{a^2 + x^2}$$

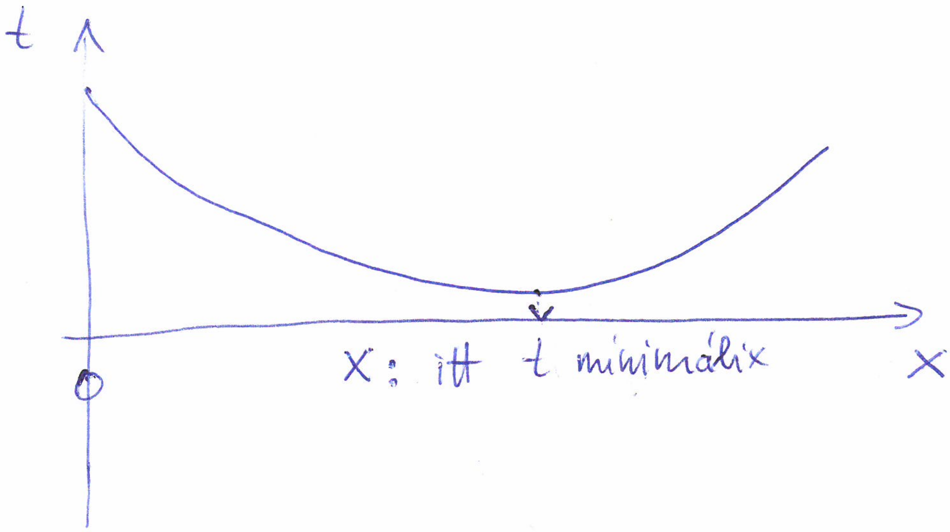
$$b^2 + (d-x)^2 = s_2^2$$

$$s_2 = \sqrt{b^2 + (d-x)^2}$$

$$v = \frac{s}{t} \Rightarrow t = \frac{s}{v}$$

$$t_1 = \frac{s_1}{c_1} = \frac{\sqrt{a^2+x^2}}{c_1} \qquad t_2 = \frac{s_2}{c_2} = \frac{\sqrt{b^2+(d-x)^2}}{c_2}$$

$$t = t_1 + t_2 = \frac{\sqrt{a^2+x^2}}{c_1} + \frac{\sqrt{b^2+(d-x)^2}}{c_2}$$



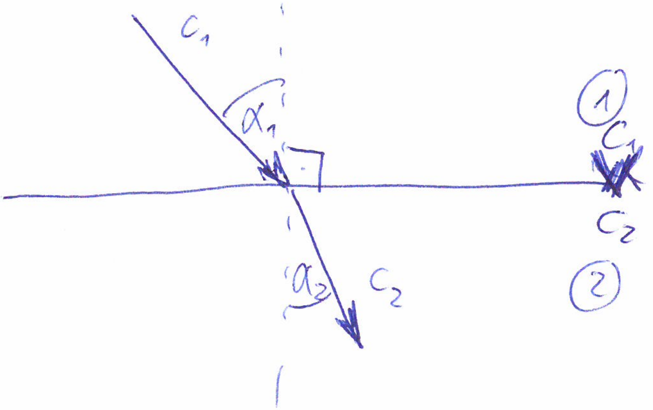
$$\frac{dt}{dx} = \frac{x}{c_1 \cdot \underbrace{\sqrt{a^2+x^2}}_{s_1}} - \frac{(d-x)}{c_2 \cdot \underbrace{\sqrt{b^2+(d-x)^2}}_{s_2}} = 0$$

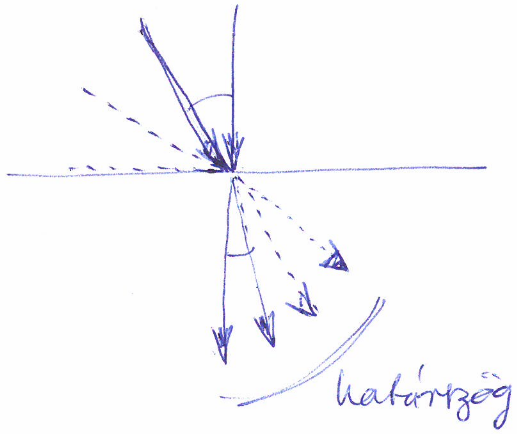
$$\frac{1}{c_1} \cdot \sin\alpha_1 - \frac{1}{c_2} \cdot \sin\alpha_2 = 0$$

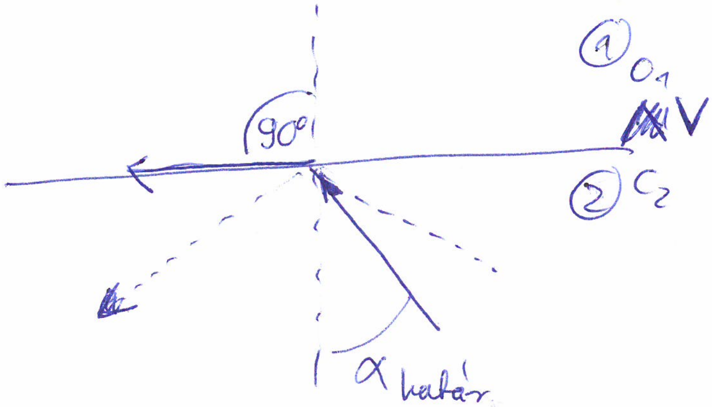
$$\frac{\sin\alpha_1}{c_1} = \frac{\sin\alpha_2}{c_2}$$

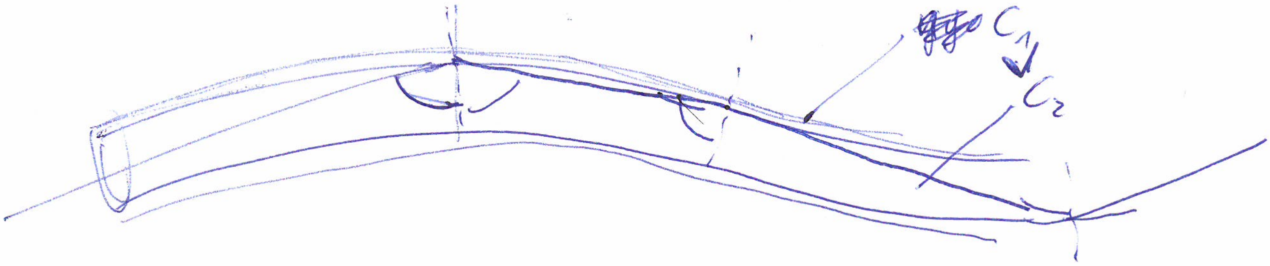
$$\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{c_1}{c_2} \Rightarrow \text{Snellius–Descartes törvény}$$

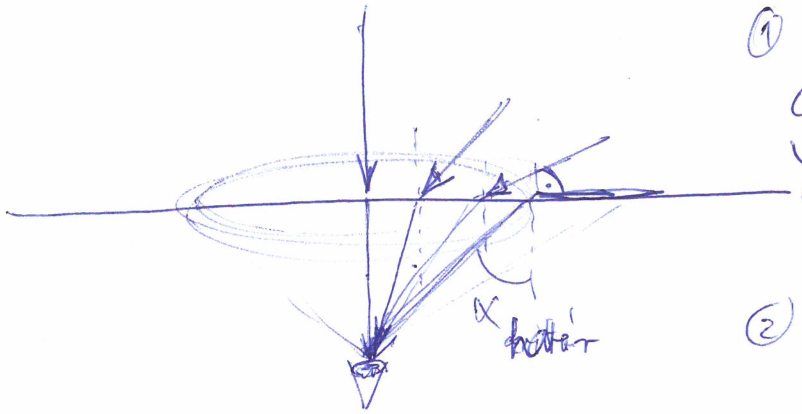
Felhasználások:











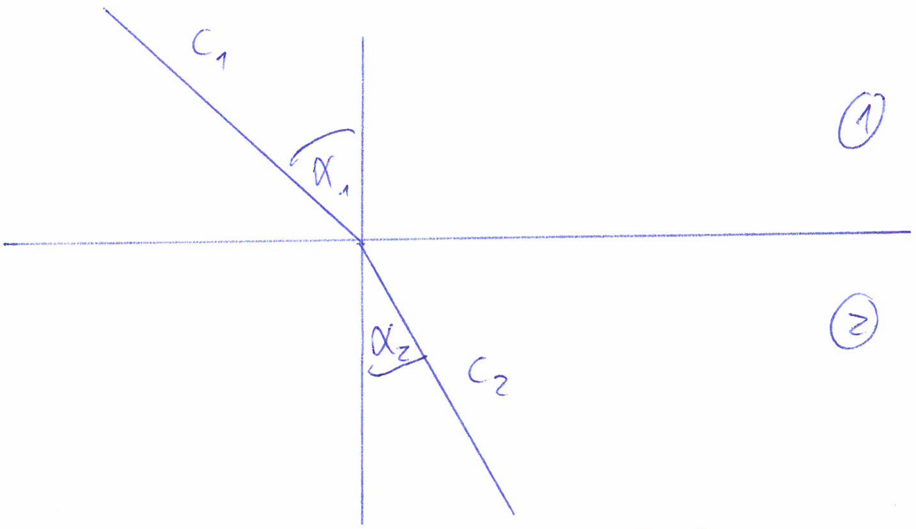
① levegő

$c_1 > c_2$

Snell-kör

② víz

$$\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{c_1}{c_2} = n_{2,1}$$



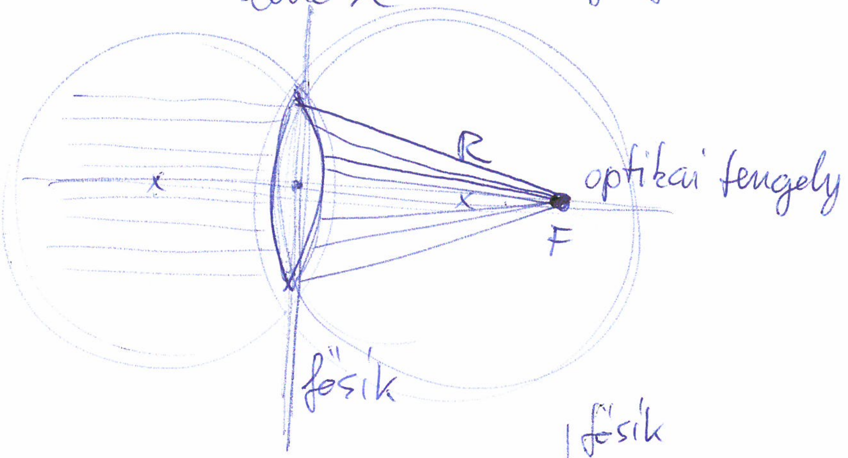
$$\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{c_1}{c_2} = n_{2,1} = \frac{\left(\frac{c_v}{n_1}\right)}{\left(\frac{c_v}{n_2}\right)} = \frac{n_2}{n_1} = \frac{\cancel{f}\cdot\lambda_1}{\cancel{f}\cdot\lambda_2}$$

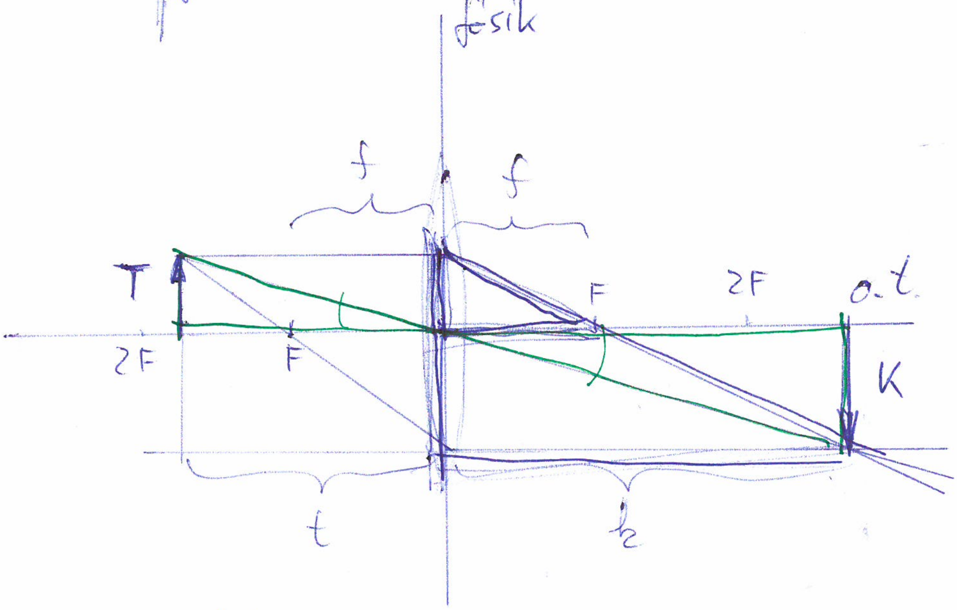
$$\frac{c_v}{c_2} = n_2 \qquad \frac{c_v}{c_1} = n_1$$

$$c_2 = \frac{c_v}{n_2} \qquad c_1 = \frac{c_v}{n_1}$$

$$c_2 = f\cdot\lambda_2 \qquad c_1 = f\cdot\lambda_1$$

lencse: vékony gömbi lencse



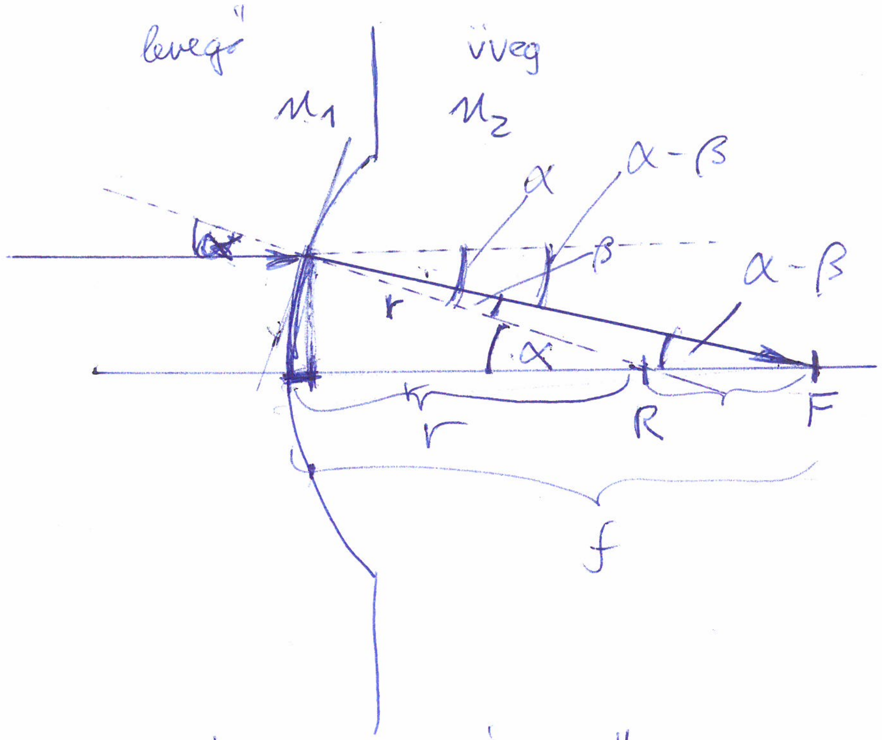


$$\frac{T}{t} = \frac{K}{k}$$

$$\frac{T}{f} = \frac{T+K}{k} = \frac{T}{k} + \frac{K}{k} = \frac{T}{k} + \frac{T}{t}$$

$$\frac{\cancel{T}}{f} = \frac{\cancel{T}}{k} + \frac{\cancel{T}}{t} \quad // : T$$

$$\boxed{\frac{1}{f} = \frac{1}{k} + \frac{1}{t}}$$



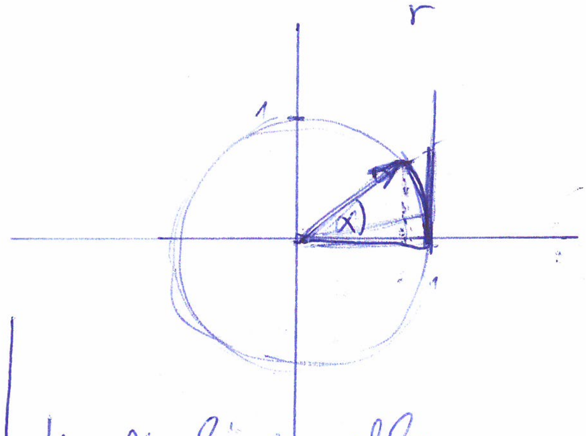
vékony lencse

paraxiális fénysugarak

$$\alpha = \frac{ív}{r}$$

$$\sin\alpha = \frac{ív'}{r}$$

$$\tan\alpha = \frac{ív''}{r}$$



(1) $\alpha = \frac{ív}{r}$ $\qquad ív \approx ív''$

$\tan(\alpha-\beta) = \frac{ív''}{f} \approx \alpha-\beta$ (2)

(3) $\frac{\beta}{\alpha} \approx \frac{\sin\beta}{\sin\alpha} = \frac{n_1}{n_2}$

ha α kicsi akkor

$\alpha \approx \sin\alpha \approx \tan\alpha$

(1) $ív = \alpha \cdot r$

(2) $ív'' = (\alpha-\beta)\cdot f$

(1) $\approx$ (2)

$$\alpha \cdot r = (\alpha-\beta)\cdot f$$

$$\frac{r}{f} = \frac{\alpha-\beta}{\alpha} = \frac{\alpha}{\alpha} - \frac{\beta}{\alpha} = 1 - \frac{\beta}{\alpha} = 1 - \frac{n_1}{n_2} = \frac{n_2}{n_2} - \frac{n_1}{n_2} = \frac{n_2-n_1}{n_2}$$

$$\frac{r}{f} = \frac{n_2-n_1}{n_2}$$

$$D = \frac{n_2}{f} = \frac{n_2-n_1}{r}$$ a görbült felület törőereje

lencse: két törőfelület

$$D = \underbrace{D_1}_{\frac{n_2}{f_1} = \frac{n_2 - n_1}{r_1}} + D_2$$

$$\frac{n_2}{f_2} = \frac{n_2 - n_1}{r_2}$$

$$D = \frac{n_2 - n_1}{r_1} + \frac{n_2 - n_1}{r_2} =$$

$$\boxed{D = (n_2 - n_1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)}$$

levegő esetén $n_1 \approx 1$

Szögnagyítás

$$N = \frac{\tan\beta}{\tan\alpha}$$

$\tan\beta$ – nagyított látószög

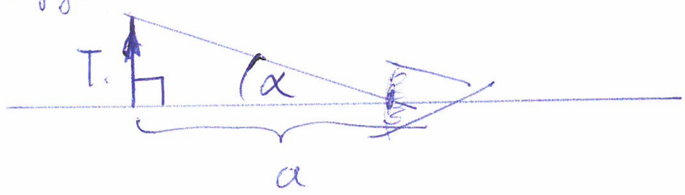
$\tan\alpha$ – eredeti látószög

1., Lupe (egyszerű nagyító)

- nagyító nélkül

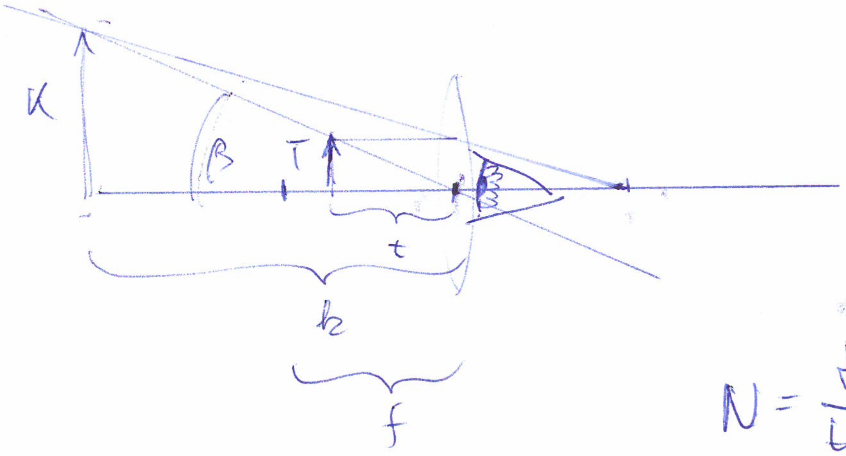
éleslátás távolsága

$a = 25\,\text{cm}$



$$\tan\alpha = \frac{T}{a}$$

- nagyítóval



$$\frac{1}{t} = \frac{1}{f} - \frac{1}{k}$$

$$N = \frac{\tan\beta}{\tan\alpha} = \frac{\frac{K}{k}}{\frac{T}{a}} = \frac{\frac{T}{t}}{\frac{T}{a}} = \frac{T}{t}\cdot\frac{a}{T} = \frac{a}{t}$$

$$\tan\beta = \frac{K}{k} = \frac{T}{t}$$

$$N = \frac{a}{t} = a\cdot\frac{1}{t} = a\cdot\left(\frac{1}{f} - \frac{1}{k}\right)$$

$k = -a$:

$$a\cdot\left(\frac{1}{f} + \frac{1}{a}\right) = \frac{a}{f} + \frac{a}{a} = \underline{\underline{\frac{a}{f} + 1}}$$

$k = \infty$:

$$a\cdot\left(\frac{1}{f} - \frac{1}{\infty}\right)$$

$$a\cdot\left(\frac{1}{f} - 0\right)$$

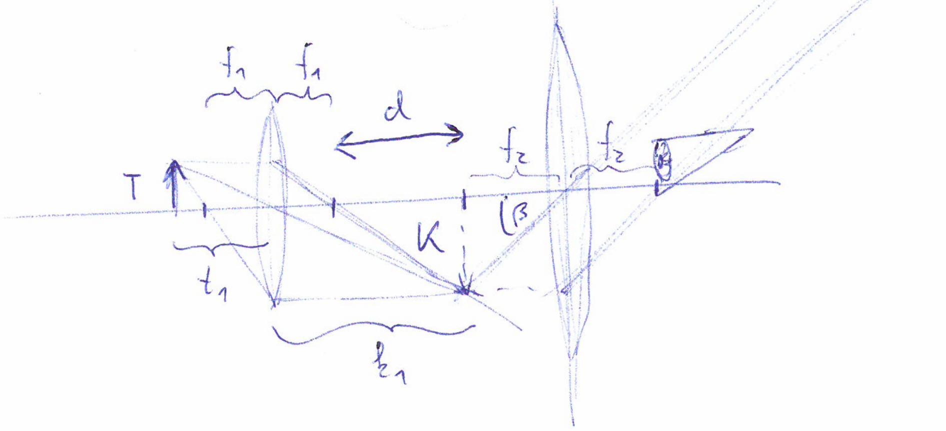
$$\underline{\underline{\frac{a}{f}}}$$

Extra anyag:

2, Mikroszkóp szögnagyítása

$$\tan\alpha = \frac{T}{a}$$

$d = k_1 - f_1$ optikai tubushossz



$$\tan\beta = \frac{K}{f_2}$$

$$N_{szög} = \frac{\tan\beta}{\tan\alpha} = \frac{\left(\frac{K}{f_2}\right)}{\left(\frac{T}{a}\right)} = \frac{K}{f_2} \cdot \frac{a}{T} = \frac{K}{T} \cdot \frac{a}{f_2} = \frac{k_1}{t_1} \cdot \frac{a}{f_2} = \frac{1}{t_1} \cdot \frac{k_1 \cdot a}{f_2}$$

$$\frac{1}{f} = \frac{1}{k} + \frac{1}{t} \Rightarrow \frac{1}{t_1} = \frac{1}{f_1} - \frac{1}{k_1} = \frac{k_1 - f_1}{f_1 k_1} = \frac{d}{f_1 k_1}$$

$$N_{szög} = \frac{d}{f_1 \cancel{k_1}} \cdot \frac{\cancel{k_1} a}{f_2} = \underline{\underline{\frac{d\,a}{f_1 f_2}}}$$