UBT Lab (30dk) Fizik LAB 071020 (1)

0830 → 930 Yasin (8.10) → 1030 persembe

1330 ↙ Lab

0 1 2 3 4 5 6 7 8 9. 10

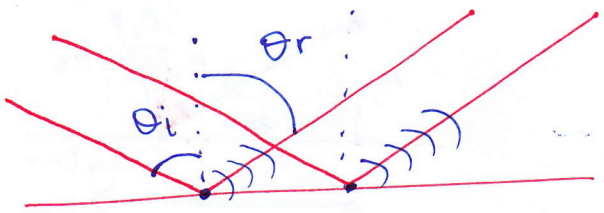
1 unite → giris EM dalga spektrum (tayf) | $E = \frac{hc}{\lambda}$ | $f = \frac{c}{\lambda}$

2 unite ⇒ Geometrik Optik

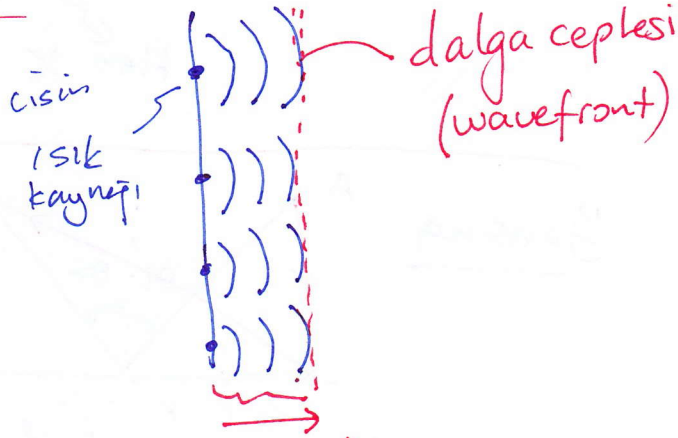
Newton ışık paracık ~ Christian Huygens (dalga)

↳ tezat "Newton halkaları"

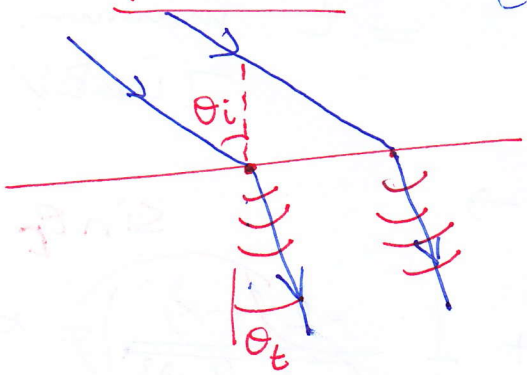
Yansıma $\theta_i = \theta_r$



i = incident (gelen)
r = reflected (yansıyan)



Kırılma t = transmitted



snell yasası

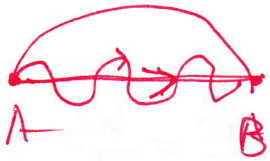
$n_i \sin\theta_i = n_t \sin\theta$

n_i = ilk ortamın kırılma indisi
n_t = geçen " "

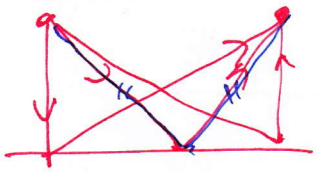
Fermat İlkesi

MÖ 2. yy Hero ⟹ ışık en kısa yolu (doğrusallık) takip eder.

Fermat ⇒ 2 nokta arasında yayılan ışık en kısa sürede gideceği yolu takip eder.

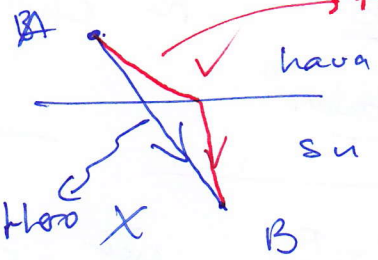


yansıma



en kısa yol ✓ Fermat ✓

kırılma



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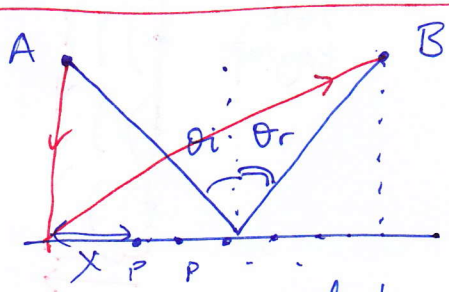
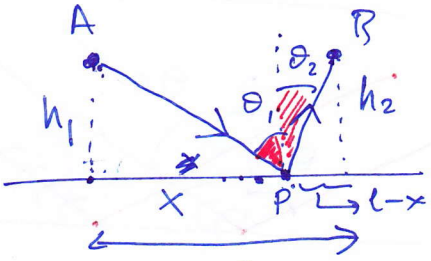
yansıma





Fermat $\underset{=}{t}$ en az olmalı!

$A \to B$ t ? c = ışık hızı

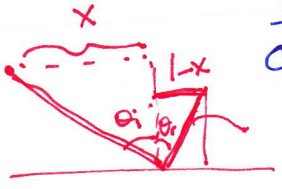
$$\frac{\sqrt{h_1^2 + x^2}}{c} + \frac{\sqrt{h_2^2 + (l-x)^2}}{c} = t \text{ minimum.}$$

TÜREV

$$\frac{dt}{dx} = 0 \qquad (h_1^2 + x^2)^{\frac{1}{2}} \to$$

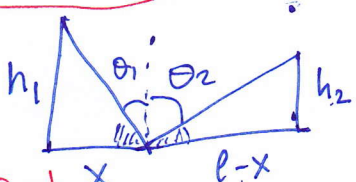
$$\frac{1}{c}\left(\frac{1}{2}\cdot\frac{2x}{(h_1^2+x^2)^{+1/2}} + \frac{1}{2}\cdot\frac{-2(l-x)}{\sqrt{h_2^2+(l-x)^2}}\right) = 0$$

$\sin\theta_i$ $\qquad$ $\sin\theta_r$



$\sin\theta_i - \sin\theta_r = 0$

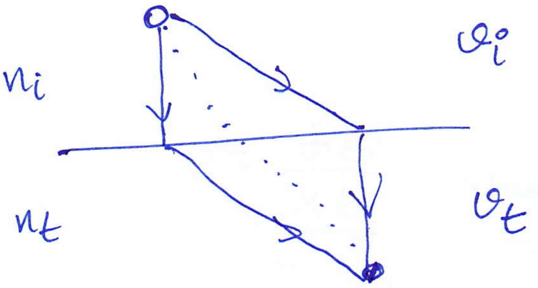
$\sin\theta_i = \sin\theta_r \Rightarrow \theta_i = \theta_r$

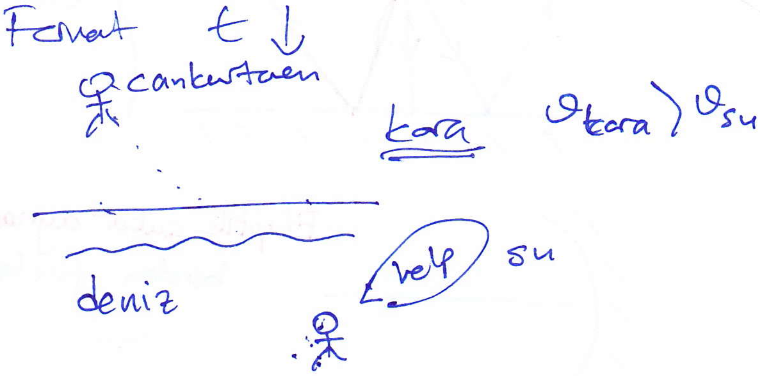


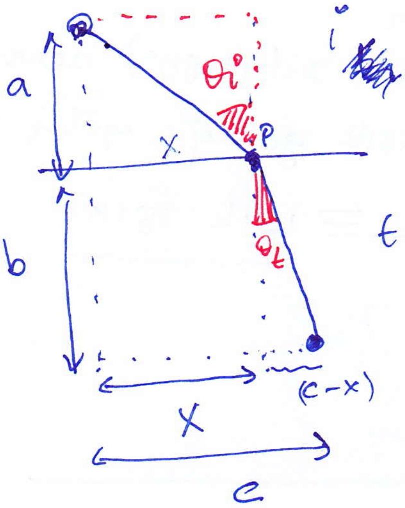
$\theta_1 = \theta_2$ (yansıma)

$$\frac{h_1}{x} = \frac{h_2}{l-x}$$

KIRILMA







$$\frac{x}{v} = t$$

$$\frac{\sqrt{a^2+x^2}}{v_i} + \frac{\sqrt{b^2+(c-x)^2}}{v_t} = t$$

$$\frac{dt}{dx} = 0$$

t nin min. olduğu x nedir?

$v_i > v_t$

$$\frac{dt}{dx} = \frac{\frac{1}{2}\,2x\,(a^2+x^2)^{-1/2}}{v_i} + \frac{\frac{1}{2}\,2\,(-1)\,(c-x)\,(b^2+(c-x)^2)^{-1/2}}{v_t} = 0$$

(bracketed terms: $\sin\theta_i$ and $\sin\theta_t$)

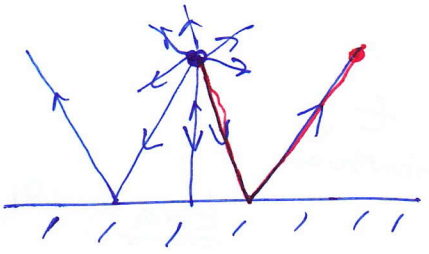
$$\sin\theta_i = \frac{x}{\sqrt{a^2+x^2}} \qquad \sin\theta_t = \frac{c-x}{\sqrt{b^2+(c-x)^2}}$$

$$0 = \frac{\sin\theta_i}{v_i} - \frac{\sin\theta_t}{v_t} \Rightarrow \frac{\sin\theta_i}{v_i} = \frac{\sin\theta_t}{v_t}$$

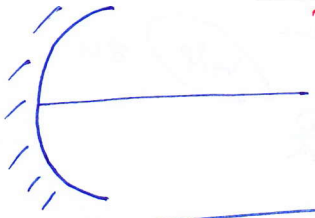
$$v_i = \frac{c}{n_i} \ ; \ v_t = \frac{c}{n_t}$$

$$n_i \frac{\sin\theta_i}{c} = n_t \frac{\sin\theta_t}{c}$$

Snell yasası



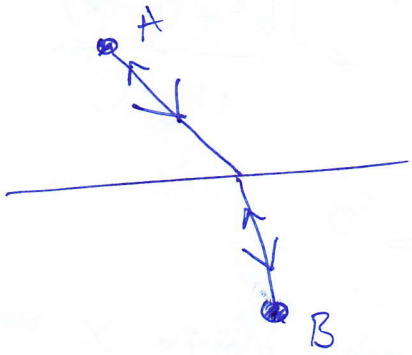
} en hızlı (en kısa sürede) yolu takip ediyor.



Eliptik çukur aynada birden fazla yol vardır. $\frac{dt}{dx} = 0$

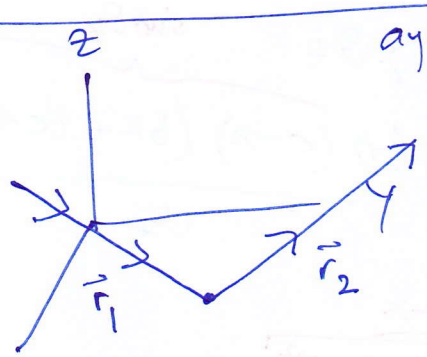
Tersinebilme ilkesi

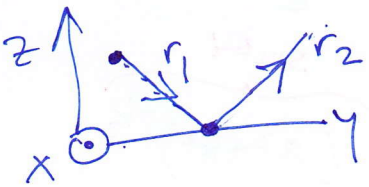
$A \to B$
$B \to A$



ışın yönü $2.t(180°)$ aynı ışık geldiği yolu takip eder.

ışık $\equiv$ ışık ışını

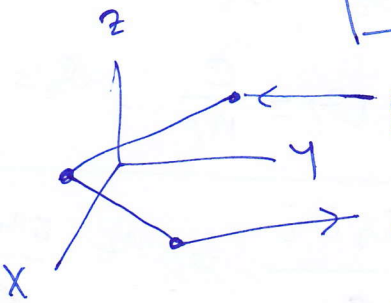




$(x, y, -z) \Rightarrow (x, y, +z)$

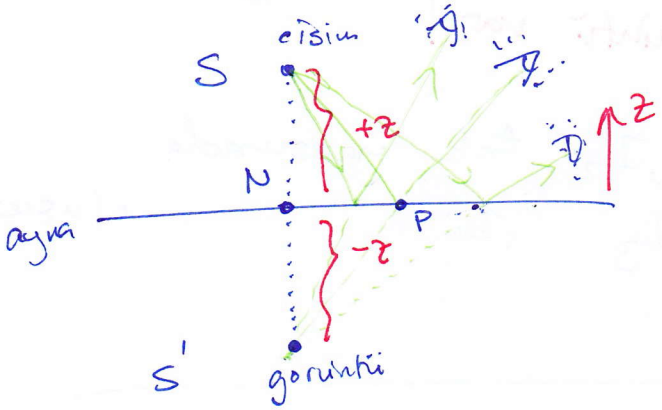
$\vec{r}_1$ $\quad$ $\vec{r}_2$

yansıma $-z \to z$
xy düz. $z \to -z$



$xyz \xrightarrow{zy} -xyz \xrightarrow{zx} -x-yz \xrightarrow{xy} -x-y-z$

DUZLEM AYNADA GORUNTU

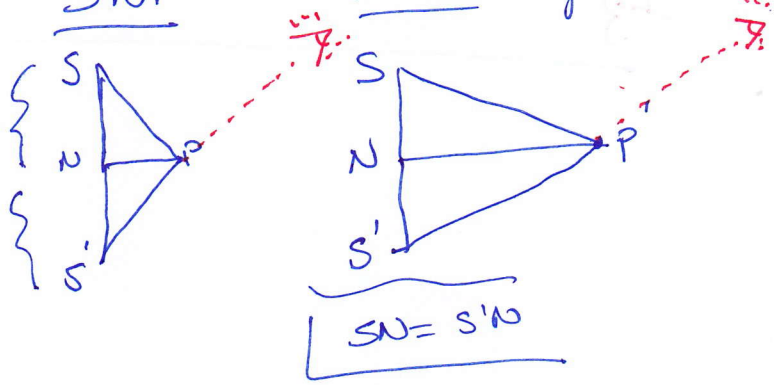


gözün konumu goruntunun yerini degistiremez.

S' den cikan isin

SNP üçgenleri

S'NP üçgenleri



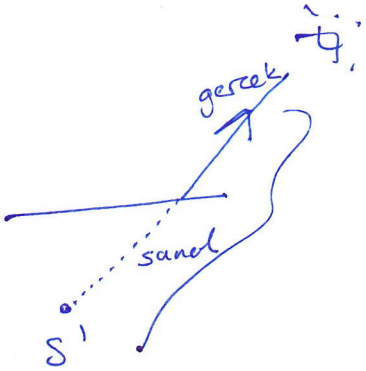
SN = S'N

SN = S'N

gercek isin: S den cikti P'den yansıdı göze geldi

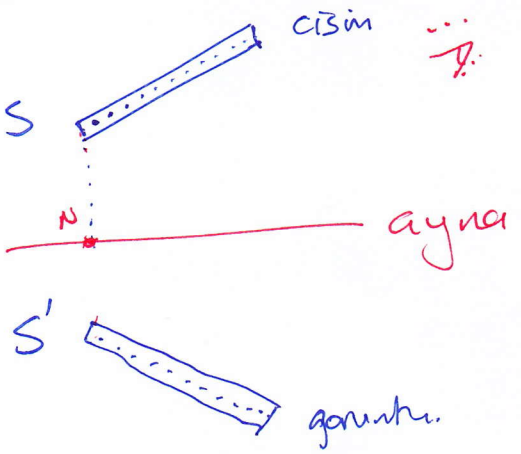
goruntüden cikan isin (S') den kaynaklıdır.

sanal görüntü
zahiri "
(imaginary image)
} sanal ışınlardan oluşan goruntüdür



⇒ gerçek ışınlar bir perdeye düşürebilir.

S' sanal bir goruntüdür = gerçek goruntü değildir.

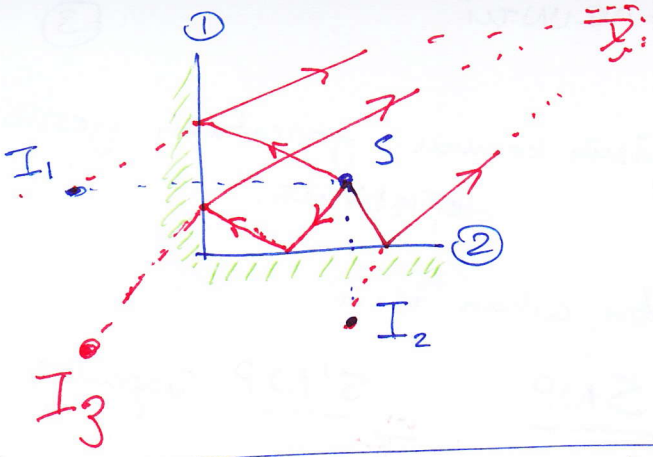


Simetri (I) → goruntü aynaya esit mesafededir.

(II) aynı büyüklüktedir goruntü cisimle

---

xyz → xy-z
sağ el → sol el



3 görüntü var!

I_1, I_2 fark yansımada

I_3 iki " oluşur.

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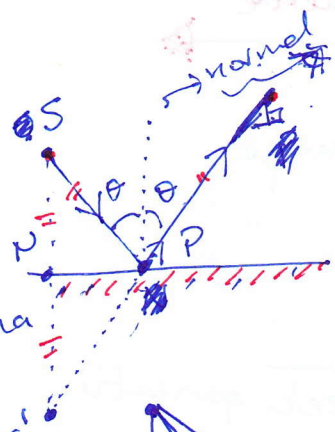
notları da okuyarak anlamadığınız yerleri bana email yolu ile sorabilirsiniz. - DK

optik

2. Bölüm – Geometrik optik



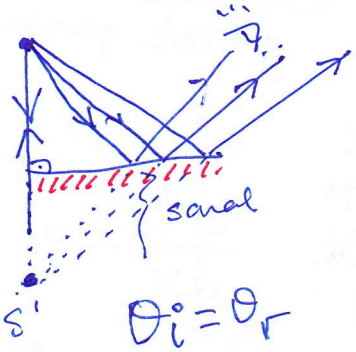
$SNP = S'NP$

S' görüntüsü sanal

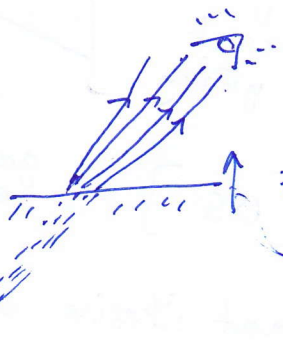
Simetri

Fermat ilkesi

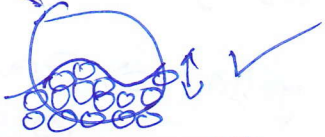
en kısa sürede gidilecek yolu tercih eder!



$\theta_i = \theta_r$



⇒



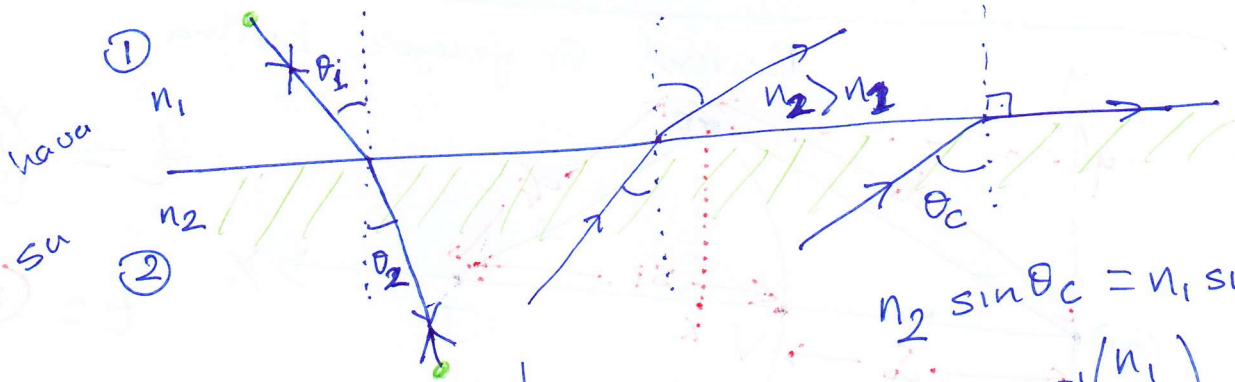
; gerçek ışın perdeye yüzeye düşürebileceğiniz ışınlar.

DÜZLEM YÜZEYDEN KIRILMA

Snell yasası (Fermat ...) (refraction)

$n_1 \sin\theta_i = n_t \sin\theta_t$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$



$n_2 \sin\theta_c = n_1 \sin 90$

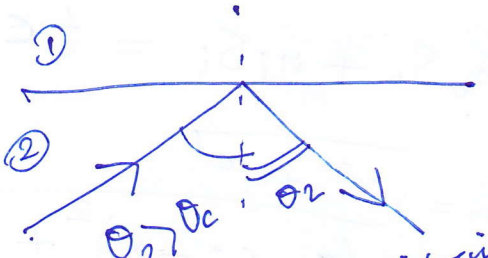
$\theta_c = \sin^{-1}\left(\frac{n_1}{n_2}\right)$

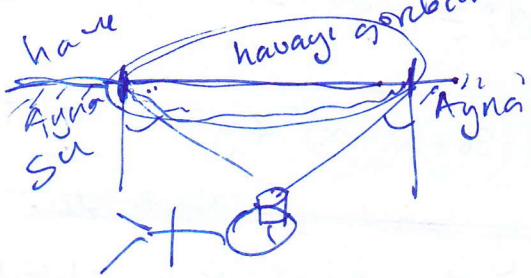
$n_1 = 1$

$n_2 = 4/3$

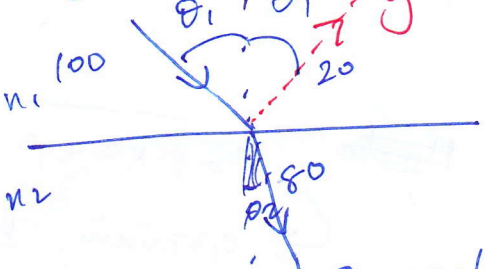
$\theta_c = \sin^{-1}\left(\frac{3}{4}\right) \simeq 48.6°$

$\theta_2 > \theta_c$; tam iç yansıma



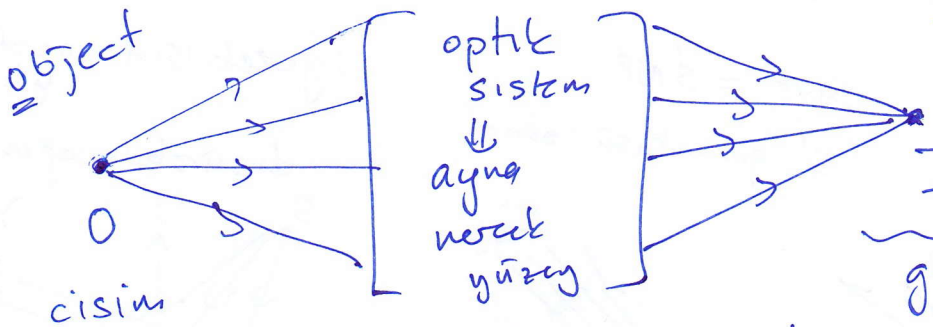


Her yüzey az da olsa yansıtır.



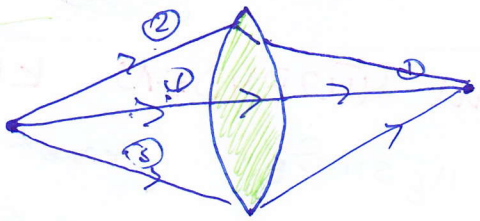
Snell yasası θ açılarını verir.

optik bir sistemde görüntüleme



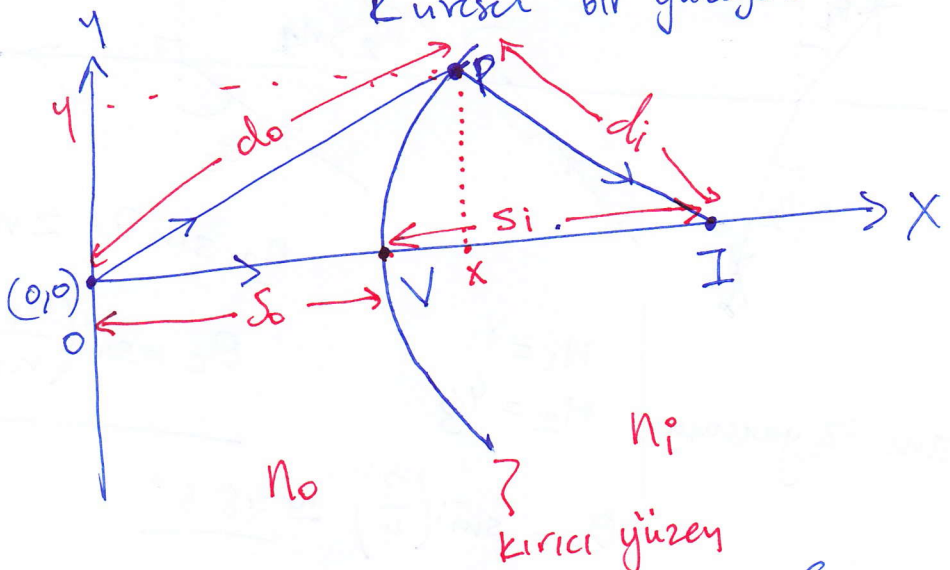
gerçek cisim uzayı $[OS]$ gerçek görüntü uzayı

Işın yolları $\Rightarrow$ Fermat ilkesine uygun. $\frac{dt}{dx} = 0$



birden fazla yol var!

Küresel bir yüzeyde kırılma



$$t = \frac{x}{v} = \frac{x}{(c/n)}$$

$$t = \frac{nx}{c} \hookrightarrow sbt$$

$$n_o d_o + n_i d_i = n_o s_o + n_i s_i = t\epsilon = sbt$$

P(x,y) koordinatı

$$d_o = \sqrt{x^2 + y^2}$$

$$d_i = \sqrt{(s_o + s_i - x)^2 + y^2}$$

$$n_o \sqrt{x^2+y^2} + n_i \sqrt{(s_o+s_i-x)^2+y^2} = sbt$$

$x^2+y^2=r^2$

↳ çözümü hangi x,y için ışın tanımlıdır

Bunun kırıcı yüzeyde hangi x,y noktalarından geçeceğini söyler.

Denklem çözümü parabol; hiperbol

ideal yüzeyler → parabol
→ hiperbol

⇒ gerçekte ≡ küresel olarak üretiliyor.

kolay ← R

x,y
z
paraksiyel

parabol ≅ hiperbol ≅ küre

küçük açılarda birbirine eşit

$$\sin\theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \dots$$

$$\cos\theta = 1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \dots$$

$\theta \Rightarrow$ küçük → $\sin\theta \simeq \theta$; $\cos\theta \simeq 1$

↳ $\tan\theta \simeq \theta$

radyan . derece

$3.14 = \pi = 180^\circ$

$\frac{3.14}{180} = 1^\circ$

$1\,rad = \frac{180}{3.14} =$

$1\,rad = 57.3^\circ$

$\tan\theta \simeq \frac{\sin\theta}{\cos\theta \simeq 1} \simeq \theta$ | Radyan

radyan $\sin(0.1) \simeq 0.099$

$0.1\,rad = 5.7^\circ$

$\sin(0.2\,rad) = 0.198 \simeq 0.2$

$\sin(\theta) \simeq \theta$; 0,2rad ≅ 11.4°

0.3 rad = 17.1°

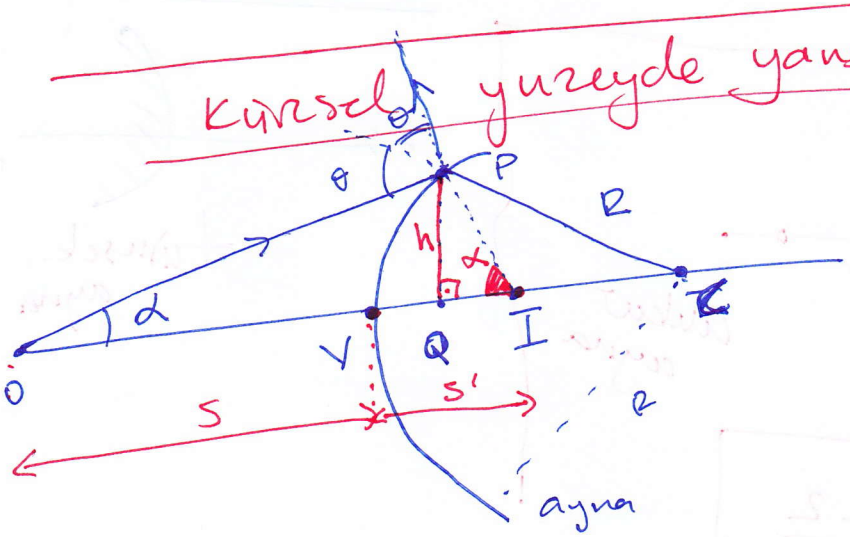
0.5 rad = 28.5°

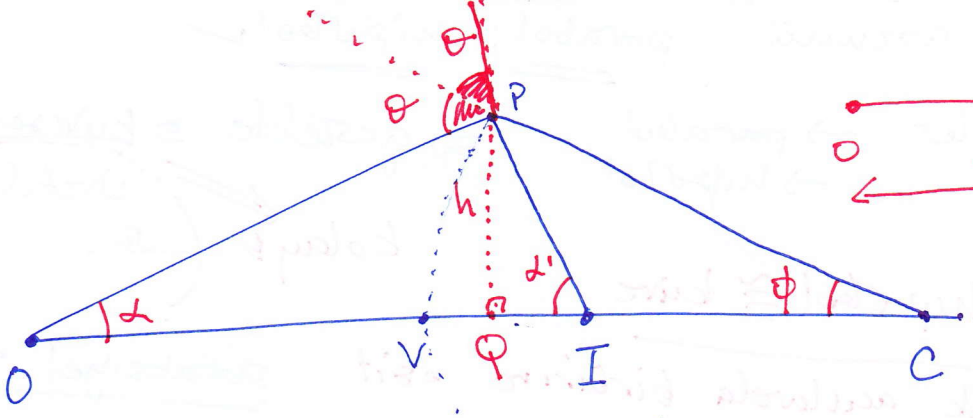
1 rad = 57.3°

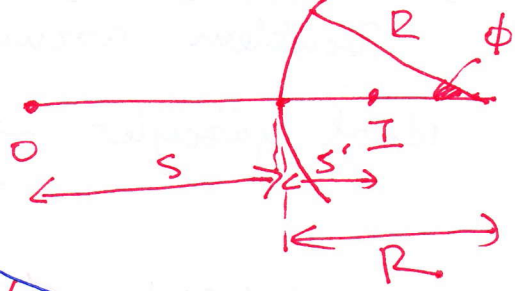
$\sin(0.5\,rad) = 0.48$ %4

$\sin(1\,rad) = 0.84$ → %16 sapma

Küresel yüzeyde yansıma







$\triangle PC$ üçgeni $\quad \theta = \alpha + \phi$

$\triangle PI$ üçgeni $\quad 2\theta = \alpha + \alpha'$

$$2\theta = \alpha + \alpha'$$
$$-(2\theta = 2\alpha + 2\phi)$$
$$\theta = -\alpha + \alpha' + 2\phi$$

$$\boxed{\alpha' - \alpha = +2\phi}$$

$\tan\alpha \simeq \alpha \simeq \sin\alpha$

$\tan\alpha' \simeq \alpha' \simeq \sin\alpha'$

$OV \cong QQ$

$V\varphi \simeq 0$

α

$VI \cong QI$

$V\varphi \simeq 0$

α'

$S = OV \simeq OQ$

$S' = VI \simeq QI$

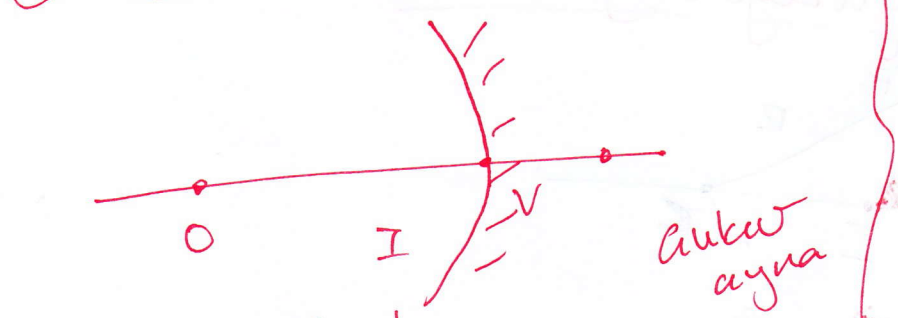
$QC \simeq VC \simeq R$

ϕ

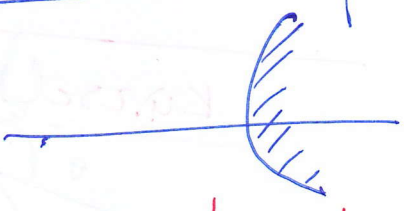
$$\frac{h}{S'} - \frac{h}{S} = \frac{2h}{R}$$

$$\alpha' - \alpha = 2\phi$$

$$\frac{1}{S'} - \frac{1}{S} = \frac{2}{R} \Rightarrow \frac{1}{S} - \frac{1}{S'} = -\frac{2}{R}$$



çukur ayna



tümsek ayna

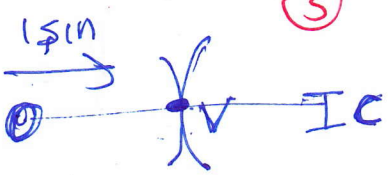
α, α', ϕ

$$\boxed{\frac{1}{S} + \frac{1}{S'} = \frac{-2}{R}}$$

O: cisimin yeri
I: goruntunun yeri
V: aynanin tepesi
C: aynanin merkezi
Isik soldan → saga

Aynalar

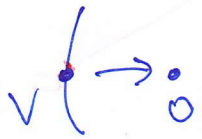
Tumsek cukur
dis bukey ic bukey



$$\frac{1}{S} + \frac{1}{S'} = -\frac{2}{R}$$

*** 1) O noktası V'nin solunda O ← V

O " V'nin sağında



$S < 0$
cisim sanal.

cisim uzaklığı $S > 0$
gerçek cisim

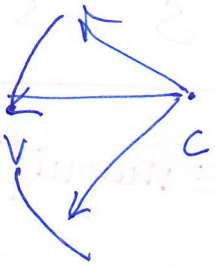
2) I noktası V'nin solunda I ← V

$S' > 0 \Rightarrow$ gerçek görüntü

I " V'nin sağında V → I

$S' < 0 \Rightarrow$ sanal görüntü

3) C noktası V'nin sağında



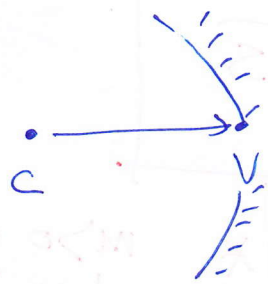
$V \rightarrow C$

Dış bukey ayna

$\Rightarrow R > 0$
eğrilik yarıçapı

C " V'nin solunda C ← V

$\Rightarrow R < 0$



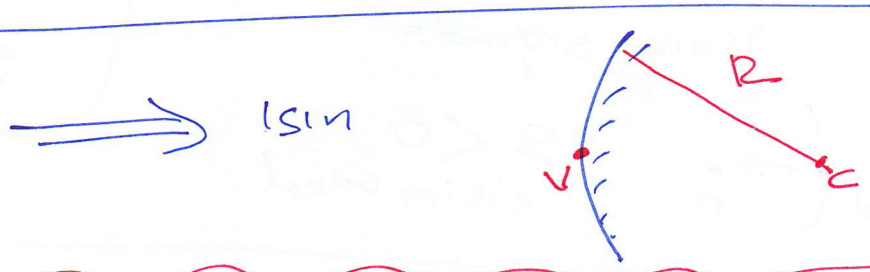
İç bukey ayna

$\frac{1}{S} + \frac{1}{S'} = -\frac{2}{R}$; $S \overset{+}{\underset{-}{}}$ $R \overset{+}{\underset{-}{}}$ $S' \overset{+}{\underset{-}{}}$

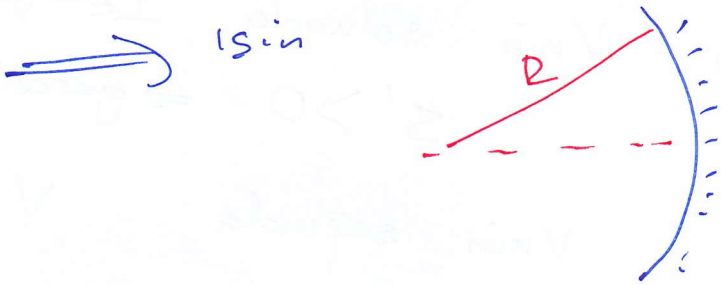
f = focus ≡ odak noktası

$f \equiv -\frac{R}{2}$ (yarıçapın yarısına odak (−1) × uzunluğu denir)

$$\frac{1}{s} + \frac{1}{s'} = -\frac{2}{R} = +\frac{1}{f}$$



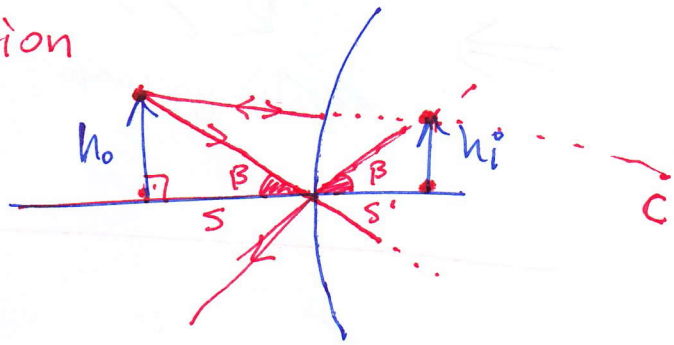
dışbükey
tümsek
R +
f +



içbükey
çukur
R −
f +

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} = -\frac{2}{R} \qquad f \equiv -\frac{R}{2}$$

m ≡ büyütme ≡ magnification
katsayı

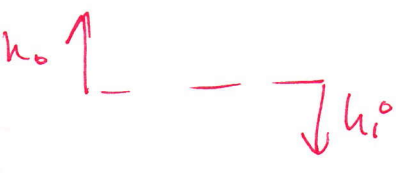


$$|m| \equiv \frac{h_i'}{h_0} = \frac{s'}{s}$$

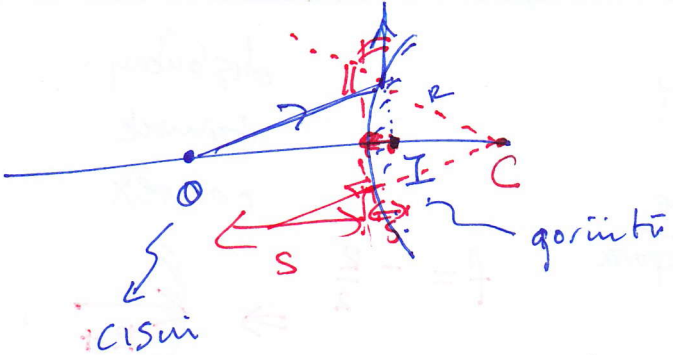
$$\frac{h_0}{s} = \frac{h_i'}{s'}$$

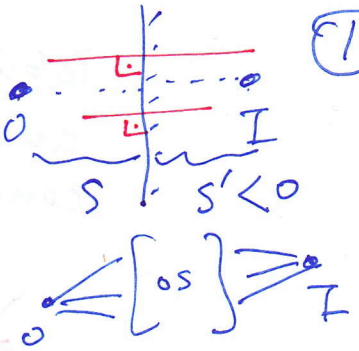
$$m = -\frac{s'}{s}$$

✗ m>0 ! düz
✗ m<0 ters !



14 10 20
optik





(1)

O - I

eşlenik doğrultu

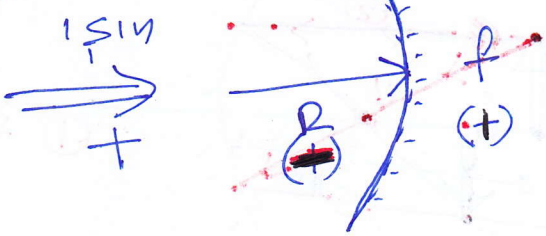
conjugate

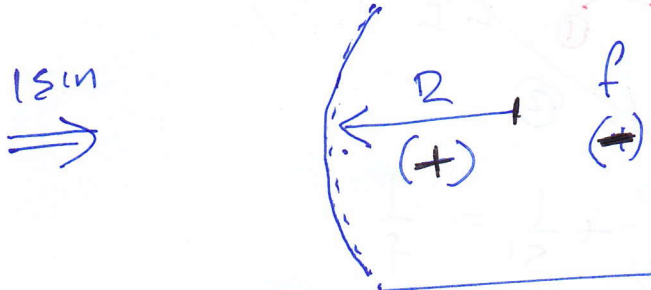
$$\frac{1}{s} - \frac{1}{s'} = -\frac{2}{R}$$

$$\frac{1}{s} + \frac{1}{s'} = -\frac{2}{R} = \frac{1}{f}$$

$$f = -\frac{R}{2}$$

R s → +
↳ −

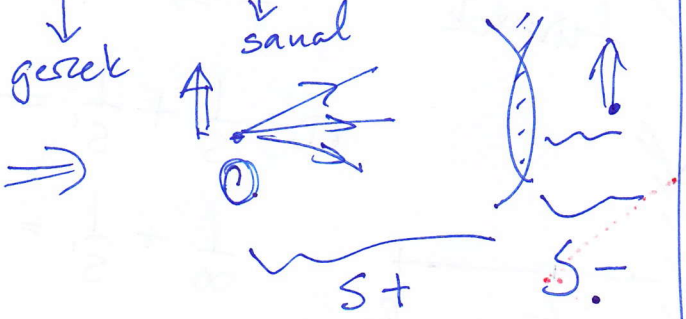




s (cisim)

gerçek

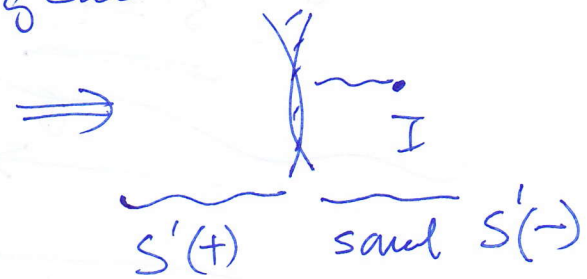
sanal



s' (görüntü)

gerçek

sanal



$$m = -\frac{s'}{s}$$

$|m| > 1$ büyüme

$|m| < 1$ küçülme

(+) düz

(−) ters

içbükey
çukur
concave
mercek

dışbükey
tümsek
convex

$f = -\frac{R}{2}$ ⇒ R +

⇒ C R(+) V

$f \Rightarrow (+)$

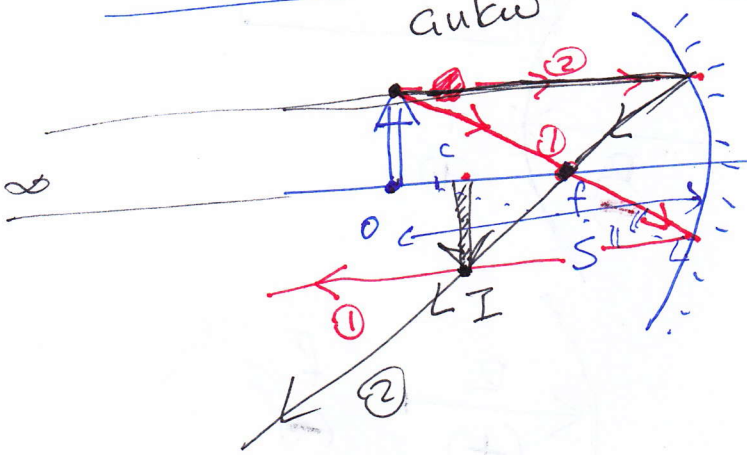
$f \Rightarrow (+)$

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

s, s' ışının optik ekseni kestiği konum.

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$

çukur



① $s = f$ $\quad \frac{1}{f} + \frac{1}{s'} = \frac{1}{f}$

$s' \to \infty$ $\quad \frac{1}{s'} = 0$

sonsuzda optik ekseni keser! (paralel)

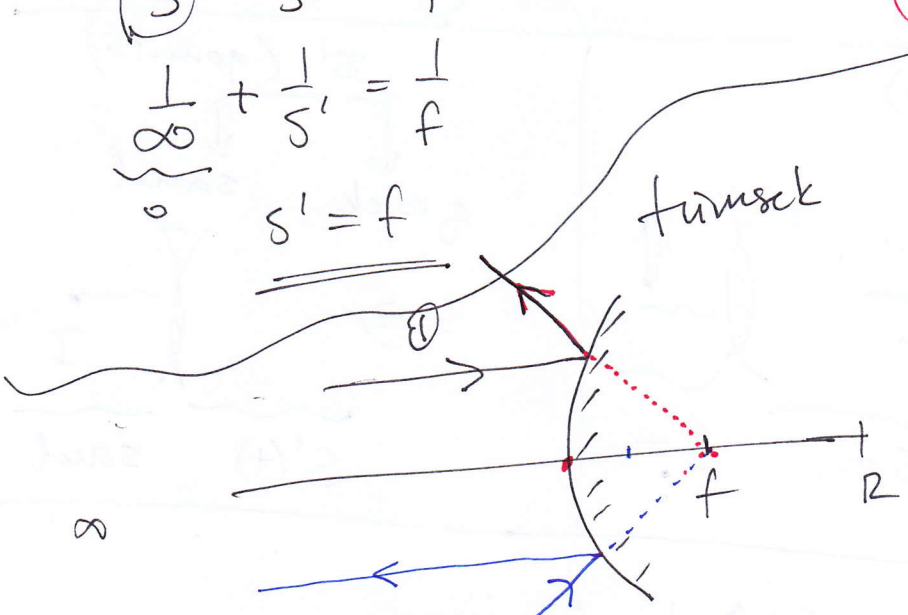
$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$

$\frac{1}{\infty} + \frac{1}{s'} = \frac{1}{f}$

0 $\quad s' = f$

tümsek

$f \Rightarrow -f$



① $\frac{1}{s} + \frac{1}{s'} = -\frac{1}{f}$

$\frac{1}{\infty} + \frac{1}{s'} = \frac{1}{-f}$

$s' = -f$

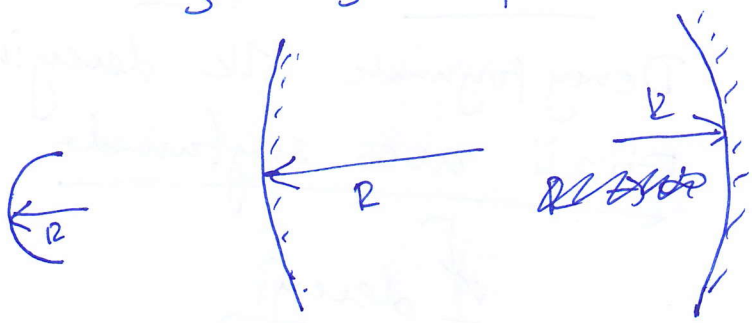
② ↝ $s = -f$ $\quad \frac{1}{s} + \frac{1}{s'} = \frac{1}{-f}$

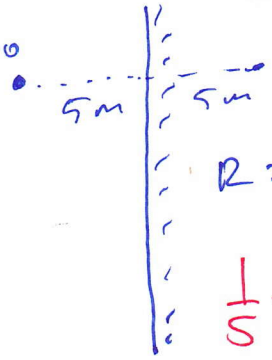
$\frac{1}{-f} + \frac{1}{s'} = -\frac{1}{f}$

$s' = \infty$ 'da keser

(2)

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} = -\frac{2}{R}$$





$$\frac{1}{s} + \frac{1}{s'} = -\frac{2}{\infty} \quad (90°)$$

$$m = -\frac{s'}{s}$$

$$m = -\frac{s'}{s} = 1 \quad \frac{1}{s} = -\frac{1}{s'}$$

$$\boxed{s = -s'}$$

$$\boxed{m = +1}$$

$s' = s \quad m = -1$

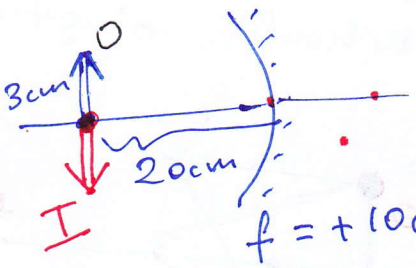
aynı O noktası R üzerinde

3cm yükseklikte $f = 10$cm olan ⓐ içbükey (çukur) ⓑ dışbükey (tümsek)

küresel aynadan 20 cm uzaklığa yerleştiriliyor.

$s' = ? \quad m = ?$

(a)



$f = +10$cm

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s'} = \frac{1}{f} - \frac{1}{s}$$

$$\frac{1}{s'} = \frac{s-f}{fs}$$

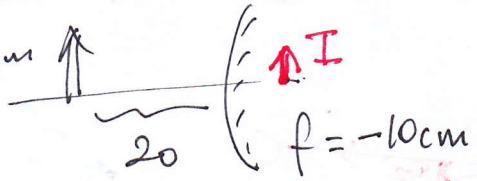
$$s' = \frac{(10)(20)}{20-10} = 20\text{cm} \quad (+) \text{ gerçek}$$

$$\boxed{s' = \frac{fs}{(s-f)}}$$

$$m = -\frac{s'}{s} = -\frac{20}{20} = -1$$

aynı yükseklikte ; ters

(b)



$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \quad ; s' = \frac{fs}{(s-f)}$$

$$= \frac{(-10)\,20}{20-(-10)}$$

$$m = -\frac{s'}{s} = -\frac{(-6.67)}{20} = +0.33$$

$$s' = -6.67\text{cm} = -\frac{200}{30}$$

→ sanal

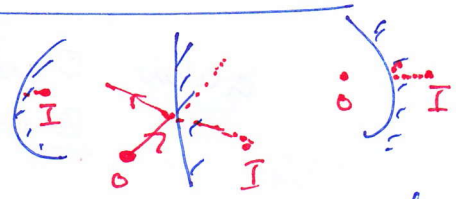
düz küçük

Optik Lab. Dersi — UBT 9:00'da — fizik 13.30

Deney föyünde ilk deneyinizi yapacaksınız
Föyü ders sayfasından

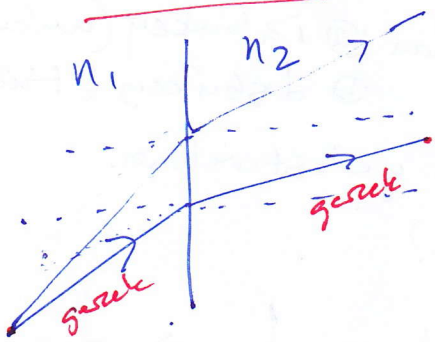
deneyi
1/2
1/2

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$

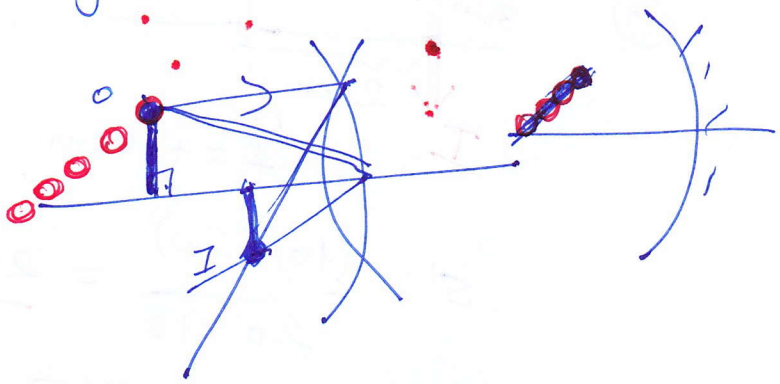


s' sanal gerçek oluşan ışınların birleştiği

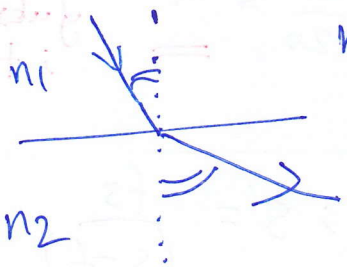
kırılma



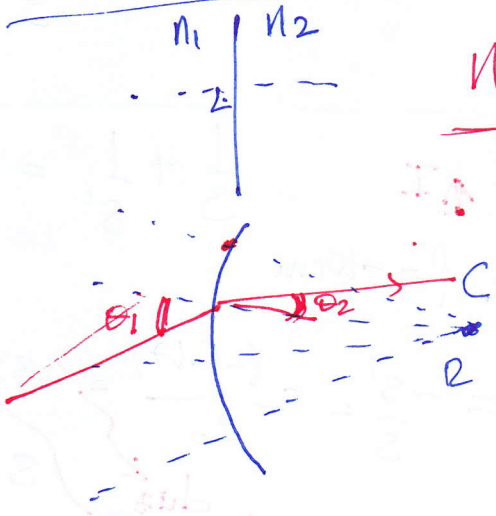
aynalarda görüntü oluşturmuyorum.



KÜRESEL YÜZEYDE KIRILMA

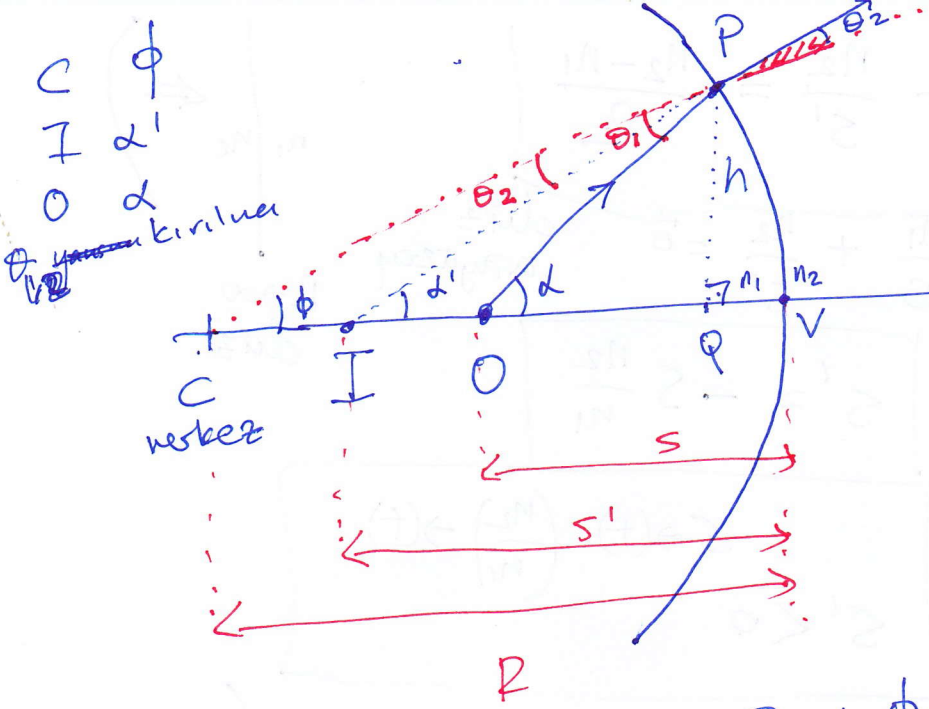


$n_1 > n_2$



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

C ϕ
I α'
O α



$n_1 < n_2$ ③

küçük açı yaklaşımı. ✓

$QV \to 0$ ✓

$\sin\alpha = \tan\alpha = \alpha$

$\sin\alpha' = \tan\alpha' = \alpha'$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_1 \theta_1 = n_2 \theta_2$

CPO üçgeni $\alpha = \theta_1 + \phi$

CPI " $\alpha' = \theta_2 + \phi$

$n_1(\alpha - \phi) = n_2(\alpha' - \phi)$

$\alpha \Rightarrow OPQ \Rightarrow \tan$ $\quad QV \to 0$, $OQ \cong OV$

$\alpha = \dfrac{h}{s}$

$\alpha' \Rightarrow IPQ$ üçgeni

$\alpha' = \dfrac{h}{s'}$

$\phi \Rightarrow CPQ \quad \phi = \dfrac{h}{R}$

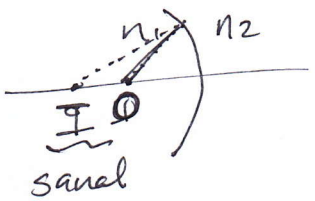
$$n_1\left(\frac{h}{s} - \frac{h}{R}\right) = n_2\left(\frac{h}{s'} - \frac{h}{R}\right)$$

$$\frac{n_1}{s} - \frac{n_2}{s'} = -\frac{n_2}{R} + \frac{n_1}{R}$$

$$\frac{n_1}{s} - \frac{n_2}{s'} = \frac{n_1 - n_2}{R}$$ (yukarıdaki geometriye göre yapılış)

$\frac{(-)}{R}$

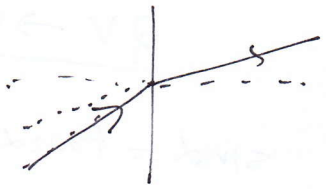
$$\boxed{\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}} \; ***$$



$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

$$\frac{n_1}{s} + \frac{n_2}{s'} = 0$$ düz arayüzey

$n_1 \mid n_2$ ⇐ $R \to \infty$ düz



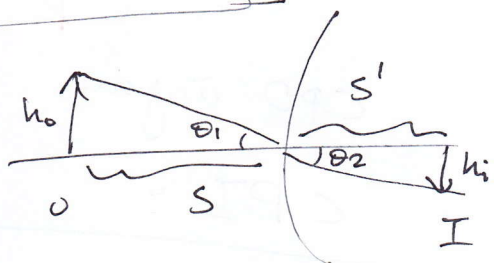
$$s' = -s\frac{n_2}{n_1}$$

$s \to (+)$ $\left(\frac{n_2}{n_1}\right) \to (+)$

$s' < 0$

⇒ ?

$$m = \frac{h_i'}{h_0} = -\frac{s' n_1}{s n_2}$$



$n_1 \theta_1 = n_2 \theta_2$

$$n_1 \frac{h_0}{s} = n_2 \frac{h_i}{s'}$$

$$\frac{n_1}{s} = \frac{n_2}{s'}\left(\frac{h_i}{h_0}\right)$$ ⇐ m

$$m = -\frac{n_1 s'}{n_2 s}$$

$m > 1$ büyümüş

$m \to +$ aynı yönde

$\to -$ ters yönde

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

⇒ 

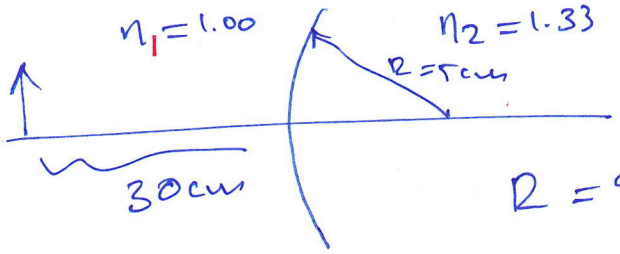
$s' < 0$ sanal

$s < 0$ sanal

$s > 0$ } gerçek

$s' > 0$ }

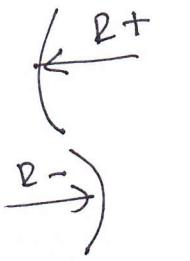
⇒ 



R = 5cm dışbükey yüzeyden 30cm uzakta gerçek cisim hava ortamında bulunuyor.

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

$s' = ?$ $\quad m = ?$



$$\frac{1}{30} + \frac{1.33}{s'} = \frac{1.33 - 1}{+5}$$

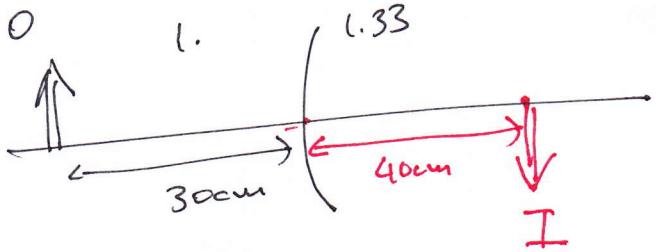
$$s' = \left(\frac{0.33}{5} - \frac{1}{30}\right)^{-1} \frac{1}{1.33}$$

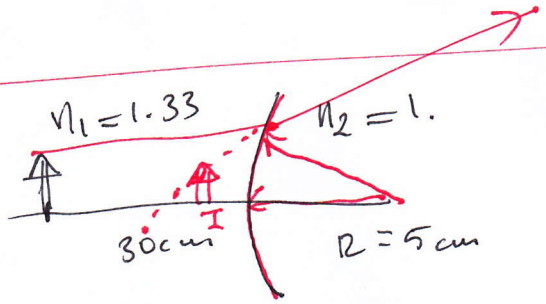
$$s' = +40 \text{ cm} \rightarrow \text{gerçek görüntü } (n_2 \text{ ortamında bulunuyor})$$

$$m = -\frac{n_1 s'}{n_2 s}$$

$$= -\frac{(1)(40)}{(1.33)(20)} = -1 \rightarrow \text{aynı büyüklükte, ters}$$

$\Rightarrow$





eğer

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R} \qquad \frac{1 - 1.33}{+5}$$

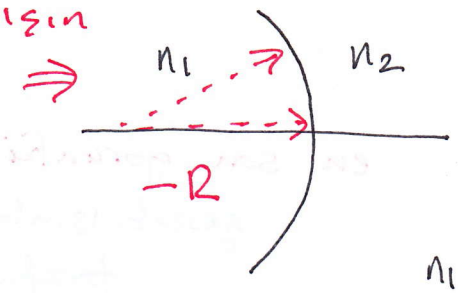
$$\frac{1.33}{30} + \frac{1}{s'}$$

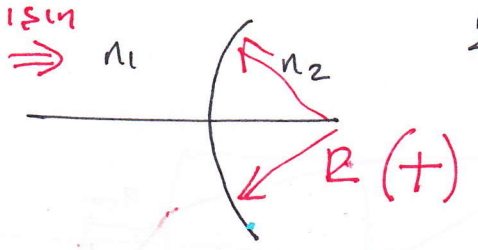
$s' \rightarrow (-)$ (sanal)

$$\frac{1.33}{30} + \frac{1}{s'} = \frac{-0.33}{5}$$

$$m = -\frac{n_1 s'}{n_2 s} = -\frac{(1.33)(-9.1)}{(1)(30)} = +0.4$$

$$\frac{1.33}{30} + \frac{0.33}{5} = \frac{-1}{s'} \qquad s' = -9.1 \text{ cm}$$



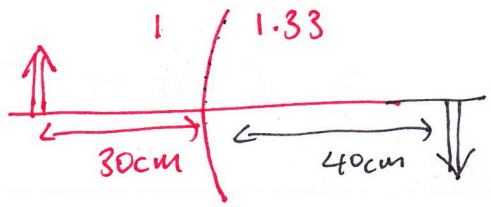


20/10/20

(1)

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R} \quad ; \quad m = -\frac{n_1 s'}{n_2 s}$$

ör)

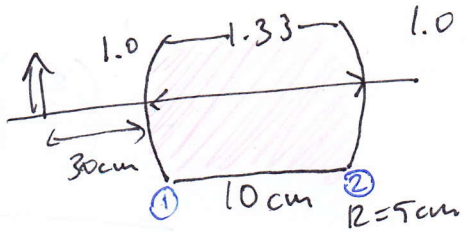


$$\frac{1}{30} + \frac{1.33}{s'} = \frac{1.33 - 1}{5}$$

$s' = +40\text{cm}$ (gerçek)

$$m = -\frac{(1)\,40}{(1.33)\,30} = -1$$

b)



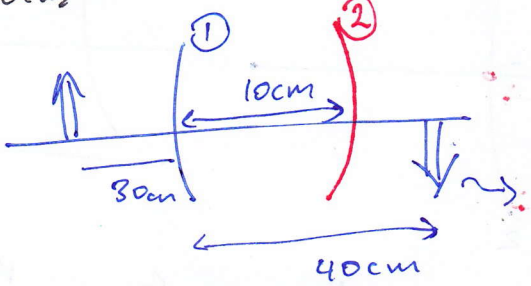
m ≡ büyütme → +, − ters düz

m > 1 büyümüş

m < 1 küçülmüş

ör $m = -0.3$ ters ve küçülmüş

oluşan en son görüntü nerede? m?



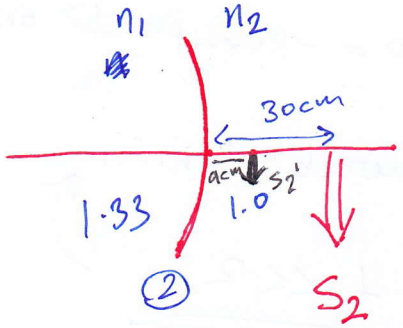
$s_1 = 30\text{cm}$ ✓

$s_1' = +40\text{cm}$

s_1' ② nin sağında oluştuğu için sanal bir cisim $= s_2$

$s_1' \Rightarrow$ 1. yüzeyden oluşan görüntü

② . yüzey için cisim



$s_2' = ?$

$s_2 = -30\text{cm}$ sanal cisim

$$\frac{n_1}{s_2} + \frac{n_2}{s_2'} = \frac{n_2 - n_1}{R}$$

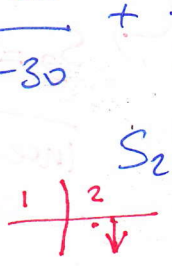
$$\frac{1.33}{-30} + \frac{1}{s_2'} = \frac{1 - 1.33}{-5}$$

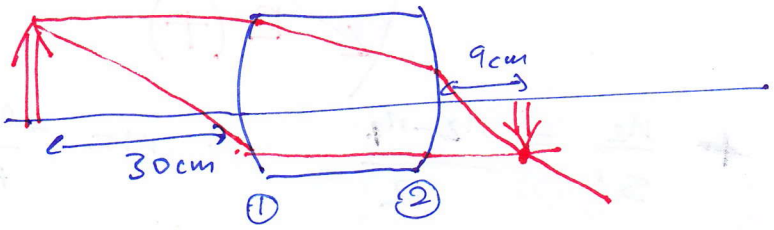
$s_2' = +9\text{cm}$ (gerçek görüntü)

$$m = -\frac{n_1 s'}{n_2 s} = -\frac{1.33\,(9)}{1\,(-30)}$$

$m = +2/5$

(R+ ←, R− →)





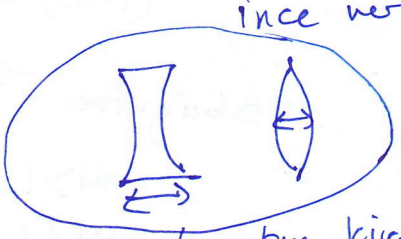
en son görüntü gerçek gerçek ışınlar tarafından oluşturulur.

toplam büyütme $M_T = M_1 M_2$

$(-1)\left(\frac{+2}{5}\right) = -\frac{2}{5}$ (ters ve %40 boyutunda)

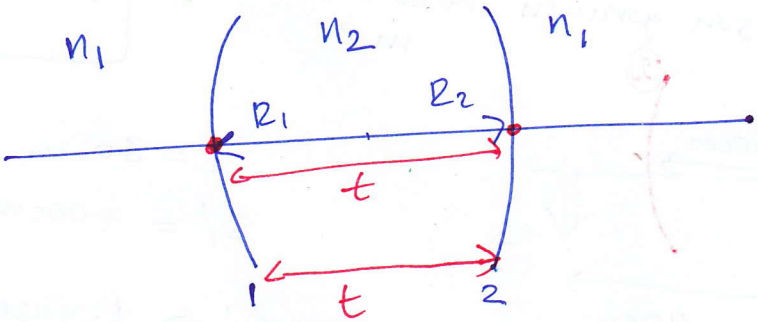
İNCE MERCEKLER

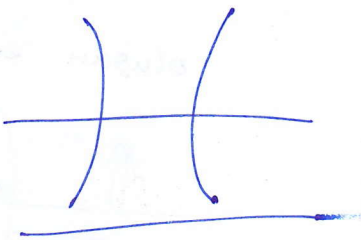
ince mercek ≠ ince kenarlı mercek



boyutun küçük olması

kalınlığın az olması.





(1) $\frac{n_1}{s_1} + \frac{n_2}{s_1'} = \frac{n_2 - n_1}{R_1}$ (2) $\frac{n_2}{s_2} + \frac{n_1}{s_2'} = \frac{n_1 - n_2}{R_2}$

(1) yüzeyin oluşturduğu görüntü (2) yüzey için cisimdir

$s_2 = t - s_1' = (10 - 40 = -30\text{cm}$ önceki örnek)

$t \to 0 \equiv$ ince mercek tanımı

$t \ll R$

$s_2 = -s_1'$

ince mercek

(1) + (2)

$$\frac{n_1}{s_1} + \frac{n_2}{-s_2} + \frac{n_2}{s_2} + \frac{n_1}{s_2'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2} \quad (2)$$

$s_2 = -s_1'$

$-s_2 = s_1'$

Yani

$$n_1\left(\frac{1}{s_1} + \frac{1}{s_2'}\right) = n_2 - n_1\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{s_1} + \frac{1}{s_2'} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$s_2' \Rightarrow s'$

$s_1 \Rightarrow s$

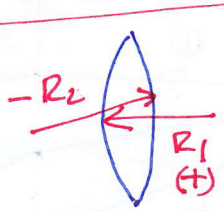
$$\equiv \frac{1}{f}$$

$$\boxed{\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}}$$

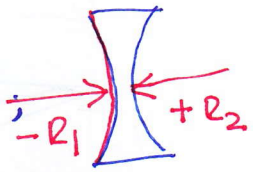
İnce mercek $t \simeq 0$

$$\boxed{\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

Mercek yapımcısı denklemi



İnce kenarlı mercek



Kalın kenarlı mercek

$n_2 > n_1$

$$\frac{1}{f} = \underbrace{\left(\frac{n_2 - n_1}{n_1}\right)}_{+}\left(\frac{1}{R_1} - \underbrace{\left(\frac{1}{-R_2}\right)}_{+}\right)$$

$\frac{1}{f} > 0$ İnce kenarlı mercek

$f > 0$

$$\frac{1}{f} = \underbrace{\left(\frac{n_2 - n_1}{n_1}\right)}_{+}\underbrace{\left(\frac{1}{-R_1} - \frac{1}{+R_2}\right)}_{(-)}$$

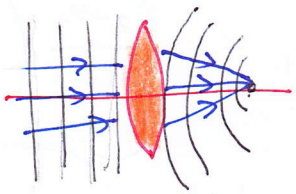
$\frac{1}{f} < 0$ Kalın kenarlı mercek

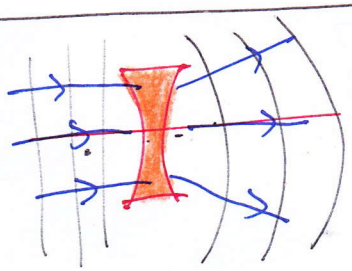
$f < 0$

İnce mercekler — $t=0$

İnce kenarlı
dışbükey
mercek
$f>0$

kalın kenarlı
içbükey
mercek
$f<0$





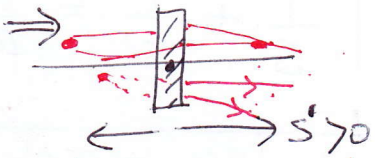
dalga cepheleri = wave front

Mercek formülü

$$\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Cisim-görüntü

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

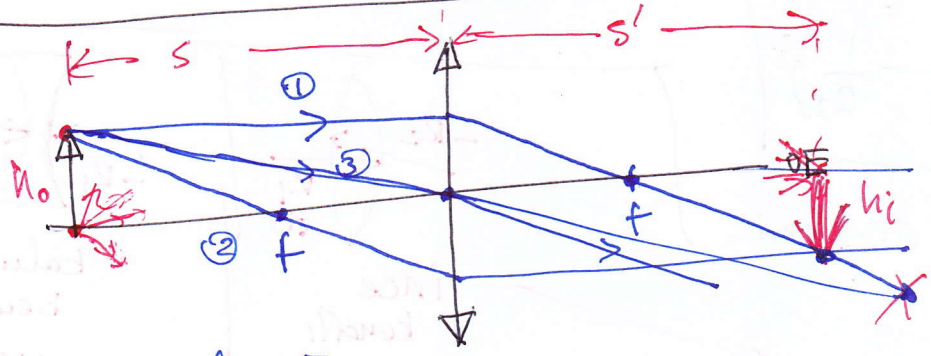


Sanal ≡ sanal ışınlar

gerek ≡ gerek

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

Işının optik ekseni kestiği yerle



① s ∞'da ok tersi

$s \to \infty$

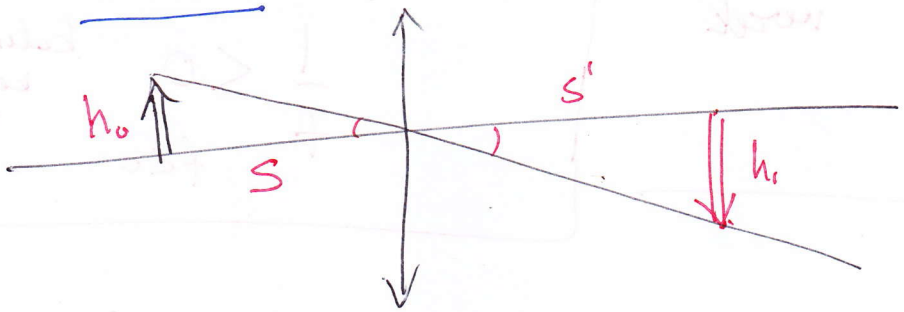
$$\frac{1}{\infty} + \frac{1}{s'} = \frac{1}{f}$$

$s' = +f$

② Işın ilkesi

$$\frac{1}{f} + \frac{1}{s'} = \frac{1}{f}$$

$s' \to \infty$



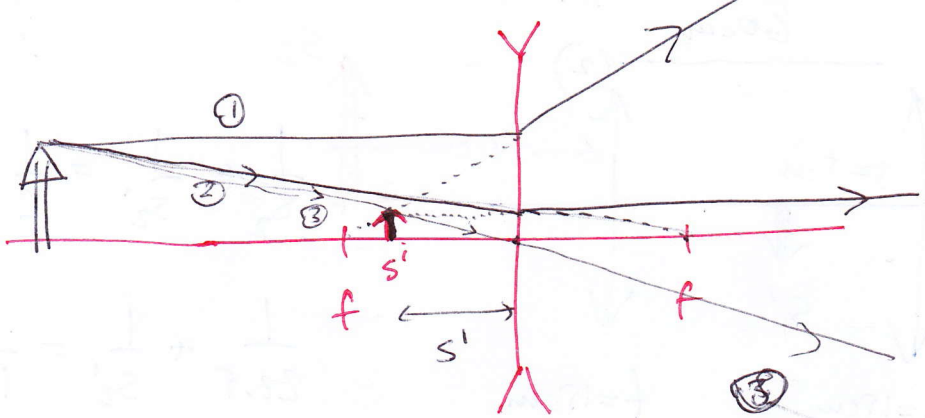
$$\frac{h_o}{s} = \frac{h_i}{s'}$$

$$\frac{h_i}{h_o} = m = -\frac{s'}{s}$$

büyütme katsayısı

$m<0$ ters

$m>0$ düz



$f < 0$

① $\frac{1}{s} + \frac{1}{s'} = \frac{1}{-f}$

$\frac{1}{\infty} + \frac{1}{s'} = -\frac{1}{f}$

$s' = -f$

② $\frac{1}{s} + \frac{1}{s'} = -\frac{1}{f}$

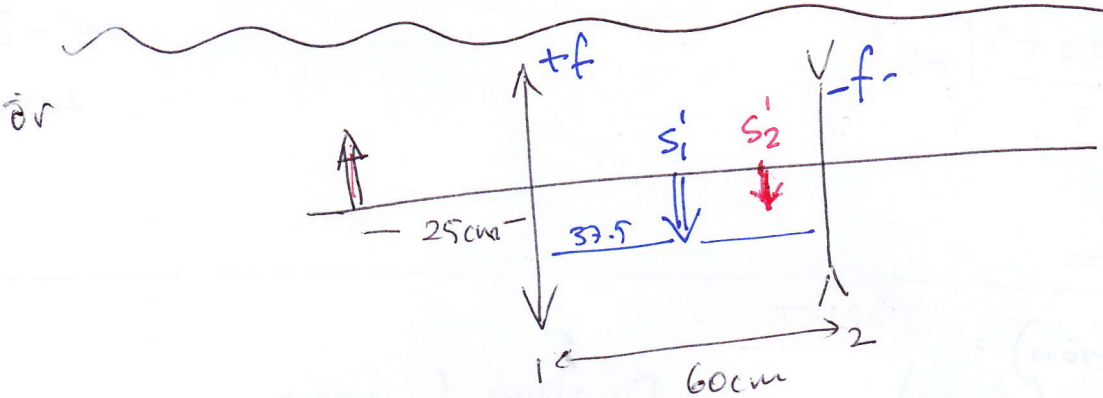
$\frac{1}{-f} + \frac{1}{s'} = -\frac{1}{f}$

$s' \to \infty$

(3)

girmek $s' < 0$

sanal görüntü !



ör

$f_1 = 15\text{cm}$

$f_2 = 15\text{ cm}$

ara mesafe 60cm

son görüntü?

$\frac{1}{s_1} + \frac{1}{s_1'} = \frac{1}{f}$ $\quad s_1' = \frac{s_1 f}{s_1 - f} = \frac{25(15)}{25-15} = +37.5\text{cm}$ gerçek görüntü

$m_1 = -\frac{s_1'}{s_1} = -\frac{37.5}{25} = -1.5$ (ters)

$s_2 = 60 - s_1' = 22.5\text{cm}$

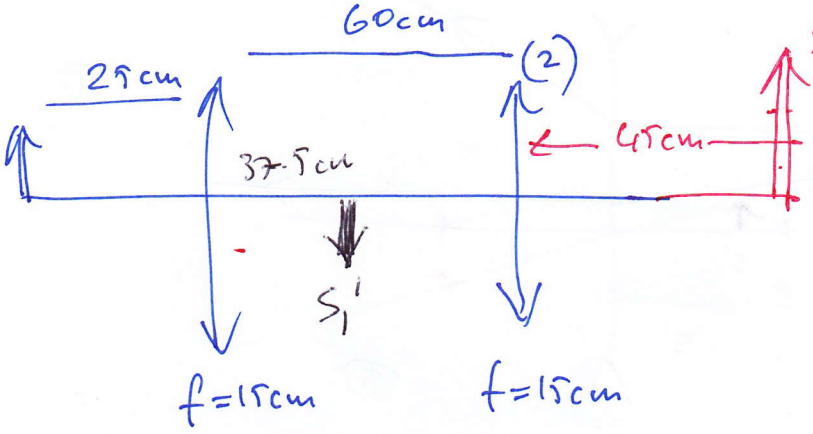
$\frac{1}{s_2} + \frac{1}{s_2'} = \frac{1}{f}$ $\quad s_2' = \frac{s_2 f}{s_2 - f} = \frac{(22.5)(-15)}{22.5 - (-15)}$

$s_2' = -9\text{cm}$ (sanal görüntü)

$m_2 = -\frac{s_2'}{s_2} = -\frac{(-9)}{22.5} = +0.4$

Toplam büyütme

$m_T = m_1 m_2 = (-1.5)(0.4) = -0.6$ (s_1''e göre son görüntünün büyüklüğü ve yönü)



$$\frac{1}{S_2} + \frac{1}{S_2'} = \frac{1}{f}$$

$$\frac{1}{22.5} + \frac{1}{S_2'} = \frac{1}{15}$$

$S_1' = 37.5\text{cm}$ $\quad S_2 = 22.5\text{cm}$ $\quad S_2' = 45\text{cm}$

gerçek

$$M_2 = -\frac{S_2'}{S_2} = -\frac{45}{22.5} = -2$$

ters

$$M_T = M_1 M_2 = \left(-\frac{37.5}{25}\right)(-2) = +3$$

ÖZET

Küresel yüzey — Yansıma (reflection) (ayna)

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \qquad \left(f = -\frac{R}{2}\right)$$

$$m = -\frac{s'}{s}$$

İçbükey $f > 0$ (−R)

Dışbükey $f < 0$ (R+)

Düzlemsel yüzey

$R \to \infty$

$s' = -s$

$m = +1$

KIRILMA (refraction)

Küresel y.

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

$$m = -\frac{n_1 s'}{n_2 s}$$

(R+)

(R−)

Düzlemsel y.

$$s' = -\frac{n_2}{n_1} s$$

$R \to \infty$

$$m = \frac{n_2}{n_1}$$

$$m = -\frac{s'}{s}$$

KIRILMA İNCE MERCEK

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \quad ; \quad \frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

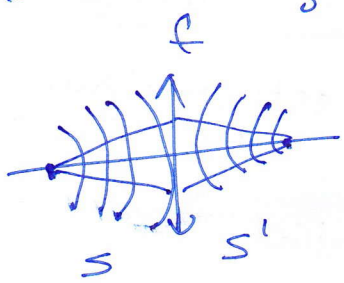
$$m = -s'/s$$

İçbükey (incekenar) $f > 0$

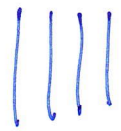
Dışbükey (kalınkenar) $f < 0$

VERGENCE ; kırınım gücü ≃ eğrilik
(verjant) (saptırma)
(divergence)

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \longrightarrow \frac{1}{s} = V \; ; \; \frac{1}{s'} = V'$



$\frac{1}{f} = P$ (power) (diopter)



dalga cephe

eğrilik $V = \infty$

$V + V' = P$

P = merceğin kırma gücü $\left(\frac{1}{m}\right)$
= gözlük numarası

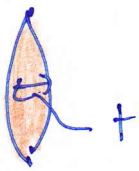
$f = 0.2m \quad P = \frac{1}{0.2m} = 5$ Diopter

$f = -0.2m \quad P = \frac{1}{-0.2} = -5$ Diopter.

$\{-5 \leftrightarrow +5\}$

20cm odak uzaklığı

ince mercek:



$t \cong 0$

$t \ll R$

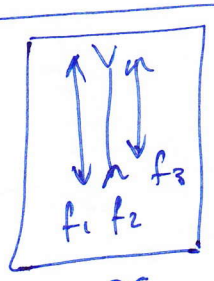
$t \simeq 4mm$

$f \simeq 20cm \simeq R$

$\frac{1}{f} \sim \frac{1}{R}$

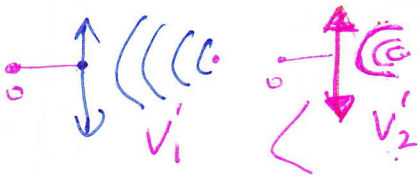
$4mm \ll 20cm$

Temas eden Birden fazla mercek sistemi

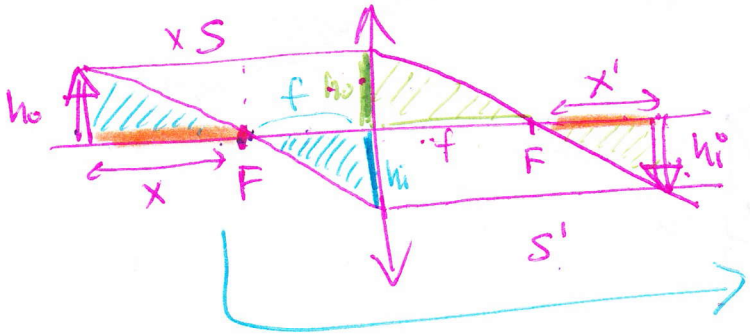


$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} \; ; \; P = P_1 + P_2 + P_3$

$V = \frac{1}{s}$



İnce mercek için Newton denklemi



$\frac{h_i}{h_0} = \frac{x'}{f}$

$\frac{h_i}{h_0} = \frac{f}{x}$

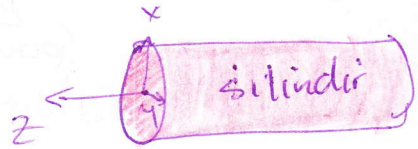
$\frac{h_i}{h_0} = \frac{x'}{f} = \frac{f}{x}$

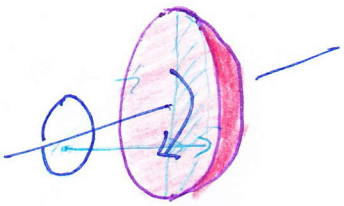
$f^2 = xx'$

$f^2 = xx'$ Newton denklemi ⇒ bazen daha kullanışlı olabilir

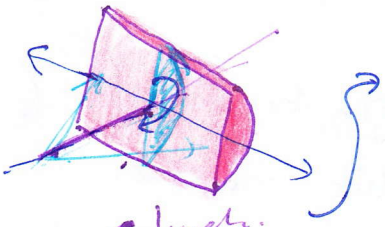
Silindirik mercekler

↳ astigmatizmi düzeltmede kullanılır.





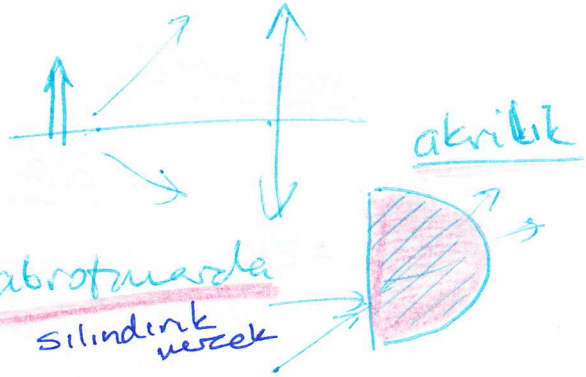
küresel



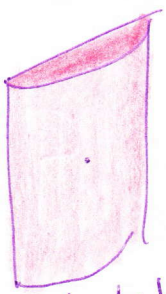
döndürülse görüntü de döner.

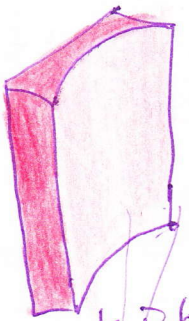
küresel mercek döndürülürse görüntü değişmez

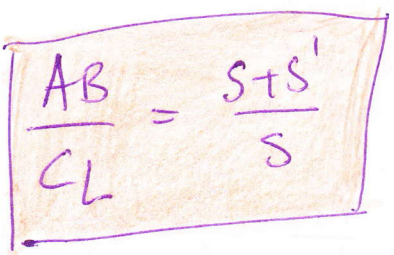
→ OE etkilenmez

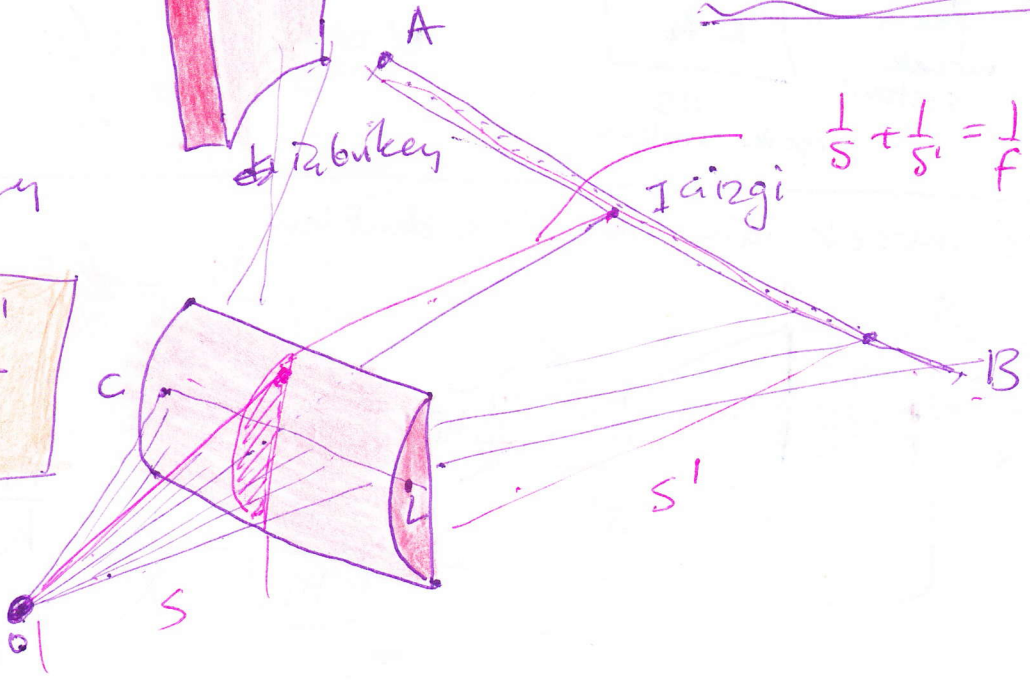


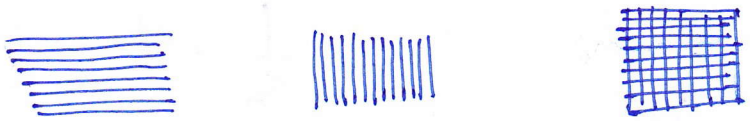
$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$$


dışbükey


içbükey



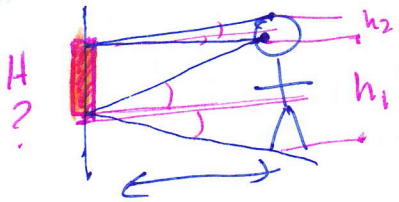




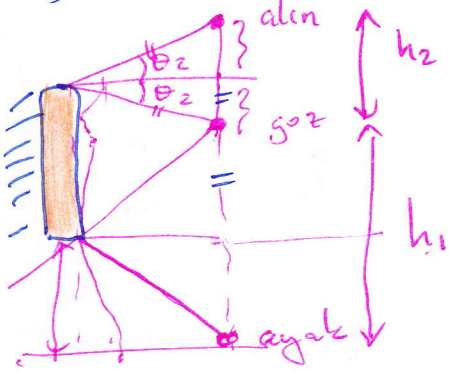
$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$

2 bölüm geometrik optik Soru & Cevap

2-4) Tamamen görebilmesi için ; ayna boyu ve olabilir? (düz)



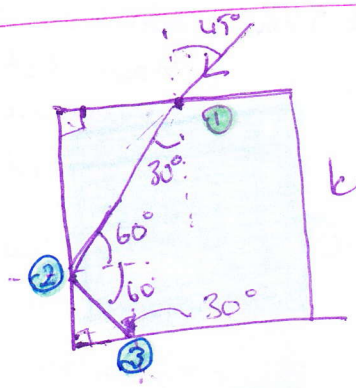
$h = h_1 + h_2$



$H = \frac{h_1}{2} + \frac{h_2}{2}$; $\frac{h}{2} = H$

170cm ⇒ ayna boyu 85cm

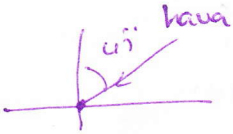
2.5)



$n_{ia} = 1.414 = \sqrt{2}$

$n_{dış} = 1.0$

Işın yolunu bulunuz.



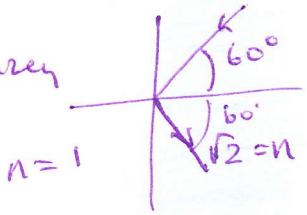
(1) $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\sin 45 = \sqrt{2} \sin\theta_2$

$\frac{\sqrt{2}}{2\sqrt{2}} = \sin\theta_2$

$30° = \theta_2$

(2) yüzey



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

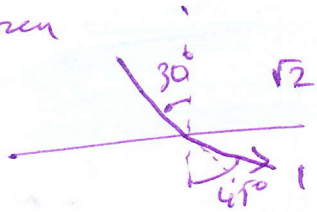
$\sqrt{2} \sin 60 = 1 \sin\theta$

$\sqrt{2} \frac{\sqrt{3}}{2}$

$\frac{\sqrt{6}}{2} > 1$

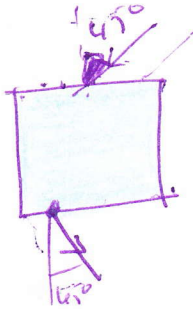
tam yansıma

(3) yüzey

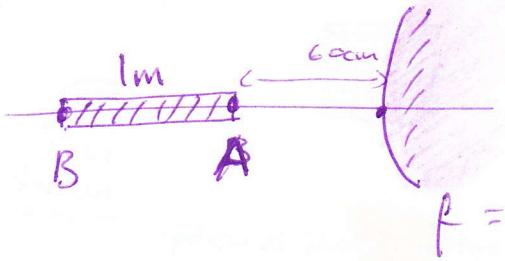


$\sqrt{2} \sin 30 = 1 \sin\theta_2$

$\sqrt{2} \frac{1}{2} = \sin\theta_2 \quad \theta_2 = 45°$



2.9)

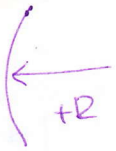


$$\frac{1}{S_A} + \frac{1}{S_A'} = \frac{1}{f}$$

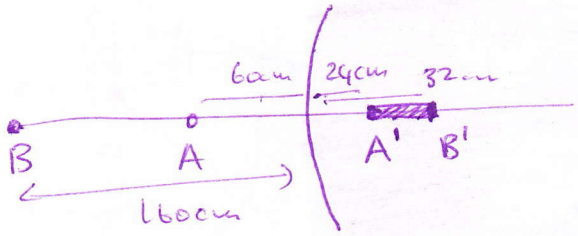
$f = 40\,cm$

$$\frac{1}{60} + \frac{1}{S_A'} = \frac{1}{-40}$$

$f = -\frac{R}{2}$



$S_A' = -24\,cm$ sanal



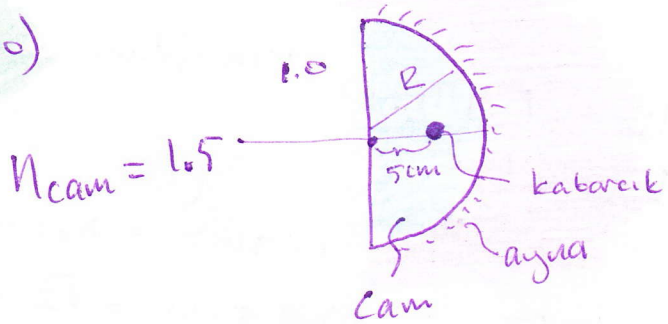
$$\frac{1}{S_B} + \frac{1}{S_B'} = \frac{1}{f}$$

$S_B \to 160$, $f \to -40$

$S_B' = -32\,cm$

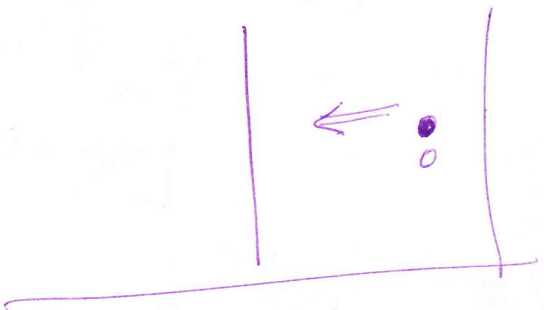
1m çubuk görüntüsünün uzunluğu 8cm düştü

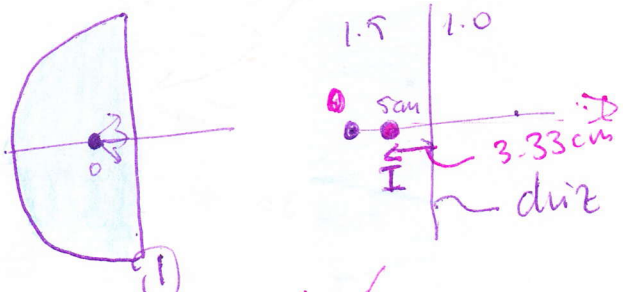
2.10)



$R = 7.5\,cm$ cam içerisinde hava kabarcığı yüzeyden 5cm içeridedir.

OE boyunca kabarcığın iki görüntüsü oluşur. Bu görüntüleri bulunuz.

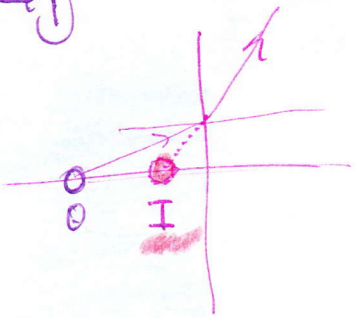




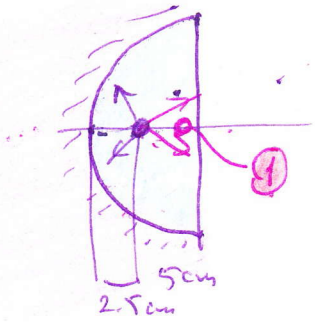
$$\frac{n_1}{S} + \frac{n_2}{S'} = \frac{n_2 - n_1}{R \to \infty} = 0$$

$$\frac{1.5}{5} + \frac{1}{S'} = 0 \;;\; S' = \frac{-5}{1.5} = -3.33\,cm$$

İlk görüntü camın içinde! ✓



2.10) devamı — Aynadan yansıyan ışınların arayüzden geçip bize gelişi

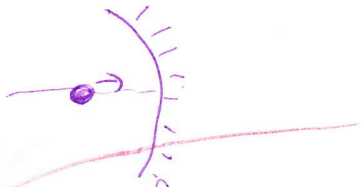


$R = 7.5\,cm \qquad f = \frac{R}{2} = \frac{2.5}{2} = \frac{15}{4}\,cm$

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

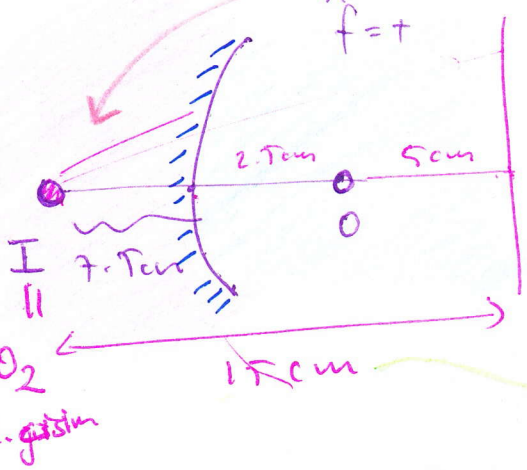
$$\frac{1}{2.5} + \frac{1}{s'} = \frac{4}{15} \Rightarrow \frac{1}{s'} = \underset{(2)}{\frac{4}{15}} - \underset{(3)}{\frac{4}{10}} = \frac{4}{30}$$

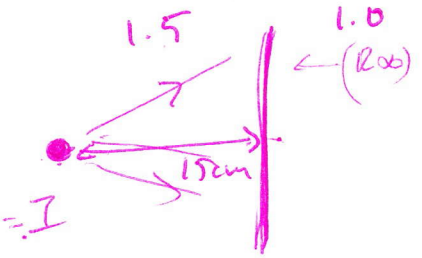
$s' = 7.5\,cm$



$$\frac{1}{s'} = \frac{8-12}{30} = \frac{-4}{30} \Rightarrow \boxed{s' = -7.5\,cm}$$

ayna gerisinde



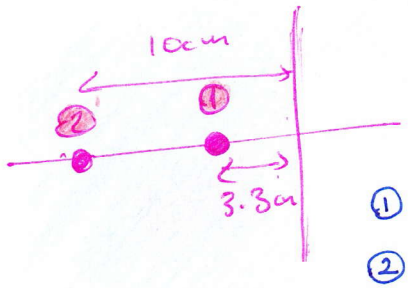


$$\frac{n_1}{s_1} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R} = 0$$

$$\frac{1.5}{15} + \frac{1}{s'} = 0$$

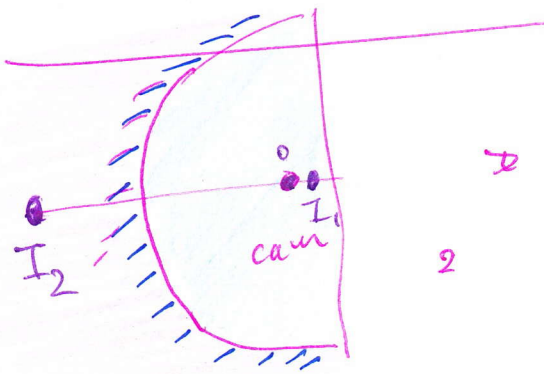
$s' = -10\,cm$

İkinci görüntü

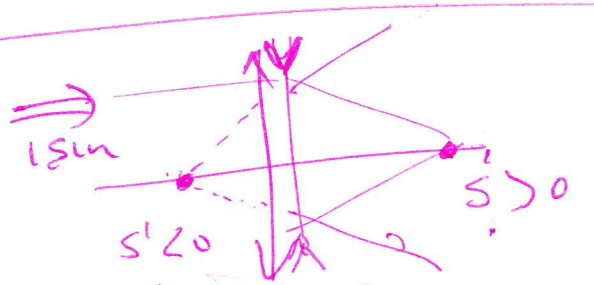


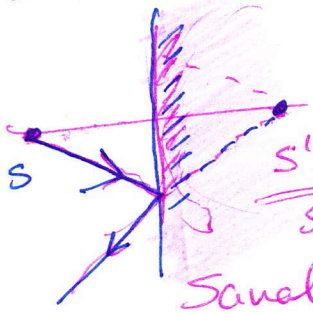
① İlk görüntü 3.3cm içeride

② İkinci görüntü 10cm içeride



cam = hava





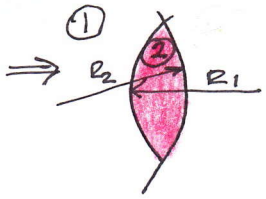
Sanal ⇒ $s' < 0$

2.12) $\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$ → next episode!!

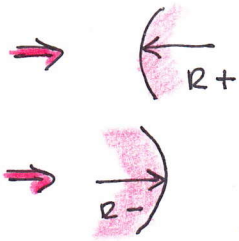
cisim

$s' = ?$ $m = ?$ görüntüsü nerede? Büyük? $m = ?$

KIRILMA (İNCE MERCEK)



hatırlatma



* $\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

mercek yapım formülü

* $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$; $s' = \left[\frac{s-f}{sf}\right]^{-1}$

$\Rightarrow$ s+ s− / s'− s'+

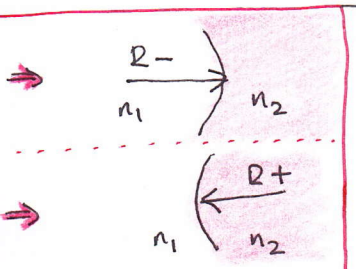
Büyütme oranı

* $m = -\frac{s'}{s}$ $\begin{cases} m<0 & \text{TERS} \\ m>0 & \text{DÜZ} \end{cases}$ GÖRÜNTÜ ; $|m|>1$ büyümüş, $|m|<1$ küçülmüş

KIRILMA (TEK KÜRESEL YÜZEY ; KALIN MERCEK SİSTEMLERİ VS)

* $\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$

* $m = -\frac{n_1 s'}{n_2 s}$



KIRILMA DÜZ YÜZEY

$R \to \infty$

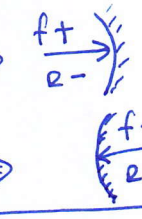
$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{\infty} = 0$

$s' = -s\frac{n_2}{n_1}$; $m = +1$

YANSIMA

KÜRESEL YÜZEY

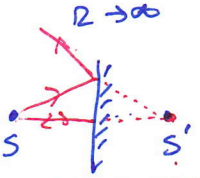
* $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$; $f = -\frac{R}{2}$ $\Rightarrow$



* $m = -\frac{s'}{s}$ $\Rightarrow$

DÜZ YÜZEY

$R \to \infty$



$\frac{1}{s} + \frac{1}{s'} = \frac{1}{\infty}$

$s = -s'$

$m = +1$

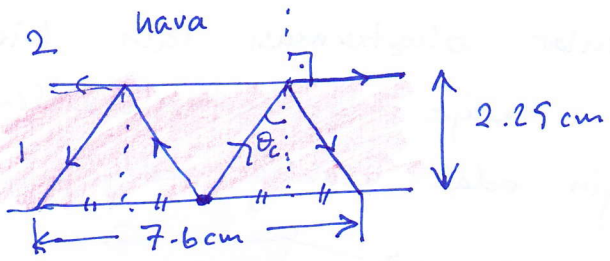
Geometrik Optik

Ayna & Mercek Formülleri

DK

27-10-20

2.7



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

tam iç yansıma $\quad n_1 \sin\theta_c = n_2 \sin 90$

$n_1 \sin\theta_c = 1$

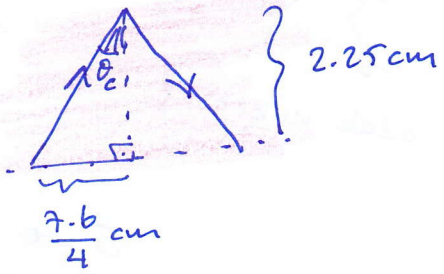
üçgenden $\quad \tan\theta_c = \left(\frac{7.6}{4} \quad \frac{1}{2.25}\right)$

$\theta_c = \tan^{-1}(0.84)$

$= 40.2°$

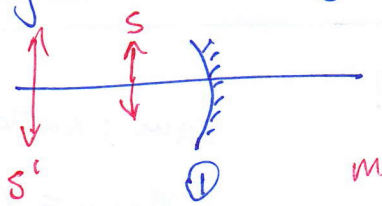
$n_1 \sin 40.2 = 1$ $\quad n_1 = 1.55$

noktasal ışık tavanın ışık yansıma yaparak alt yüzeyde 7.6 cm çapında bir çember oluşturuyor. camın kırılma indisi?



2.11 İnbükey ayna cismin 2 katı büyüklüğünde görüntüyü ekranda oluşturuyor. Hem ekran, hem cisim hareket ettirilerek ekranda cismin 3 katı büyüklüğünde başka bir görüntü oluşuyor. Ekran bu işlemde 75 cm hareket etmiş.

- cisim ne kadar hareket etti?
- aynanın odak uzaklığı?

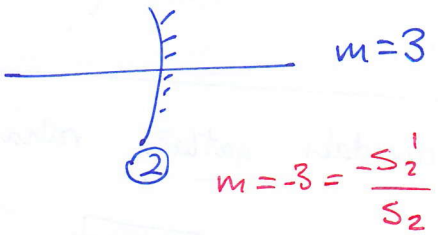


$m = 2$

$m = -\frac{s_1'}{s_1} = -2$

$s' > 0$ gerçek

ekrana düşmüş



$m = -3 = -\frac{s_2'}{s_2}$

$\frac{1}{s_1} + \frac{1}{s_1'} = \frac{1}{f} \Rightarrow s_1' = \frac{s_1 f}{s_1 - f}$ $\quad \Rightarrow 3 = \frac{s_2'}{s_2} = \frac{f}{s_2 - f}$ $\quad s_2 = \frac{4}{3} f$

$2 = \frac{s_1'}{s_1} = \frac{f}{s_1 - f}$

$2s_1 - 2f = f$

$s_1 = \frac{3}{2} f$

$s_1' = \frac{\left(\frac{3}{2} f\right) f}{\frac{1}{2} f} = 3f$

$s_1' \rightarrow s_2'$ (ekran hareket) 75 cm

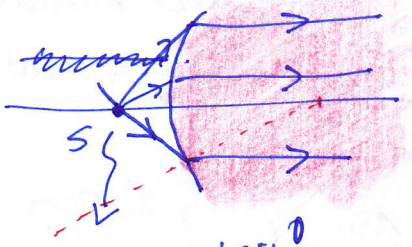
$s_2' - s_1' = 75\text{cm} \Rightarrow 4f - 3f = 75_{cm}$

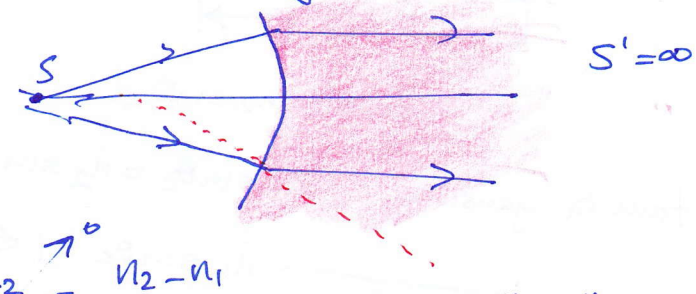
$f = 75\text{cm}$

$s_2' = \frac{\frac{4}{3} f \, f}{\left(\frac{4}{3} f - f\right)} = \frac{4f}{\frac{1}{3}}$

$s_1 \rightarrow s_2$; $s_2 - s_1 = \left(\frac{4}{2} - \frac{3}{2}\right) f = 12.5\text{ cm}$

2.13) · Kırılmanın paralel ışınlar oluşturması için bir cismin küresel yüzeyin önünde nereye yerleştirilmelidir? (yani tek kırıcı yüzeyin odak uzaklığı nedir?)





$$\frac{n_1}{S} + \frac{n_2}{S'} = \frac{n_2 - n_1}{R}$$

$S' = \infty \Rightarrow S = f$

$$\frac{n_1}{S} = \frac{n_2 - n_1}{R}$$

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

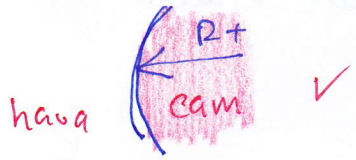
$$\boxed{f = R\left(\frac{n_1}{n_2 - n_1}\right)} \quad \checkmark$$

S ⇉ gerçek olmalı $S > 0$

$f > 0$

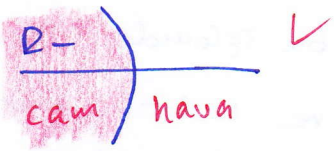
$f > 0$ olmalı

$R+ ;\ n_2 > n_1$



✓

$R- ;\ n_2 < n_1$



✓

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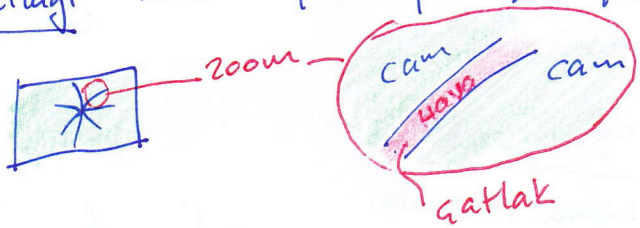
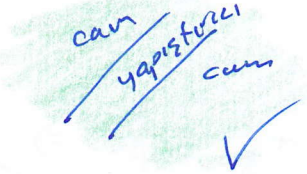
camdaki çatlağı rahat görebiliyoruz; niye?



Çatlak hava boşluğu demektir

cam ; çatlak için

$n_{cam} = n_{yapıştırıcı}$



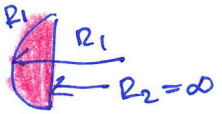
✓

$n_{hava} < n_{cam}$ olduğu için

- tam yansıma ve farklı yönde kırılmalar meydana gelir.
- çatlak çok ince de olsa cam-hava yüzeyi oluştuğu için çok rahat farkederiz çatlağı
- çatlak gidecek için çatlağın içine $n_{cam} = n_{yapıştırıcı}$ olacak şekilde bir sıvı sıkılabilir.

2.16 odak uzaklığı $f = 25\,cm$ dışbükey - düzlem yüzeyli mercegin $n = 1.52$ olması gerektiğine göre mercegin R yüzey eğriliği ne olmalı?

$$\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$\Rightarrow$ 

$$\frac{1}{f} = \frac{1.52-1}{1}\left(\frac{1}{R} - \frac{1}{\infty}\right) = \frac{1}{25} \Rightarrow R \cong 13\,cm$$

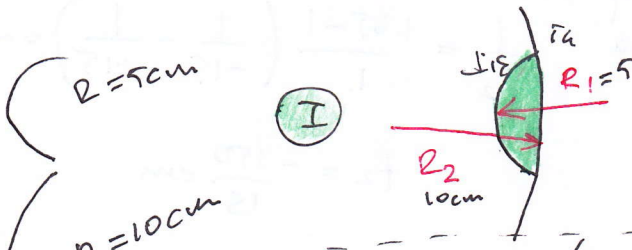
eğer 

$$\frac{1}{25} = \frac{1.52-1}{1}\left(\frac{1}{\infty} - \frac{1}{R_2}\right) \Rightarrow R_2 = -13\,cm \Rightarrow \text{iç bükey yüzey}$$

2.17 R değerleri 5 cm ve 10 cm olan mercek için f değerlerini hesaplayınız. ($n = 1.5$ cam)

- iç bükey dış bükey olacak şekilde; mesela f > 0

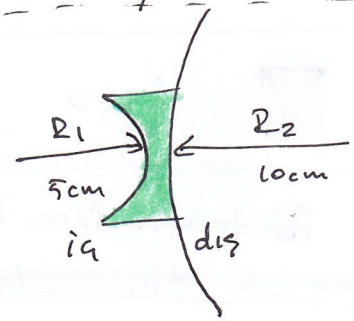
olacak şekilde çiziniz.

I 

$$\frac{1}{f} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

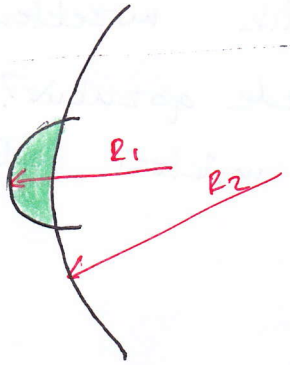
$$\frac{1}{f} = 0.5\left(\frac{1}{5} - \left(\frac{1}{-10}\right)\right) = \frac{1}{2}\left(\frac{2}{10} + \frac{1}{10}\right)$$

$$f = +20/3\,cm$$

II 

$$\frac{1}{f} = 0.5\left(\frac{1}{-5} - \frac{1}{+10}\right)$$

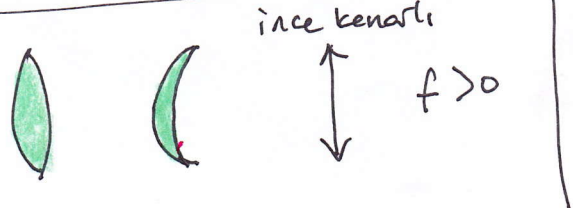
$$f = -\frac{20}{3}\,cm$$

III 

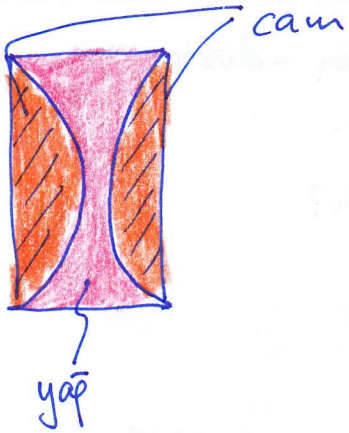
2 dış bükey

$$\frac{1}{f} = 0.5\left(\frac{1}{5} - \frac{1}{+10}\right) = \frac{1}{2}\left(\frac{1}{10}\right)$$

$$f = +20\,cm$$



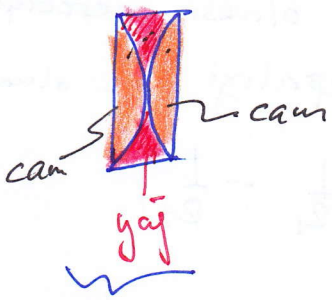
2.20)



$R = 15$ cm

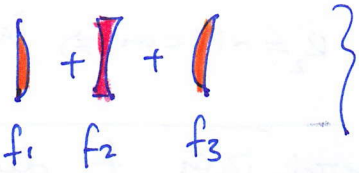
$n_{cam} = 1.5$

$n_{yağ} = 1.65$

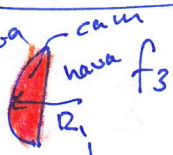


f odak uzaklığı ?

3 tane ince mercek birleşimi düşünelim.

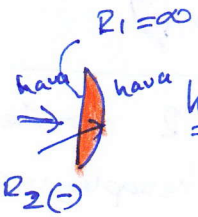


$$\frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} = \frac{1}{f_{eş}} \qquad f_{eş} = ?$$



$$\frac{1}{f_3} = 0.5\left(\frac{1}{15} - \frac{1}{\infty}\right)$$

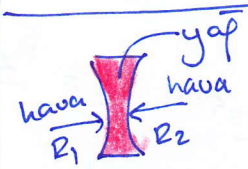
$$f_3 = 30\,cm$$



havada

$$\frac{1}{f_1} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_1} = \frac{1.5 - 1}{1}\left(0 - \frac{1}{-15}\right) \Rightarrow f_1 = 30\,cm$$



$$\frac{1}{f_2} = \frac{1.65 - 1}{1.}\left(\frac{1}{-15} - \frac{1}{+15}\right) = -\frac{0.65\,(2)}{15}$$

$$f_2 = -\frac{150}{13}\,cm$$

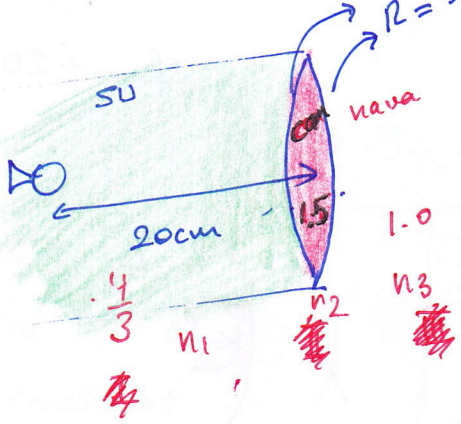
$$\frac{1}{f_{eş}} = \frac{1}{30} + \left(\frac{-13}{150}\right) + \frac{1}{30}$$

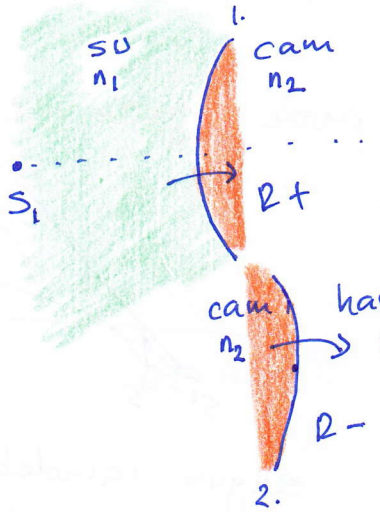
$$f_{eş} = -\frac{150}{3} = -50\,cm$$

$f_{eş} < 0$

2.18) akvaryumun kenarında ~~iki taraflı~~ ince kenarlı mercek bulunuyor. ~~R değerleri 5 ve 10 cm dir. (içbükey dış bükey)~~

İki R 30 cm dir. Balık mercekten 20 cm uzaktadır. Mercekten bakılınca balık nerde gözükür? Büyütme miktarı nedir?





$$\frac{n_1}{S_1} + \frac{n_2}{S_1'} = \frac{n_2 - n_1}{R} \quad \text{(I)}$$

ince mercek

$S_1' = -S_2$

niye eksi?

$$\frac{n_2}{S_2} + \frac{n_3}{S_2'} = \frac{n_3 - n_2}{R} \quad \text{(II)}$$

; S_1' 2. yüzey için cisim ve ~~solanca~~ sağına düştüğü için sanal cisim

$S_1' = -S_2$

(I) + (II)

$$\frac{n_1}{S_1} + \frac{n_2}{-S_2} + \frac{n_2}{S_2} + \frac{n_3}{S_2'} = \frac{n_2 - n_1}{R} + \frac{n_3 - n_2}{-R}$$

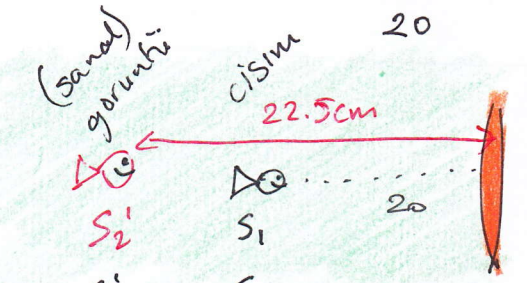
$$= \frac{n_2 - n_1 + n_2 - n_3}{R}$$

$$\frac{n_1}{S_1} + \frac{n_3}{S_2'} = \frac{2n_2 - (n_1 + n_3)}{R}$$

$$\frac{\frac{4}{3}}{20} + \frac{1}{S_2'} = \frac{2(1.5) - \left(\frac{4}{3} + 1\right)}{30}$$

$$S_2' = -\frac{90}{4} = -22.5\,\text{cm}$$

sanal



Son görüntü sanal

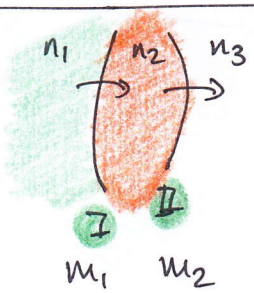
$S_2' < 0$

son görüntü 1.5 kat büyüklükte ve aynı yönde

$$M_I = -\frac{n_1}{n_2}\frac{S_1'}{S_1}$$

$$M_{II} = -\frac{n_2}{n_3}\frac{S_2'}{S_2}$$

$$M_{eş} = M_I M_{II}$$



$$= -\frac{n_1}{n_2}\frac{(-S_2)}{S_1} - \frac{n_2}{n_3}\frac{S_2'}{S_2}$$

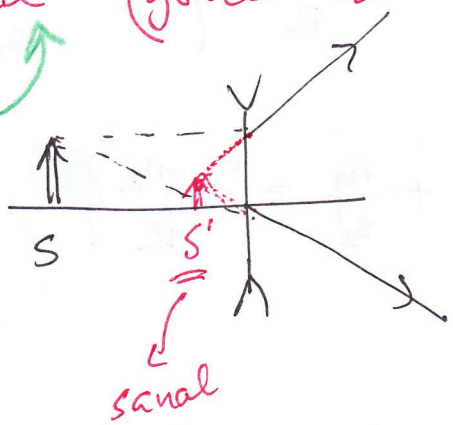
$$M = -\frac{n_1}{n_3}\frac{S_2'}{S_1} = -\frac{4/3}{1}\frac{(-22.5)}{20}$$

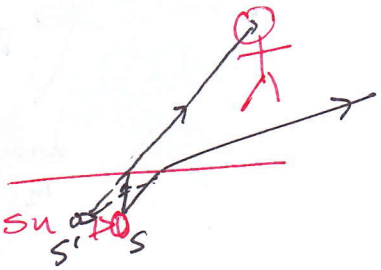
$M_{eş} = M_{top} = +1.5$ büyüme aynı yönde

görüntü

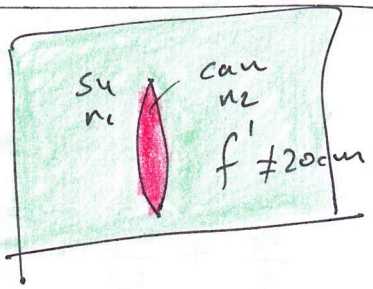
sanal (gerçek ışın değil) ≡ perde üzerine düşmez

gözümüzle göremediğimiz görüntüye sanal demiyoruz!

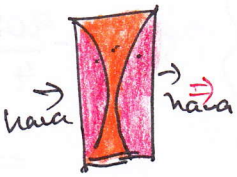


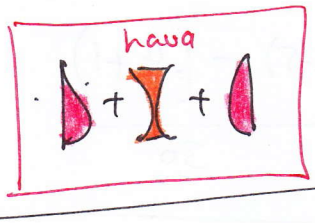


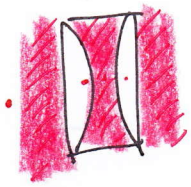
Suyun içindeki balık sanal görüntü verir.



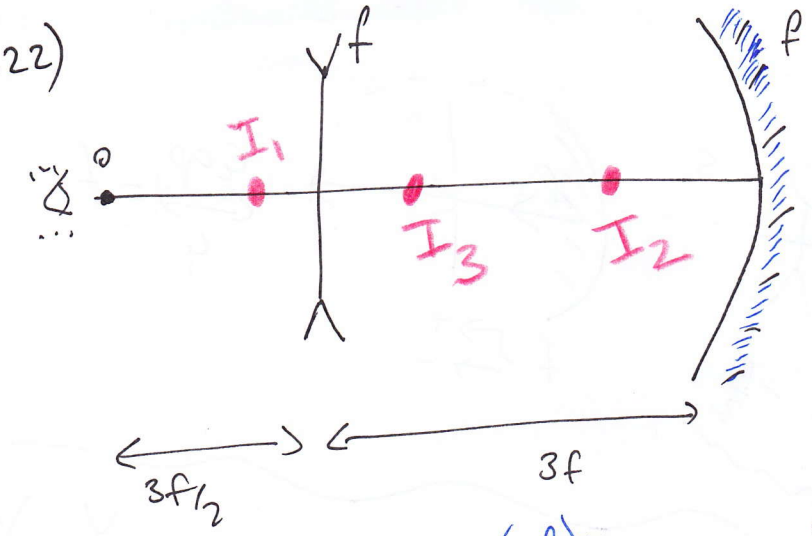
2.20)







2.22)



ayna
mercek ayni f' e sahip.

2 kırınım sonrası oluşan son görüntüyü bulmuş.

yani mercekten iki kez gececek.

kalın kenarlı mercek $(-f)$
ince ayna $(+f)$

1 mercek

$$\frac{1}{\frac{3f}{2}} + \frac{1}{s'} = \frac{1}{-f} \Rightarrow -\frac{3f}{5} = s' \quad \text{(mercegin solunda)} \quad I_1$$

ayna

$$s = \frac{3f}{5} + 3f = \frac{18f}{5}$$

$$\frac{1}{\frac{18f}{5}} + \frac{1}{s'} = \frac{1}{f} \quad ; s' = \frac{18}{13} f \quad I_2$$

(aynanın solunda)

2 kez mercek

$$s = 3f - \frac{18}{13} f = \frac{21f}{13}$$

$$\frac{1}{\frac{21f}{13}} + \frac{1}{s'} = -\frac{1}{f} \Rightarrow \frac{1}{s'} = -\frac{34}{21f}$$

$$s' = -\frac{21}{34} f \quad I_3$$

(mercegin sağında)

Toplam büyütme: $m_1\ m_2\ m_3$

$$m_T = \left[-\frac{(-3f/5)}{3f/2}\right]\left[-\frac{\frac{18}{13}f}{\frac{18f}{5}}\right]\left[-\frac{-\frac{21}{34}f}{21f/13}\right] = \left(\frac{2}{5}\right)\left(-\frac{5}{13}\right)\left(\frac{13}{34}\right) = -\frac{2}{34}$$

$$m_T = -\frac{1}{17}$$

görüntü 17 kat küçülmüş ve ters!

Deneme Sınavı Sonsuyda.