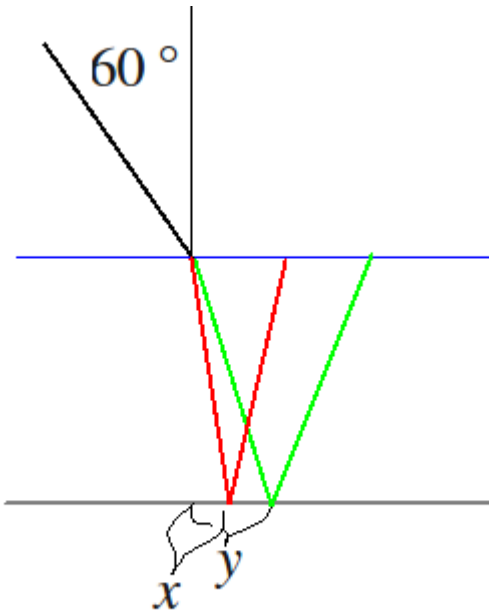
5.1



slika 5.1

- upadnu kud $u=60\,°$
- izlazni kutevi l_1 I l_2
- h udaljenost od povrsine do zrcala

$n_{11}=n_{12}=1$

$n_{21}=\frac{4}{3}$

$n_{22}=\frac{8}{3}$

$l=\frac{n_1}{n_2}\sin u$

$l_1=40.50\,°$

$l_2=18.95\,°$

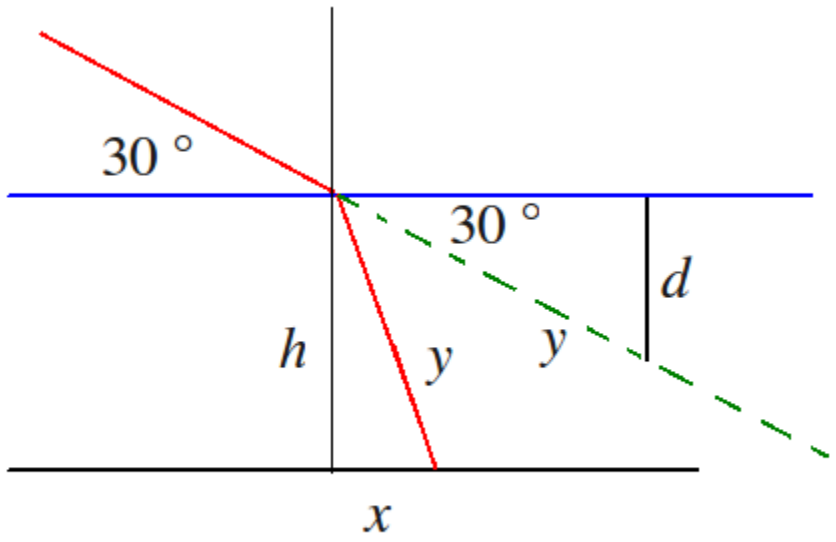
$x=h\cdot tg\,l_2$

$y=h\cdot tg\,l_1$

- udaljenosti od upadne do izlazne zrake iz vode $d_1=2\,y$ $d_2=2\,x$

$k=\frac{d_1}{d_2}=\frac{tg\,l_1}{tg\,l_2}=2.487$

5.2



slika 5.2

- ovaj nisam siguran, pretpostavljam da put koji prođe zraka u vodi po crvenoj liniji jednak je puti koji prode po zelenoj
- upadni kut $u = 60\,°$

$l = 40.63\,°$

$y = \frac{h}{\cos l}$

$d = y \sin 30 = \frac{h}{\cos l} \sin 30\,° = 1.976\,m$

5.3

$n_2 = 1.33$

$n_1 = 1.52$

- idemo unatrag, minimalan $\sin u = \frac{n_2}{n_1}$

$u = 61\,°$

- ako zraka ide unatrak tada je upadni kut na granicu presjeka valjka i vode $l = 90\,° - u$, a izlazni kut je jednak α

$\sin \alpha = \sin l \frac{n_1}{n_2}$

$\alpha = 33.59\,°$

- ako je α veci tada je l veci, pa je u manji i tad nemamo refleksiju pa mora vrijediti

$\alpha < 33.59\,°$

5.4

$\delta_{min1} = 12\,°$

- ako je δ minimalan vrijedi da je $u_1 = u_2$ $l_1 = l_2$

$2u_{vode} = \delta + A$

$l_{vode} = \frac{A}{2}$

$\sin l_{vode} = \frac{n_{vode}}{n_{prizme}} \sin u_{vode}$

$n_{prizme} = 1.621$

– ako je u ulju

$l_{ulja} = \frac{A}{2}$

$\sin u_{ulja} = \sin l_{ulja} \frac{n_{prizme}}{n_{ulja}}$

$u_{ulja} = 27.57$

$u_{ulja1} = u_{ulja2} = u_{ulja}$

$\delta_{min2} = 2u_{ulja} - A = 5.14°$

5.5

$r = 16\text{m}$

$a = 1.49 \cdot 10^{11}$

$r_s = 6.95 \cdot 10^{8}\, m$

$\frac{1}{a} + \frac{1}{b} = \frac{2}{r}$

$\frac{1}{b} = \frac{2}{r} - \frac{1}{a}$

$\frac{1}{b} = 0.125$

$b = 8\, m$

$y = \frac{-b}{a} = 8.389 \cdot 10^{-13}$

$r_{zrcalni} = r_s * y = 3.73\, cm$

$visina = 2r_{zrcalni} = 7.46\, cm$

5.6

1° $y = \frac{-b}{a}$ $\frac{1}{4} = \frac{b}{a}$ $b = \frac{a}{4}$

2° $y = \frac{-b}{a}$ $\frac{1}{2} = \frac{b}{a+5}$ $b = \frac{1}{2}(a+5)$

$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$

$\frac{1}{a} + \frac{1}{\frac{a}{4}} = \frac{1}{(a-5)} + \frac{1}{\frac{1}{2}(a-5)}$ $\frac{1}{f} = \frac{5}{a}$ $f = \frac{a}{5}$

$\frac{5}{a}=\frac{3}{(a-5)}$

$5a-25=3a$

$a=12.5$

$f=2.5\,cm$

5.7

- imamo sustav
- uzmemo kao da je predmet u beskonacnosti $a_1=\infty$

$\frac{1}{f_{lece}}=n_1-1(\frac{1}{r_1}-\frac{1}{r_2})$

$f_{lece}=0.4\,m$

$f_{zrcala}=\frac{r}{2}=0.2$

$\frac{1}{a_1}+\frac{1}{b_1}=\frac{1}{f_{lece}}$

$b_1=f_{lece}$ - to predstavlja sliku za zrcalo (virtualni sliku)

$a_2=-b_1=-f_{lece}$

$\frac{-1}{f_{lece}}+\frac{1}{b_2}=\frac{1}{f_{zrcala}}$

$\frac{1}{b_2}=\frac{f_{lece}+f_{zrcala}}{f_{lece}f_{zrcala}}$

b_2 - je opet virtualna slika za lecu

$a_3=-b_2$

$\frac{1}{a_3}+\frac{1}{b_3}=\frac{1}{f_{lece}}$ - b_3 je zarisna duljina

$-\frac{f_{lece}+f_{zrcala}}{f_{lece}f_{zrcala}}+\frac{1}{b_3}=\frac{1}{f_{lece}}$

$\frac{1}{f}=\frac{1}{b_3}=\frac{f_{zrcala}+f_{lece}+f_{zrcala}}{f_{lece}f_{zrcala}}$

$f=0.1\,m$

5.8

$f=30 \quad a=40 \quad \frac{1}{a}+\frac{1}{b}=\frac{1}{f}$ - treba postaviti zrcalu na mjestu gdje nastaje slika

$\frac{1}{a}+\frac{1}{b}=\frac{1}{f} \quad \frac{1}{b}=\frac{1}{30}-\frac{1}{40}=\frac{4-3}{120}=\frac{1}{120}$

$d=b-a=80\,cm$

5.9

$n=1.33$

– od vode imamo plan-konkavno zrcalo

$\frac{1}{f_{lece}}=(n-1)(\frac{-1}{r_2})=\frac{1}{180}$ $n_1=1$ $r_1=\infty$

- imamo predmet $a_1=\infty$

$\frac{1}{b_1}=\frac{1}{f_{lece}}$

$b_1=180=-a_2$ - a_2 je udaljenost realna slike lece (virtualna slika za zrcalo)

$\frac{1}{a_2}+\frac{1}{b_2}=\frac{1}{f_{zrcal}}$

$\frac{1}{b_2}=\frac{1}{30}+\frac{1}{180}=\frac{6+1}{180}=\frac{7}{180}$

$b_2=\frac{180}{7}=-b_3$ - virtualna slika za lecu

$\frac{1}{b_3}+\frac{1}{f}=\frac{1}{f_{lece}}$ $\frac{-7}{180}+\frac{1}{f}=\frac{1}{180}$

$\frac{1}{f}=\frac{8}{180}$

$f=22.5\,cm$

5.10

– isti ko i 5.9

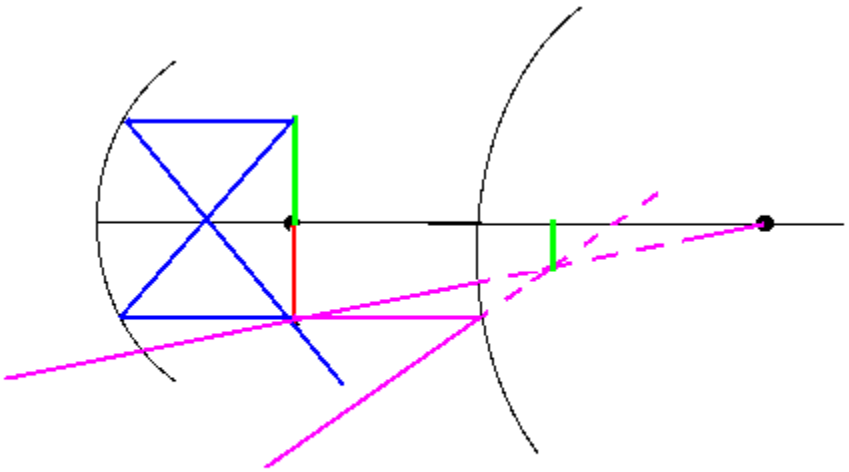
$f_{lece}=2.22\text{m}$ $f_{zrcala}=0.4\text{m}$

$b_1=2.22\text{m}$

$b_2=0.33\text{m}$

$f=0.294\,m$

5.11



slika 5.11

- na konkavnom zrcalu

$$\frac{1}{a}+\frac{1}{b}=\frac{2}{r}$$
$$\frac{1}{b}=\frac{1}{12.5}-\frac{1}{25}$$
$$b=25\,cm$$

- na konveksnom

$$\frac{1}{a}+\frac{1}{b}=\frac{-2}{r}$$
$$\frac{1}{25}+\frac{1}{b}=\frac{-1}{25}$$
$$b=-12.5$$

- posto je b negativan sa desne strane konveksnog zrcala predmet je vitualan u 12.5 cm iza zrcala
- a ako je zrcalo ravno onda je predmet sa suprotne strane ravnog zrcana na istoj udaljenosti (25 cm)

5.12

- imamo 2 dioptra
- za prvi vrijedi

$$d=10\,cm$$
$$\frac{n_1}{a}+\frac{n_2}{b}=\frac{n_2-n_1}{r}$$
$$n_1=1$$
$$a_1=jako\,veliki\,broj$$
$$n_2=1.5$$
$$\frac{n_2}{b_1}=\frac{n_2}{r}$$
$$b_1=5$$

- za drugi dioptar

$$a_2=d-b_1=5$$
$$\frac{n_1}{a_2}+\frac{n_2}{b}=\frac{n_2-n_1}{r} \qquad r=\infty \qquad n_2=1 \qquad n_1=1.5$$
$$\frac{1.5}{a_2}+\frac{1}{b}=0$$
$$b=-3.33$$

5.13

y = 5

$$\frac{y'}{y}=\frac{b}{a}$$

1° $y' = 15$ $\frac{b_1}{a} = \frac{15}{5}$ $b = 3\text{a}$

2° $y' = 10$ $\frac{b_2}{(a+1.5)} = \frac{10}{5}$ $b_2 = 2(a+1.5)$

$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$

$\frac{1}{a} + \frac{1}{3\text{a}} = \frac{1}{(a+1.5)} + \frac{1}{2(a+1.5)}$

$\frac{4}{3\text{a}} = \frac{3}{2(a+1.5)}$

$8\text{a} + 12 = 9\text{a}$

$a = 12\,cm$

$\frac{1}{f} = \frac{4}{3\text{a}} = \frac{1}{9}$

$f = 9\,cm$

5.14

$r_1 = 10\,cm$ $r_2 = 12\text{cm}$

$a = 48\,cm$

$b = 96\,cm$

$n_v = \frac{4}{3}$

$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$

$\frac{1}{48} + \frac{1}{96} = \frac{3}{96} = \frac{1}{32} = \frac{1}{f}$

$\frac{n_2 - n_1}{n_1}(\frac{1}{r_1} - \frac{1}{r_2}) = \frac{1}{f}$

$n_2 = \frac{n_1(\frac{1}{f} + \frac{1}{r_1} - \frac{1}{r_2})}{\frac{1}{r_1} - \frac{1}{r_2}}$

$n_2 = 1.56$

5.15

– ako je slika realna onda se nalazi s desne strane konvergentne

$b = 0.3$

$a_d = -b$

– jer je kod dovergentne leće predmet s desne strane (slika od prve leće)

$\frac{1}{a_d} + \frac{1}{b_d} = \frac{1}{f_d}$

$\frac{1}{f_d} = \frac{-1}{0.3} + \frac{1}{0.4}$

$f_d = -1.2\text{m}$

5.16

$d = 10\,cm$

$f_1 = f = -f_2 = 25$

$a_1 = \infty$

$\frac{1}{b_1} = \frac{1}{f}$

$b_1 = 25\,cm$

$a_2 = d - b_1 = -15\,cm$

$\frac{1}{a_2} + \frac{1}{b_2} = \frac{1}{f_2}$

$\frac{1}{b_2} = \frac{-1}{25} + \frac{1}{15} = \frac{-3+5}{75} = \frac{2}{75}$

$b_2 = 37.5\,cm$

5.17

- slika leće

$j = 8$

$a_1 = \infty$

$\frac{1}{b_1} = \frac{1}{f} = j$

$b = \frac{1}{8} m = 12.5\,cm$

- predmet za plocu

$a_2 = d - b = -10\,cm$

- ploca je zapravo 2 dioptra

$\frac{n_1}{a_2} + \frac{n_2}{b_2} = \frac{n_2 - n_1}{r} \qquad n_1 = 1 \qquad n_2 = \frac{3}{2} \qquad r = \infty$

$\frac{-1}{10} + \frac{3}{2 b_2} = 0$

$b_2 = 15\,cm$

- debljina plex $d_p = 20\,cm$
- slika za drugu stranu ploce

$a_3 = d_p - b_2 = 5\,cm$

$\frac{n_1}{a_3} + \frac{n_2}{b_3} = \frac{n_2 - n_1}{r} \qquad n_1 = \frac{3}{2} \qquad n_2 = 1 \qquad r = \infty$

$\frac{3}{15} + \frac{1}{b_3} = 0$

$b_3 = -5\,cm$ - znaci da je slika unutar plexiglasa, udaljena 5 cm o dna plex

5.18

$a = 2\,cm$
$f = 6\,cm$
$d = 10\,cm$

- lijeva strana pravokutnika $a_2 = d + \frac{l}{2} = 11\,cm$
- desna strana pravokutnika $a_1 = d + \frac{l}{2} = 9\,cm$

$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$

- povećanje stranice $m = \frac{b_1 - b_2}{a_2 - a_1}$

$b = \frac{1}{\frac{1}{f} - \frac{1}{a}} = \frac{f\,a}{a - f}$
$b_2 = 13.2 \qquad b_2 = 18$

5.19

$u = a + b$
$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$
$b = \frac{f\,a}{a - f}$
$u = a + \frac{fa}{a - f}$ - trazimo minimu funkcije

$\frac{du}{da} = 1 + \frac{f \cdot (a - f) - fa}{(a - f)^2} = 0$
$af - f^2 - af = -a^2 + 2\,af - f^2$
$a^2 - 2\,af = 0$
$a\,(a - 2\,f) = 0$
$a = 2\,f$
$a = 40$

$d = a + b = 80\,cm$

5.20

$a = ?$
$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$
$b = \frac{p}{100} f$

$$\frac{1}{a}+\frac{100}{pf}=\frac{1}{f}$$

$$a=\pm\frac{p}{p-100}f$$

5.21

$f_1 \quad f_2$

$a_1=\infty$

$$\frac{1}{b_1}=\frac{1}{f_1}$$

$b_1=f_1$

$a_2=d-b_1=d-f_1$

$$\frac{1}{d-f_1}+\frac{1}{a_2}=\frac{1}{f_2}$$

$$\frac{1}{a_2}=\frac{1}{f_2}-\frac{1}{d-f_1}=\frac{d-f_1-f_2}{f_2(d-f_1)}$$

$$a_2=f_{sustava}=\frac{f_2(f_1-d)}{f_1+f_2-d}$$

5.22

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

a)

$r_1=\infty$

$r_2=4.5\,cm$

$n_1=1$

$n_2=1.62$

$f_1=-7.26\,cm$

b)

$r_1=-4.5$

$r_2=-6.3\,cm$

$n_1=1$

$n_2=1.52$

$f=-30.28$

c)

$a_1=\infty$

$$\frac{1}{b_1}=\frac{1}{f_1} \qquad a_2=d-b_1-b_1$$

...

$$\frac{1}{f}=\frac{1}{f_2}+\frac{1}{f_1} \qquad j_{sustava}=j_1+j_2=0.17$$

$f=5.9\,cm$