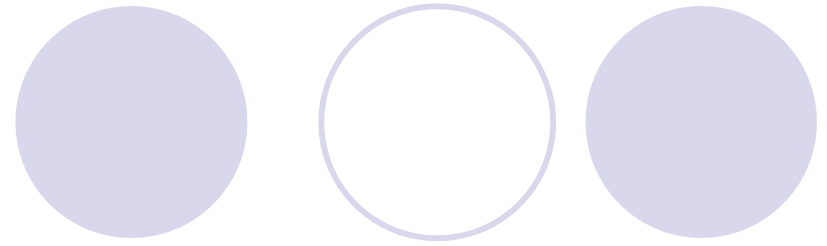


# Optika

- Deo fizike koji se bavi proučavanjem, ispitivanjem i tumačenjem svetlosti kao i njenom interakcijom sa materijalnom sredinom naziva se optika.

# Priroda svetlosti

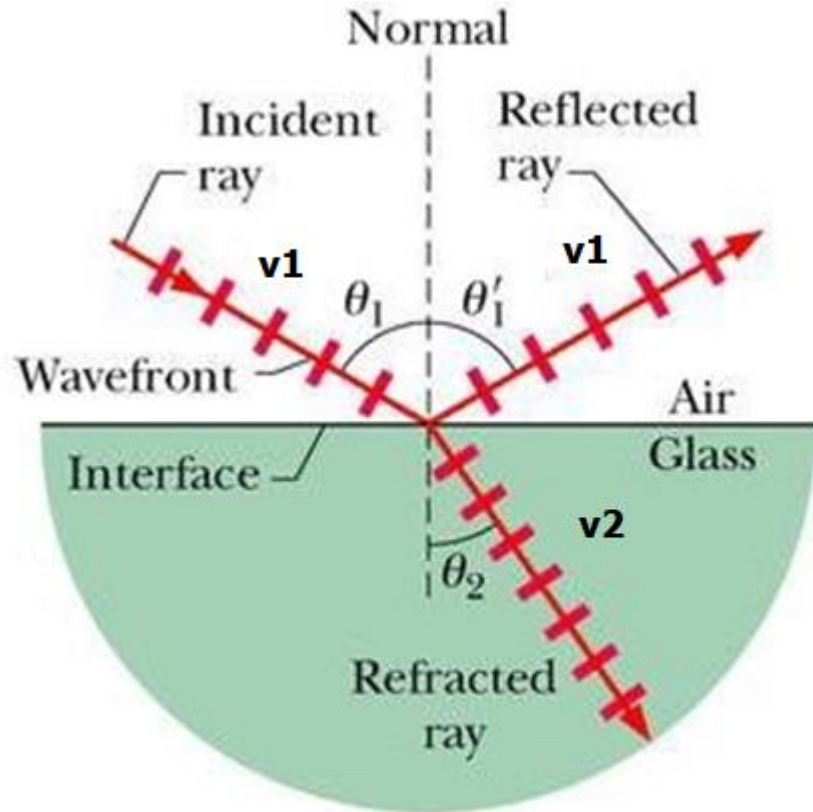


- Priroda svetlosti je dualistička.
- Svetlost se u nekim eksperimentima ponaša kao:
- čestica (fotoefekat, Komptonov efekat);
- talas (interferencija, difrakcija, polarizacija). Svetlost je elektromagnetni talas, čija je brzina  $c = 3 \cdot 10^8$  m/s.

# Odbijanje (refleksija) i prelamanje (refrakcija) svetlosti



(a)



(b)

# Zakoni odbijanja i prelamanja svetlosti

1. Upadni zrak, normala i odbijeni zrak leže u istoj ravni.
2. Ugao upadnog zraka i ugao odbijenog zraka međusobno su jednaki.

$$\Theta_1 = \Theta_1' \text{ refleksija}$$

1. Upadni zrak, normala i prelomljeni zrak leže u istoj ravni.
2. Odnos sinusa ugla upadnog zraka i sinusa ugla prelomljenog zraka je konstantantan.

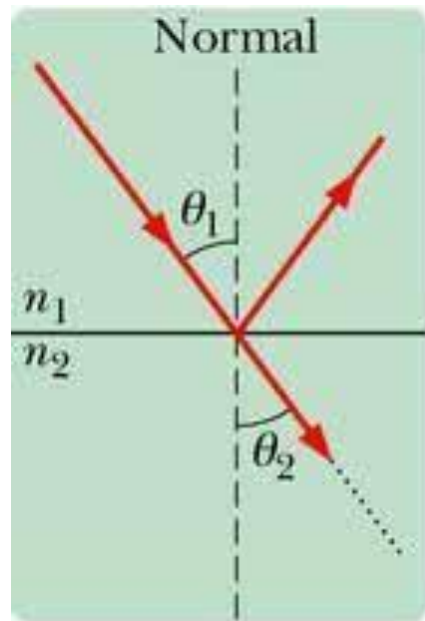
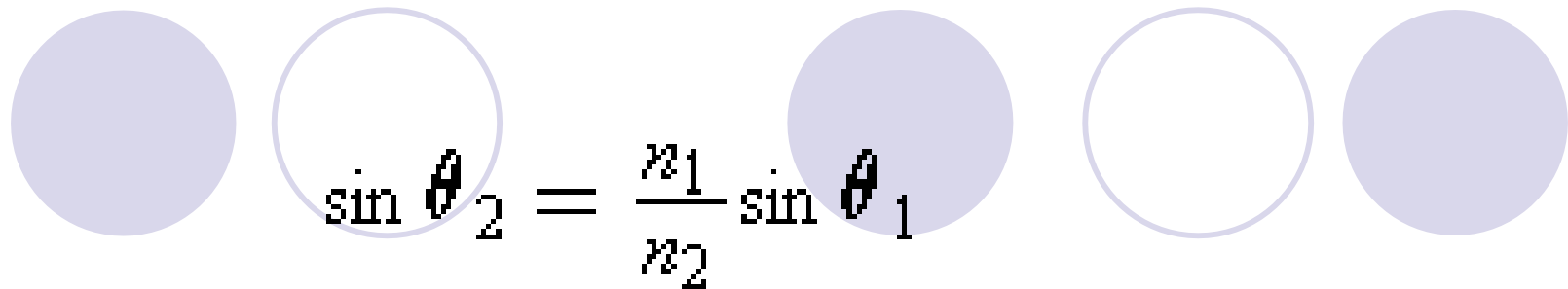
$$\frac{\sin \Theta_1}{\sin \Theta_2} = n_{2,1} = \frac{v_1}{v_2} = \frac{n_2}{n_1} \text{ refrakcija}$$

$$n_1 \sin \Theta_1 = n_2 \sin \Theta_2$$

$$n = \frac{c}{v}$$

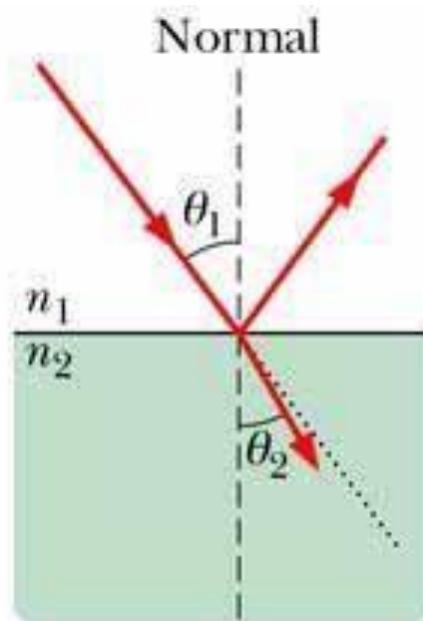
$$v = \frac{c}{\sqrt{\epsilon\mu}}$$

$$n = \sqrt{\epsilon\mu}$$



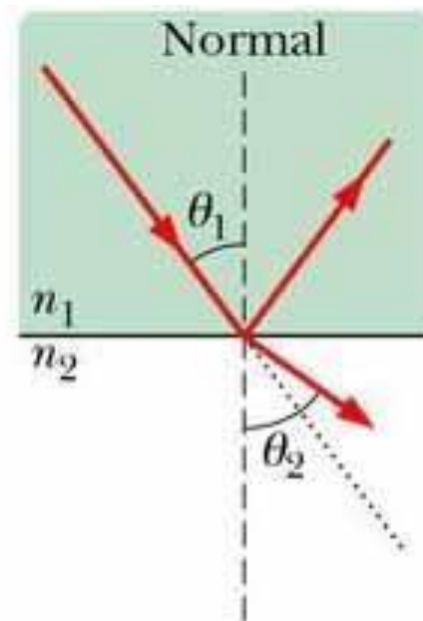
$$n_2 = n_1$$

(a)



$$n_2 > n_1$$

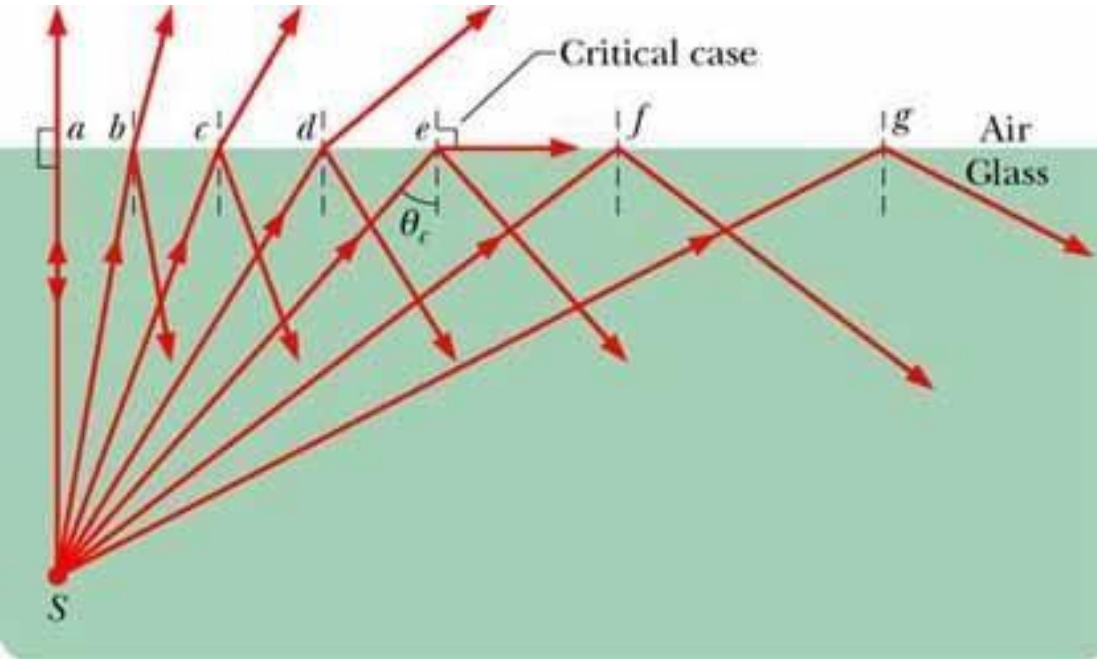
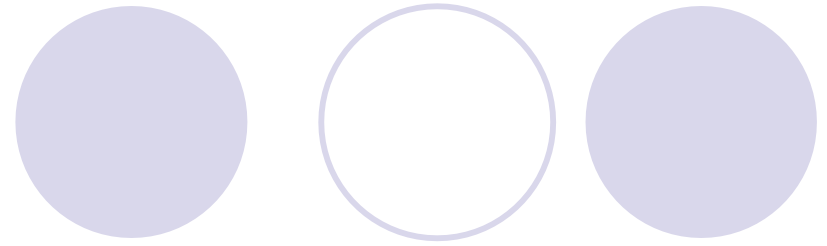
(b)



$$n_2 < n_1$$

(c)

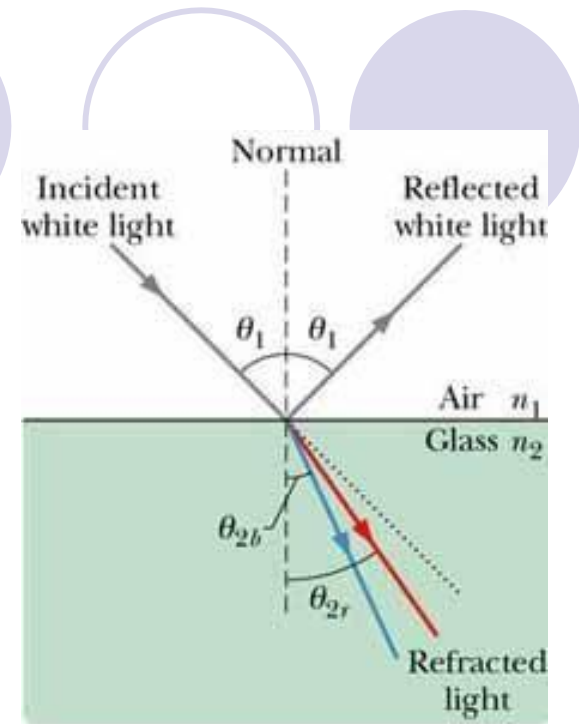
# Totalna refleksija



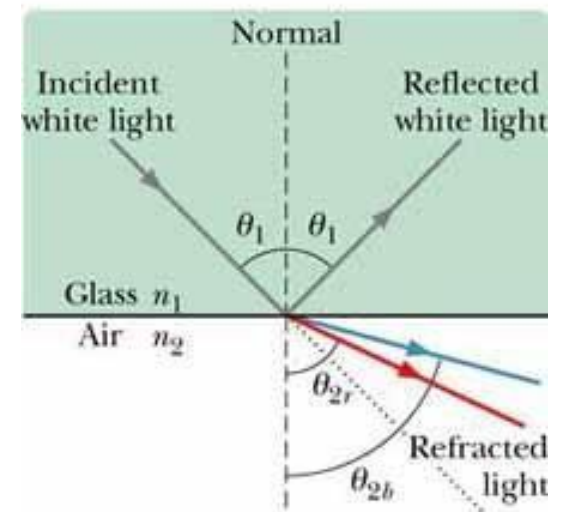
$$n_1 \sin \theta_c = n_2 \sin 90^\circ,$$
$$\theta_c = \sin^{-1} \frac{n_2}{n_1} \quad (\text{critical angle}).$$

# Hromatska disperzija

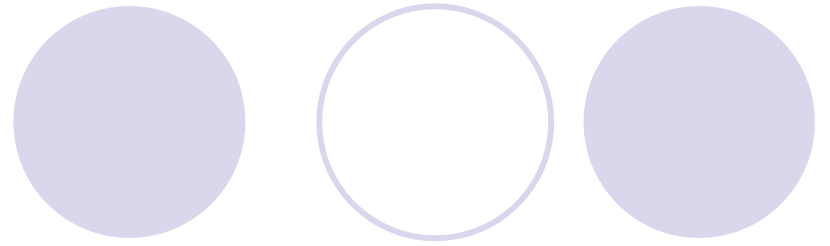
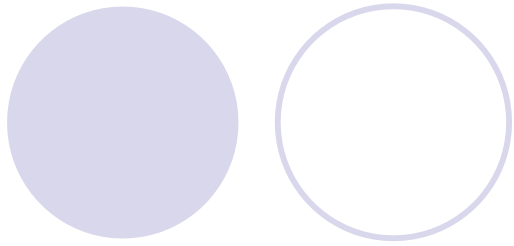
- Indeks prelamanje bilo koje sredine, osim vakuma, zavisi od talasne dužine svetlosti.
- To znači da će se svetlost različite  $\lambda$  prelamati pod različitim uglovima.
- Indeks prelamanja je veći za kraće talasne dužine.
- Plava svetlost  $\lambda=475$  nm.
- Crvena svetlost  $\lambda=650$  nm.
- Plava svetlost više skreće od crvene.



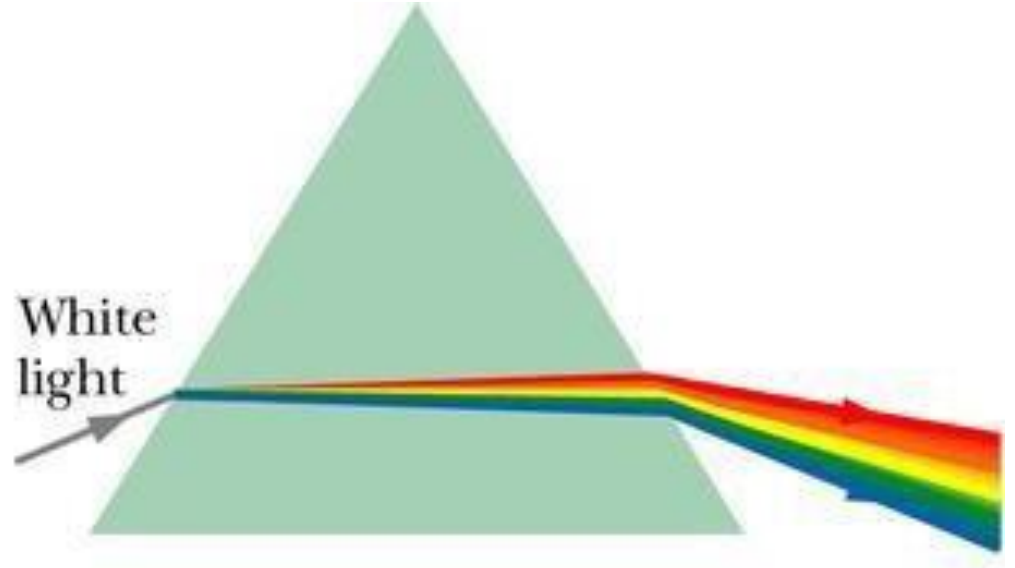
(a)



(b)



(a)

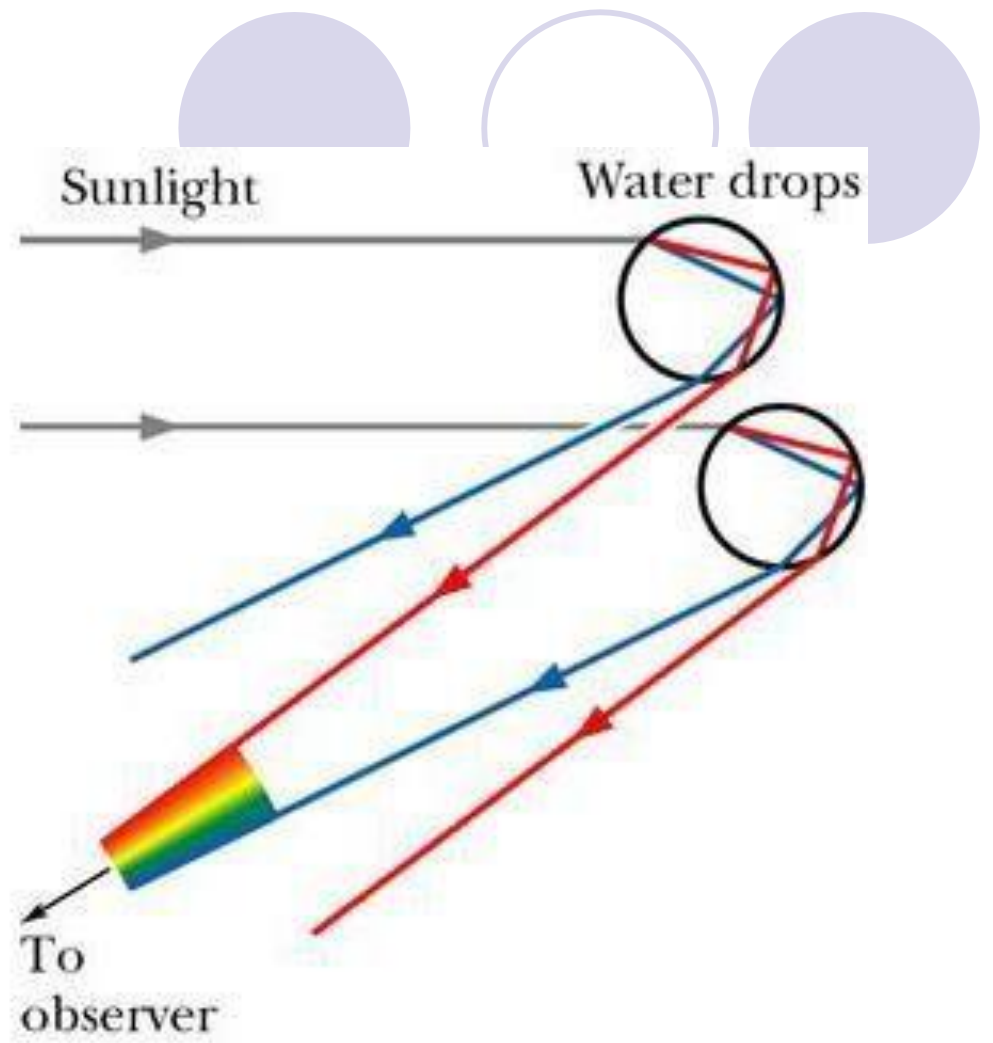


(b)





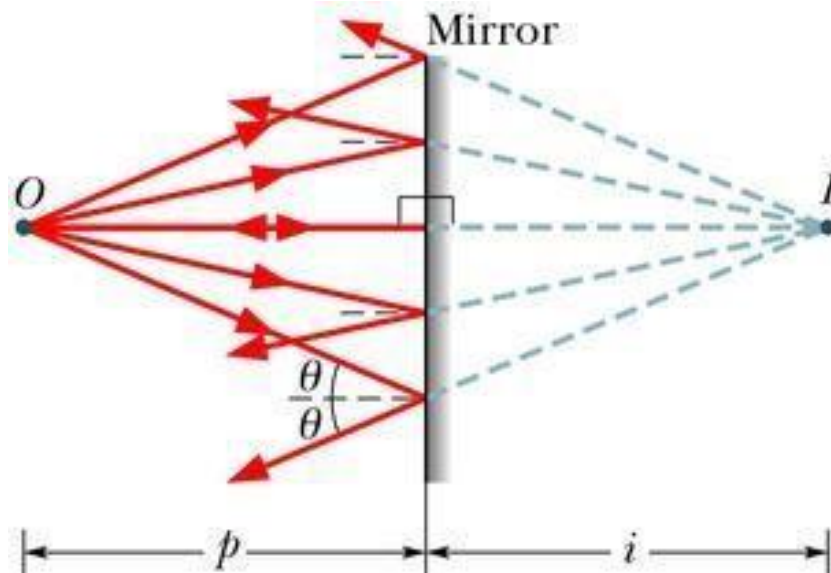
(a)

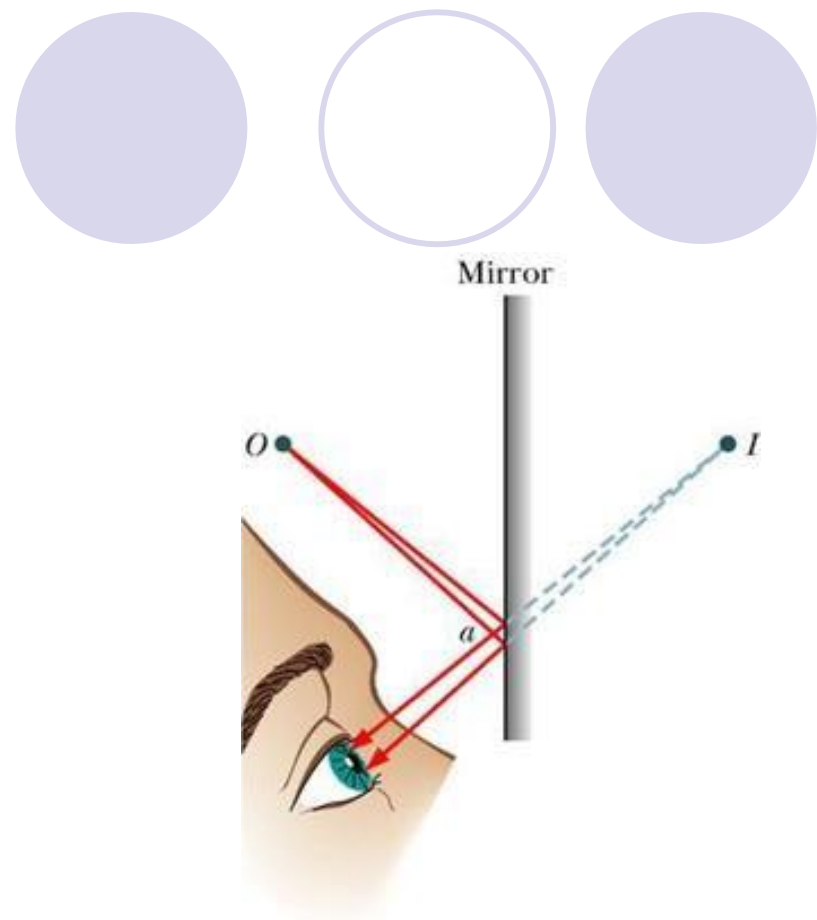
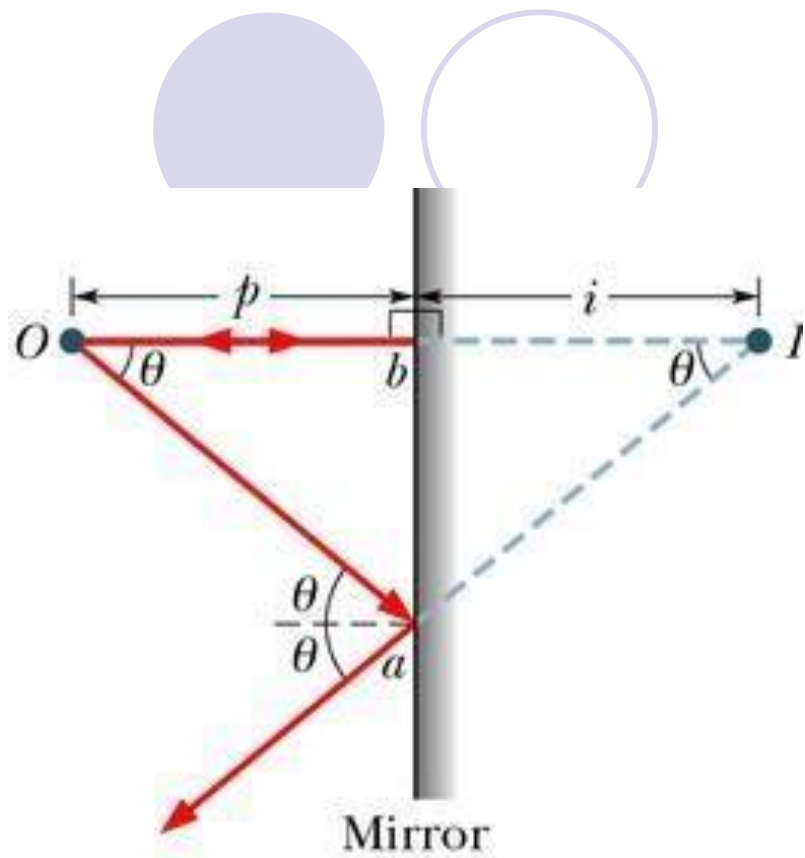


(b)

# Ravna ogledala

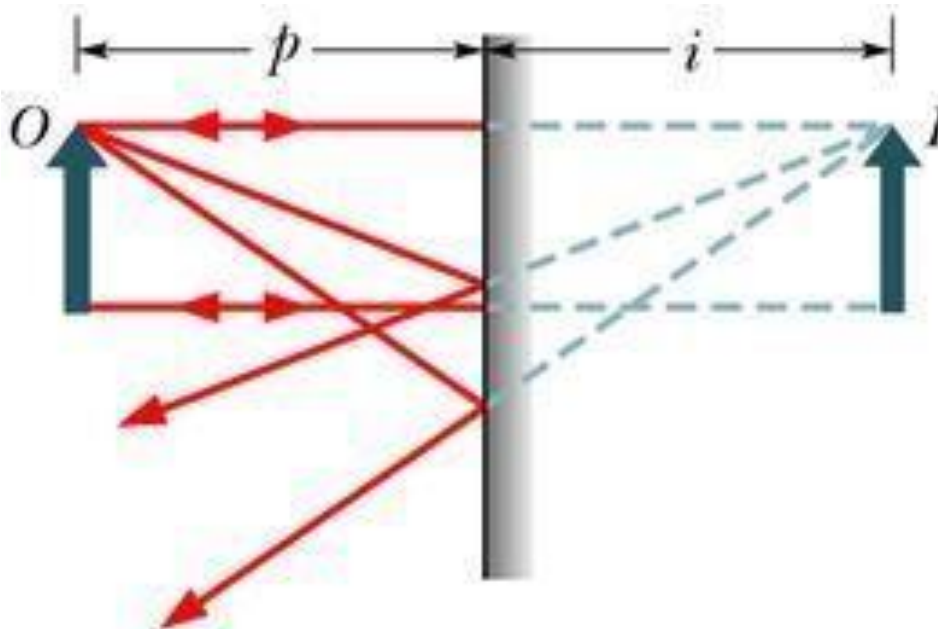
Ogledala su uglačane površine koje pravilno reflektuju svetlost u jednom pravcu, niti ih rasejavaju u različitim pravcima, niti ih apsorbuju.



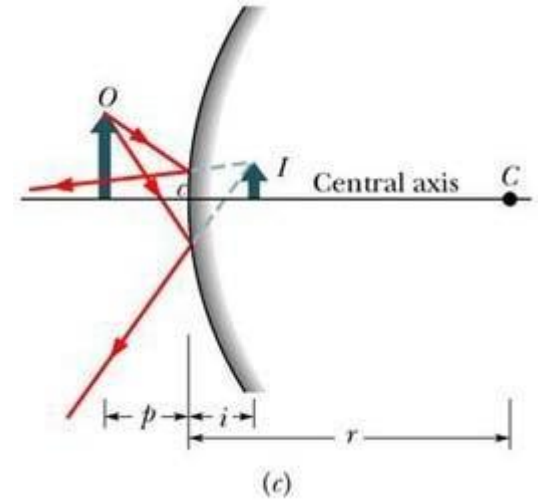
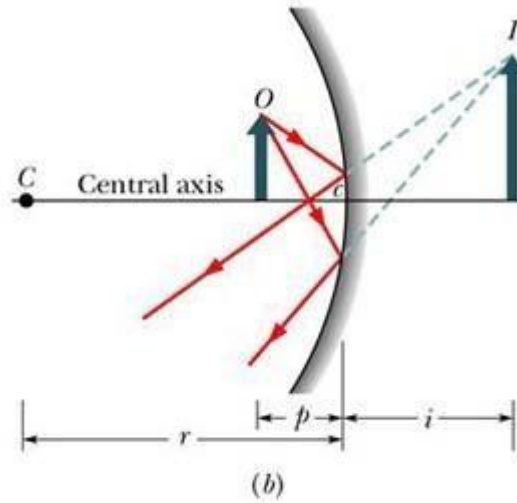
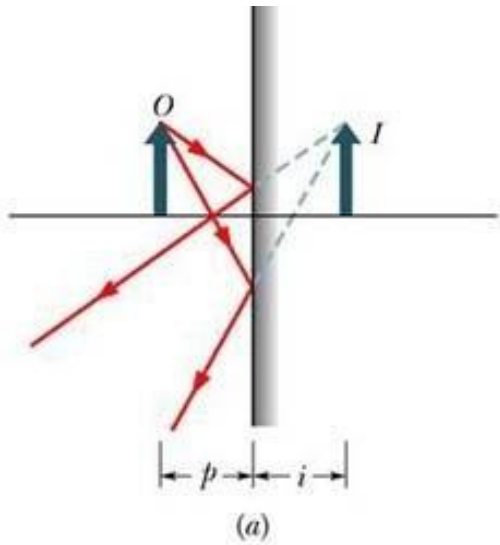


$$Ib = Ob, \quad i = -p \quad (\text{plane mirror}).$$

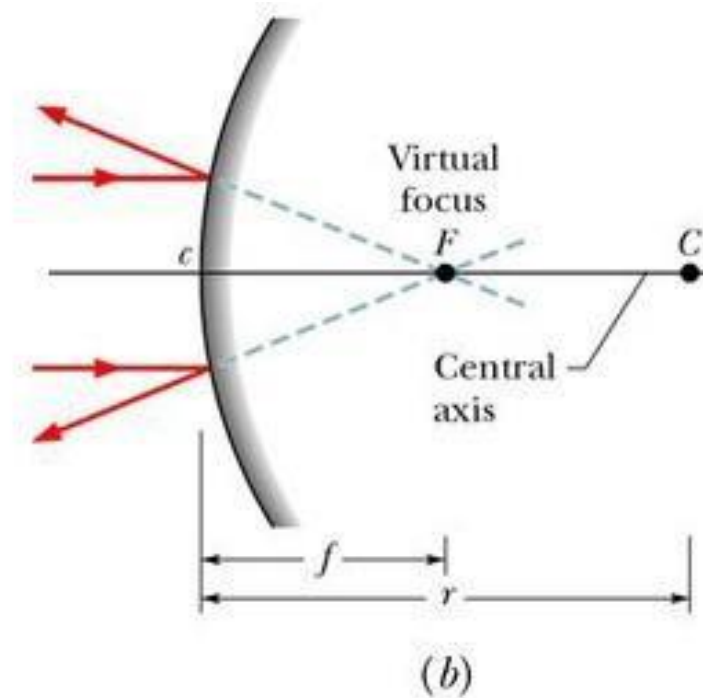
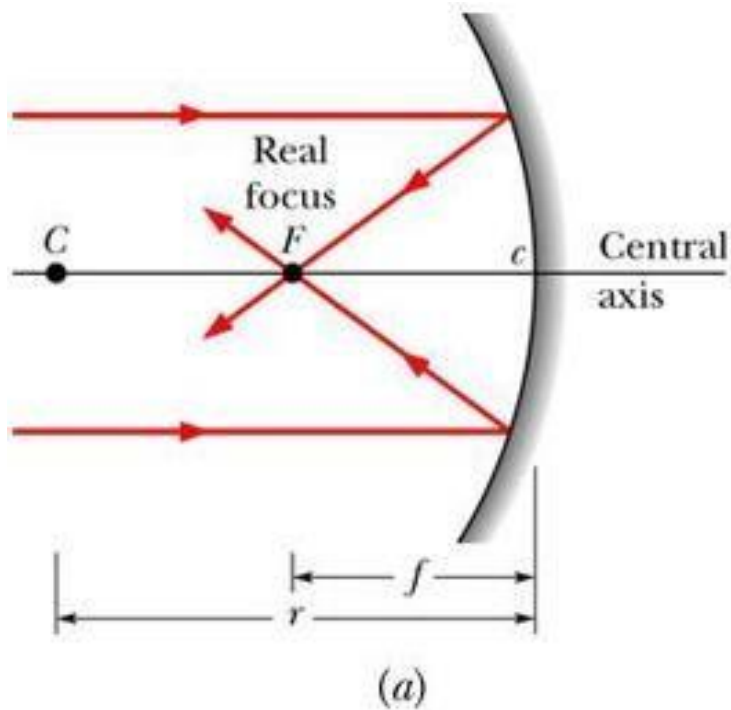
Predmeti koji imaju dimenziju



# Sferna ogledala

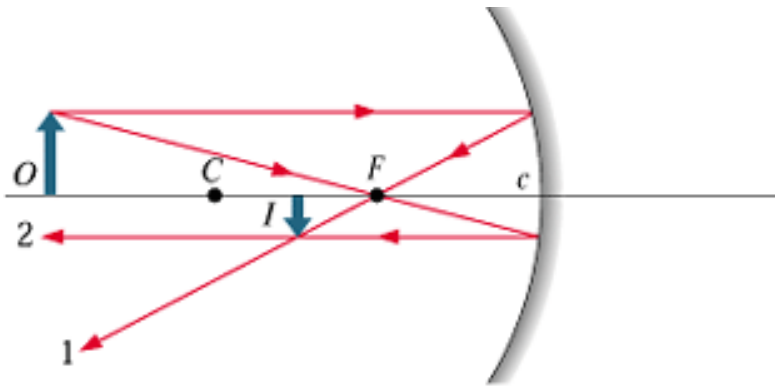


# Žiža kod sfernih ogledala

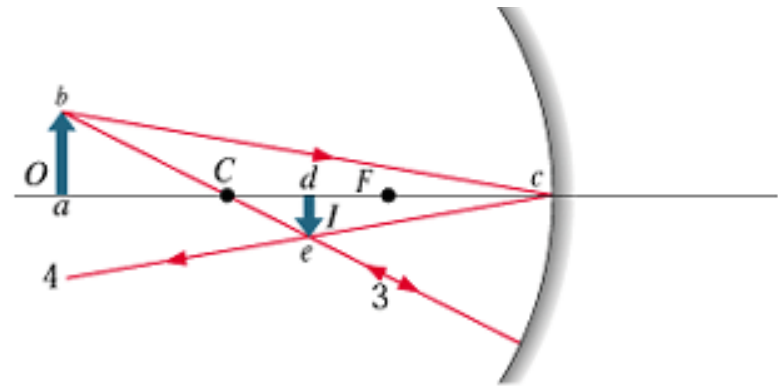


$$f = \frac{1}{2}r \quad (\text{spherical mirror}),$$

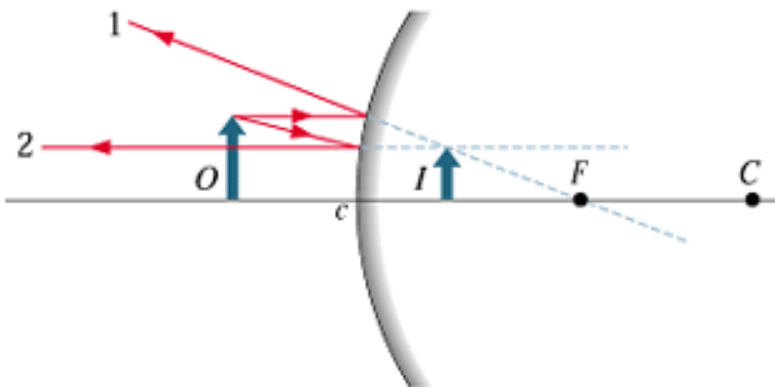
# Konstrukcija likova kod ogledala



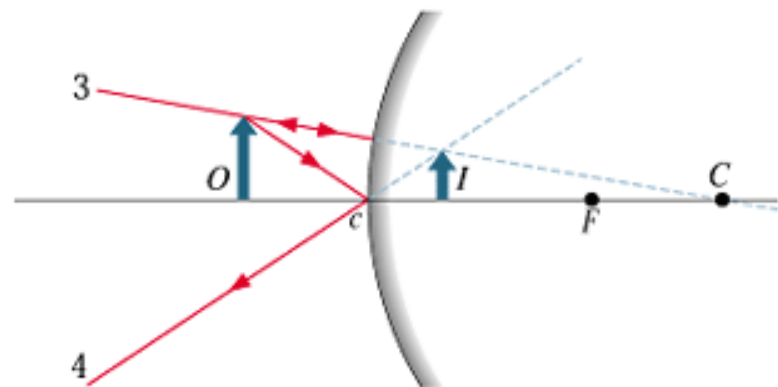
(a)



(b)

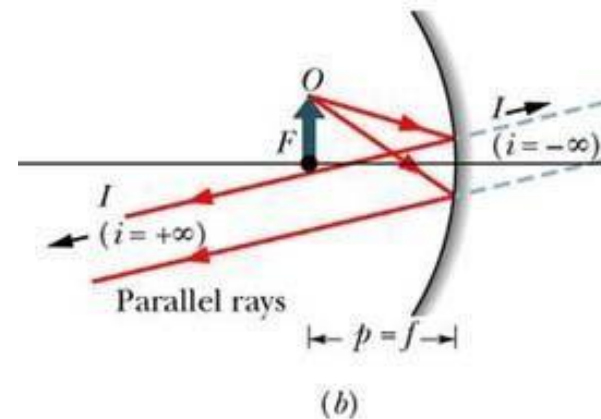
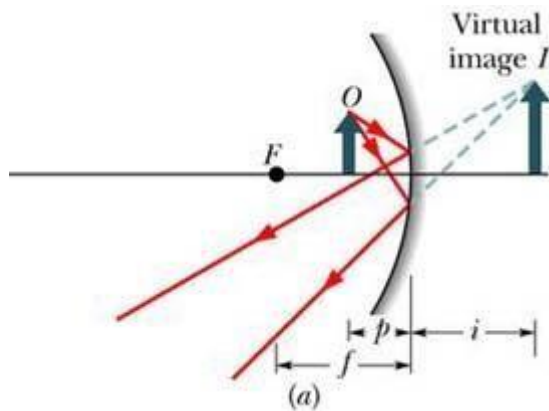


(c)



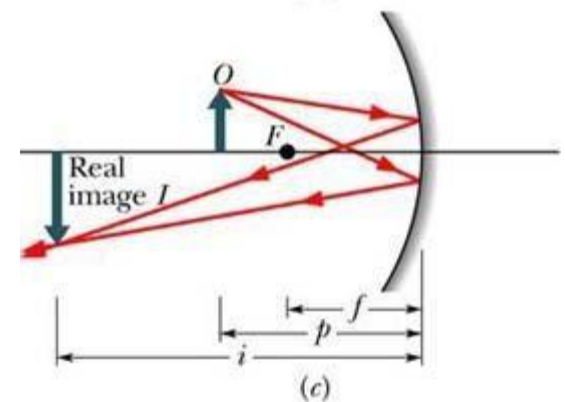
(d)

# Likovi kod sfernog ogledala



--Realni likovi kod ogledala nalaze se sa iste strane gde je i objekat.

--Imaginarni likovi se nalaze na suprotnoj strani od objekta.





# Jednačina sfernog ogledala

$$\frac{1}{p} + \frac{1}{i} = \frac{1}{f} \quad (\text{spherical mirror}).$$

$$|m| = \frac{h'}{h} \quad (\text{lateral magnification}).$$

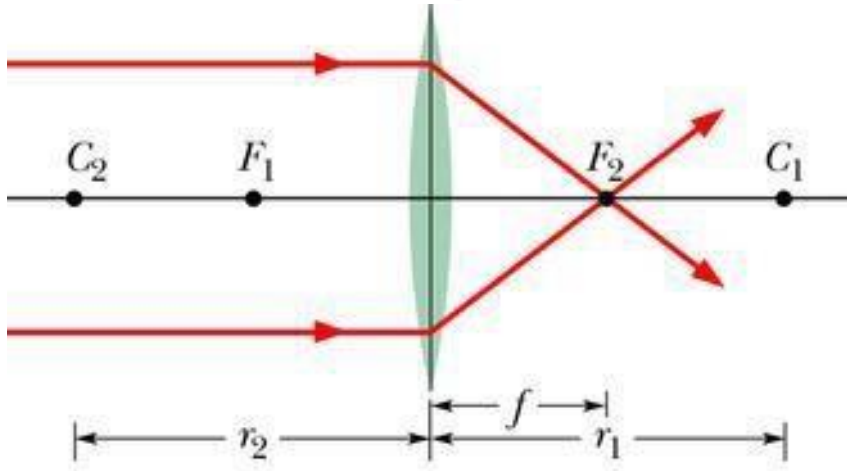
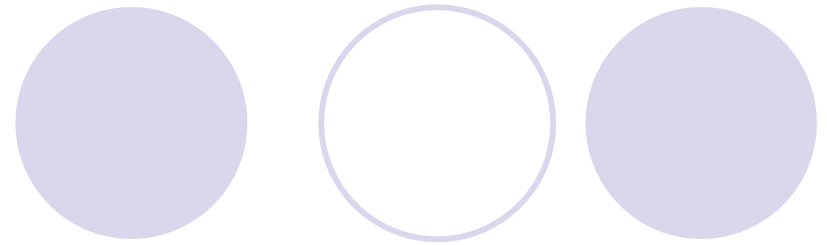
$$m = -\frac{i}{p} \quad (\text{lateral magnification}).$$

$h$  je veličina objekta  
(predmeta)

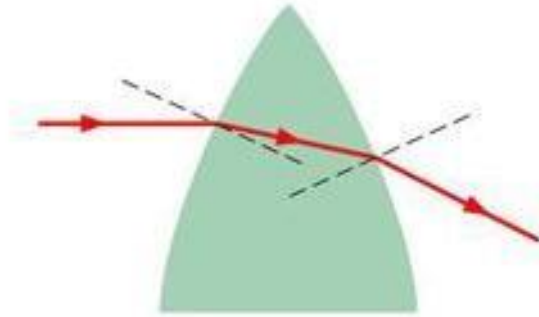
$h'$  je veličina lika

$m$  je uvećanje

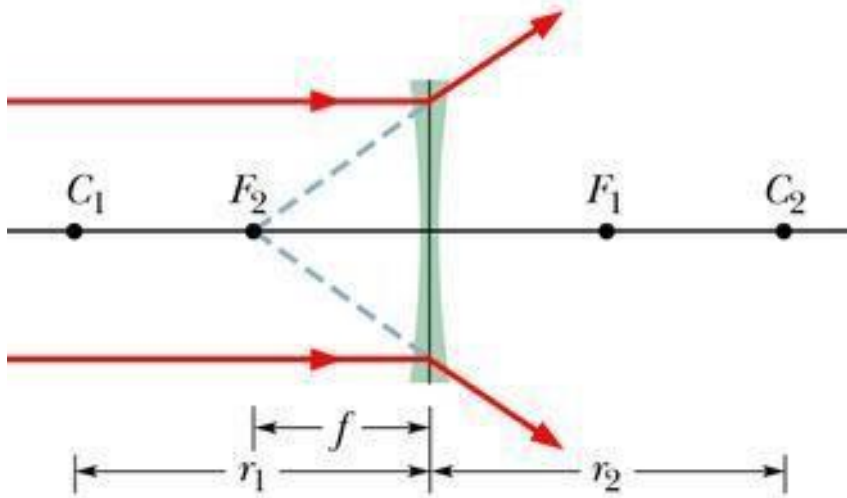
# Tanka sočiva



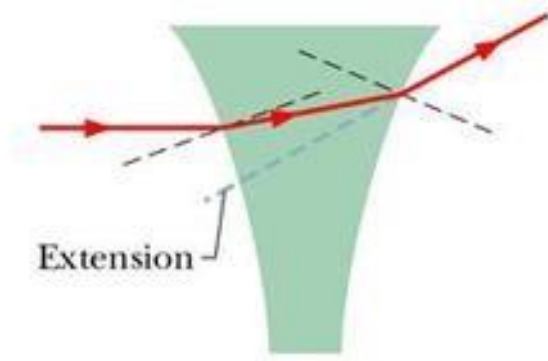
(a)



(b)

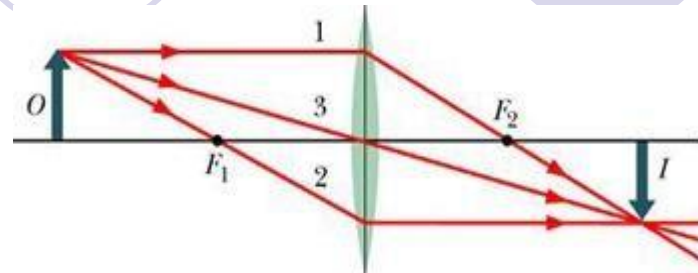


(c)

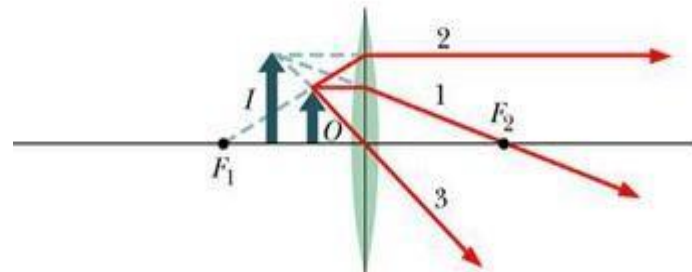


(d)

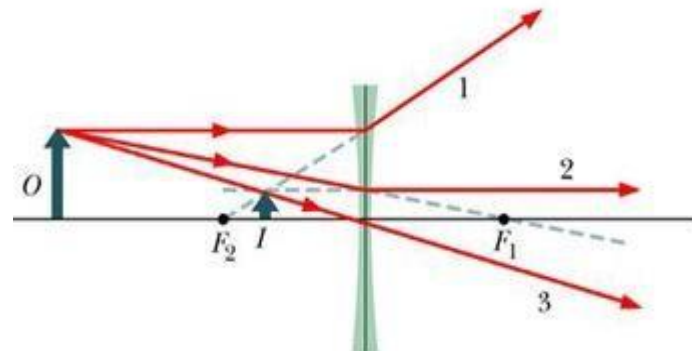
# Konstrukcija likova kod sočiva



(a)

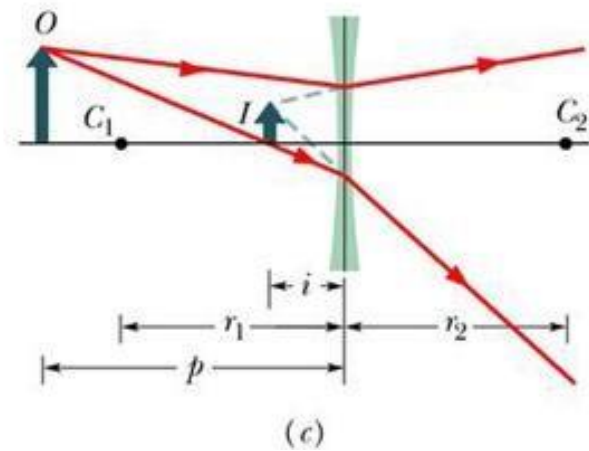
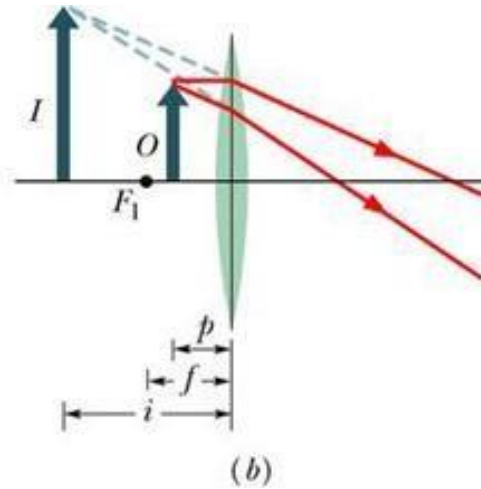
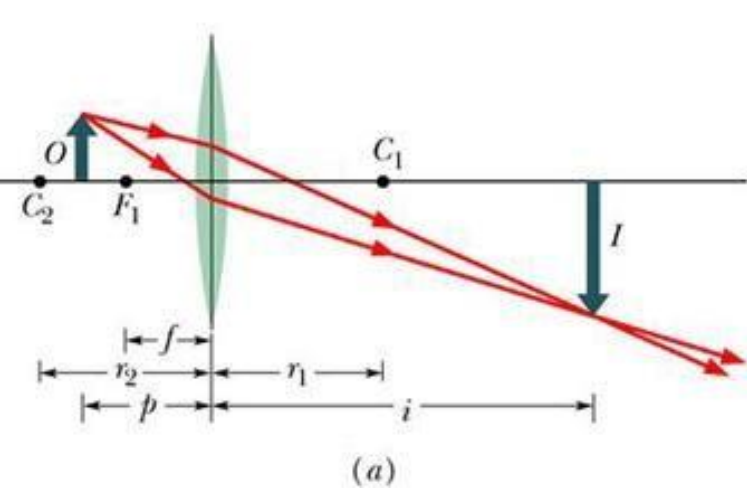
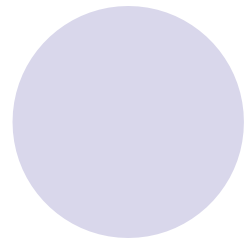
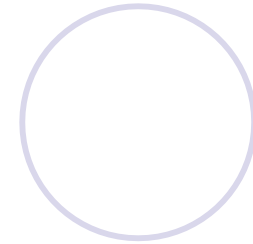
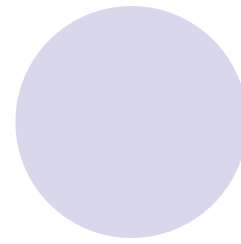


(b)

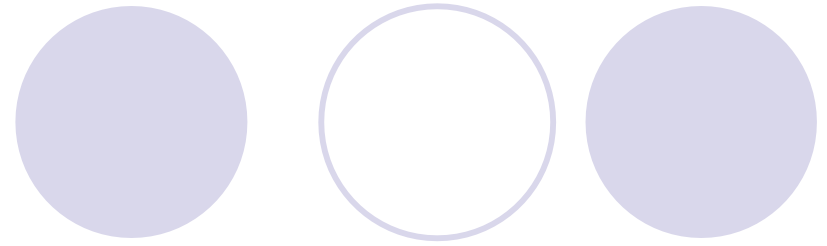


(c)

# Likovi kod sočiva



# Jednačina sočiva



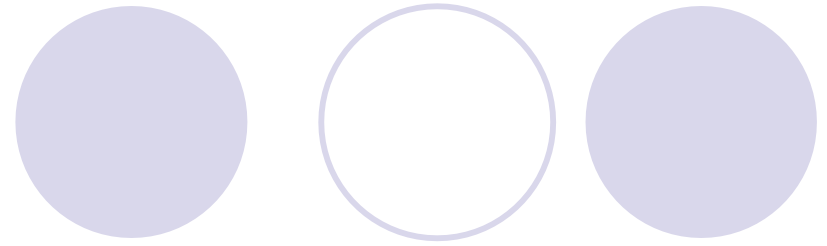
$$\frac{1}{f} = \frac{1}{p} + \frac{1}{i} \quad (\text{thin lens}), \quad \omega = \frac{1}{f}$$

Optička moć sočiva se meri dioptrijama, kada se žižna daljina izrazi u metrima.

$$\frac{1}{f} = (n - 1) \left( \frac{1}{r_1} - \frac{1}{r_2} \right) \quad (\text{thin lens in air}),$$

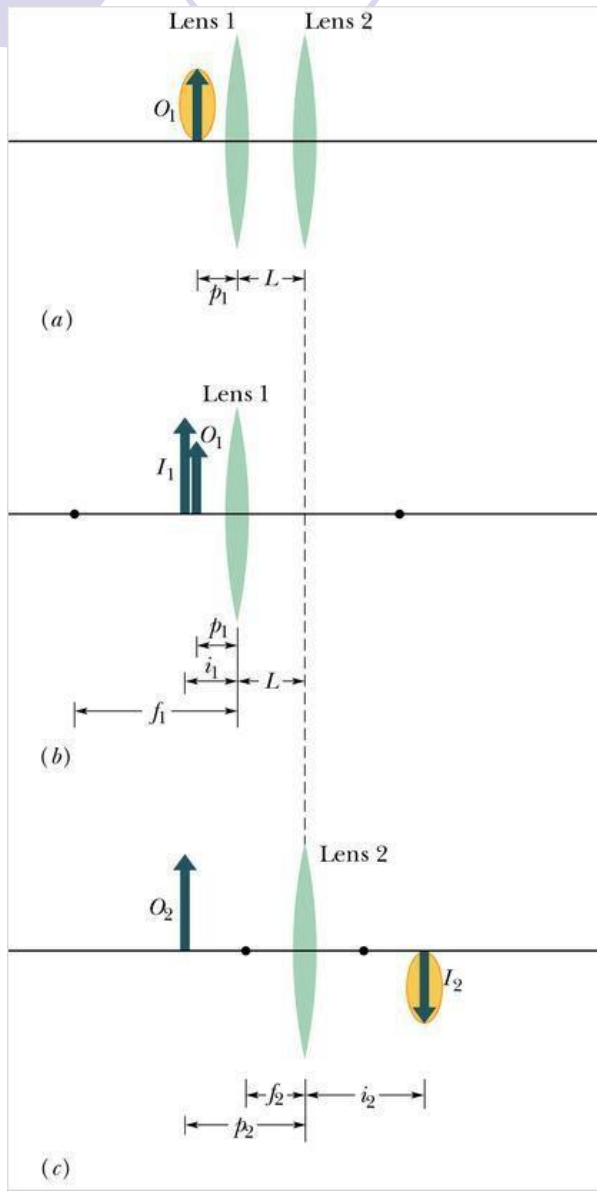
*Umesto  $n$  stavljamo  $n/n_{\text{medium}}$  ukoliko se sočivo nalazi u nekoj sredini.*

# Nedostaci sočiva



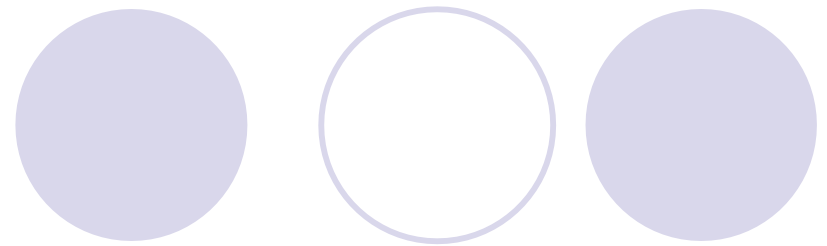
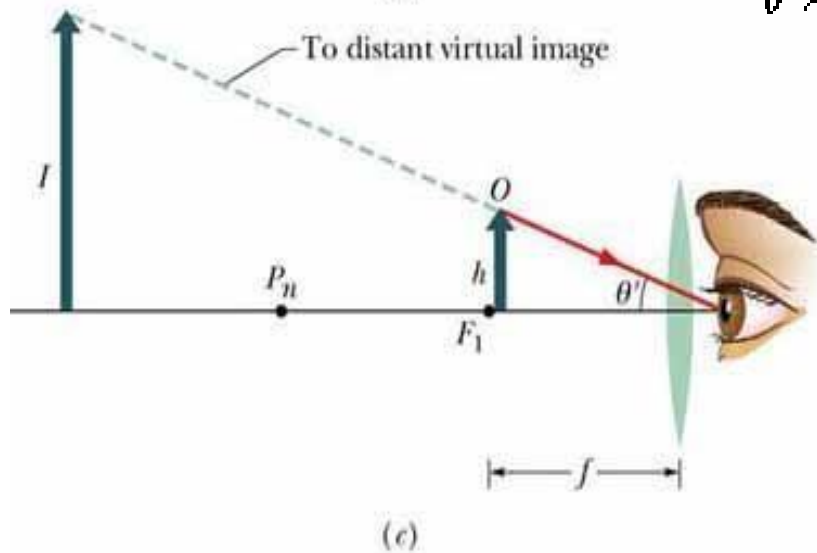
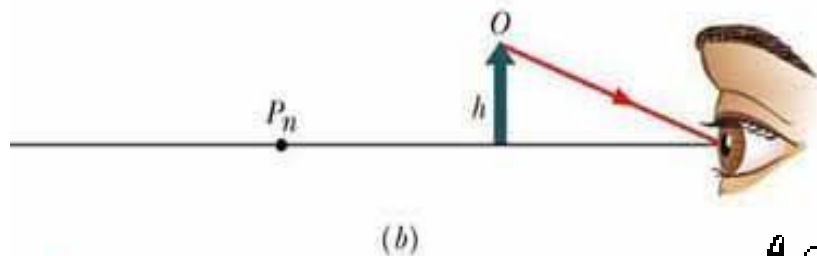
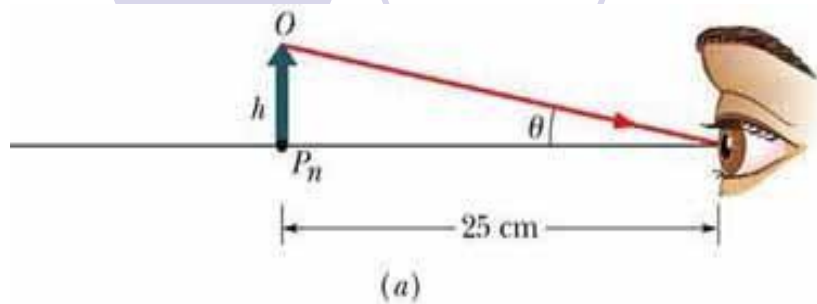
- Sferna aberacija--zraci koji padaju na periferiju sočiva prelamaju se jače.
- Hromatska aberacija--posledica disperzije bele svetlosti.
- Koma—lik tačke je u obliku komete, kod zraka koji padaju pod velikim uglom u odnosu na centralnu osu.
- Astigmatizam- nepravilno prelamanje širokog i kosog snopa svetlosti.
- Distorzija (krivljenje lika).

# Sistem dva sočiva



$$M = M_1 M_2.$$

# Lupa



$$m_{\theta} = \theta' / \theta.$$

$$\theta \approx h / 25 \text{ cm}$$

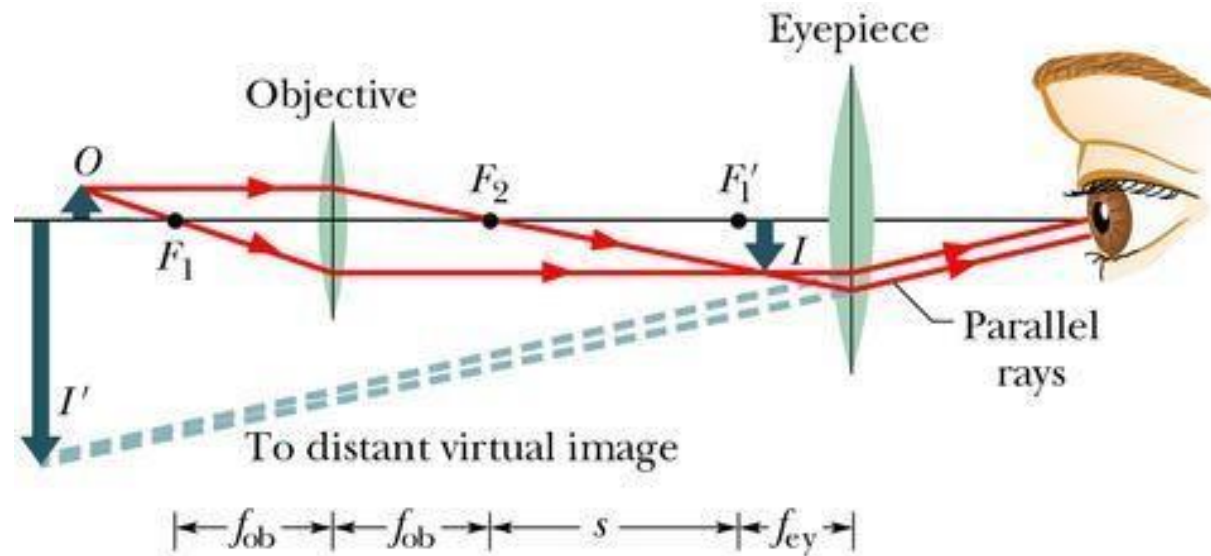
and

$$\theta' \approx h / f.$$

$$m_{\theta} \approx \frac{25 \text{ cm}}{f} \quad (\text{simple magnifier}).$$



# Mikroskop



$$m = -\frac{i}{p} = -\frac{s}{f_{ob}}$$

$$M = mm_{\theta} = -\frac{s}{f_{ob}} \frac{25 \text{ cm}}{f_{ey}} \quad (\text{microscope}).$$