Phy 4C 3/1

Wednesday, March 1, 2017 11:42 AM

Review from Last Lecture:

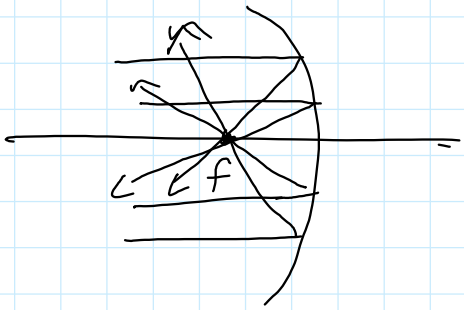
1) Understand image formation by spherical mirrors, including the mirror equation, focal length, and magnification

Goals for this Lecture:

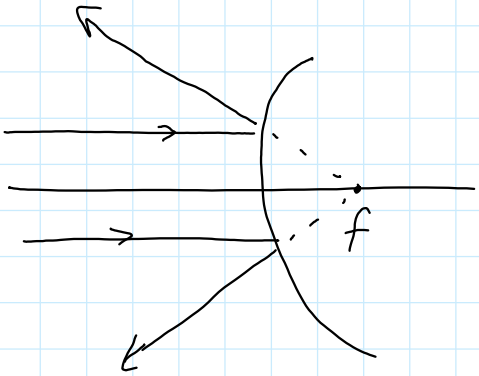
2) Understand image formation from refraction, including the equation for refracting surfaces, magnification, and the sign conventions for these equations
3) Understand image formation by thin lenses, including the lens maker's equation and the thin lens equation, focal length, magnification, and the sign conventions for these equations

Spherical Mirror

Concave or Converging



Convex or diverging



Diverging Mirror

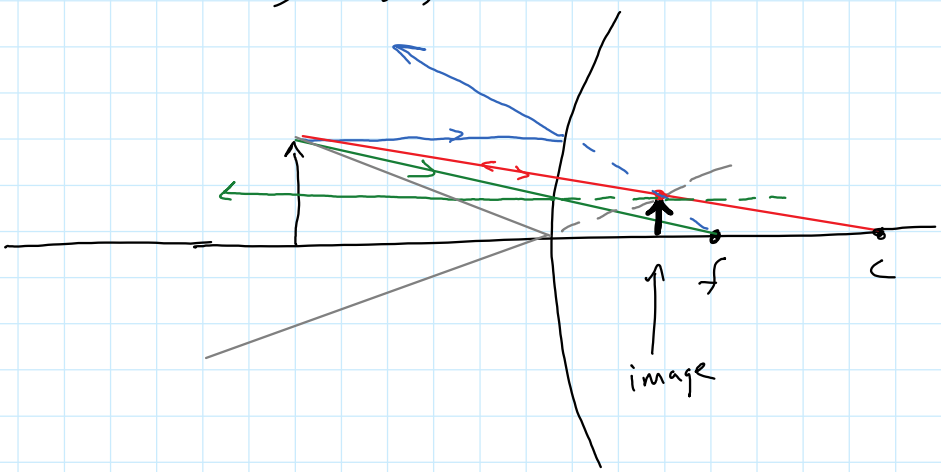


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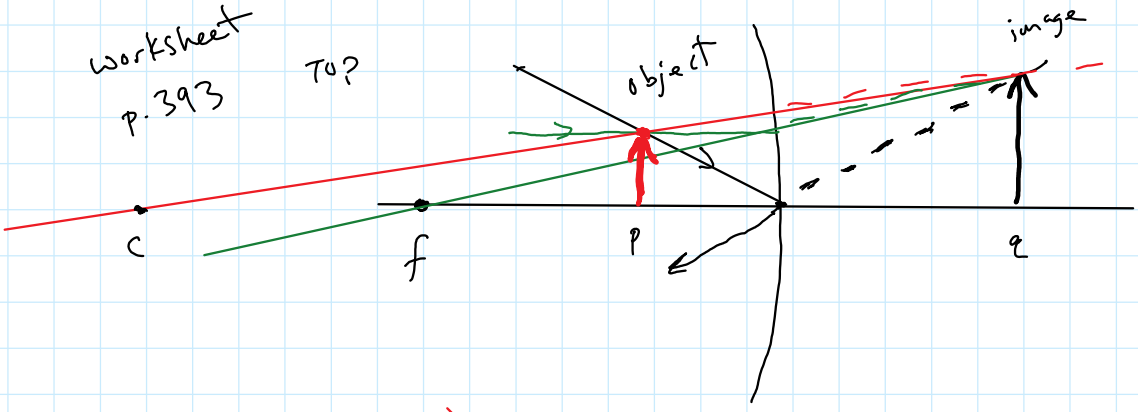
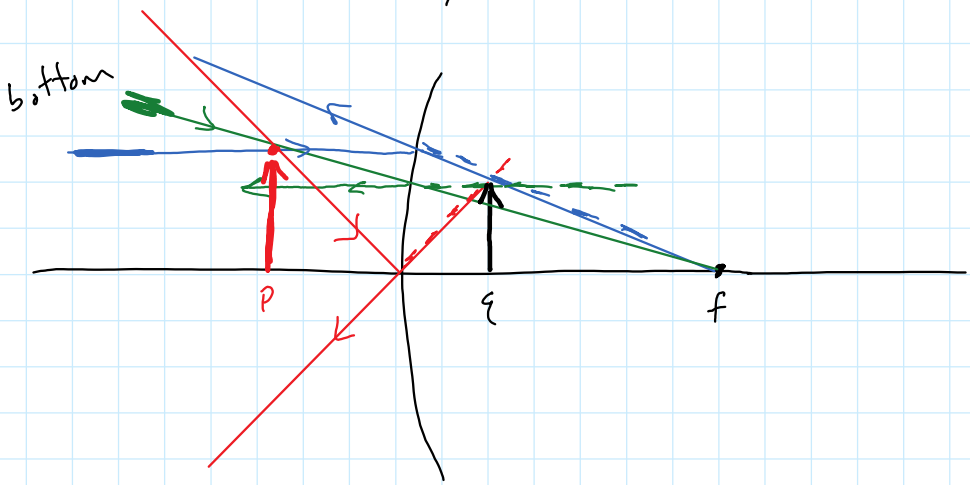
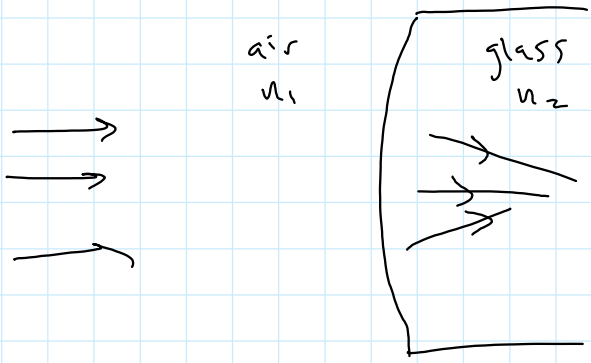
image

Worksheet p. 393 TQ?





Images formed by refraction:



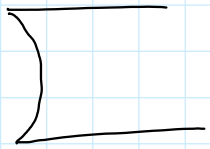
Front is where the light originates (also defines n_1)

$$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$$

R ← radius of curvature

Sign convention:

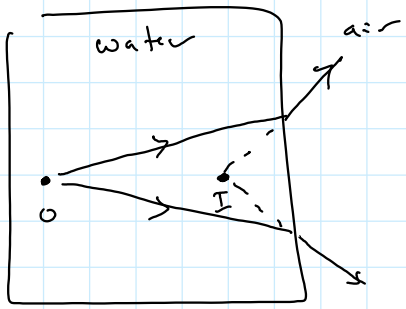
	+	−
p	on Front	on back
q	on back	on front
h'	upright	inverted
R	on Back	on front



Negative R

Examples

1)



observer

Front side: water

n_1 : n_{water}

n_2 : n_{air}

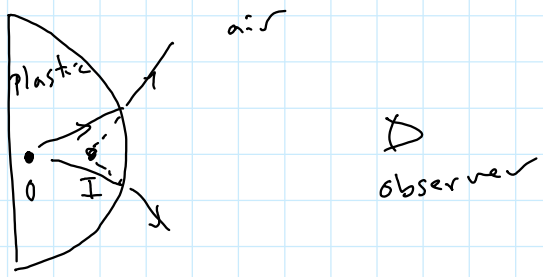
R : ∞

$$\frac{n_1}{p} + \frac{n_2}{q} = 0$$

$$q = -\frac{n_2}{n_1} p$$

q: − ; n_1: + ; p: +

2)



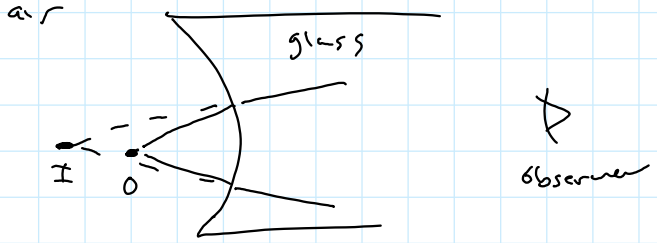
Front : plastic

n_1 : $n_{plastic}$

n_2 : n_{air}

	+	−
P	✓	
Q		✓
R		✓

3)



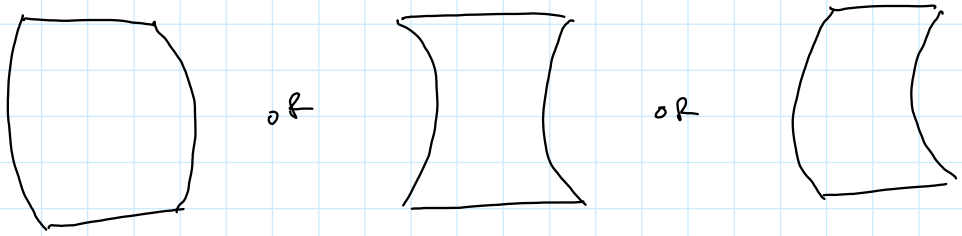
Front : air

n_1 : n_{air}

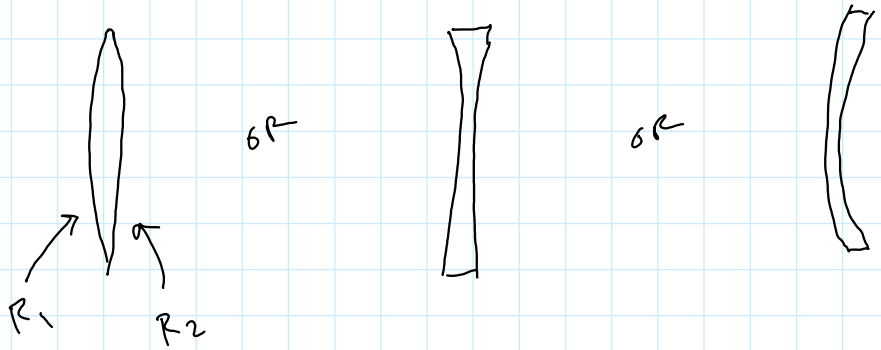
n_2 : n_{glass}

	+	−
P	✓	
Q		✓
R		✓

Len has 2 refracting surfaces typically:



if lenses are thin:



Lens maker's Equation

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

Thin lens equation

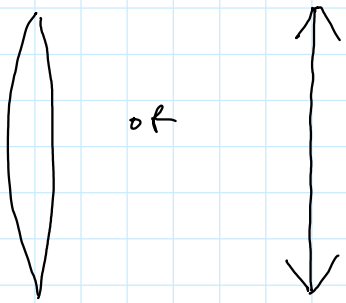
$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

Sign Convention:

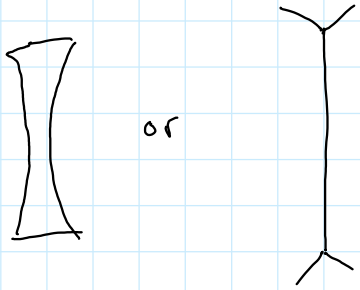
	+	−
p	on Front	on back
q	on back	on front
h'	upright	inverted
f	Converging lens	Diverging Lens

Front is where the light originates

Converging lens:

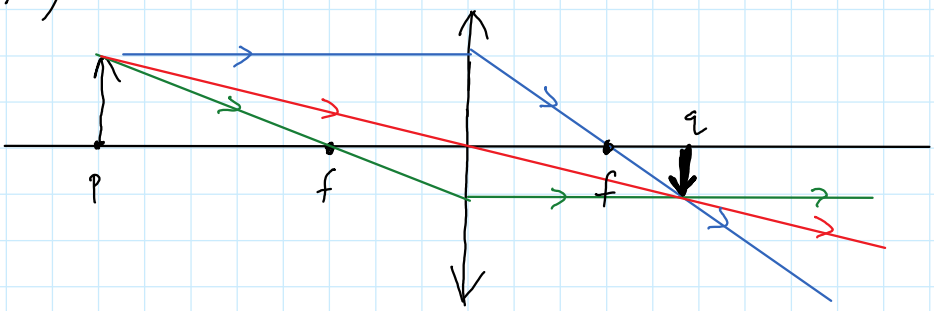


Diverging lens:



Ray Diagrams

Converging lens:



1) In parallel → out through f on other side

2) In through f → out parallel

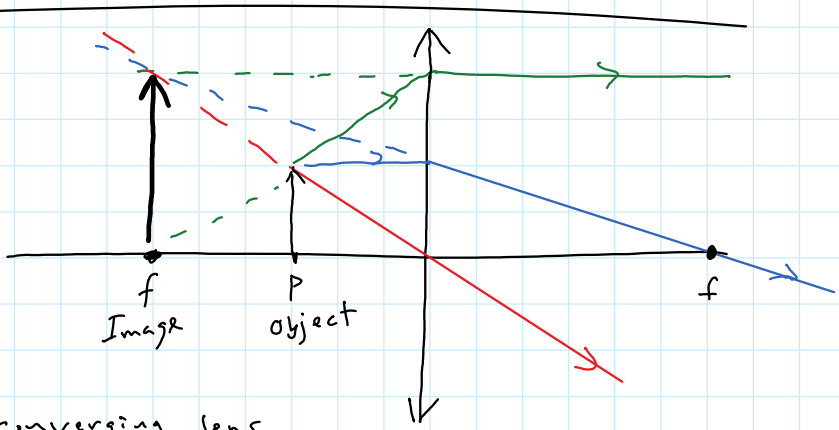
3) In through center of lens → continues in a straight line

Example:

p = 30 cm

f = 60 cm

h = 2 cm



f is positive → converging lens

using equations:

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{\quad} + \frac{1}{\quad} = \frac{1}{\quad}$$

$+30 \quad q \quad +60$

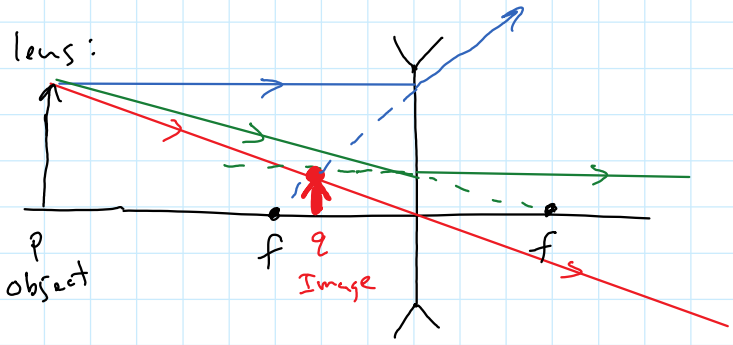
$q = -60$ cm

$M = -\frac{q}{p} = -\frac{-60}{30} = +2$

upright; twice as big as object

Virtual image

Diverging lens:



1) In parallel → out from f on left

2) In toward f on Right → out parallel

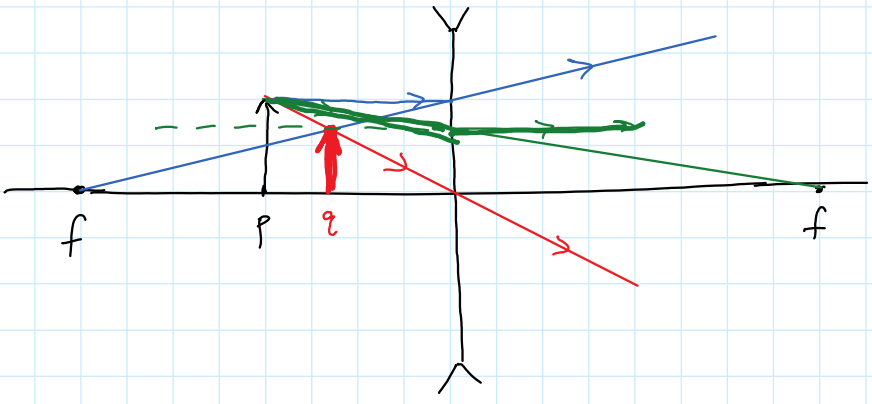
3) In through center of lens → continues in straight line

Example:

$f = -80$ cm

$p = 40$ cm

$h = 2$ cm



$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$\frac{1}{40} + \frac{1}{q} = \frac{1}{-80}$

$q = -26.7$ cm

$$M = -\frac{q}{p} = -\frac{-26.7}{40} = +0.667$$

upright

virtual image

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worksheet p. 388

Top: $n_A > n_B$

Bottom: $n_B > n_A$

$V_A > V_B$

$n_w \sin\theta_w = n_{oil} \sin 90$

$\sin\theta_w = \frac{n_{oil}}{n_w}$

if $\theta_w = 50°$ for both cases

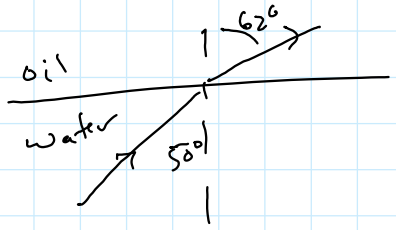
$n_{water} = 1.5$

$n_{oil} = 1.15$ gets total internal reflection

if $n_{oil} = 1.3$

$1.5 \sin 50 = 1.3 \sin\theta_{oil}$

$\theta_{oil} = 62°$



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virtual images: A, B, E, F

inverted images: C, D

reduced size images: B, C, D, E, F

Book Problem 24-40

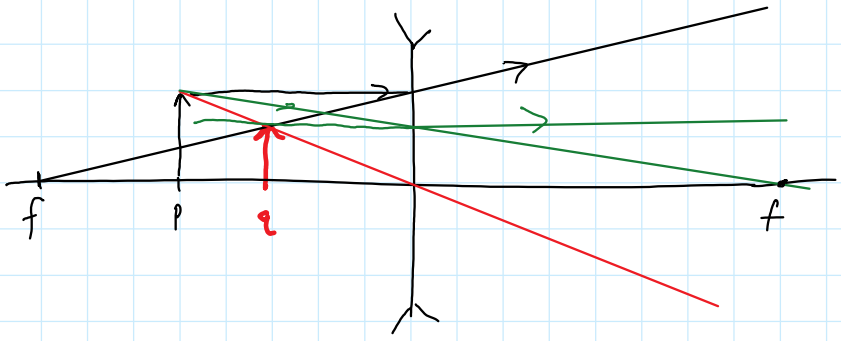
object located 20 cm to left diverging lens

Book Problem 36-40

Object located 20 cm to left diverging lens ($f = -32$ cm)

a) use a ray diagram to solve

b) use equations to solve



$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{20} + \frac{1}{q} = \frac{1}{-32}$$

$$q = -12.3 \text{ cm}$$

$$M = -\frac{q}{p} = -\frac{-12.3}{20} = +0.615$$

upright

virtual image