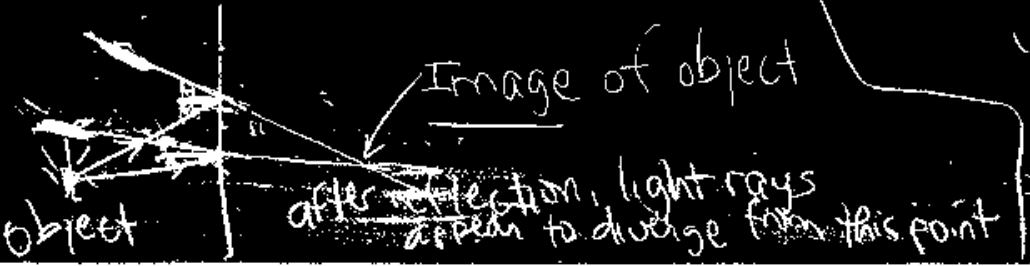
Phys 202
Exam 3
Wed 4/20 5 45pm

§36 Image formation
[cameras, telescope]

mirrors and lenses
geometric optics

§36.1 Flat mirrors

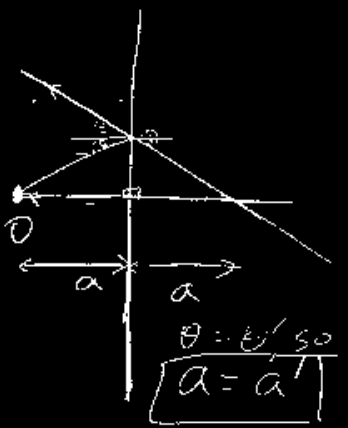


Virtual vs real image

light rays appear to diverge from I (image)

if they don't really, image is virtual

(real image — light rays really do diverge from I)



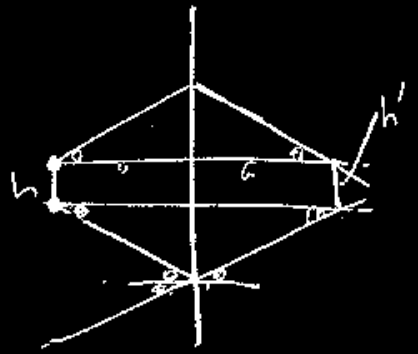
where is image for flat mirror?

image formed by an object in front of a flat mirror is as far behind the mirror as object is in front

Image height

flat mirror

Image = object
height height



$h = h'$

image is right up

has front-back reversal

§36.2 Spherical mirrors

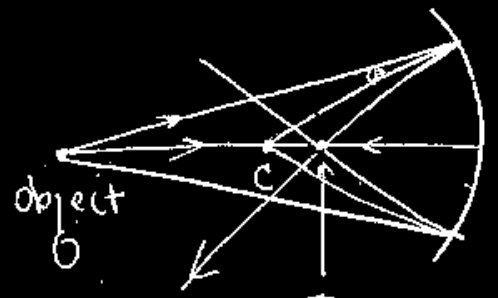
(shape is section of sphere)

concave mirror

[convex =

]

focus point of concave mirror



real image of source

what is magnification and location of image?

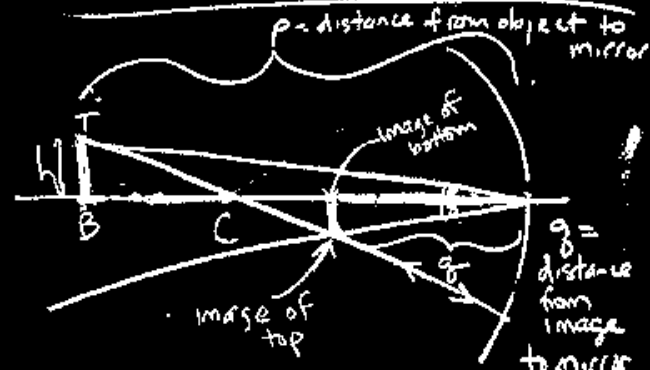


image of B is along axis

image of T is below image of B

→ image is upside down

Where is image?

how big does object look?

$h = p\sin\theta$

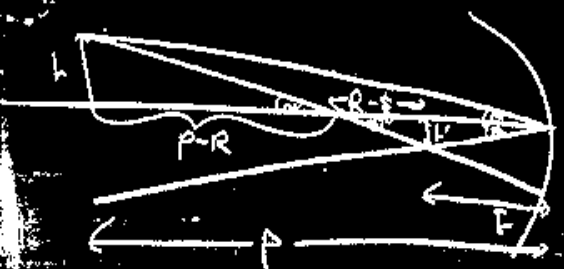
$h' = -q\sin\theta$

$\Rightarrow \frac{h'}{h} = -\frac{q}{p}$

we know h and p.

need q + h'

$\Rightarrow$ need 2nd equation



$\tan\alpha = \frac{h}{p-R} = \frac{-h'}{R-q}$

(lh Δ) (rh Δ)

now can solve for h' and q'

$\frac{h}{h'} = -\frac{p-R}{R-q}$

so $-\frac{p}{q} = -\frac{p-R}{R-q}$

Simplify: $p/q = \frac{p-R}{R-q}$

$pR - pq = pq - qR$

$pR + qR = 2pq$

$\frac{1}{q} + \frac{1}{p} = \frac{2}{R}$ mirror equation

p = distance of O from mirror

q = distance of I from mirror

R = radius of curvature of mirror

Solve for image height

$\frac{h}{h'} = \frac{(p-R)}{(R-q)}$

Use $\frac{1}{q} + \frac{1}{p} = \frac{2}{R}$ + solve.

$\frac{h}{h'} = 1 - \frac{2p}{R}$

if p large, $\frac{h}{h'} = -\frac{2p}{R}$

or $\frac{h'}{h} = -\frac{R}{2p}$ image is inverted + smaller

back to mirror equation:

$$\frac{1}{p} + \frac{1}{q} = \frac{2}{R}$$

... very large, $\frac{1}{p} \approx 0$

$$\Rightarrow \frac{1}{q} \doteq \frac{2}{R} \quad \left[q = \frac{R}{2}\right]$$

focal length is $R/2$

(value of q if object is very far from mirror)

So can rewrite mirror equation

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

f = focal length

for spherical mirror $f = R/2$