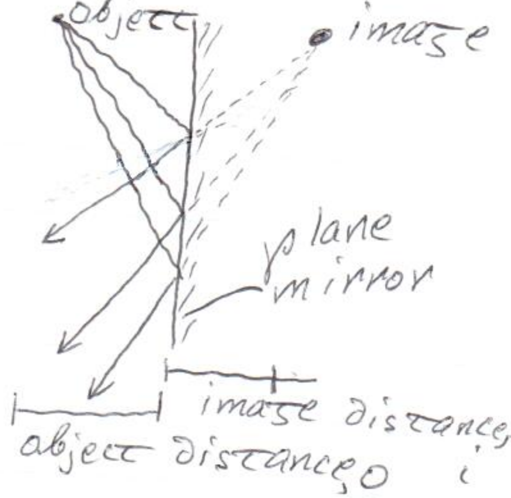
Making Images

image: a point from which rays (appear to) diverge

We are often interested in distance + orientation of an image.



Two types

- real image: if rays actually pass thru image
- virtual image
  → flat mirrors always have virtual image

Flat mirrors:

- obect height = image height
- apparent reversal of image

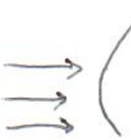
left hand

right hand

Spherical Mirrors

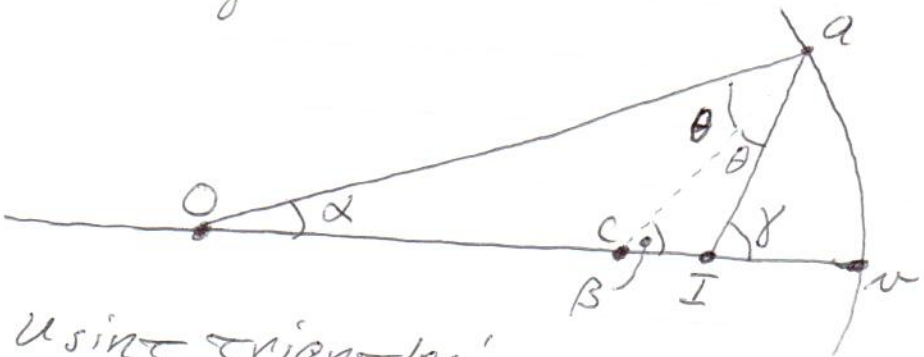
Two ~~shps~~ shapes:

<u>concave</u>: 'caved in', seems to 'wrap around' incoming rays



<u>convex</u>: bends away from source of light

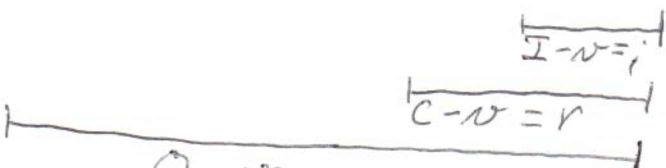
Analysis of image:



Using triangles:

OaC: $\underline{\beta = \alpha + \theta}$

OaI: $\underline{\gamma = \alpha + 2\theta}$



We don't want to keep track of θ, just angles at O, I and C positions

Algebra:

1) $2\theta = 2\beta - 2\alpha$

2) $2\theta = \gamma - \alpha$

1) = 2) Gives

$$2\beta - 2\alpha = \gamma - \alpha$$

$$\underline{2\beta = \gamma + \alpha}$$

From the geometry, for nearly paraxial rays (ie. α, γ <u>small</u>)

$$\alpha \cong av/o$$
$$\beta \cong av/r$$
$$\gamma \cong av/i$$

$$\therefore \boxed{\frac{1}{o} + \frac{1}{i} = \frac{2}{r}}$$

Focal Length of a Mirror

When parallel light falls on spherical mirror

$$o \to \infty$$

$$\therefore \frac{1}{i} = \frac{2}{r} \Rightarrow i = \boxed{\frac{r}{2} = f}$$

focal length

Generally write

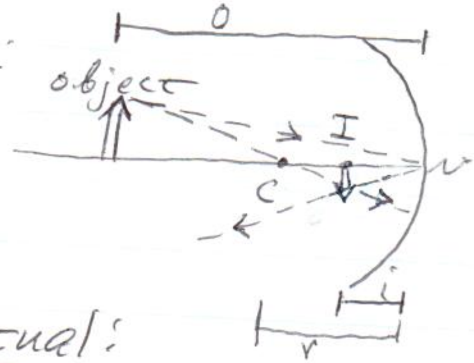
$$\boxed{\frac{1}{i} + \frac{1}{o} = \frac{1}{f}}$$

- a ray $\parallel$ to axis of mirror
  - passes thru focal point on reflection
- a ray passing thru focal point
  - reflects to be $\parallel$ to axis

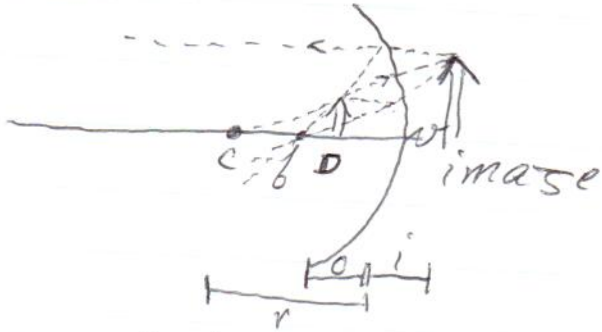
Images from Spherical Mirrors

Can have real + virtual images.

real:



virtual:



real image: inverted

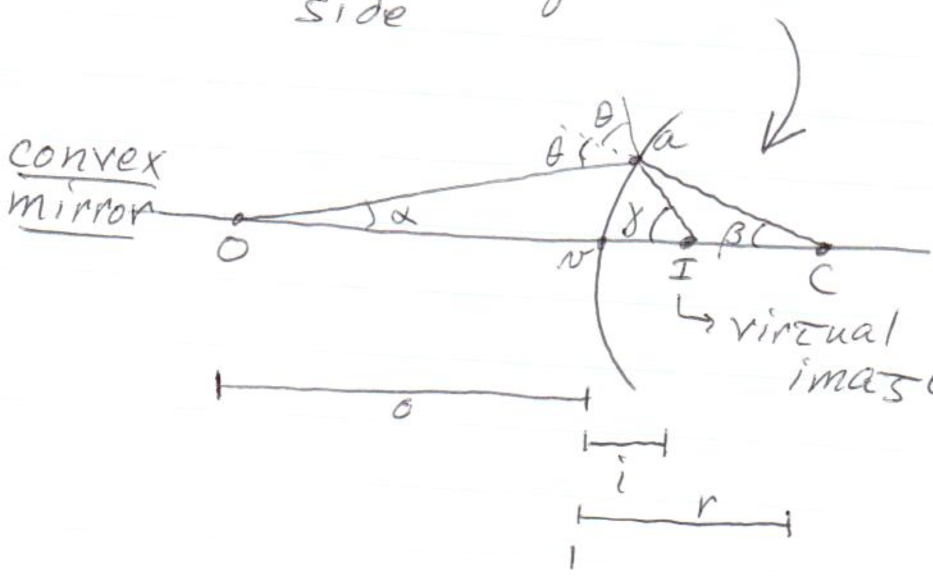
virtual: when $O < f$

- larger, upright image

Sign Conventions

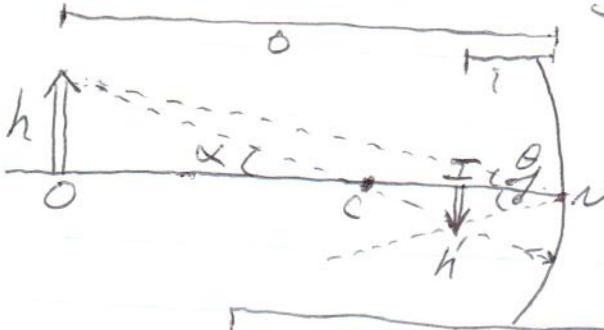
- o and i are positive for real objects, negative for virtual objects + images
  ??(comes up in compound systems later)

- r positive if center of curvature C lies on left of object
  - negative if it lies on right side



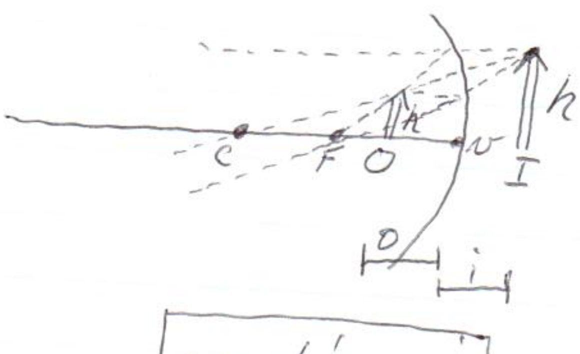
Magnification

Consider real image case,



$$\boxed{M = \frac{h'}{h} = -\frac{i}{o}} < 0 \text{ (inverted)}$$

Virtual image case:



$$\boxed{M = \frac{h'}{h} = -\frac{i}{o}} > 0 \text{ (upright)}$$