This unit of course - pencil and ruler!
(Also - bring ruler and pencil to exam.)

Image Formation - topic of Lab L2 (last week)
Lab L3 (this week) - compound optical systems

Approximations:

1. Light travels in infinitely narrow rays
   "Ray Approximation"

2. Mirrors (1) and lenses (x) are achromatic - all colors have same path
   (i.e. in doesn't depend on wavelength)
   When not true \( \rightarrow \) chromatic aberration

3. Rays cross same focal point regardless of where they passed through lens
   When not true \( \rightarrow \) spherical aberration

1. Flat Mirror

\[ \theta = \theta' \]

\[ h = h' \]

\( \Rightarrow \) No magnification

\[ M = \frac{h'}{h} = 1 \]

VIRTUAL
IMAGE
(no actual
light here)

EFFECT

incident angle
reflection angle
Is flat mirror image always upright? NO

(Just a different point of view, really)

(2) Spherical Mirrors

(A) Parallel incoming rays reflect through point off axis at \( R/2 \) = focal point

(B) Rays through center of curvature reflect back on themselves

(A') Incoming rays through \( F \) reflect out parallel to axis

\( \Rightarrow \) Use (B), (C) usually for image formation
(2a) Image formation by Spherical Mirror (Concave)

(A) Parallel ray through F = R/2

(B) Ray through C comes straight back. REAL IMAGE INVERTED

(C) Ray hitting center has equal angle below

Right Triangles: \[ \frac{h}{p} = \frac{h'}{q} \] negative for inverted image

\[ 1 = \frac{h'}{n} = -\frac{q}{p} \] magnification is negative if image inverted

Also \[ \frac{h}{p-R} = \frac{-h'}{R-q} \] \[ M = \frac{h'}{h} = -\frac{R-q}{p-R} \] \[ (1) \]

\[ (1) \times (2) \Rightarrow \frac{1}{p} + \frac{1}{q} = \frac{2}{R} = \frac{1}{f} \] Mirror Equation

\[ M = -\frac{q}{p} \] magnification
Convex Mirror

\( f = -\frac{R}{2} \) mirror is convex

Virtual
Erect \( h' > 0 \)

Image \( q < 0 \), behind mirror

\[ M = \frac{q}{p} > 0 \quad (q < 0) \]

**Sign Conventions**

- \( p > 0 \) object in front of mirror
- \( f < 0 \) object (virtually) behind mirror
- \( q > 0 \) image (real) in front
- \( q < 0 \) image (virtual) in back
- \( h' > 0 \) image erect
- \( h' < 0 \) image inverted

- \( f = \frac{R}{2} \) concave
- \( f = -\frac{R}{2} \) convex

\[ M = \frac{h'}{h} > 0 \text{ erect image} \]
\[ < 0 \text{ inverted image} \]