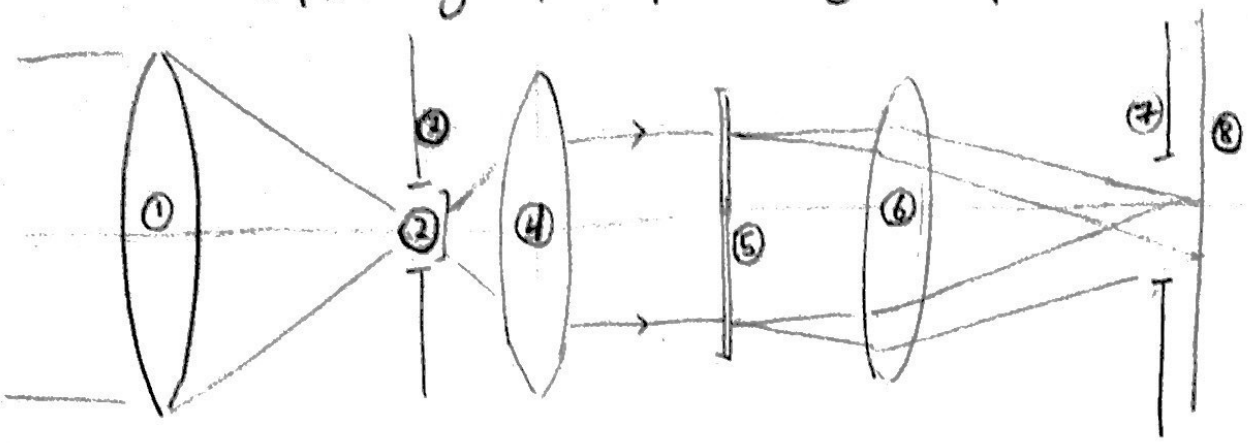
Spectrograph optical system parts



① Telescope / Objective: Focusses source light within spectrograph

② Aperture stop: Limits the angle of incoming light

③ Pupil: Image of aperture stop, viewed from light incoming (entrance) or outgoing (exit) the system

④ Collimator: Transforms incoming light rays to be parallel

⑤ Disperser / Diffraction grating: Separates different wavelengths of incoming light via $m\lambda = d(\sin\alpha + \sin\beta)$

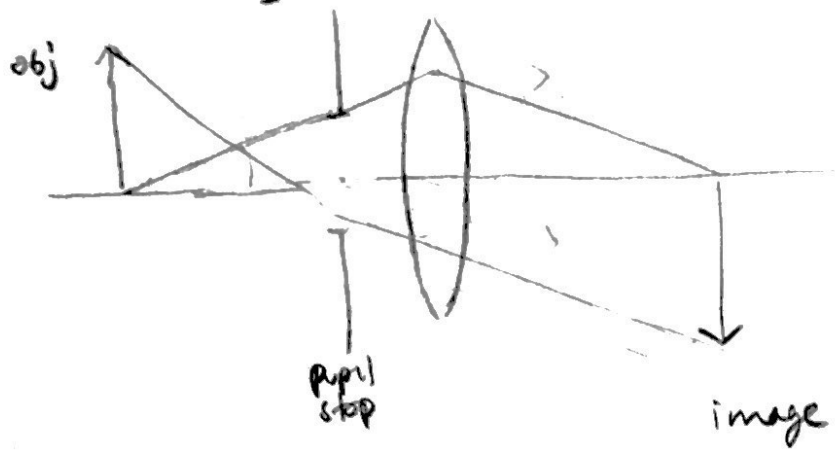
⑥ Camera: Refocusses diffracted light onto sensor

⑦ Field stop: Limits angle of light reaching sensor / whichever aperture in the system limits FoV

⑧ Sensor / detector: focal plane of camera lens, translates incoming light signals into digital information

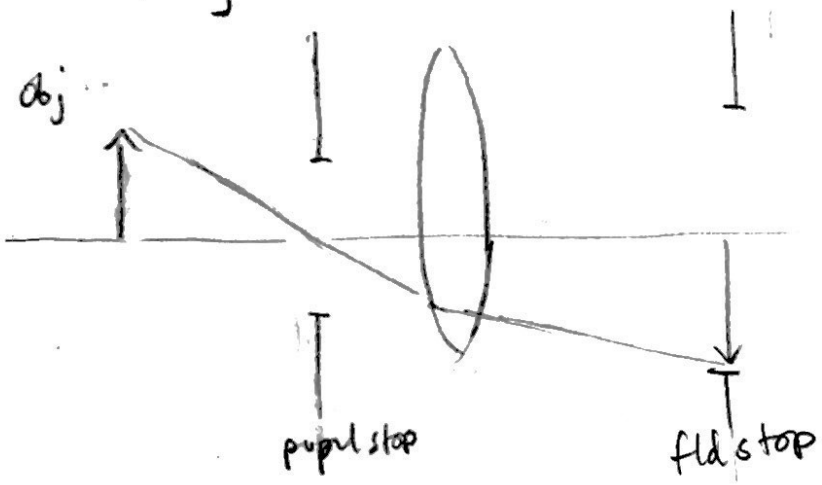
Spectrograph optical system concepts

Marginal Ray



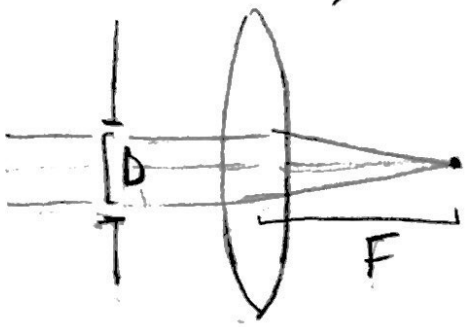
Maximum angle of collection, limited by aperture stop

Cheif Ray



Light ray passing through center of aperture stop and limited by field stop, determining the maximum size object (or FOV) that can be imaged

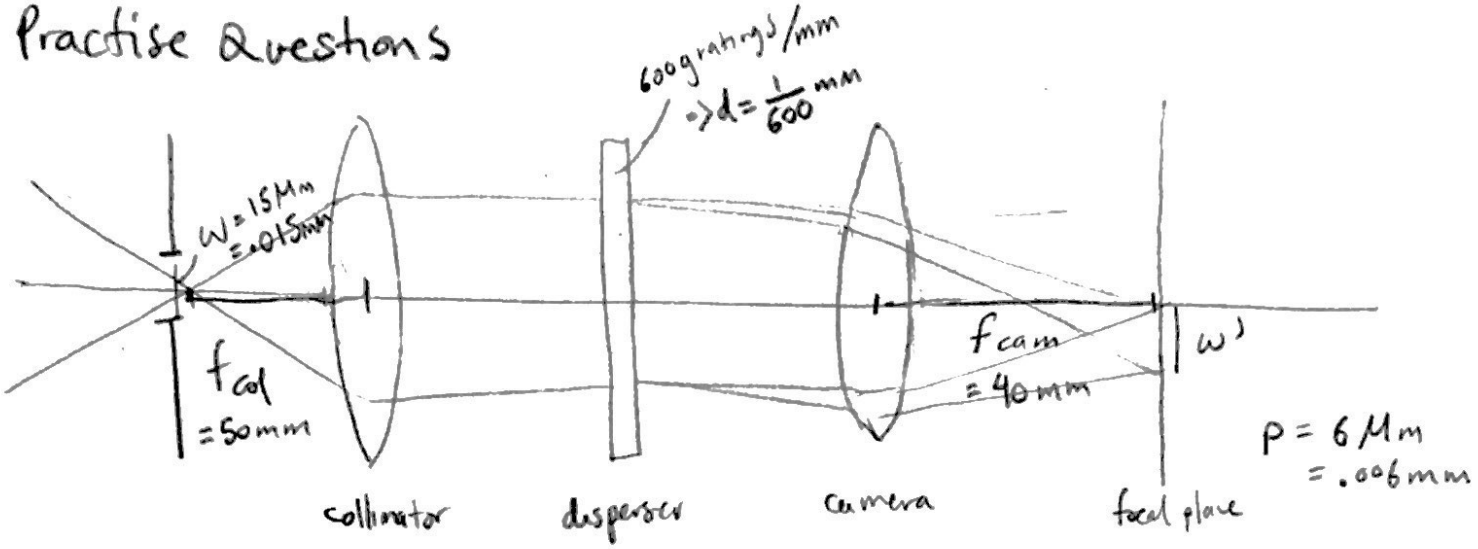
f-ratio (f/#)



$$f/\# = \frac{F}{D}$$

Ratio of system focal length to aperture stop diameter

Practise Questions



assuming: $\alpha = 10.4$ deg, $\lambda = 600$ nm $= .0006$ mm $m = 1$

① want resolution

$$R = \frac{\lambda f_{cam}\left(\frac{d\beta}{d\lambda}\right)}{w'}$$

$$\frac{d\beta}{d\lambda} = \frac{m}{d\cos\beta} \qquad \beta = \arcsin\left(\frac{m\lambda}{d} - \sin\alpha\right)$$

$$= \arcsin\left((.0006)(600) - \sin 10.4\right)$$

$$= 10.33952$$

$$\Rightarrow \frac{d\beta}{d\lambda} = \frac{600}{\cos(10.34)} = 609.9$$

$$w' = w\left(\frac{f_{cam}}{f_{col}}\right)$$

$$= .015\left(\frac{4}{5}\right) = .012 \text{ mm}$$

$$= 2p$$

$$R = \frac{(.0006\text{ mm})(40\text{ mm})(609.9\text{ mm})}{.012\text{ mm}} = 1219.8$$

$$\Rightarrow \Delta\lambda = 4.9 \times 10^{-7}\text{ mm}$$

$$= .49\text{ nm}$$

② Magnification

$$M = \frac{f_{cam}}{f_{col}} = \boxed{.8}$$

(assuming no telescope lens)