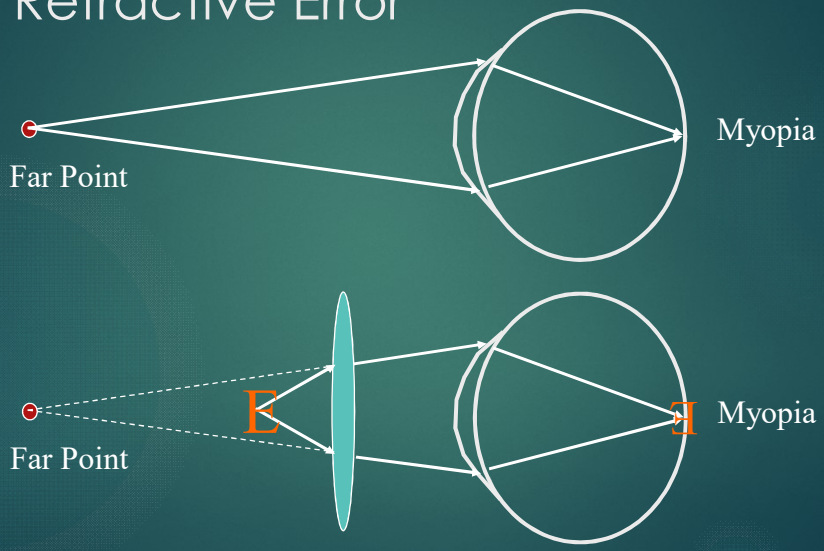
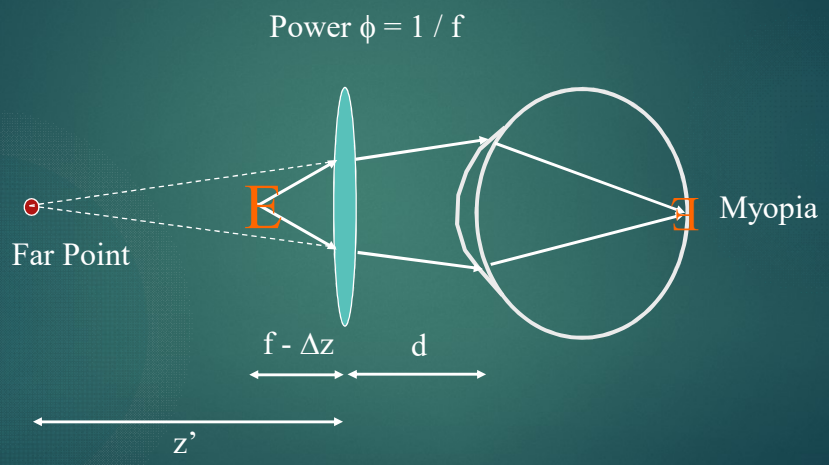
Optometer

Subjective Assessment of Refractive Error



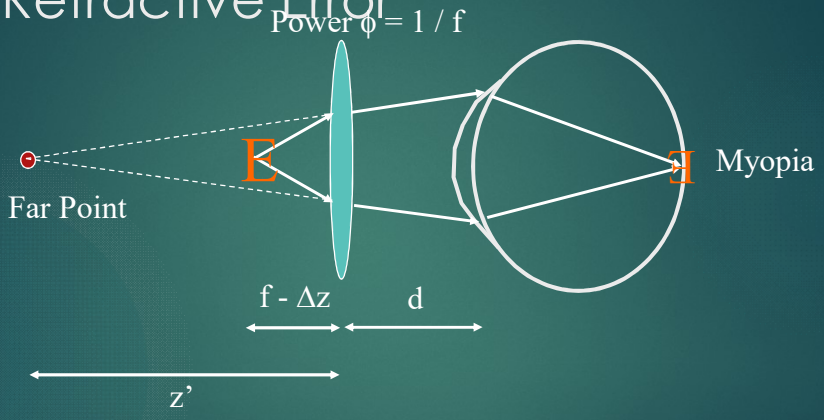
Subjective Assessment of Refractive Error



Subjective Assessment of Refractive Error

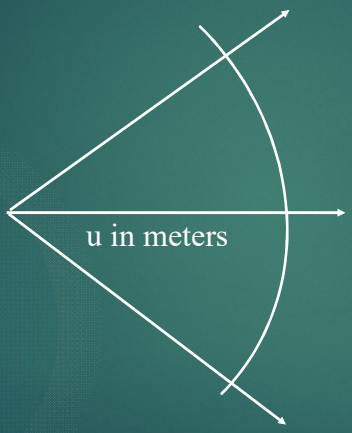
- For $\Delta z = 0$, the light emerging from the lens is collimated (i.e. object at infinity)
- For $\Delta z > 0$, the light emerging from the lens is diverging. The object appears in front of eye, so will be in focus for myopes.
- For $\Delta z < 0$, the light emerging from the lens is converging. The virtual image is behind the eye, so will be in focus for hyperopes.

Subjective Assessment of Refractive Error



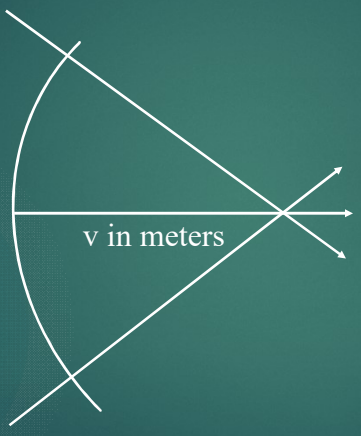
$$\frac{1}{z'} + \frac{1}{f - \Delta z} = \phi \quad \Rightarrow \quad z' = -\frac{1 - \phi \Delta z}{\phi^2 \Delta z}$$

Vergence - Diverging Beam



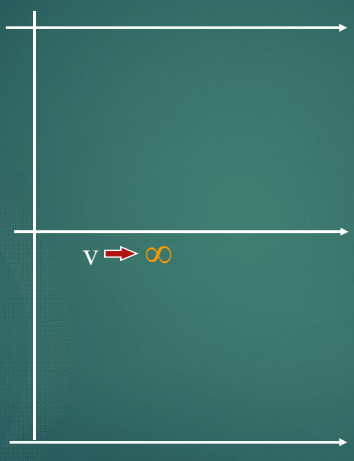
U = -n/u Diopters

Vergence - Converging Beam



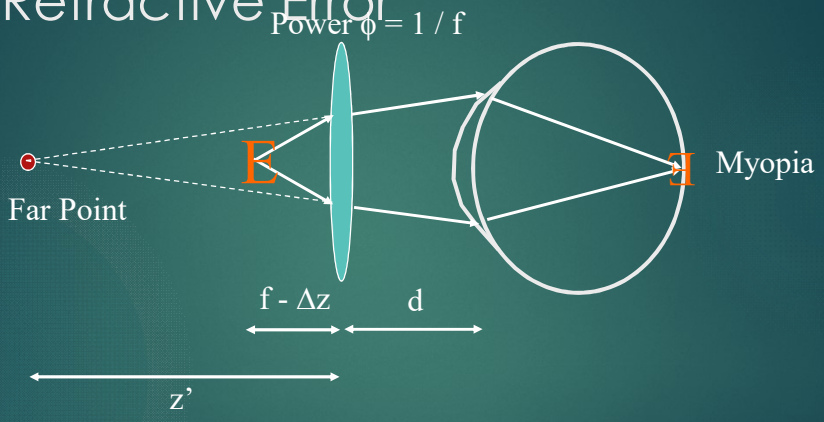
$V = +n/v$ Diopters

Vergence - Plane wave



$V = n/\infty = 0$ Diopters

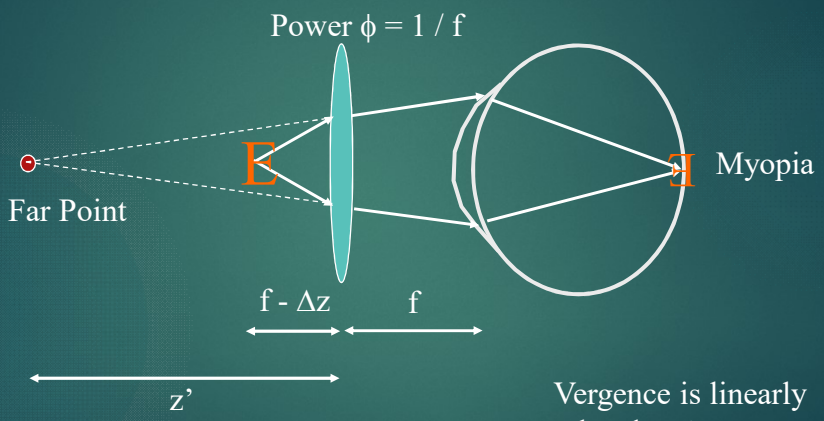
Subjective Assessment of Refractive Error



$$\text{Vergence} = -\frac{1}{d - z'} = -\frac{\phi^2 \Delta z}{1 - \phi \Delta z (1 - \phi d)}$$

Badal Optometer

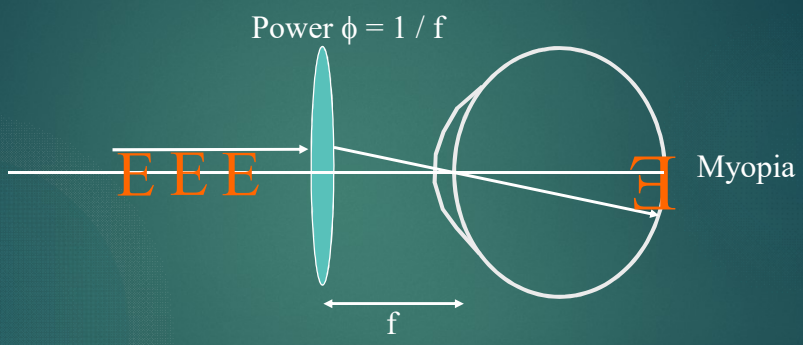
SPECIAL CASE: d = f



Vergence is linearly related to Δz.

$$\text{Vergence} = -\phi^2 \Delta z$$

Badal Optometer - Chief Ray



System is telecentric, meaning magnification is constant.

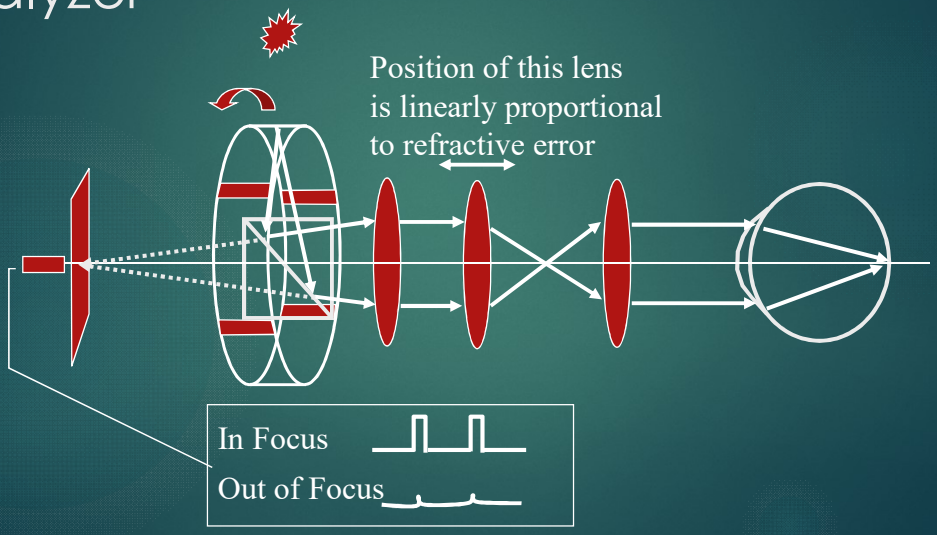
$$\text{Vergence} = -\phi^2 \Delta z$$

Autorefractors

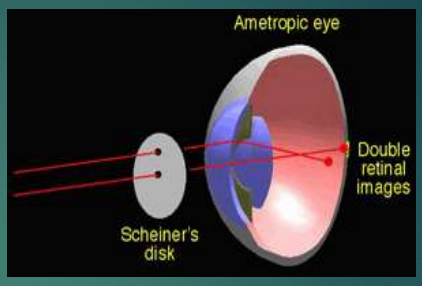
Autorefractors are devices that automatically and objectively measure refractive error in patients.

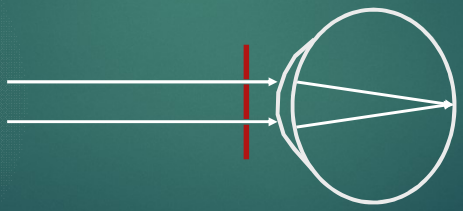
They usually have very repeatable measurements, but tend to be slightly off from a patient's subject refraction. Therefore, they are good for clinical studies to track changes in refraction and as a starting point for a subjective refraction.

Autorefractor – Image Quality Analyzer



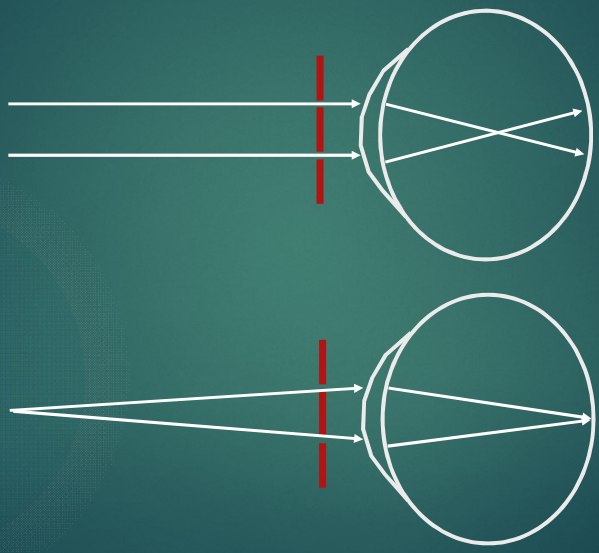
Scheiner Principle - 1619



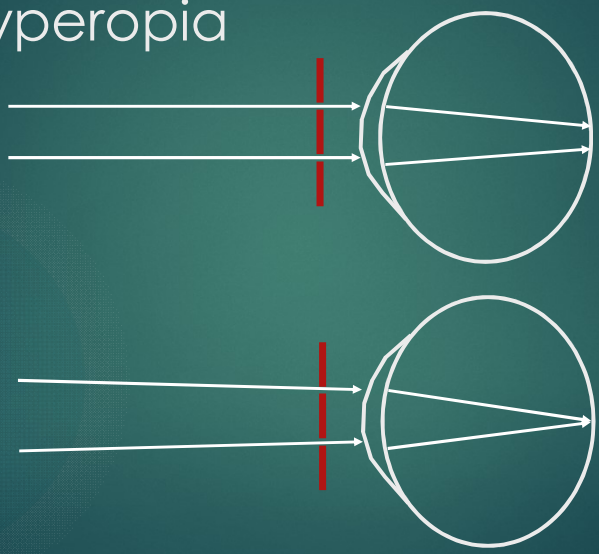


We saw earlier that the Spatially Resolved Refractometer takes advantage of this principle

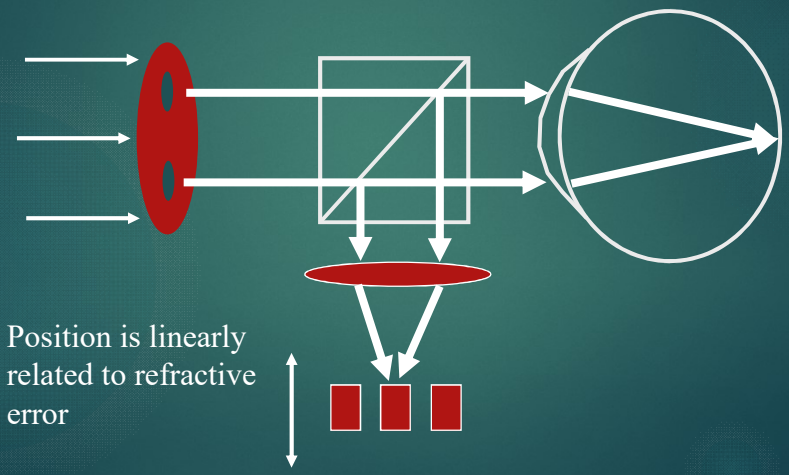
Scheiner Principle - Myopia



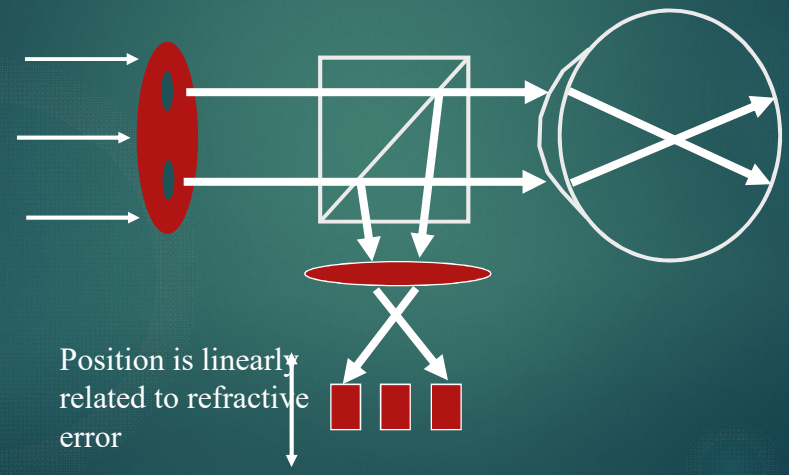
Scheiner Principle - Hyperopia



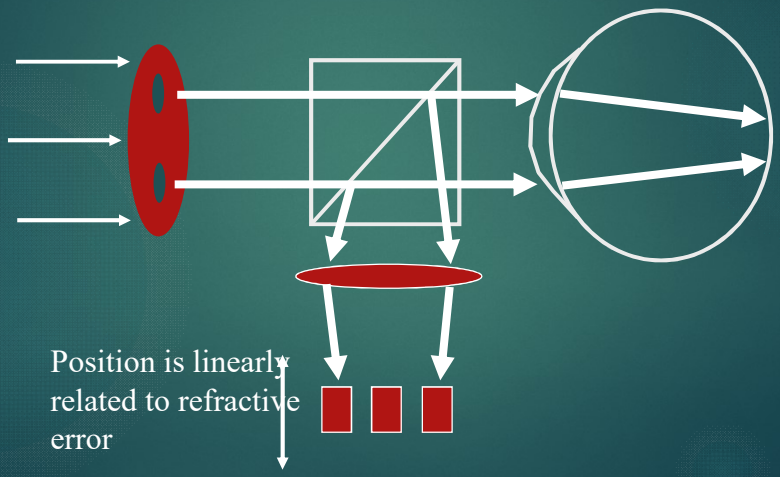
Autorefractor – Scheiner Disk



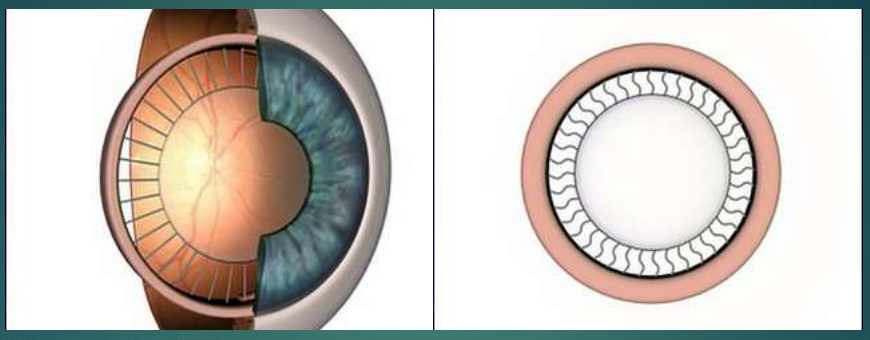
Autorefractor – Scheiner Disk



Autorefractor – Scheiner Disk



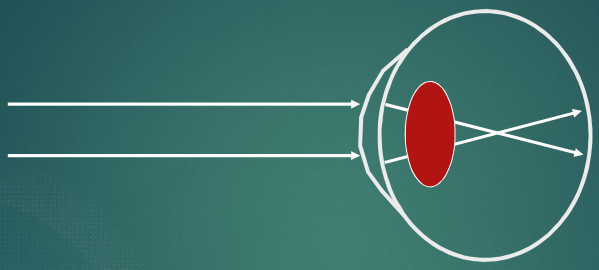
Accommodation



Relaxed ciliary muscle pulls zonules taut an flattens crystalline lens.

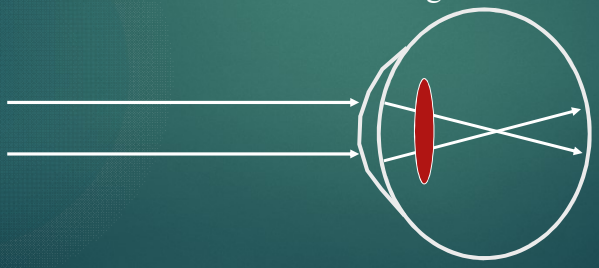
Constrict ciliary muscle releases tension on zonules and crystalline lens bulges.

Autorefractor - Issues



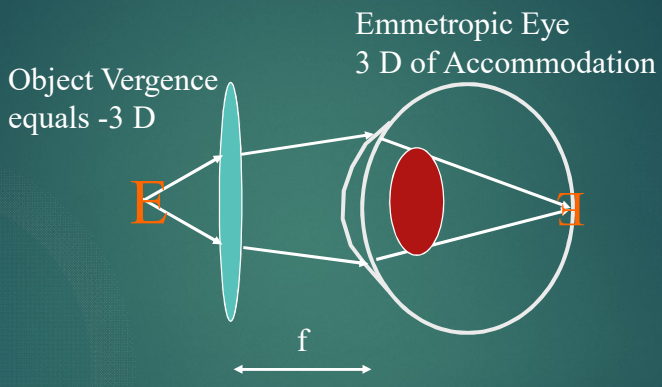
Accommodated

Autorefractors cannot distinguish between these two cases.

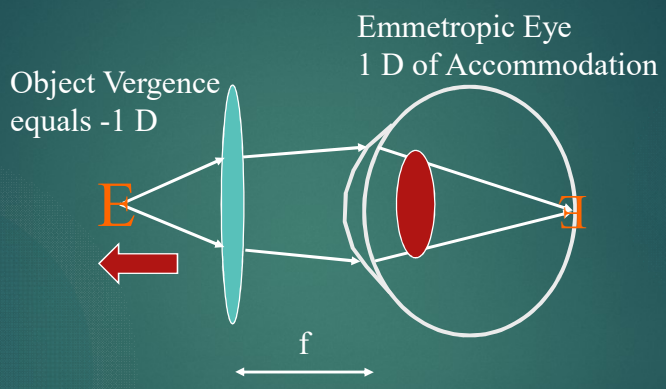


Unaccommodated

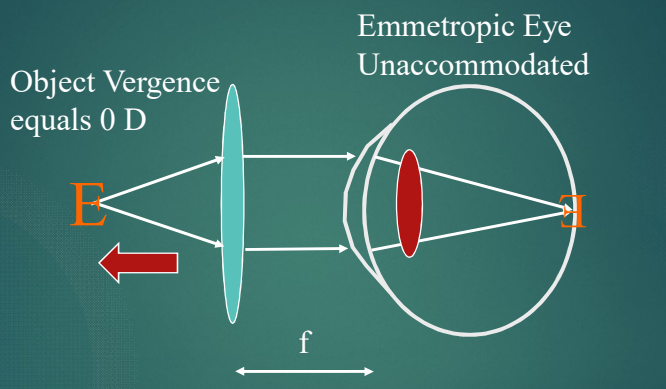
Badal Optometer - Fogging



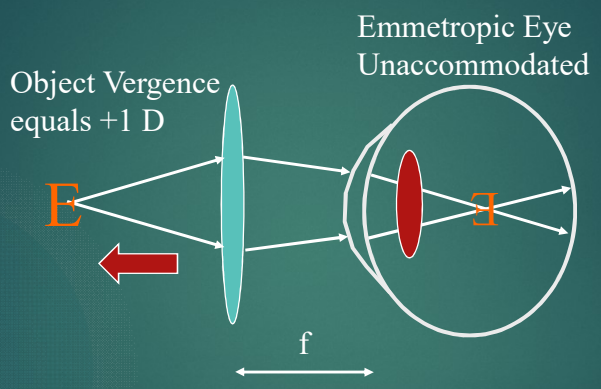
Badal Optometer - Fogging



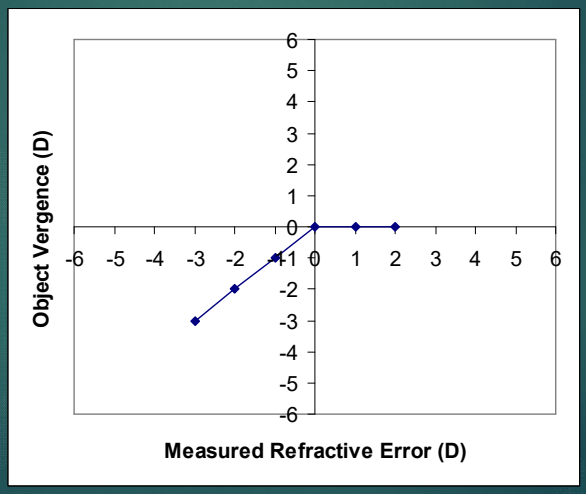
Badal Optometer - Fogging



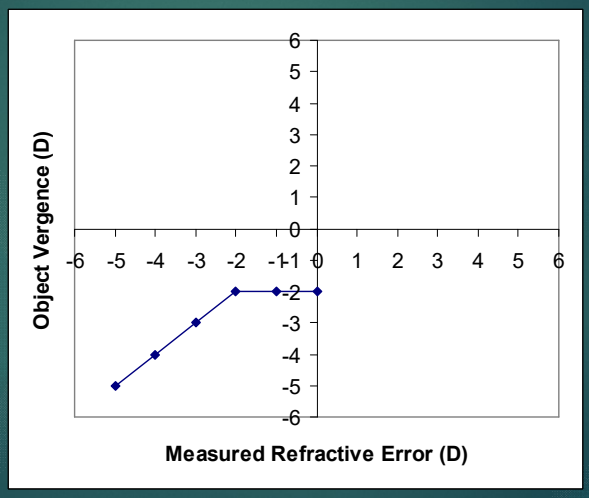
Badal Optometer - Fogging



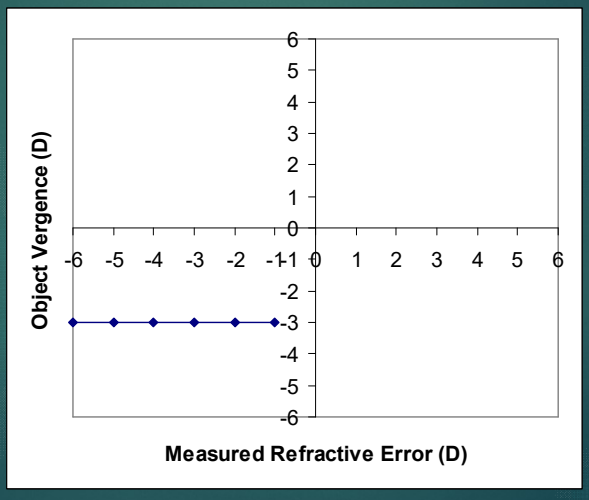
Fogging - Emmetrope



Fogging - 2 Diopter Myope



Fogging - 3 Diopter Myope with Presbyopia



Fogging

Badal Focusing Block