

# Module 1

## Illumination Engineering Basics

# Lesson 4

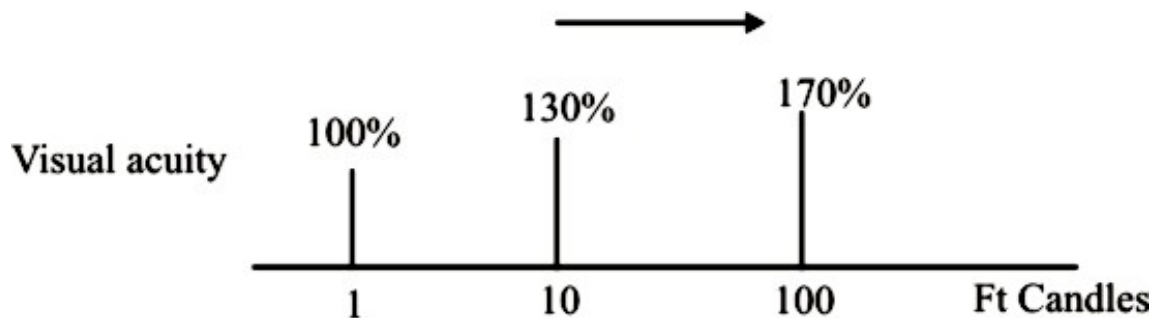
## Eye and Vision – II

## Instructional Objectives

1. What is visual acuity?
2. List qualitative factors responsible for visual acuity.
3. State how the acuity varies with other parameters.
4. State Minimum Illumination requirement for good visibility.
5. Define Chromatic aberration.

Today eye tasks are many and for long duration requiring increased illumination. More exacting the task, more illumination is required. Apart from quantity, quality is also important. Illumination affects Physiology and Psychology also. Natural Illumination conditions need to be reproduced. Artificial Illumination characteristics are influenced by the physical characteristics of room or object or illuminating equipment. Color finish of walls or ceiling etc. Quality, Glare, Diffusion, Direction and Composition effect light Distribution. Illumination requirement for equal visibility calls for at least 100 ft candles or more.

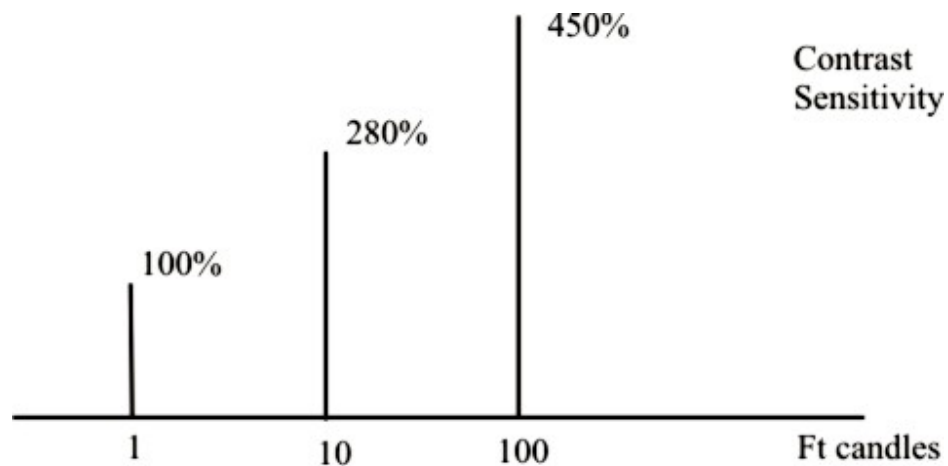
Functioning of eye may be assessed by the Visual acuity, ability of Discrimination of brightness and Speed of retinal impression. Factors responsible for visual acuity are Nervous muscular tension, Fatigue of ocular muscles, Normalcy of heart rate, Normal rate of reading, maximal rate of reading, Precision of tasks, Performance in demonstration visual test. Visual acuity is reduced in defective vision. Mainly depends on experience in day light. It bears a Logarithmic relationship.



**Figure 1**

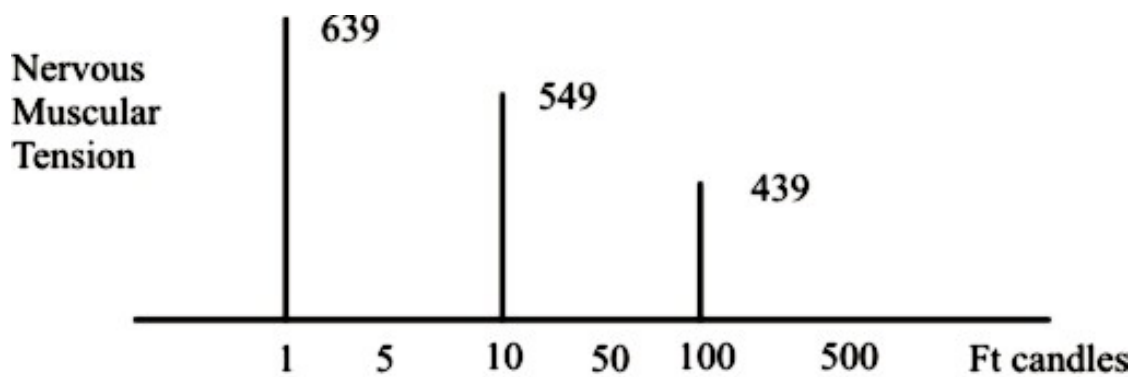
## Visual Activity Vs Illumination

As may be seen from Fig.1 visual acuity improves with illumination on a logarithmic basis. Acuity improves by 30% when illumination is increased by 10 times. It may be observed that contrasts sensitivity becomes 280% on increasing illumination 10 times (Fig 2)



**Figure 2**

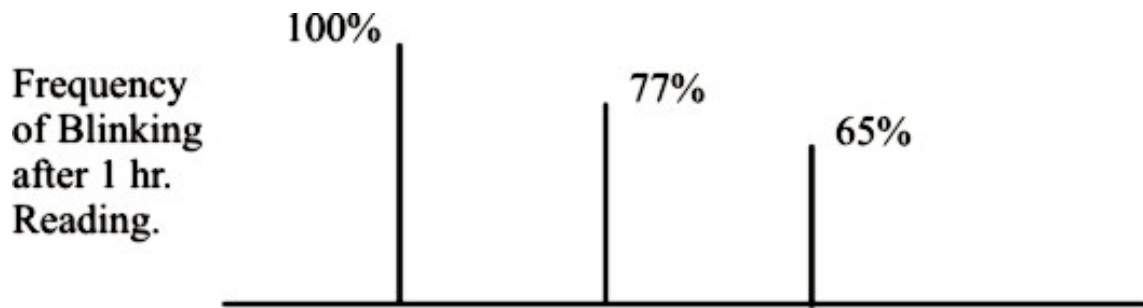
### Contrast Sensivity Vs Illumination



**Figure 3**

### Nervous Muscular Tevlion Vs Illumination

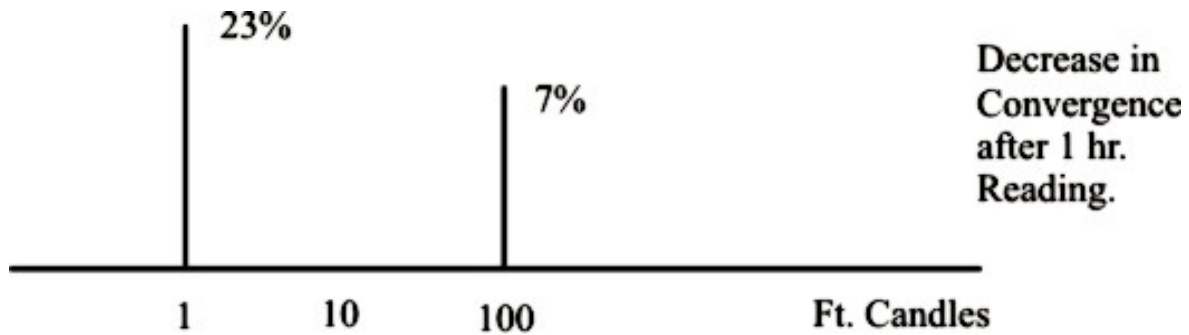
Fig. 3 shows that in order to reduce the muscular tension in the nerve system higher levels of illumination are required.



**Figure 4**

## Frequency of Blinking Vs Illumination

From figure 4 one can note that with increased illumination levels frequency of blinking is reduced. This is further corroborated by the convergence rate shown in Fig. 5



**Figure 5**

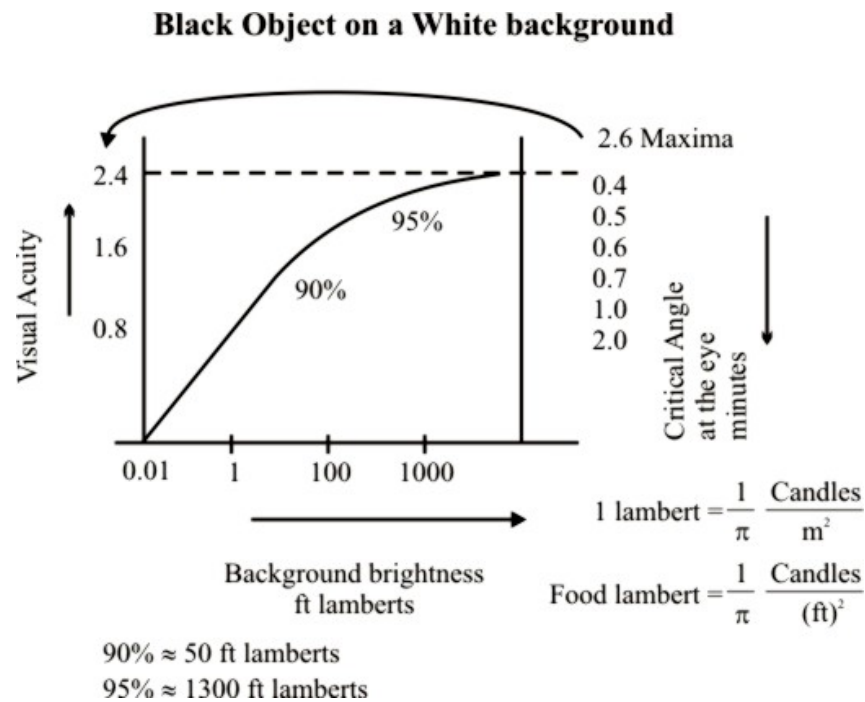
## Convergence rate Vs Illumination

Keeping this in view, Table I lists illumination levels for different Activities

**Table I : Suggested Illumination Levels**

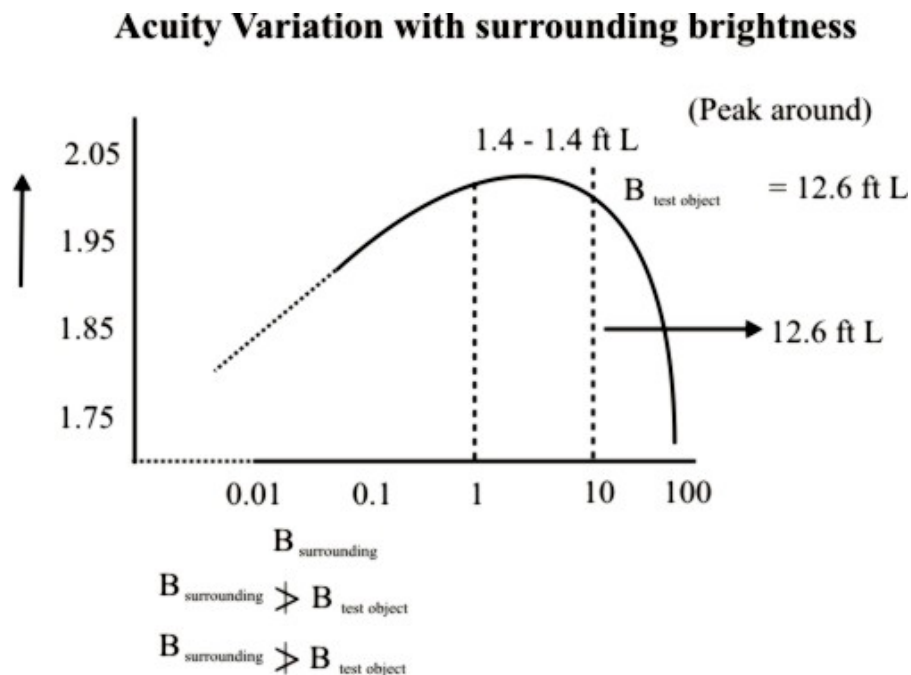
Task	Foot Candles
Black thread on black cloth	800
News paper – stock equation	100
Typing on dark blue paper	80
Telephone directory	60 ( Yellow pages)
News paper – text	40
Excellent printing 6 pt.	10
8 pt	8
Well formed letters 10 pt.	6
on pristine white background 12 pt.	5

Visual criteria apart from illumination depends on Visual acuity, Visual efficiency, Visual speed and Visual health. Distinguish detail depending on brightness of the object, Characteristics of light entering the eye and Contrast details.



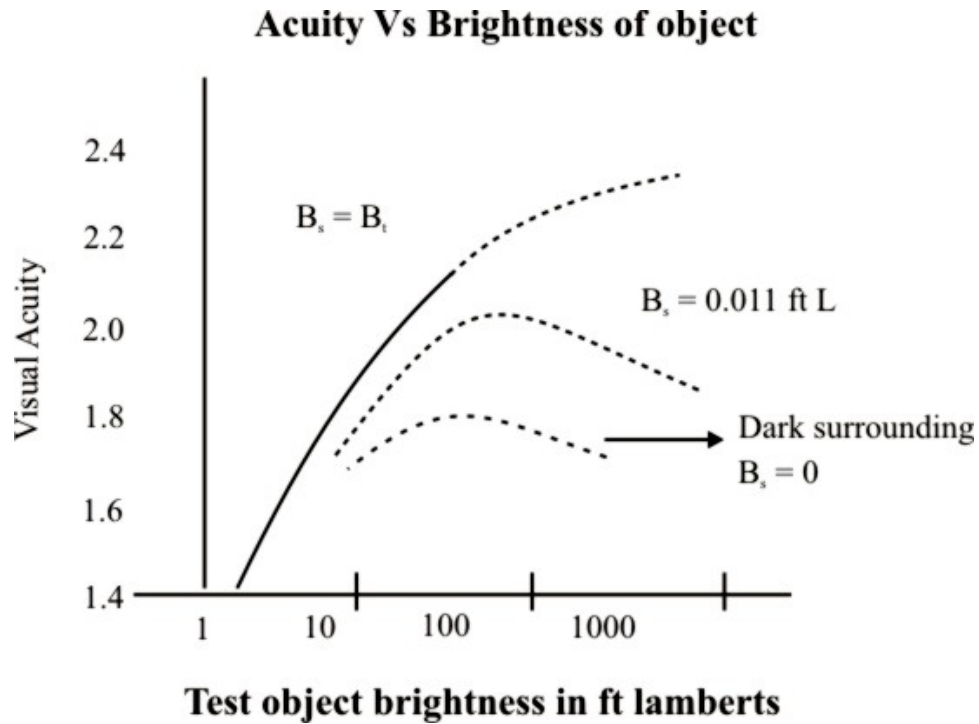
**Fig. 6**

Fig.6 shows the variation of visual acuity with background brightness. As may be noted 90% acuity levels are attained around 50 ft lamberts but increase to 95% requires 1300 ft lamberts.

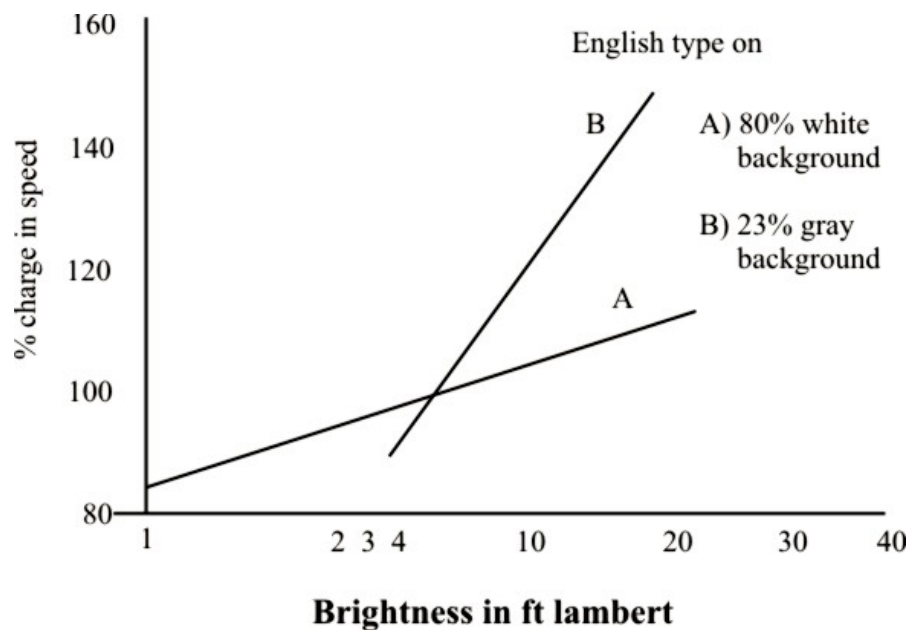


**Fig. 7**

Fig. 7 shows the acuity variation with surrounding brightness. The peak is seen to be around 1.2 – 1.4 ft L. It also shows that surrounding brightness should not be greater than object brightness. This is further confirmed by the data shown in Fig. 8.



**Fig. 8**

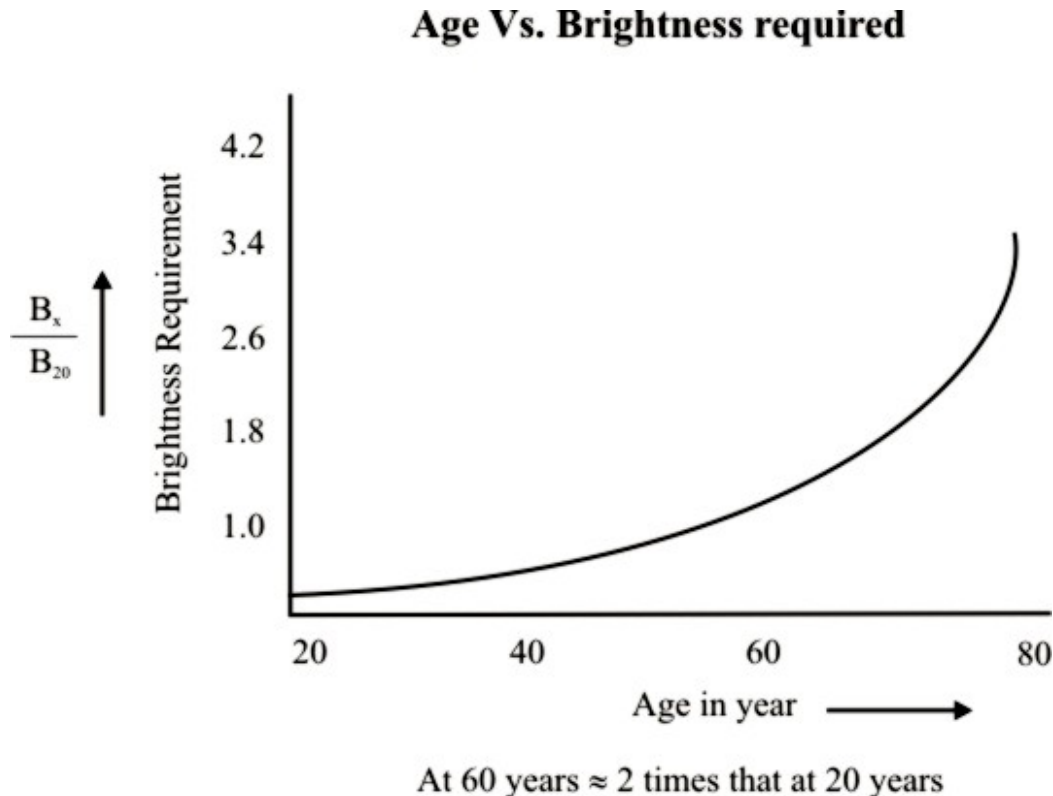


**Fig. 9**

Fig. 9 shows change in speed with increase in illumination levels. Curve A pertains to a white background. Over 1 to 40 ft lamberts, there is not much change in speed of reading. As opposed

to this in case of Curve B pertaining to Gray background, increasing illumination improves the speed, very much.

Visual acuity reduces with age due to decrease in pupil size, decrease in elasticity of pupil and decrease in flexibility of optic lens and decrease in adjustment of local length leading to higher illumination requirement in older people. This may be seen in Fig.10

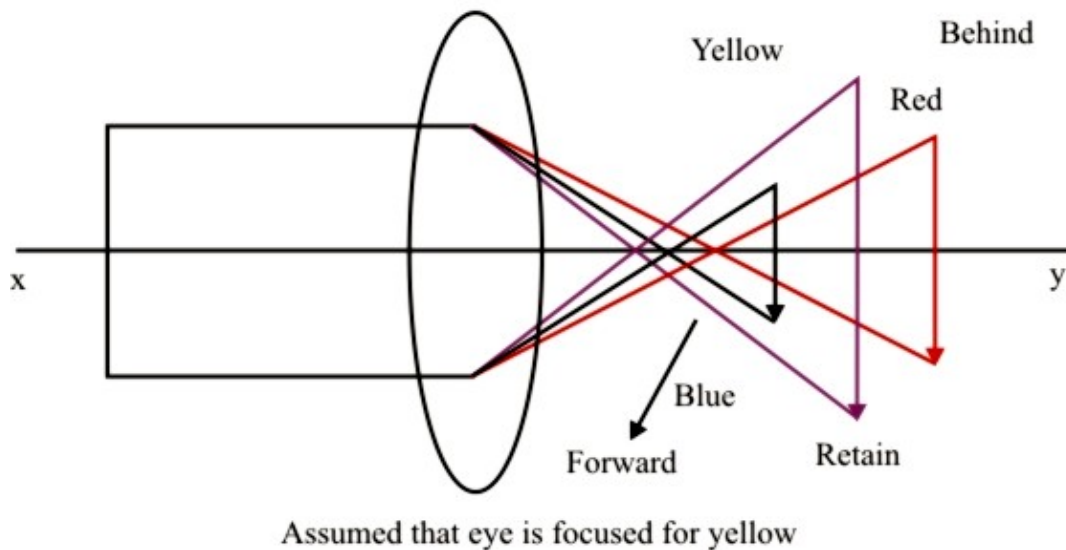


**Fig. 10**

Monochromatic light and acuity forms distinct images on retina and details are distinguished well. Gaseous source using Mercury and Sodium are used. Three primary colors are Red Green and Blue. Combination results in reduced acuity.



## Chromatic Aberration



**Fig. 11**

In Color Sensation of eye, Lag exists. Depends on presentation and cessation of stimulus, presentation of the object, rate of rise / fall of different colors. G – Green is slowest, B – Blue is fastest. Simultaneous Contrast is max. when adjustable e.g.: Red and Green.

This lecture has looked into the functioning of the eye. Various quantities affecting the acuity.

## Lecture Summary

- Illumination affects physiology as well as psychology, hence quality lighting is important
- Factors governing illumination quality :
  - glare
  - diffusion
  - direction / focus
  - composition
  - distribution
- Minimum lighting required for good visibility is 100 ft-cd or more
- For good visibility, brightness of surrounding should be greater than 0.01 ft-L & also should be less than that of test object.
- Apart from illumination, visibility is talked in terms of :
  - visual acuity
  - visual efficacy
  - visual speed
  - visual health
- Acuity is the ability to distinguish details depending upon:
  - brightness of the object
  - characteristics of light entering the eye
  - contrast maintained

- Age Vs. Vision
  - reduction of visual activity
  - decrease in size & elasticity of pupil
  - decrease in flexibility of optic lens
  - leading to higher illumination requirement
- Monochromatic light & acuity :
  - distinct images on retina
  - details are distinguished well
- Combination of different colors reduces acuity which is known as Chromatic Aberration.
- Color sensation by eye has a lag which depends on :
  - presentation & cessation of stimulus
  - rate of rise / fall (different for various colors)
  - simultaneous colors & combination of colors

## Tutorial Questions

- Why is quantity as well as quality of Illumination important?  
At present eye tasks are more & for longer duration, hence increased illuminance is required. Illumination also affects psychology, hence quality is important.
- What should be the minimum brightness of the surrounding?  
Brightness of surrounding must be less than that of the object and should not be less than 0.01 ft-L
- What are the three primary colors?  
They are Red, Green & Blue.
- How does aging leads to loss of vision?  
Aging leads to decrease in adjustment capability of the focal length of eye. Thus higher illumination is required for older people
- What is chromatic aberration? Why does it occur?  
It is the reduction in acuity due to combination of different colors. It occurs due to the fact that the eye lens has different refractive power for different wavelength of light.