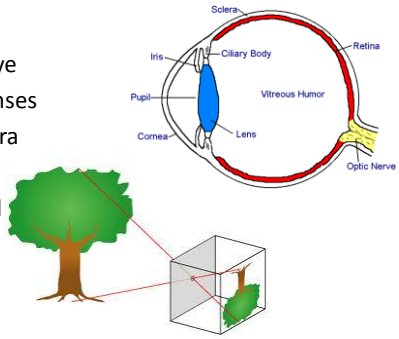
PHY385-H1F Introductory Optics

Class 12 – Outline: Section 5.7, Sub-sections 5.7.1 – 5.7.6

- Fibre-Optics
- The Human Eye
- Corrective Lenses
- Pinhole Camera
- Camera
- Depth of Field



What determines data speed?

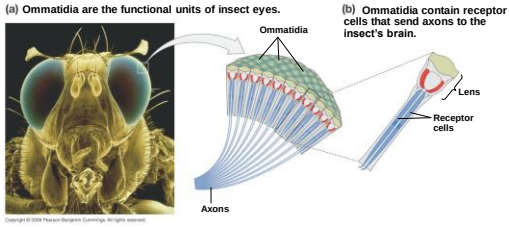
- Broadband networks deliver speeds of 100Mbps (108 bits per second)
- A "bit" is a zero or a one
- To increase data speed over a line, you should

1. Increase the speed, in m/s of signals going through the line
2. Decrease the time between bits (in s)
3. Both 1 and 2

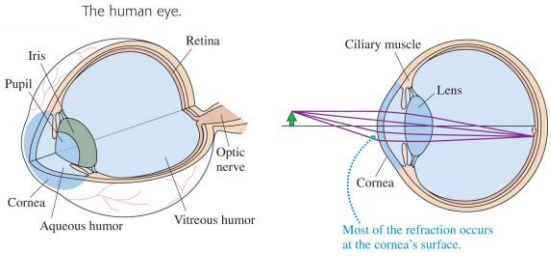
Why is fibre optic technology "faster" than traditional copper wires?

- The carrier waves of signals in a copper wire are radio frequency
- The signals travel at very close to the speed of light
- Copper coax cables have strong attenuation for frequencies above 1 GHz
- Minimum time between bits $\Delta t = 1/f = 10^{-9}$ s
- The carrier waves of signals in an optical fibre are light
- The signals travel at very close to the speed of light
- Light has a frequency of > 10^{14} Hz
- Theoretical time between bits is 10^{-14} s, 100,000 times better than coax.

Insect eyes are compound!
Each ommatidium sends separate information to their brain.



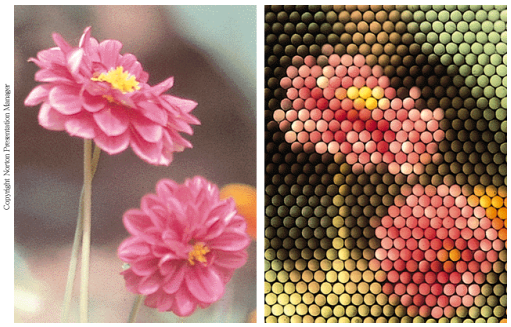
Slide courtesy of Ross Koning, Biology Department, Eastern Connecticut State University
http://plantphys.info/sciencematters/vision.ppt



Eyes

- The compound eye is made of many ommatidia. Each detects light from a certain direction, and sends an intensity signal to the brain.
- Human eye is a positive double-lens arrangement which projects a real image onto a light-sensitive concave retina.
- Most of the focusing power of the eye comes from the air-cornea interface.
- The lens is pliable (although less so with age), and so it has a variable focal length.

Human vs Insect Vision



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http://plantphys.info/sciencematters/vision.ppt

Retina

- The retina is filled with rods and cones
- The spot where the optic nerve exits contains no receptors and is insensitive to light: ***blind spot*** (we don't notice it because our brain fills in the gap with what it expects)
- At the centre of the retina is the **macula**, which contains twice as many cones as rods
- At the centre of the macula is the **fovea centralis**. It contains no rods, and the cones are very densely packed.
- We constantly move our eyeballs to cause the light coming from the object of primary interest to fall on the fovea centralis.

Use right eye only (close left eye)…focus **only** on the target for this test!
Lock head in position…hold one finger up at arm's length to cover view of target
Move arm slowly to the right, away from the target
Find your blind spot for that eye

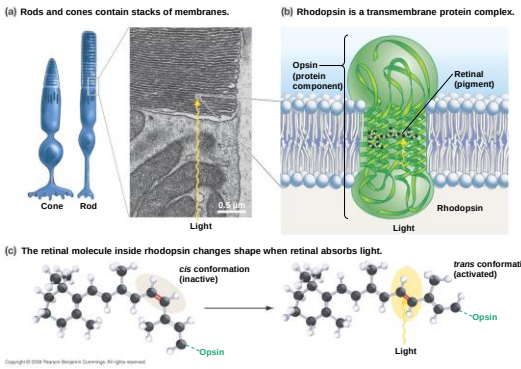
Slide courtesy of Ross Koning, Biology Department, Eastern Connecticut State University
http://plantphys.info/sciencematters/vision.ppt

Use right eye only (close left eye)…our target is a row of numbers

1 2 3 4 5 6 7 8 9

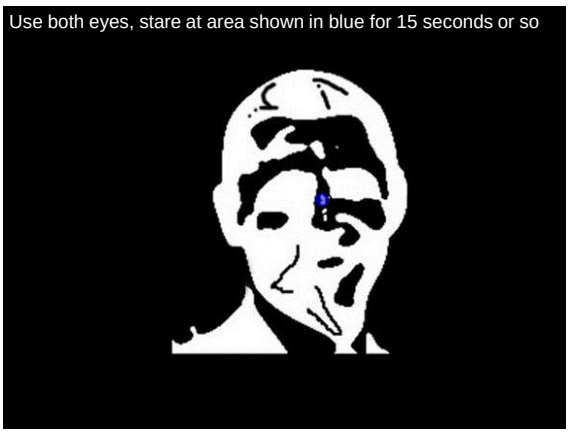
Focus on each number in turn, until the break in the blue lines is in your blind spot. What is different when the blind spot holds a blank area?

Slide courtesy of Ross Koning, Biology Department, Eastern Connecticut State University
http://plantphys.info/sciencematters/vision.ppt



Slide courtesy of Ross Koning, Biology Department, Eastern Connecticut State University
http://plantphys.info/sciencematters/vision.ppt

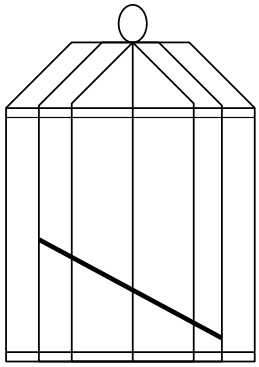
Use both eyes, stare at area shown in blue for 15 seconds or so



What do you see on this blank white slide? Blink if needed!

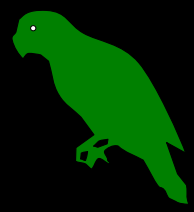
Use both eyes, stare at the parrot's eye for 15 seconds or so

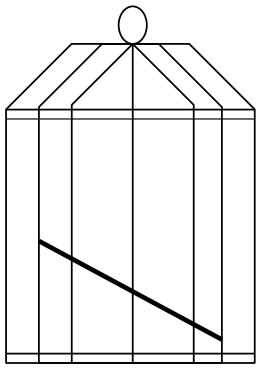
This is called an "after image"
Does it move around as you move your gaze?



What color is the bird in the cage?
Blink if needed

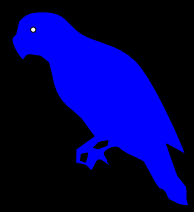
Use both eyes, stare at the parrot's eye for 15 seconds or so

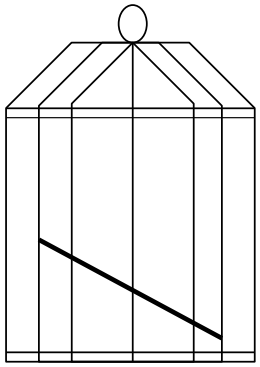




What color is the bird in the cage?
Blink if needed

Use both eyes, stare at the parrot's eye for **20** seconds or so



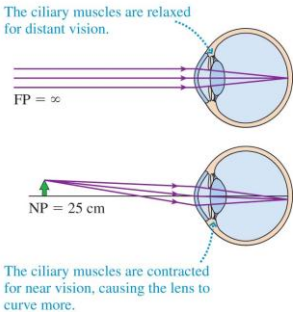


What color is the bird in the cage?
This color is a bit harder to visualize

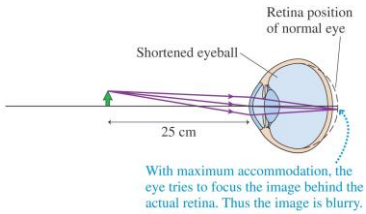
- For artists using paint, red blue and yellow are the useful primary colours.
- Note that this is different than the RGB additive primaries used in computer screens.
- The "opposite" colours match well with my experience of the after-image in the previous slides.

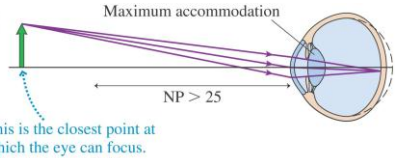
Image is from Designedly, Kristi
http://www.designedlykristi.com/tutorials/color_intro/color_theory2.html

The Normal Eye



Hyperopia
(far-sightedness)





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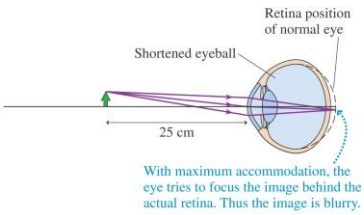
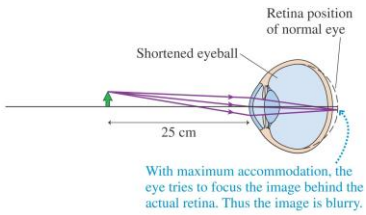
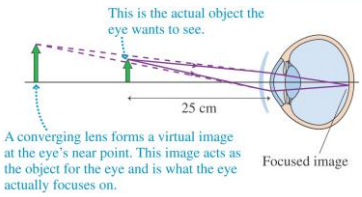


To focus an image of the object which is 25 cm away, the positive focusing power of the eye must be
1. Increased
2. Decreased

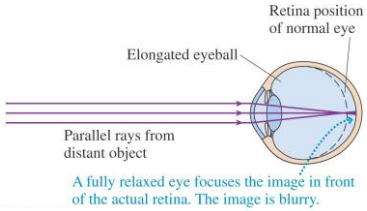
Hyperopia
(far-sightedness)

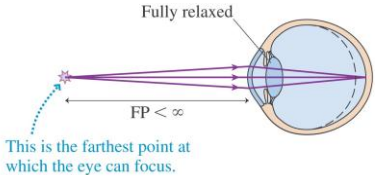
CORRECTION:
Converging lens.



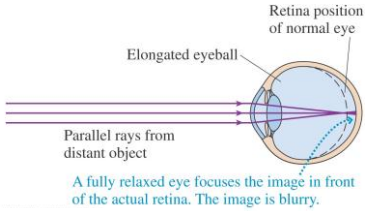


Myopia
(near-sightedness)





Myopia
(near-sightedness)



To focus an image of the object which is at infinity, the positive focusing power of the eye must be
1. Increased
2. Decreased

Myopia
(near-sightedness)

CORRECTION:
Diverging lens