Grade 10 Science

Light and Geometric Optics

Class 13

Applications of Lenses

- Cameras use a converging lens to produce an inverted, smaller, real image on the film or digital sensor
- Object must be located more than 2F' and the image will be between F and 2F; cannot change the film so the lens moves back and forth to focus

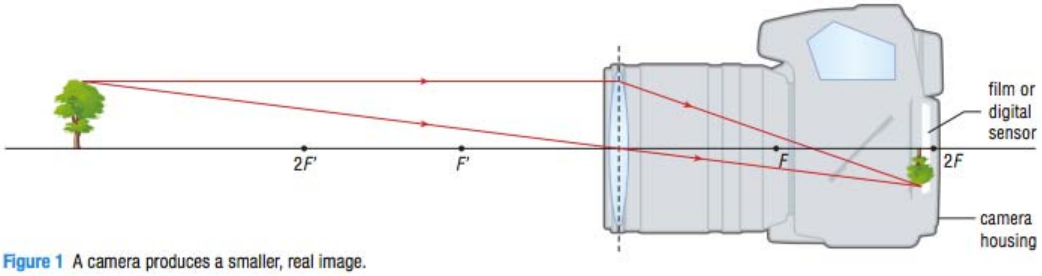


Figure 1 A camera produces a smaller, real image.

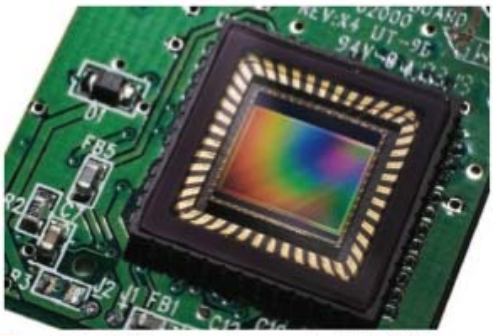
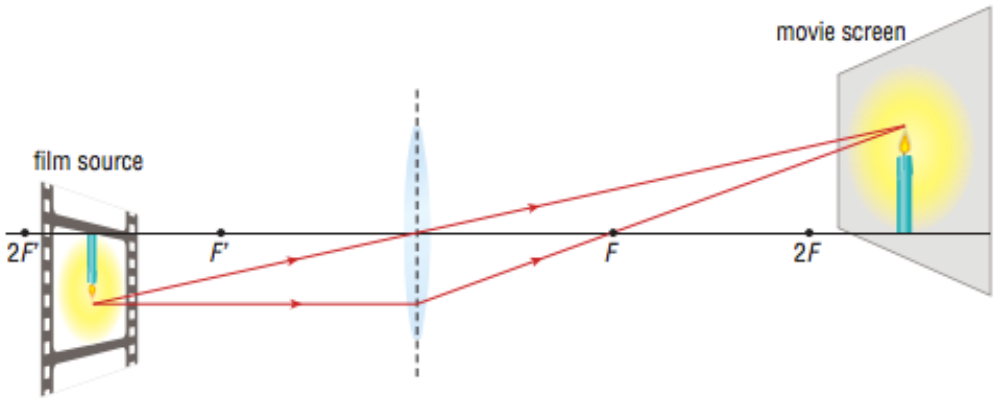


Figure 2 In a digital camera, a charge-coupled device (CCD) replaces the film found in a traditional camera.

- Traditional film was developed by George Eastman in 1884
- Digital cameras use a charge-coupled device (CCD) to capture the light

Movie Projector

- Takes a small object and projects a large, inverted, real image on a screen
- Film must be located F' and 2F' and loaded upside down for image to be upright



Magnifying Glass

- Converging lens in which object is between F' and the lens
- Human brain extends the refracted rays backwards to produce an enlarged, virtual image

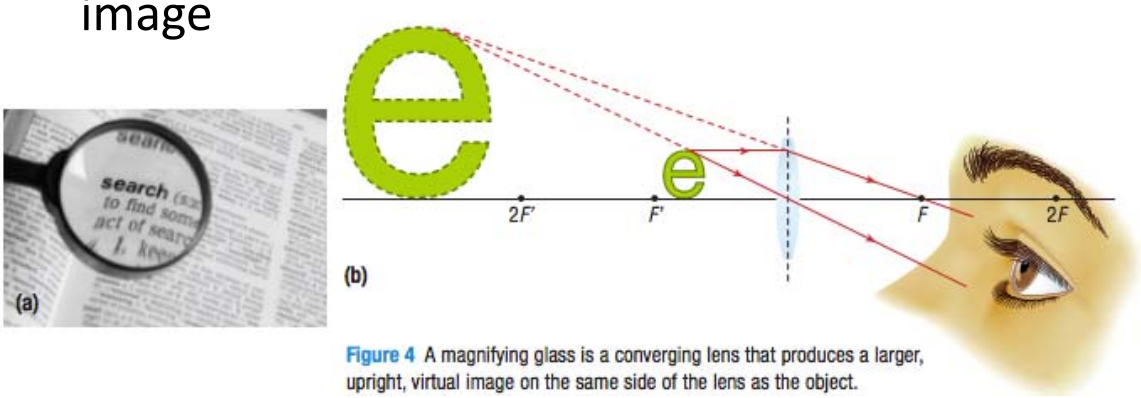
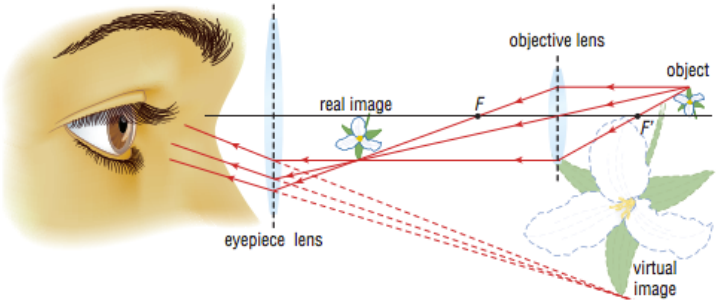


Figure 4 A magnifying glass is a converging lens that produces a larger, upright, virtual image on the same side of the lens as the object.

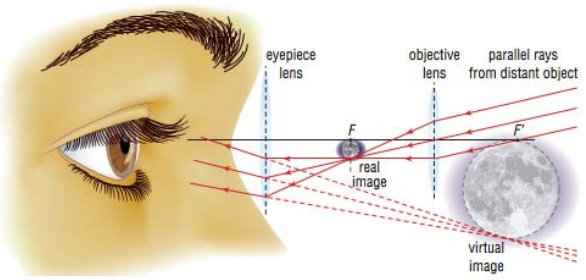
Compound Microscope

- Arrangement of two converging lenses to produce two enlarged, inverted images: one real and one virtual
  - Real image is in the body tube of the microscope
  - Virtual image is the one you see through the eyepiece



Telescope

- The object you are looking at is so far beyond 2F' that incident rays passing through the lens are considered to be parallel
- Produces two enlarged, inverted images, one real image that is inside the telescope and one larger virtual image that you see



The Human Eye

- Iris – opens and closes to let in more or less light
- Pupil – where light enters the eye
- Cornea – causes light to converge
- Lens - causes light to converge
- Retina – where the image is focused; sends electrical signals to the brain through the optic nerve

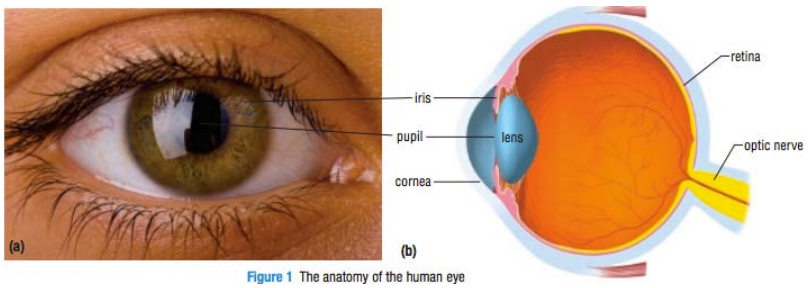
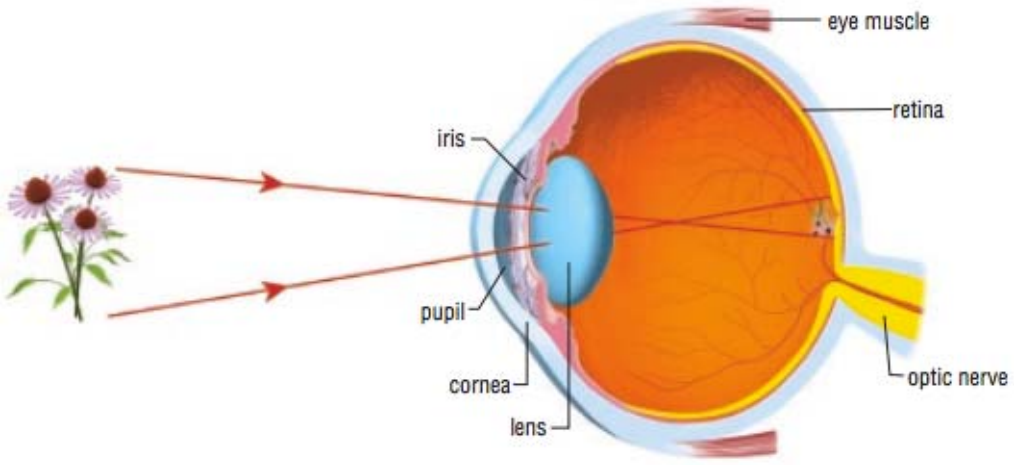


Figure 1 The anatomy of the human eye

Find Your Blind Spot

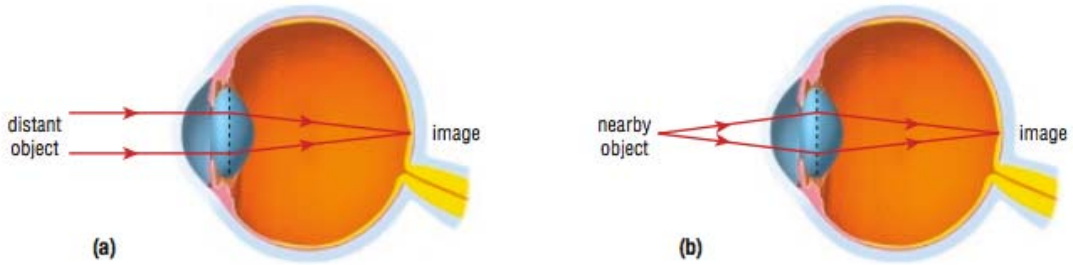
- Find your blind spot, close your left eye and focus on the small ball until the larger ball disappears

- The eye is a light gathering instrument, we see with our brain
- Brain flips the real, inverted image on the retina so that we see an upright image



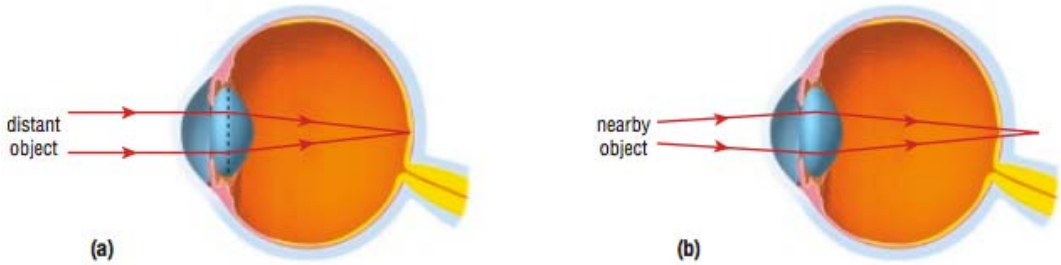
Accommodation in Healthy Eyes

- Ciliary muscles help the eye focus by changing the shape of the lens which changes the focal length to allow focusing on the retina
- Lens gets fatter when focused on nearby objects



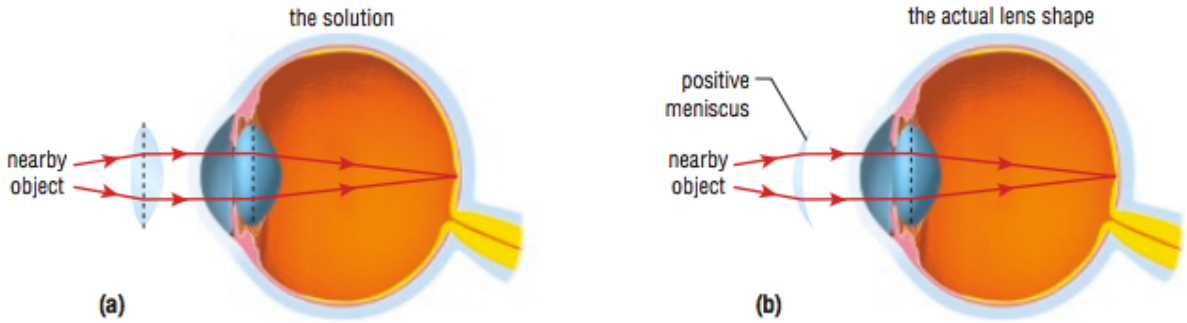
Hyperopia (Far-sightedness)

- Inability to see near
- Occurs because distance between the lens and retina is too small or cornea-lens combination is too weak
- Light focuses behind the retina



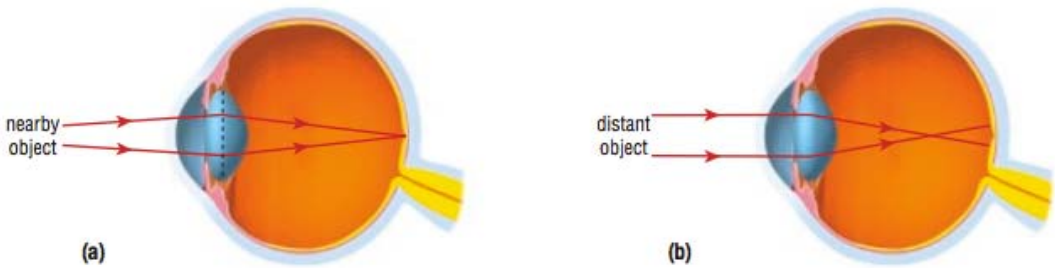
Correcting Hyperopia

- Needs help in refracting light – uses a converging lens
- **Presbyopia** – caused by age; eye lens loses elasticity



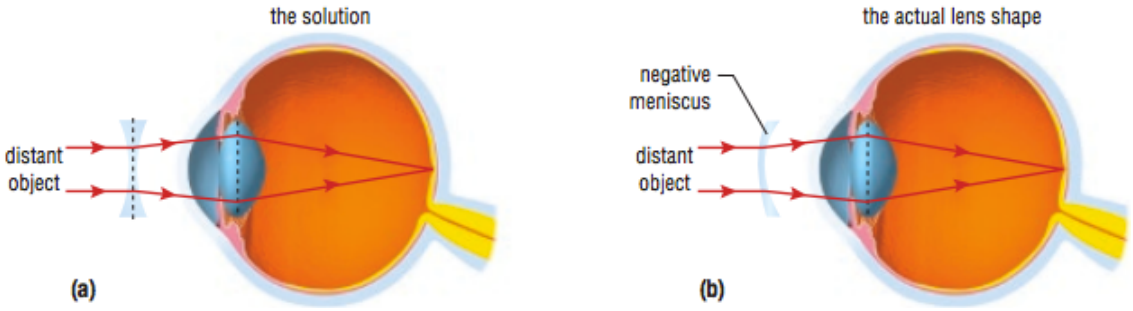
Myopia (Near-Sightedness)

- Inability to see far
- Distance between lens and the retina is too large or cornea-lens combination converges too strongly
- Light focuses in front of the retina



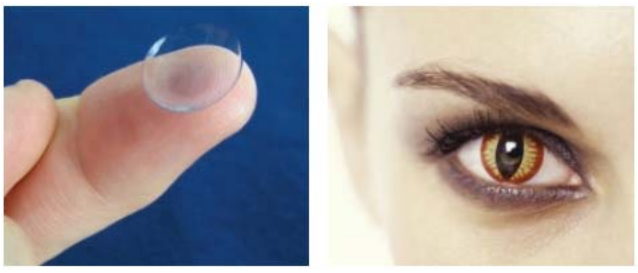
Correcting Myopia

- Corrected with a diverging lens
- Positive meniscus and Negative meniscus are lenses with a modified shape to make glasses more cosmetically appealing that a regular lens



Contact Lenses

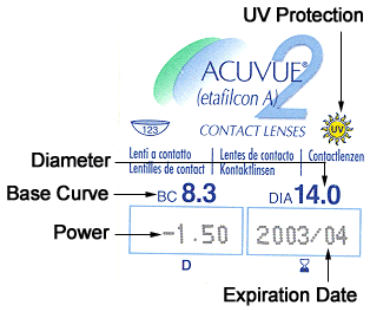
- Lens placed in front of the cornea
- Shaped to correct hyperopia and myopia
- Proximity to the eyeball allows the optic zone (central part of the lenses that contains the corrective power) to be smaller than glasses



Diopters (D)

- Contact lens and eyeglass lens powers are expressed in diopters (D)
- Lens powers that correct nearsightedness start with a (-) and farsightedness start with a (+) sign

$$D = \frac{1}{f}$$



Common Eye Problems

- **Astigmatism** - light fails to focus on a single point on the retina; instead multiple focus points occur
  - Symptoms: Causes vision to be blurred, lights seem to come from all directions
- **Glaucoma** – pressure buildup due to fluid in the aqueous humor damaging the optic nerve; can lead to blindness
  - Symptoms: Tends to be inherited; loss of peripheral or side vision, appearance of halos around lights

- **Cataract** – Clumping of proteins in the lens due to old age, UV light, diabetes, etc.
  - Symptoms: Blurred vision, glaring lights, dull colours; can lead to blindness
  - Can be helped with cataract surgery in which the clouded lens is replaced with a clear plastic intraocular lens
  - Patients regain clear vision

Cataract Patient