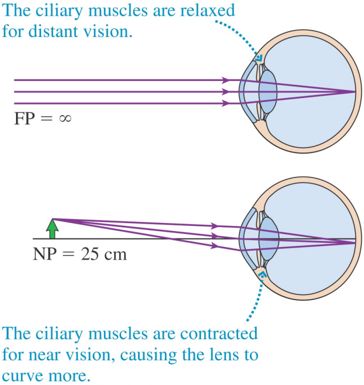
Focusing and Accomodation



- Most of the refracting power of the eye comes from the air-cornea boundary, not from the lens.
- Things are blurry underwater because you have a water-cornea boundary instead with little difference in n.
- An eye focuses by changing the focal length of the lens using the ciliary muscles to change the curvature. This is known as accomodation.
- Relaxed muscles give a long f, contracted gives small f.

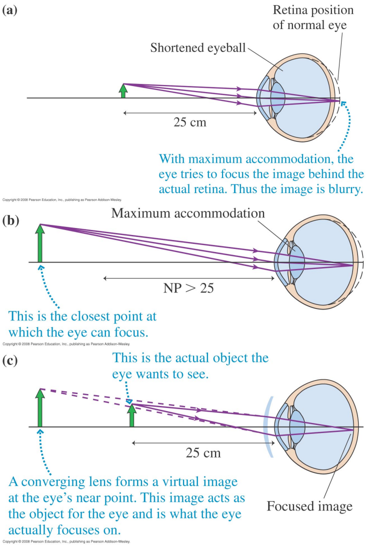
Vision Defects and Their Correction

- The farthest distance a relaxed eye can focus is the far point (FP). The closest is the near point (NP).
- The NP changes with age as your lens becomes less flexible. It moves from $\approx 25cm$ to $\approx 200cm$ by age 60. This is called presbyopia.
- Presbyopia is known as a refractive error of the eye. Other refractive errors include myopia and hyperopia. All can be corrected by lenses.
- Lenses are prescribed by their power

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

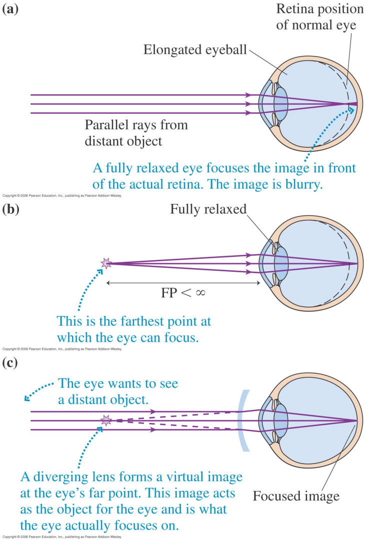
  The SI unit of power is the diopter (D) (or dioptre) defined in m^{-1}
- If you have glasses with $P = +2.5D$ you have a converging lens with focal length 0.4 m.

Hyperopia



- Hyperopia causes far-sightedness. The FP might be fine, but the NP is too far away.
- The eyeball is too short for the refractive power of the cornea.
- Add a lens to boost refractive power. A converging lens is needed.
- The lens should form an upright virtual image at the eye's actual NP. This image then becomes the object for the eye.

Myopia

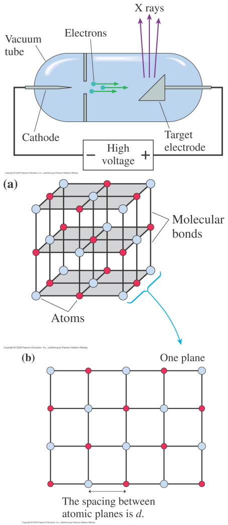


- Myopia causes near-sightedness. The NP might be fine, but the FP needs adjustment.
- The eyeball is too long for the refractive power of the cornea.
- Add a diverging lens to fix the problem.
- The lens should form an upright virtual image at the eye's actual FP. This image then becomes the object for the eye.

Modern Optics and Matter Waves (Chapter 25)

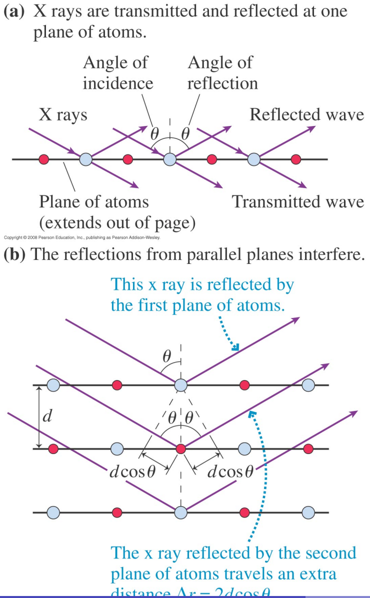
- We have been studying different physical models for light: the wave model and the ray model.
- Chapter 25 of your text gets into the third model: the particle model.
- It turns out that sometimes describing light as a wave or as a ray cannot explain its behaviour! Light behaves in very strange ways which puzzled physicists for a long time.
- Until now we have been treating light the way it was treated pre-1900. Experiments at that time already were challenging the way we thought about light.
- The greatest technological advances of the 20th century would not have been possible without a huge leap in our understanding of light (radiation) and matter...and the birth of Quantum Mechanics.

X-Ray Diffraction (25.2)



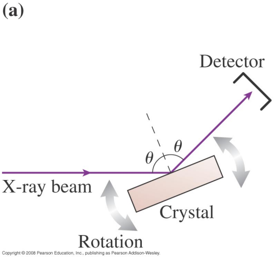
- One of the interesting experiments of the late 19th century lead to the discovery of x-rays by Roentgen.
- These x-rays were very peculiar. They acted like rays. However, they penetrated matter. He could not reflect them, diffract them, etc. They were not obviously wave-like.
- Nevertheless, it was speculated that x-rays were very short-wavelength waves.
- Luckily, people had recently discovered that solids were crystaline arrangements of atoms spaced about 1nm apart - a natural diffraction grating!!

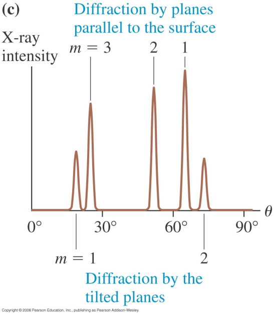
X-Ray Diffraction



- Most x-rays will be transmitted by a solid, but there may be some reflection too. The reflections should obey the law of reflection.
- However, there are many parallel planes of atoms. So, destructive intereference is setup for all but a few angles. Those few angles should see constructive interference.
- We could analyze this by looking at the path-length difference between rays reflected from different planes. If d is the spacing between planes we have

$$2d\cos\theta_m = m\lambda, m = 1, 2, 3, \ldots$$





- x-ray diffraction has proved incredibly useful in understanding the structure of matter.
- Place an unknown crystal in the x-ray beam and measure the reflected intensity to learn about its structure.
- People in the SFU physics department today run x-ray diffraction machines to study the properties of materials.
- The invention of a tool to look at the crystal strucure of matter is important. Furthermore, nature gives us pre-fabricated diffraction gratings for very small wavelengths.

X-ray Diffraction

It is by means of x-ray diffraction that we are able to determine the structures of protein molecules such as rhodopsin