

Sample Diploma Problem

p. 3 in data book:
electromagnetic spectrum

Use the following information to answer numerical-response question 7.

Some Forms of Electromagnetic Radiation (EMR)

- | | | |
|---|---|-------------|
| | 1 | Microwave |
| → | 2 | Ultraviolet |
| | 3 | Infrared |
| → | 4 | Gamma |
| | 5 | Visible |
| | 6 | Radio |
| → | 7 | X-ray |

Small frequency = small energy

Numerical Response

7. The three forms of EMR given in the list above that have the **highest** energy per photon are numbered 4, 7, and 2.

(Record all **three digits** of your answer in **any order** in the response boxes at the bottom of the screen.)

Use the following information to answer numerical-response question 8.

Type of Radiation	Applications of Radiation	Classification of Radiation
1 Infrared Infrared Used in sensors	4 <ul style="list-style-type: none">• Sending signals between cellphones• Producing images using magnetic resonance imaging (MRI)	7 Ionizing
2 X-ray	5 <ul style="list-style-type: none">• Using touch-screen digital devices• Military sensors	8 Non-ionizing
3 Radio Radio used in communication, non ionizing	6 <ul style="list-style-type: none">• Treating cancer• Producing images of bones	X ray radiation is ionizing Radiation therapy is when a beam of X rays is shot at cancer to kill them

Numerical Response

8. Using the numbers above, choose **one type of radiation** and match it with some applications of that type of radiation, and a classification of that type of radiation. (There is more than one correct answer.)

Type of radiation _____ (Record in the **first** box) 2 6 7
Application _____ (Record in the **second** box) 3 4 8
Classification _____ (Record in the **third** box) 1 5 8

(Record your answer in the response boxes at the bottom of the screen.)

Sample Diploma Problem

Use the following information to answer numerical-response question 9.

Earth-based telescopes are unable to detect electromagnetic radiation (EMR) that is reflected or absorbed by Earth's atmosphere.

Some Types of Electromagnetic Radiation (EMR)

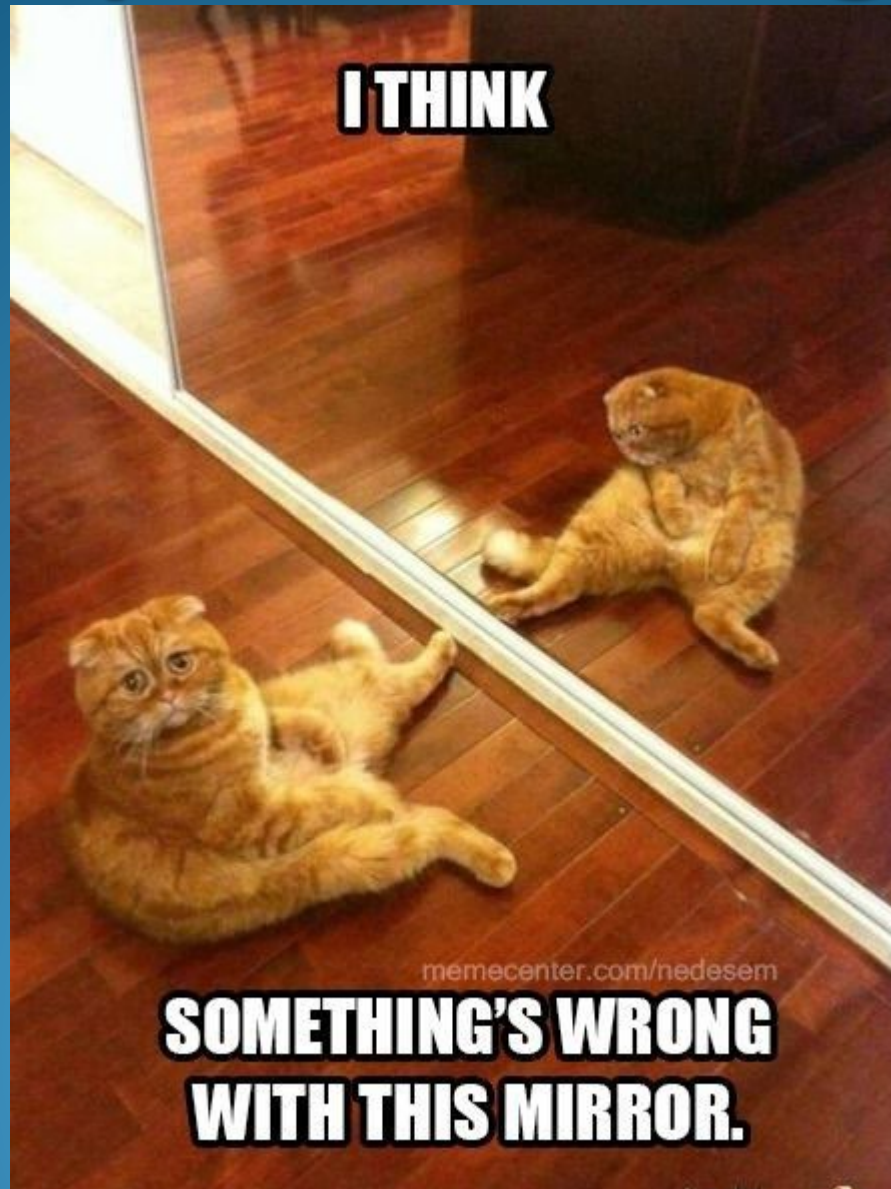
- | | | | |
|---|---------------|---|-------------------|
| ① | Gamma | 4 | Ultraviolet light |
| ② | X-rays | 5 | Radio |
| 3 | Visible light | 6 | Infrared |

Numerical Response

9. The two types of EMR above that **cannot** be detected by Earth-based telescopes are numbered 1 and 2.

(Record the **two digits** of your answer **in any order** in the response boxes at the bottom of the screen.)

Properties of Light



Curriculum

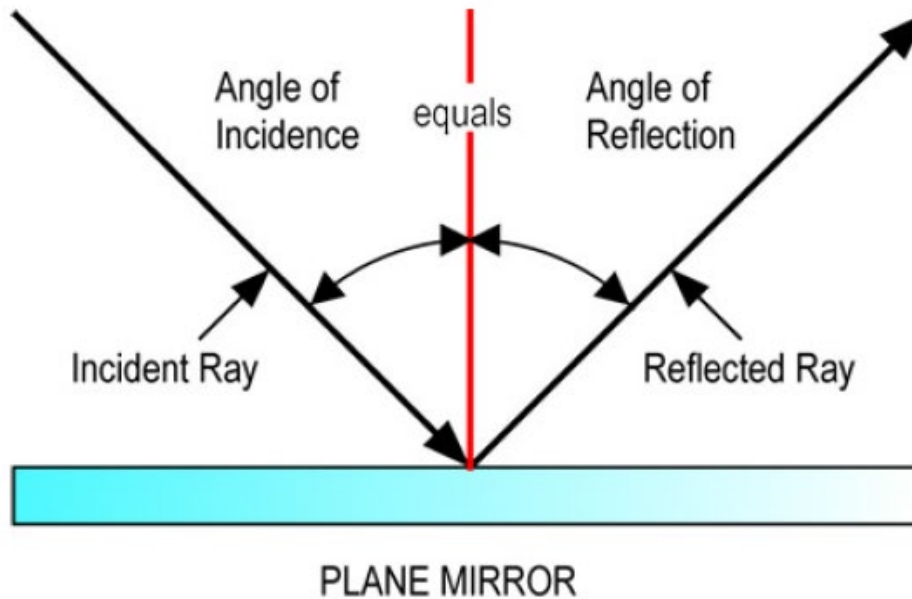
- investigate and describe, qualitatively, the phenomena of reflection, refraction, diffraction and polarization of visible light
- explain, in general terms, the design of telescopes that are used to gather information about the universe through the collection of as much EMR as possible; i.e., reflecting and refracting optical and radio telescopes

Properties of Light

- Light is thought of as both a wave and a particle so it possesses properties of both
- All waves can:
 - Reflect
 - Be polarized
 - Diffract
 - Refract

Reflection

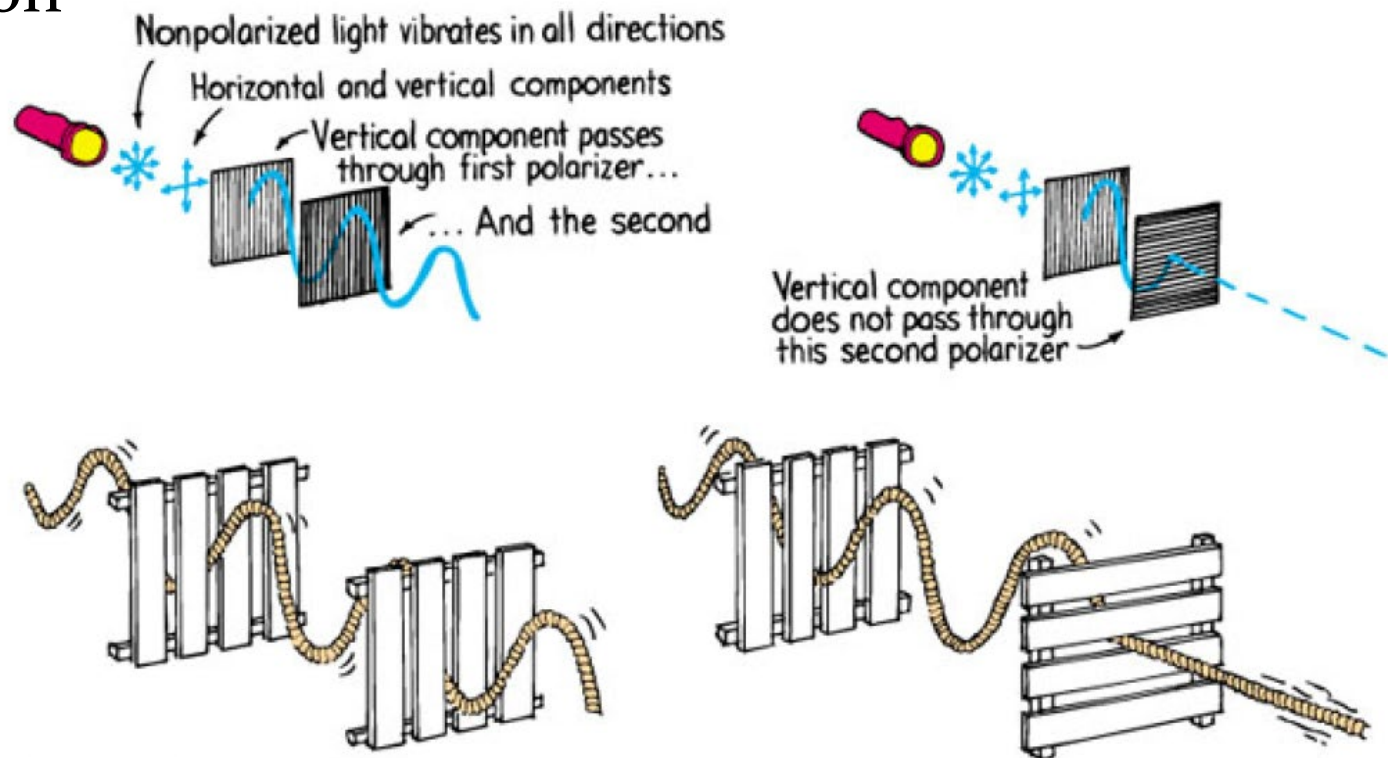
- Angle of Reflection = angle of Incidence



POLARIZATION

(Confining a wave to vibrate in one direction)

- Light can vibrate in any direction
- Polarizing filters allows only light that is vibrating in one direction



Polarization (15 minutes)

- <https://www.youtube.com/watch?v=PJHCADY-Bio>

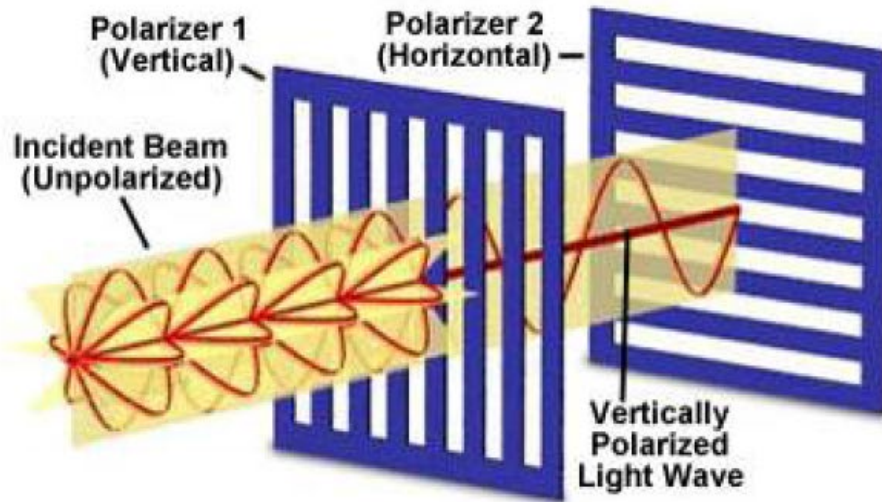


Figure 1

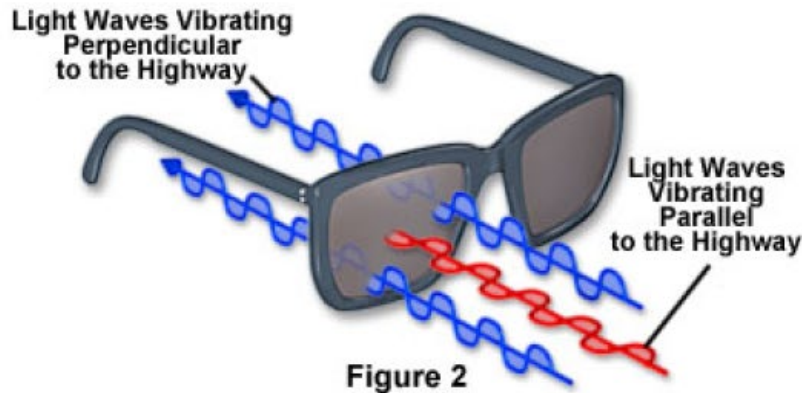


Figure 2

Seven-Segment Liquid Crystal Display (LCD)

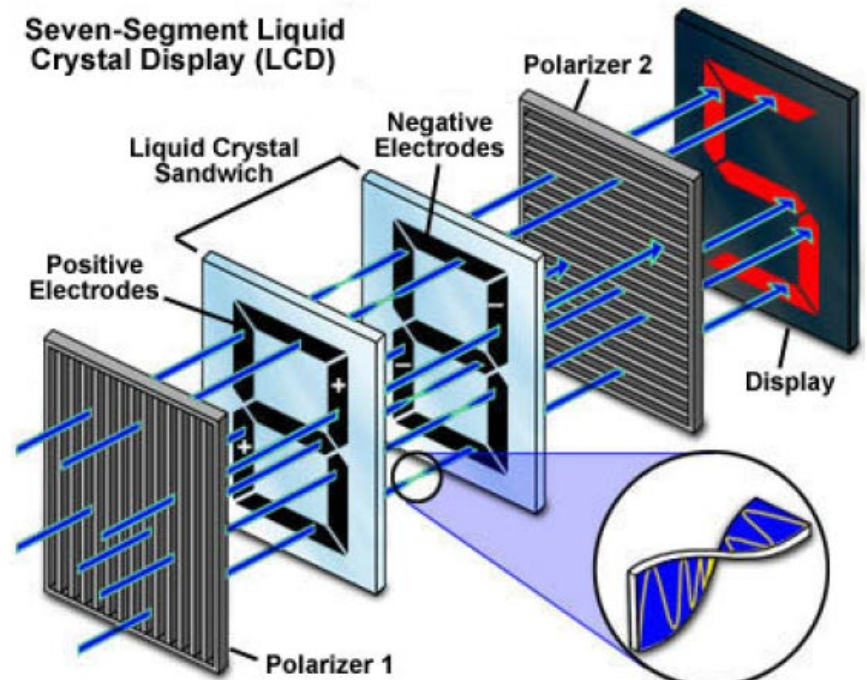
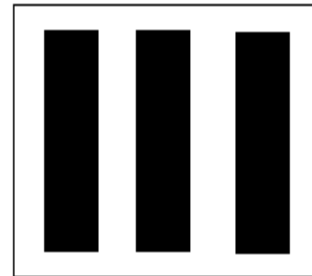
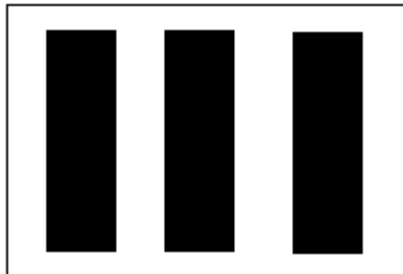
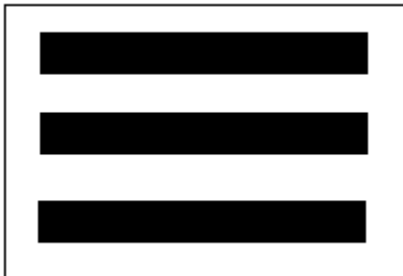


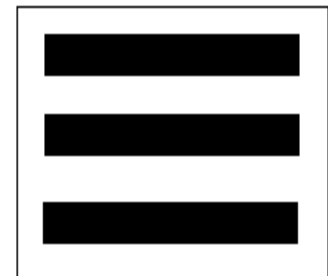
Figure 3

Polarization

- Light is a transverse wave
- Because light is a transverse wave, it can be polarized
- How polarization works:

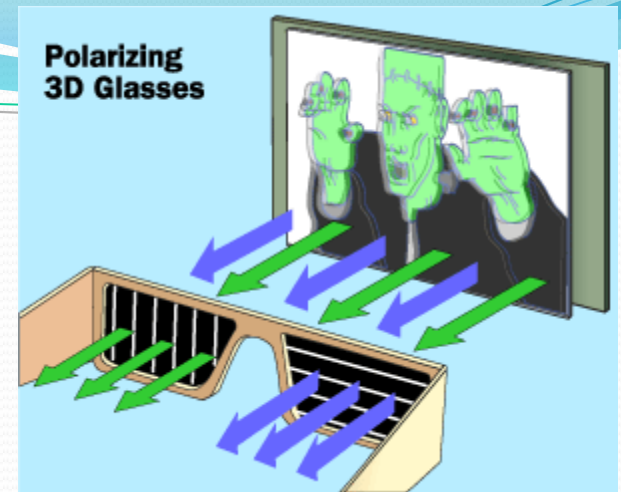


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Uses of Polarization

- 3D movies use polarization
- The movie is shot with two images
- One image is polarized so only vertical light come out
- The other image is polarized so only horizontal light comes out
- Your 3D glasses block out one of the images so that each eye sees a different picture
- Your brain brings these two images together for an image that appears out of the screen

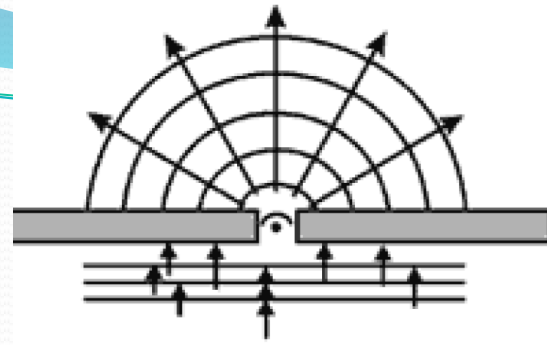


Uses of Polarization

- When light reflects off of water it is mostly in the horizontal direction
- Fisherman and boaters use polarized sunglasses to reduce the glare off the water
- The polarized lenses block out all the horizontal light reflected by the water

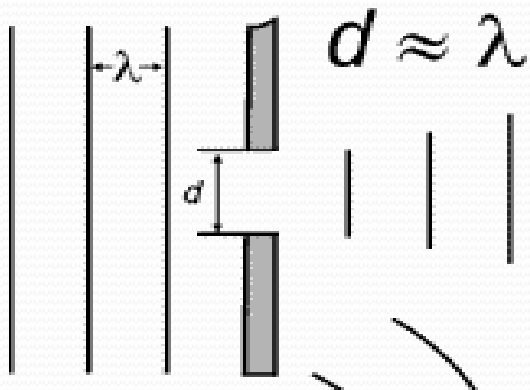
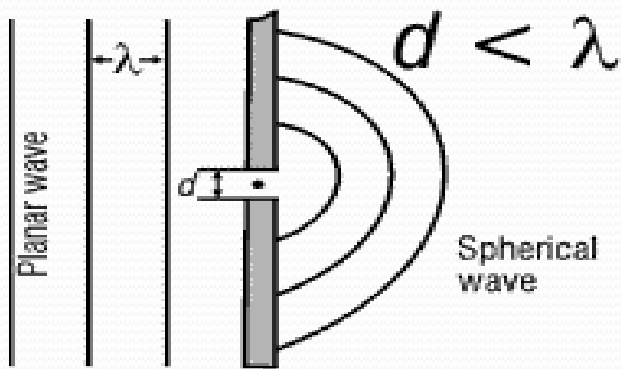


Diffraction

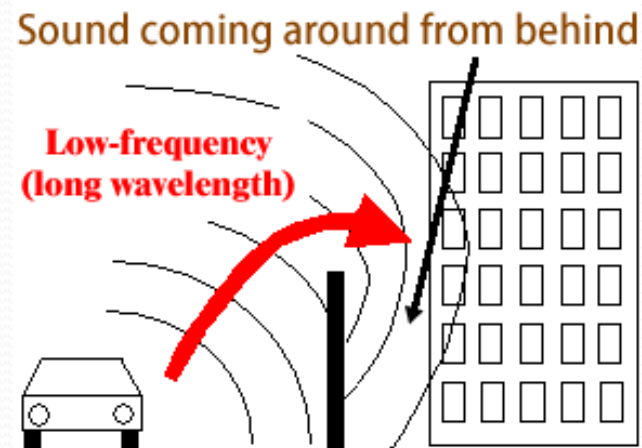
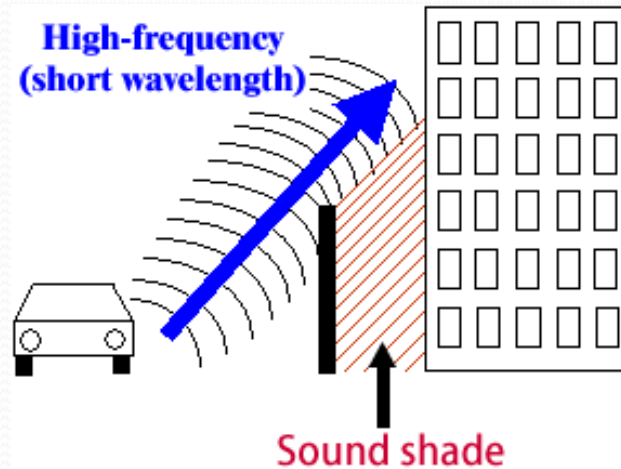


- **Diffraction** is the bending or spreading out of waves as they pass through an opening or around a corner
- Waves diffract and particles do not
- As wavelength increases, the amount of diffraction increases
- Which type of EMR would diffract the most?
- Radio b/c it has highest wavelength (light would be red)
- Lower frequency diffract more than higher frequency
- The opening the wave diffracts through must be same size or less than the wavelength

Diffraction



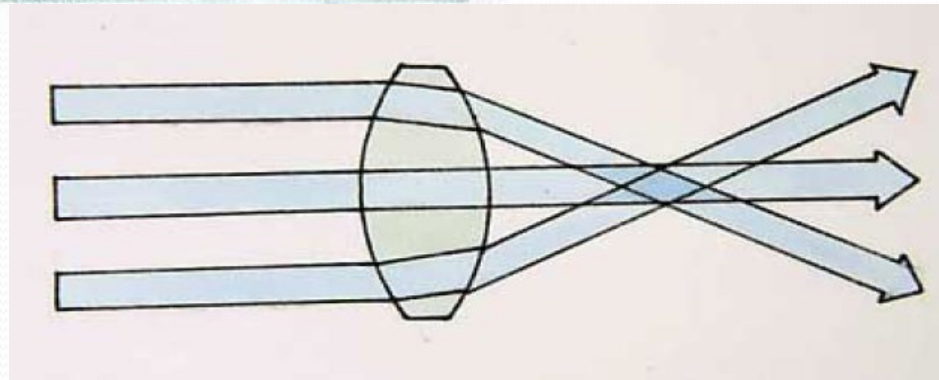
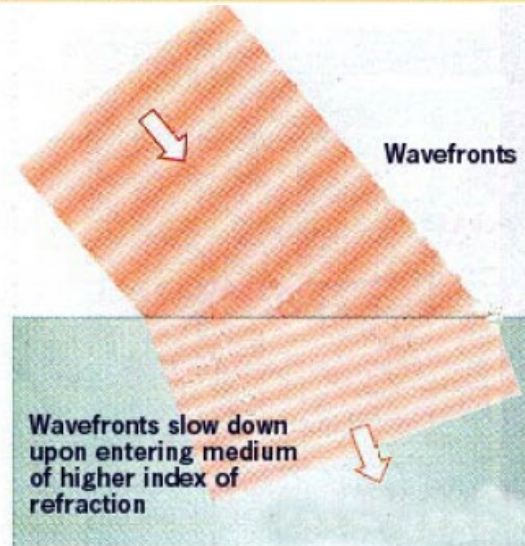
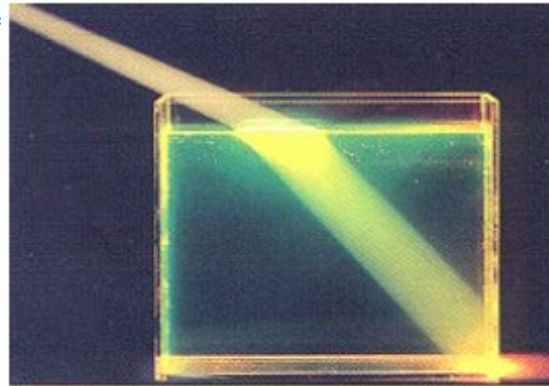
Smaller openings work better to diffract



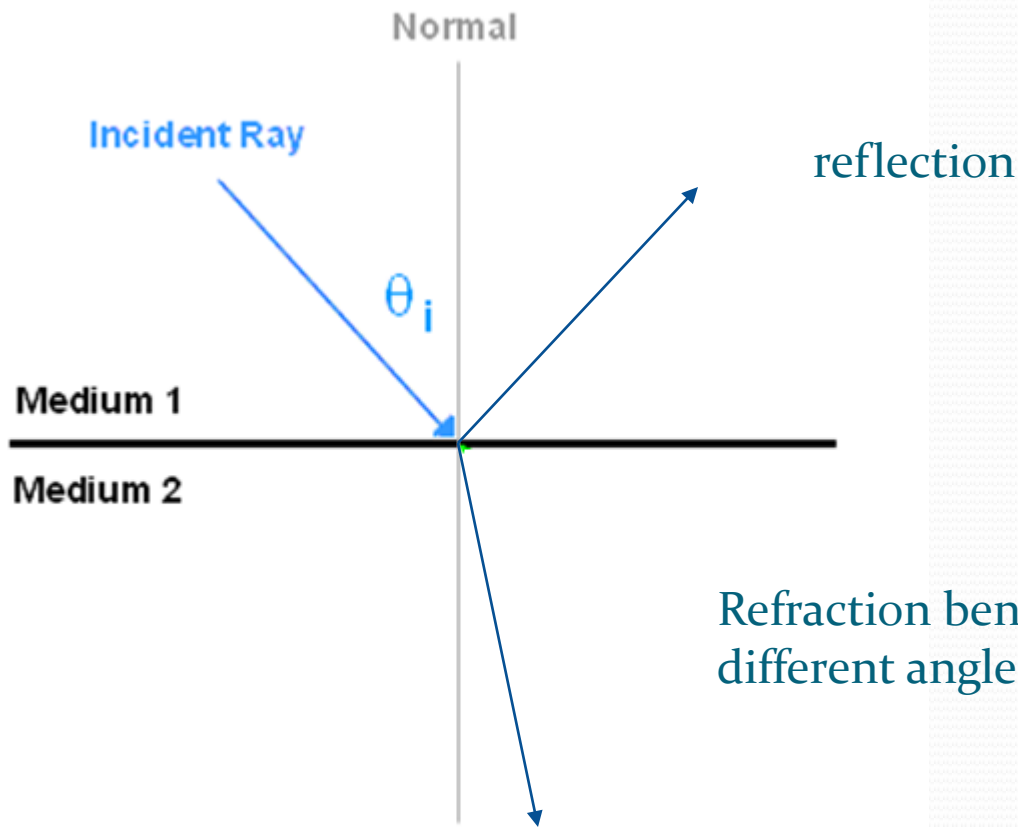
Low notes diffract better and bends around

Refraction

- When a wave strikes a boundary to a new medium (in which it travels speed), it will bend (**refract**)
- This can cause objects to become magnified



Ray Diagram



Showing reflection vs refraction

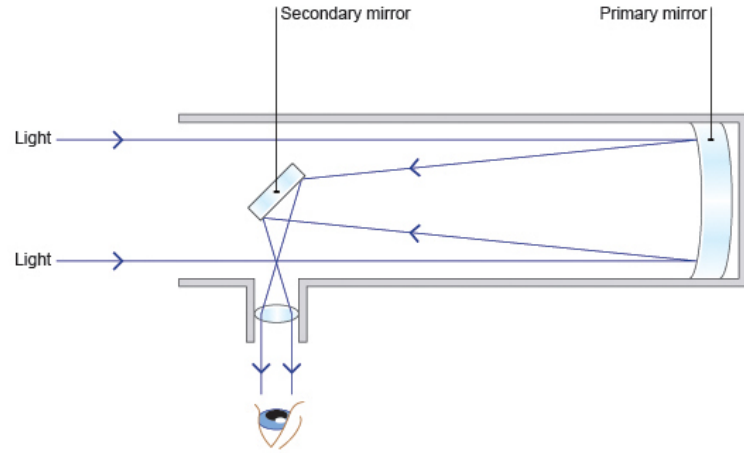
- [\(187\) Total Internal Reflection – YouTube](#)

Telescopes

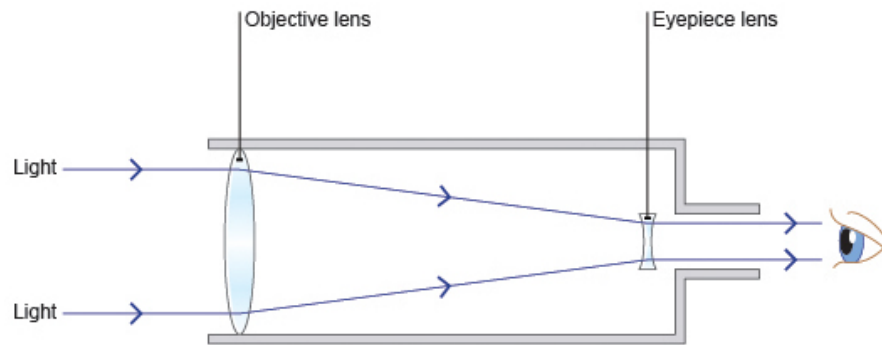
- There are two types of optical telescopes that are used to study the stars by collecting light:
- **Refracting telescopes** use *two lenses* to focus starlight
- However, refracting lenses are limited in size – if they are too large, they bend under their own weight
- Lenses can also absorb IR and UV radiation
- **Reflecting telescopes** use a large *curved mirror*
- The curved mirrors are not limited in size (the largest one has a diameter of 6 m)

Reflecting vs. Refracting

- Reflecting:



- Refracting



video (5 min)

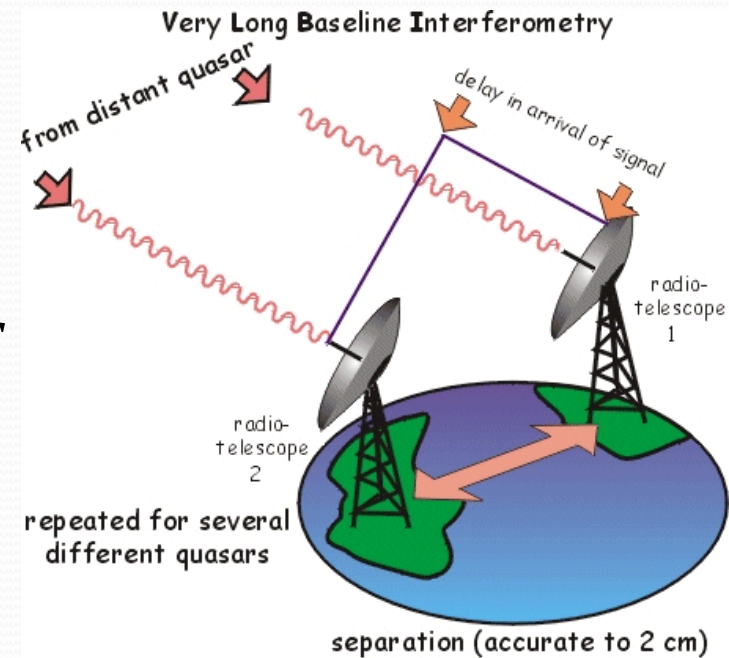


Radio Telescopes

- Stars not only produce visible light, but they also produce other radiation
- Radio signals can travel straight through clouds
- These telescopes have an advantage over optical telescopes – they can operate day or night, regardless of weather
- However, they must be placed far away from any sources of radio waves

Interferometry

- In **interferometry**, two telescopes are linked and their images are combined, forming one image
- Ground-based telescopes are limited, however, by the clarity of the atmosphere
- Space-based telescopes, like the Hubble Space Telescope, do not have the disadvantage of atmospheric interference



X ray Telescope

- Because X rays can penetrate through matter so well, a reflecting system can not be used

