# Optical Recording and Communications

Turn off all electronic devices



## Observations about Optical Recording and Communications

Optical disks can store lots of audio or video

That audio or video is of the highest quality

Optical disks continue to play perfectly for years

Playback of optical disks involves lasers

Lasers and fibers are used in communication



## 5 Questions about Optical Recording and Communication

1. How is information represented digitally?
2. How is information recorded on an optical disk?
3. How is information read from an optical disk?
4. How can light carry information long distances?
5. Why does light follow an optical fiber's bends?



## Question 1

Q: How is information represented digitally?

A: As a sequence of digital symbols

Audio or video information is a sequence of numbers

Each number can be represented as a group of symbols

- Symbols can be anything: letters, images, coins
- There could be a different symbol for each number, or multiple symbols
- Representing the number *423* as 4 2 3 uses 3 symbols: decimal digits
- Representing 423 as 1 1 0 1 0 0 1 1 1 uses 9 symbols: binary digits

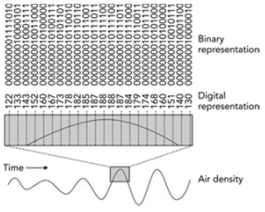
Digital representations of numbers

- offers good noise-immunity because the symbols are easily recognized
- permits error detection and correction to further reduce noise issues



## Digital Audio

- The air pressure fluctuations that are sound are measured thousands of times per second
- Each measurement is represented digitally using about 16 binary digits, each a 0 or a 1.






## Question 2

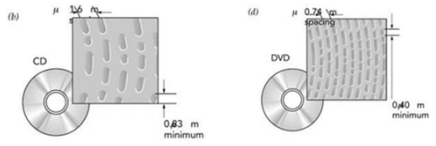
Q: How is information recorded on an optical disk?

A: As reflective symbols in a spiral track.

Symbols are lengths/spacing of reflective regions

Symbols are as small as can be detected optically

- Laser wavelength determines symbol density



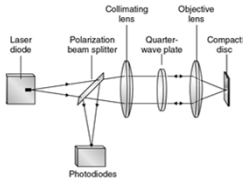
# Question 3

Q: How is information read from an optical disk?

A: A focused laser beam reflects from the disk.

Diode laser light is focused on the shiny layer

Reflected light is detected by photodiodes





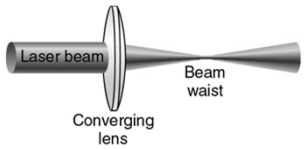

# Playback Issues

Laser light must focus exactly on the symbols

Light wave forms a "waist"—its minimum width

- Wave limits on focusing are known as diffraction
- Waist can't be much smaller than a wavelength

Symbols can't be much smaller than a wavelength






# Question 4

Q: How can light carry information long distances?

A: Changes in that light can represent information.

Analog representations such as AM modulation

- often used for remote process monitoring.

Digital representations such as pulse codes

- pulses with discrete amplitudes used as symbols
- provides noise-immunity, error correction, compression, and channel-sharing.

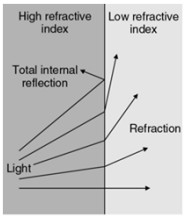


# Question 5

Q: Why does light follow an optical fiber's bends?

A: The light is trapped by total internal reflection.

- As light enters a material with a lower index of refraction, it bends away from the perpendicular
- If bend exceeds 90°, light reflects perfectly: total internal reflection.






# Optical Fibers

High-index glass core in a low-index glass sheath

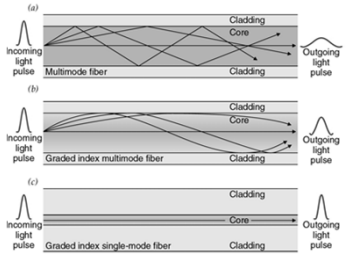
- Light in core encounters interface at shallow angle
- Light experiences total internal reflection
- Light is trapped; it bounces endless through the core
- Light travels for many kilometers in ultrapure fibers

Pulse spreading can limit information bandwidth

- Minimize light path difference: single mode fibers
- Minimize dispersion: operate at dispersion minimum



# Optical Fiber Types



## Summary about Optical Recording and Communication

Optical disks store information as pits and flats

Focused laser light reads that information

Digital representations allow perfect playback

Optical fibers carry information as light