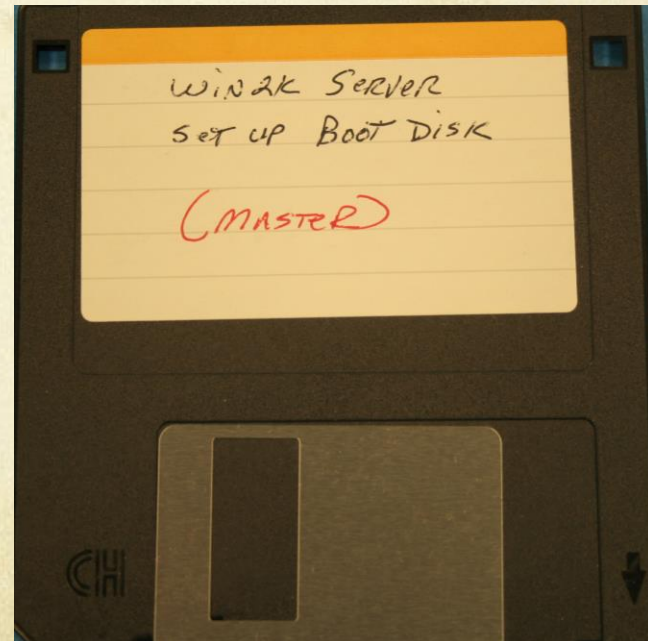




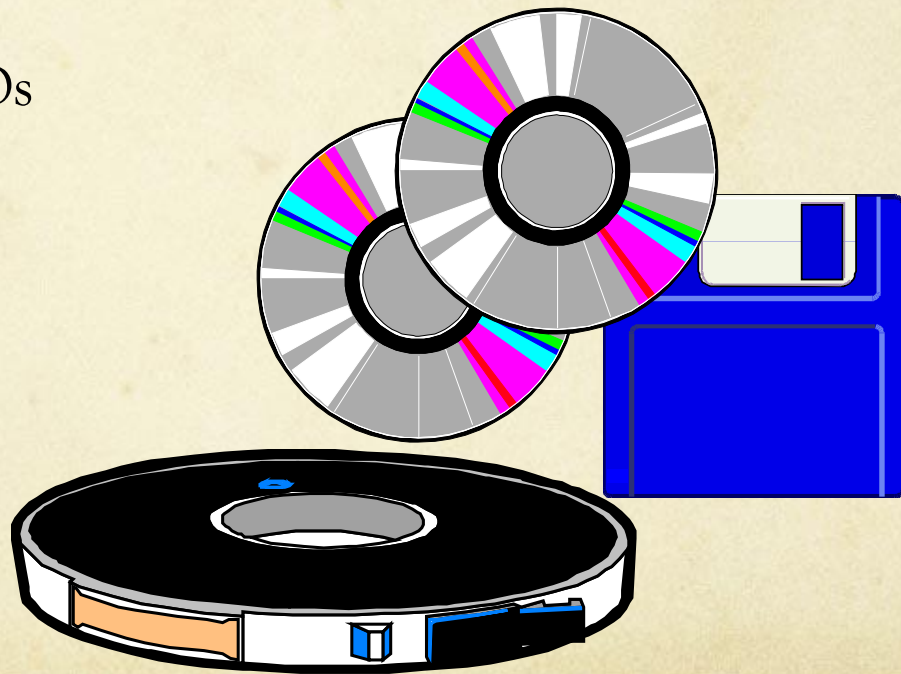
Storage Devices



Today we will learn about:

Storage Devices

- Ancient technology (from my days as a student)
- Floppies
- CD_ROM, DVDs
- Hard drives
- Magnetic tape



Storage versus Memory

- Memory holds data, programs and instructions.
- Storage devices hold data, programs and instructions

So how is storage different from memory???

- Memory is used by the computer while the program or data is in use.
- Storage saves programs/data for later use.
- Also, main memory is volatile while storage is not.

Storage serves as both input and output

- Reading: Storage to memory (input)
- Writing: Memory to storage (output)

Measuring Storage

- Access time (the speed of a storage device) is the speed it takes to locate a single item on a disk.
- Size (or capacity) is how many bytes the storage device can hold.

STORAGE TERMS

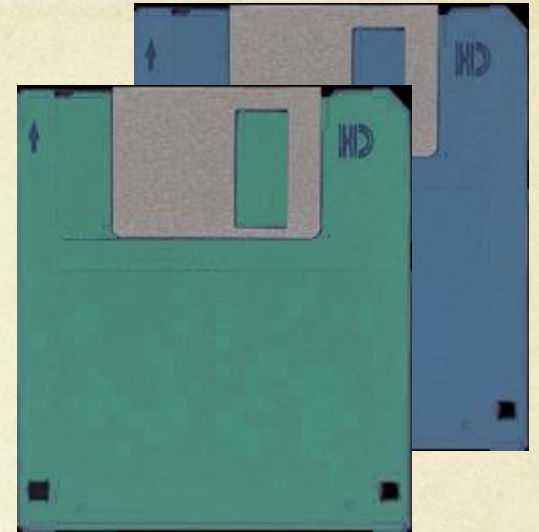
| Storage Term | Approximate Number of Bytes | Exact Number of Bytes |
|----------------|-----------------------------|---|
| Kilobyte (KB) | 1 thousand | 2^{10} or 1,024 |
| Megabyte (MB) | 1 million | 2^{20} or 1,048,576 |
| Gigabyte (GB) | 1 billion | 2^{30} or 1,073,741,824 |
| Terabyte (TB) | 1 trillion | 2^{40} or 1,099,511,627,776 |
| Petabyte (PB) | 1 quadrillion | 2^{50} or 1,125,899,906,842,624 |
| Exabyte (EB) | 1 quintillion | 2^{60} or 1,152,921,504,606,846,976 |
| Zettabyte (ZB) | 1 sextillion | 2^{70} or 1,180,591,620,717,411,303,424 |
| Yottabyte (YB) | 1 septillion | 2^{80} or 1,208,925,819,614,629,174,706,176 |

Types of storage:

- Paper tape, punched cards (the good old days)
- Cassette tape, Magnetic tape
- Floppy Disk: portable, inexpensive, magnetic media.
- Hard Drive: magnetic media. Consists of multiple platters.
- Compact Disks and DVDs: optical storage media
- USB flash drive: flash memory storage device that plugs into a USB drive.

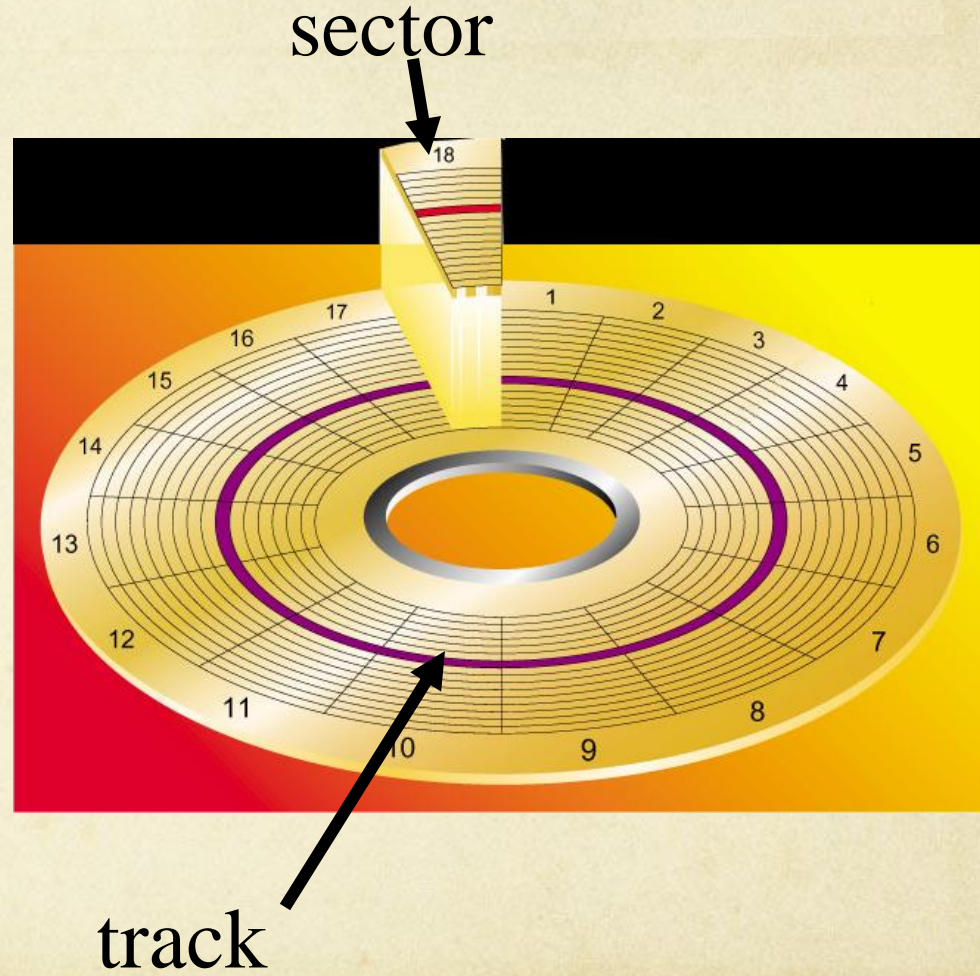
Floppy Disks

- portable
- inexpensive
- magnetic media



Today's standard is 3.5 inches and hold 1.44 MB.

How does a floppy work?



How does the drive work?

- 1. The drive slides the shutter (metal part) open to expose a portion of the recording surface.
- 2. The circuit board on the drive sends signals to the read/write heads and the disk
- 3. If write instruction, verifies that not write protected (light not visible through notch)
- 4. Motor causes floppy disk to spin
- 5. Motor positions read/write head over correct location
- 6. Read/Write heads read or write

Step 1:

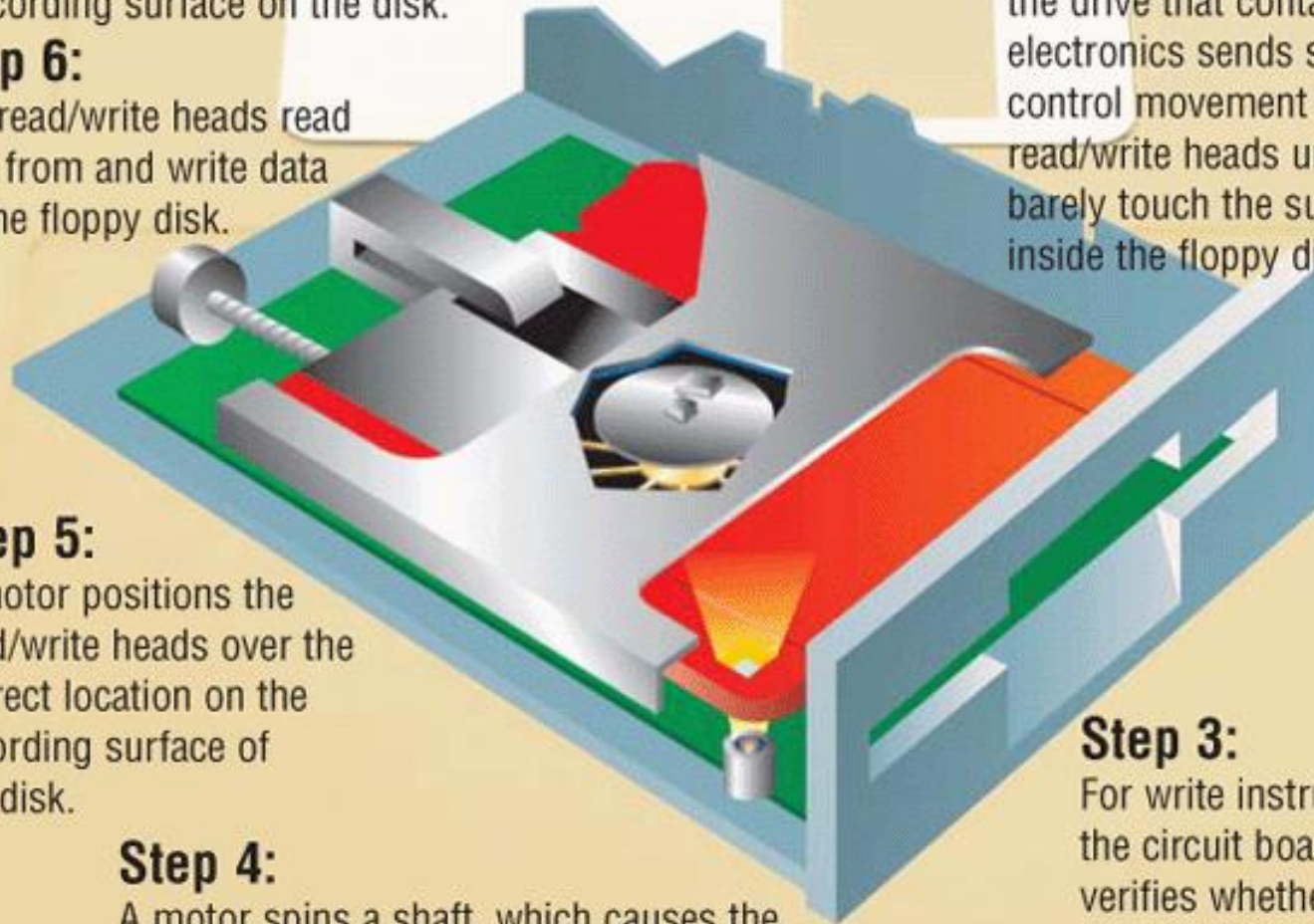
When you insert the floppy disk into the drive, the shutter moves to the side to expose the recording surface on the disk.

Step 6:

The read/write heads read data from and write data on the floppy disk.

Step 2:

When you initiate a disk access, the circuit board on the drive that contains electronics sends signals to control movement of the read/write heads until they barely touch the surface (film) inside the floppy disk's shell.



Step 5:

A motor positions the read/write heads over the correct location on the recording surface of the disk.

Step 4:

A motor spins a shaft, which causes the surface inside the floppy disk's shell to spin.

Step 3:

For write instructions, the circuit board verifies whether the disk can be written on or not.

Zip Disks

- Portable Magnetic media with larger capacity than a floppy.
- External zip drives are a convenient way to share between multiple computers.

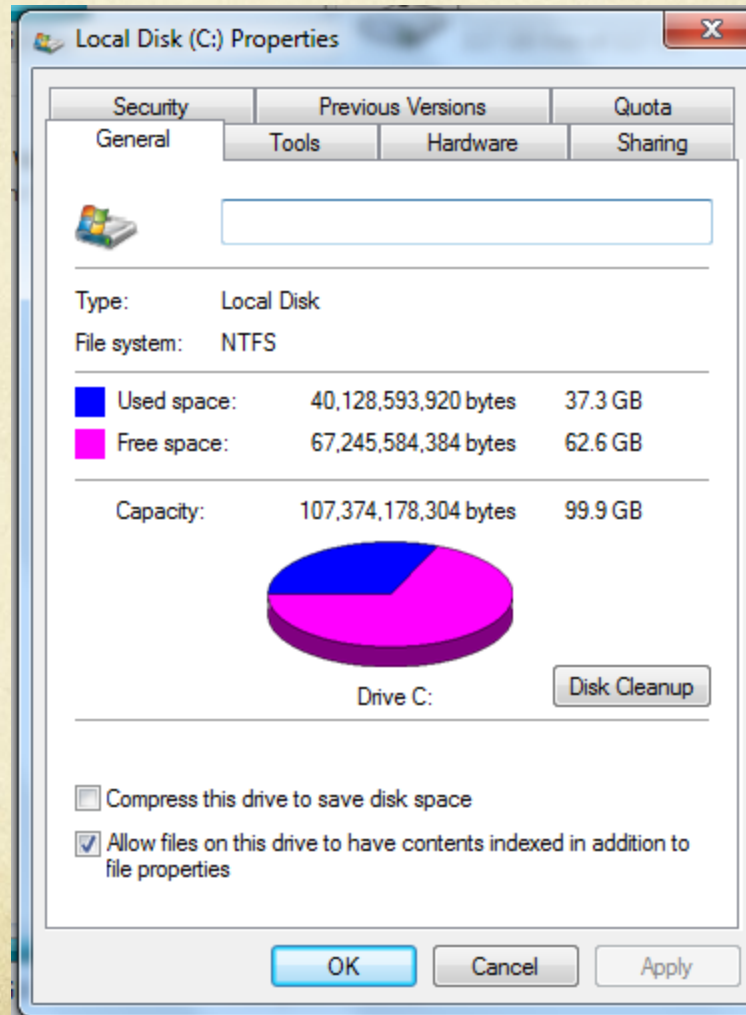


Hard Drive

- Typically Magnetic media (more about solid state drives later)
- High-capacity storage
- Consists of several inflexible, circular platters
- Components enclosed in airtight, sealed case for protection

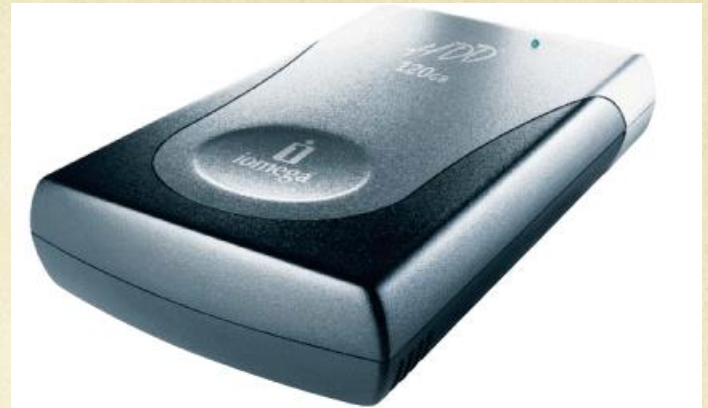


Characteristics of a hard drive



External and Removable Drives

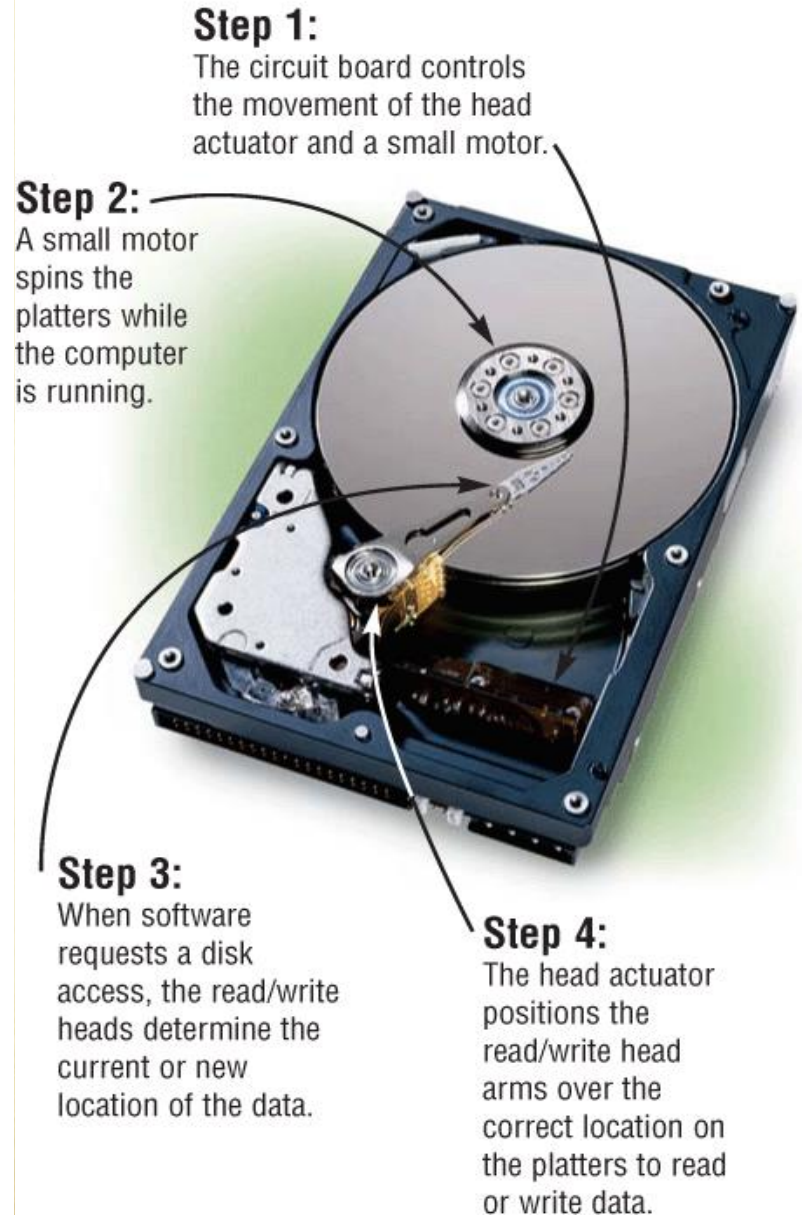
- Share data with multiple computers
- Secure data by removing Hard Drive
- Add Storage space
- Use for backups



How the Hard Drive Works

FIGURE 7-14 HOW A HARD DISK WORKS

- 1. circuit board controls the movement of the head actuator
- 2. motor spins the platter the entire time the computer is running (spinning creates a cushion of air so heads float above the platter)
- 3. when disk access is requested, read/write heads move to the FAT to determine location of data
- 4. head actuator positions the read/write head arms over the correct location to read/write



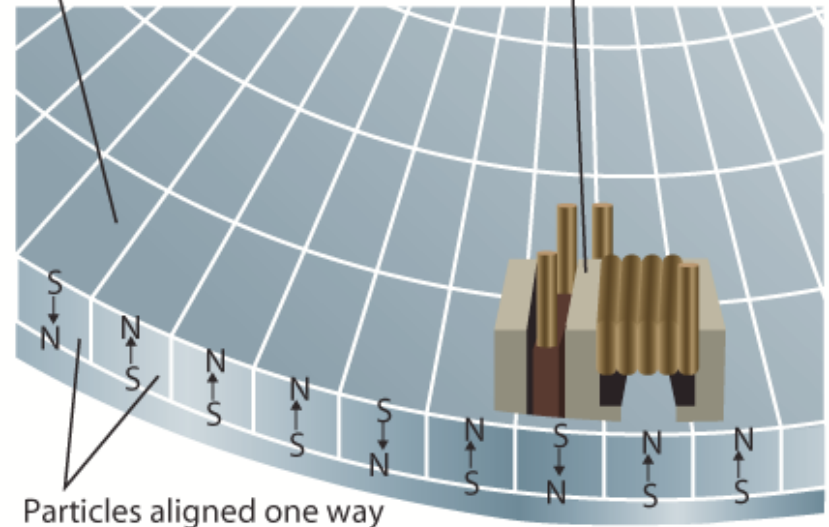
How Data is stored



Exhibit 2-12 How data is stored on magnetic disks

The read/write head inscribes data by aligning each of the magnetic particles in one of two ways.

Disk surface



Particles aligned one way represent 0s; the other way represent 1s.

Solid State Drives

A newer type of hard drive is the **solid-state drive (SSD, also called flash memory hard drives)**, which is a hard drive that uses flash memory technology instead of spinning hard disk platters and magnetic technology.

Access time is faster than magnetic hard drives.

Exhibit 2-15 Solid-state drives (SSDs)



Data is stored in flash memory chips located inside the drive; there are no moving parts like in magnetic hard drives.

Optical Discs (CDs & DVDs)

- Optical storage media use laser beams to read data.
- Single spiral track (instead of multiple tracks like floppies and hard drives) divided into sectors.
- Can be read-only, recordable (WORM) or re-writable.

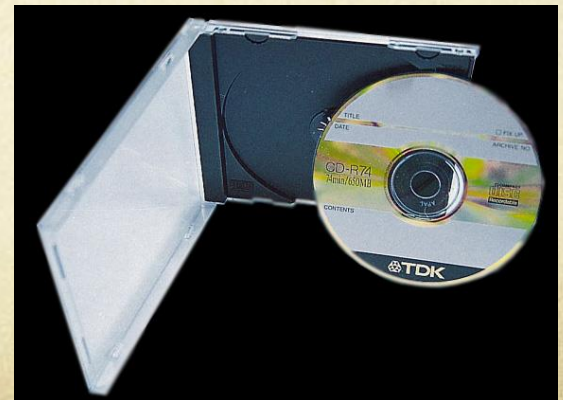
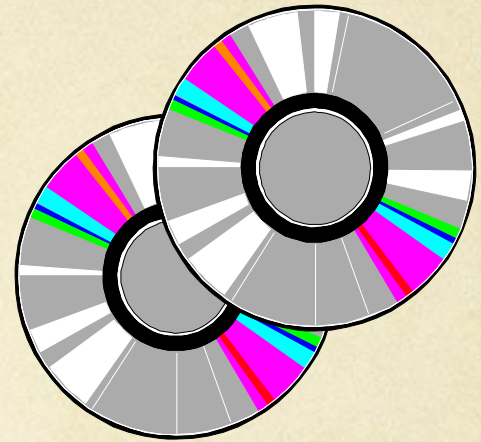
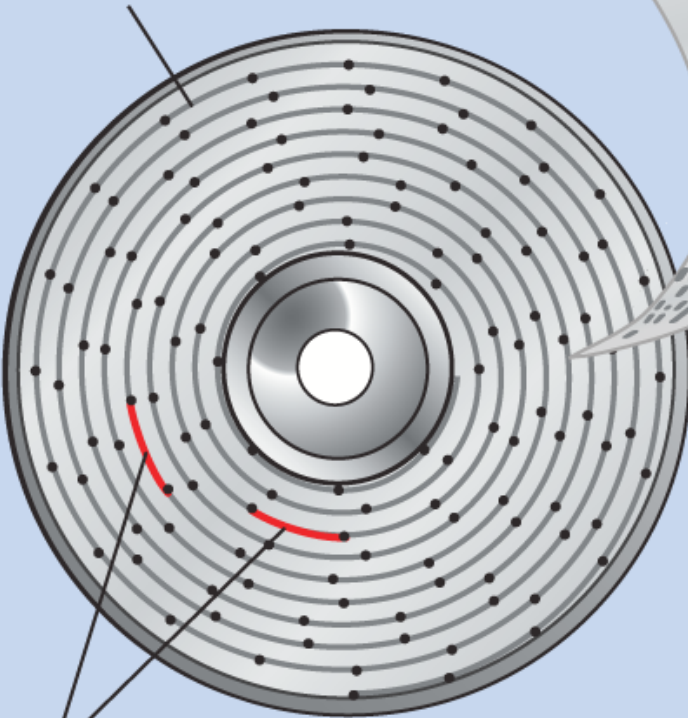


Exhibit 2-18 How recorded optical discs work

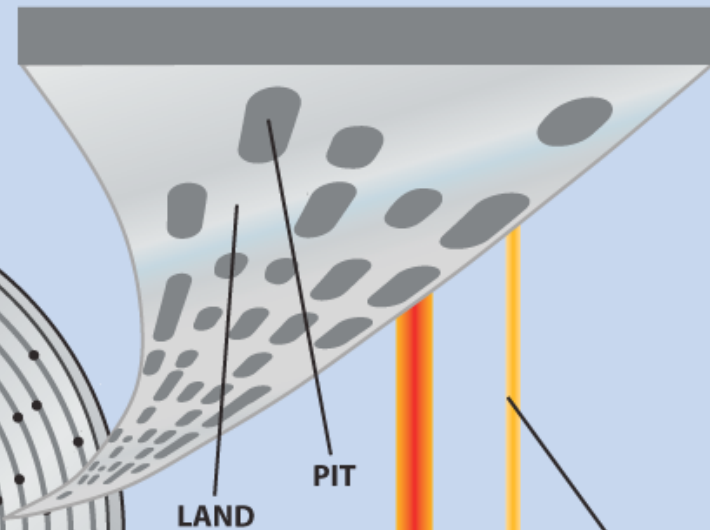
TRACK

A single track spirals from the center of the disc outward; recorded data is stored on the track.



SECTORS

The track is divided into sectors for data organization.



LAND

PIT

WRITING DATA

When data is written to the disc, a laser beam creates pits, represented by dark, nonreflective areas on the disc.

READING DATA

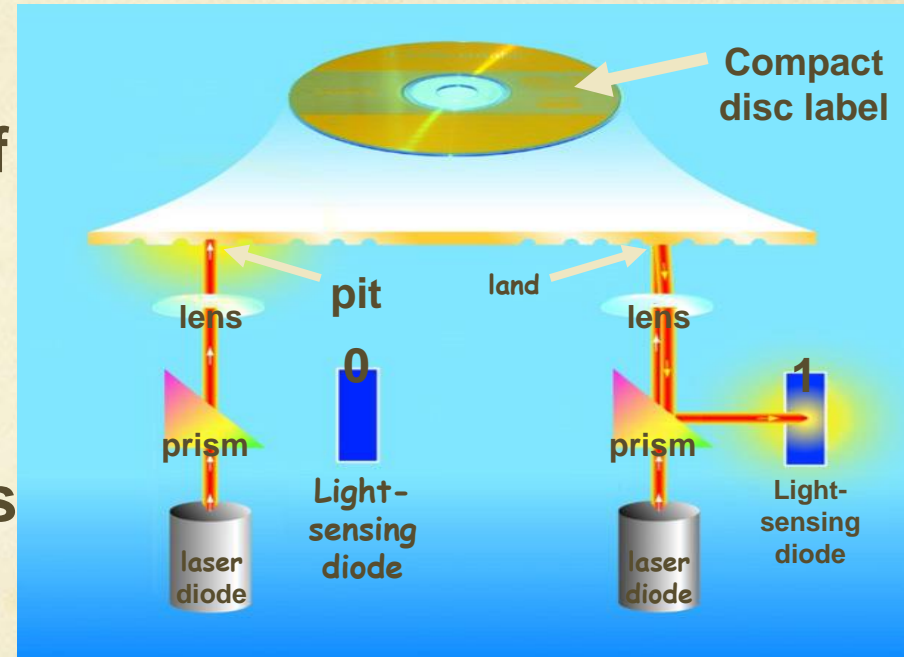
A low intensity laser beam reads the disc. A transition between a pit and a land is interpreted as a 1; a set period of time between transitions is interpreted as a 0.

How does it work?

1: Laser diode shines light beam toward compact disc

2: If light strikes pit, it scatters. If light strikes land, it is reflected back toward laser diode.

3: Reflected light deflected to light-sensing diode, which sends digital signal of 1. Absence of reflected light read as digital signal of 0.



How do the different types of CDs/DVDs create land/pits?

Exhibit 2-19 Recordable CDs and DVDs



CD-R DISCS
Hold 700 MB.



DVD+R DL DISCS
Hold 8.5 GB.



BD-R DL DISCS
Hold 50 GB.

Courtesy Verbatim America LLC, Memorex Products, Inc. and Sony Electronics Inc.

- Read-only - surface is molded or stamped to create pits.
- WORM - burns pit into dye that coats the disk.
- Re-writable - uses heating process that creates reflective or opaque areas depending upon the amount of heat used.

DVDs

DVD-ROM STORAGE CAPACITIES

| Sides | Layers | Storage Capacity |
|-------|--------|------------------|
| 1 | 1 | 4.7 GB |
| 1 | 2 | 8.5 GB |
| 2 | 1 | 9.4 GB |
| 2 | 2 | 17 GB |

Other Storage Devices

Flash Memory cards – contains one or more flash memory chips, often used in digital cameras, mobile phones and other portable devices.

USB flash drives – flash memory in self-contained unit that connects through a USB port

Smart Cards – a thin microprocessor is embedded in the card

MINIATURE MOBILE STORAGE MEDIA

| Media or Device Name | Storage Capacity | Type | Use |
|--|------------------|-------------------|---|
| CompactFlash  | 32 MB to 4 GB | Flash memory card | Digital cameras, PDAs, notebook computers, printers, music players, cellular telephones |
| Smart Media  | 32 MB to 128 MB | Flash memory card | Digital cameras, PDAs, photo printers, cellular telephones |
| Secure Digital  | 16 MB to 1 GB | Flash memory card | Digital cameras, PDAs, music players, cellular telephones, digital video cameras, car navigation systems, e-books |
| xD Picture Card  | 64 MB to 512 MB | Flash memory card | Digital cameras |
| Memory Stick  | 128 MB to 1 GB | Flash memory card | Digital cameras, notebook computers, photo printers |
| Microdrive  | 1 GB to 4 GB | Magnetic media | Digital cameras, PDAs, music players, notebook computers, video cameras |



Network (remote) Storage

Data is not stored directly on the computer, but on another computer connected through a network (NAS or SAN) or the internet (cloud or on-line storage).

- Allows data to be accessed from anywhere.
- Acts as a back-up for your files.
- Allows data to be easily shared.

Life Expectancy

MEDIA LIFE EXPECTANCIES

| Media Type | Guaranteed Life Expectancy | Potential Life Expectancy |
|----------------|----------------------------|---------------------------|
| Magnetic disks | 3 to 5 years | 20 to 30 years |
| CDs and DVDs | 5 to 10 years | 50 to 100 years |
| Microfilm | 100 years | 500 years |

After completing this class, students will be able to:

- Explain what a storage device is and what it is used for
- Explain what the difference between storage and memory is
- Explain what it means to read or write to/from storage
- Explain how storage is measured
- List different types of storage
- Explain what a Floppy Disk is, how is it formatted, how does the floppy drive work
- Explain what a Hard Disk is, how is it formatted, how does the hard drive work
- Explain what a CD-ROM is, how does it work
- Explain what the differences between the various storage devices are (relative capacities...)

Homework/Labs

- Take Quiz #7 on I/O and Storage
- Study for the Exam. You are allowed one sheet of notes (front and back).
- Create your “cheat” sheet with binary/hex/decimal conversions and hardware key terms.
- Review Chapter 17 on Access databases after the test.

| Decimal | Binary | Hex |
|---------|--------|-----|
| 0 | 0000 | 0 |
| 1 | 0001 | 1 |
| 2 | 0010 | 2 |
| 3 | 0011 | 3 |
| 4 | 0100 | 4 |
| 5 | 0101 | 5 |
| 6 | 0110 | 6 |
| 7 | 0111 | 7 |
| 8 | 1000 | 8 |
| 9 | 1001 | 9 |
| 10 | 1010 | A |
| 11 | 1011 | B |
| 12 | 1100 | C |
| 13 | 1101 | D |
| 14 | 1110 | E |
| 15 | 1111 | F |