SECTION 3. STORAGE DEVICES

Learning objectives

- To discriminate between different types of magnetic drive and disk.
- To give instructions and advice on how to protect data.
- To develop listening and reading skills by recognizing the most relevant information in a text.
- To acquire technical vocabulary associated with optical storage devices and media.
- To understand the technical details of flash memory and its uses.
- To understand different ways of making new words.
- To be able to describe flash-based devices.

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1. INTRODUCTION

In this unit you will learn the differences between computer memory and computer storage. Memory and storage are important concepts to master in Information Technology. The two terms are often used interchangeably, so it is important to understand the key differences.

Computer memory needs to be quick. It is constantly feeding the CPU with data to process. Since nobody likes to wait for a computer, high-quality computers will have fast processors with lots of quick memory. This type of memory is commonly known as **RAM**. This type of memory is **volatile** which means that the actual data disappears when the computer loses power.

Because memory needs to be much faster than storage, it is rather more expensive than storage per GB. A typical desktop computer today has between 2GB and 32GB of memory running at speeds of anywhere from 1.2 GHZ to 3.2 GHZ. Speeds tend to go up about 10% every two years.

If you are a gamer, video editor, or physics geek, you may be aware of **video memory**. Video memory is special RAM which is even faster and more expensive than normal system RAM. This RAM is reserved only for the graphics and is thus kept separate from the main system RAM, which sits on the motherboard close to the CPU. A typical dedicated video card will have anywhere between 2GB and 12 GB of dedicated RAM.

But of course computers do not process all the data they have at once. They also need to save some data for long term use. This is where storage comes in. Think of all the video files, mp3s, photos, and documents on your PC. These files are not always being processed by the CPU. They are mostly just hanging around waiting to be used at some point. Storage does not need to be as quick as memory, but there does need to be a lot more of it. And storage of course needs to be **non-volatile**, meaning it will not get erased when you power off or restart your computer. These are the two key differences between memory and **storage**.... speed and volatility.

Storage today comes in many different types including **semiconductor storage**, **magnetic storage**, and **optical storage**. A typical computer today comes with anywhere between 128GB to 2TB of storage.

Low end computers normally come with a magnetic **hard disk drive** which reads data at around 75 to 200 MB/sec. These devices use rotating, magnetically-charged platters to store data. Hard disk drives are still popular because they can store a lot of data with

relatively quick access times very cheaply. Other examples of magnetic storage devices include the **tape drive** and **diskette**, both are which are obsolete. These dinosaurs of storage were painfully slow and prone to data loss with no warning.

Another type of storage is **network storage**, typically referred to as a **SAN**. This storage is usually found in a datacenter. This type of storage goes by other names such as "**cloud storage**" or "**network drive**". It is of course highly limited by network speeds. If you are offline and need a file then you are out of luck. That is why it's always a good idea to get as much storage on your PC as you can afford.

In the future all magnetic storage types will become obsolete. They will soon all be replaced by **SSDs** using **semiconductor technology**. SSDs have 3 key advantages over magnetic storage devices: speed, lack of moving parts, and low power consumption. This makes them ideal for laptops where battery life and durability are huge issues. SSDs are fast as well, and can read data at around 200MB to 800 MB per second. Unfortunately SSDs are currently more expensive than magetic storage per GB, but this should change soon.

Optical storage is another technology which is quickly becoming legacy. Very popular in the 90's and early 2000's, optical storage works by a laser either burning or reading data off a plastic disc coated with various types of light sensitive materials. Due to reliability and speed limitations, optical storage is not used as a primary means of data storage. It is (or increasingly was) used mostly to affordably deliver large datasets like movies, games, and operating systems. In case you still don't understand what optical storage is, typical examples are DVD or Blu-Ray drives.

Wel, that about covers it for the current state of memory and storage. But there are some gray areas and exceptions as always, such as **ROMs** and **EPROMs**, which are somewhere in between memory and storage. Embedded systems, BIOS and older video game machines used these for various reasons, mainly copy protection and cost.

What about the future? Expect a gradual convergence where there is no longer a need for both storage and memory in PCs. Some new technology such as **quantum memory** may arrive which has the advantages of both memory and storage. Until that time arrives, always buy a PC with the most memory and storage you can afford. Computer companies typically charge you a lot more for PCs with a decent amount of RAM and fast storage. Why? Because they know without it, your computer will be slow and completely full very quickly, forcing you to upgrade or buy into their cloud storage solutions like Apple's iCloud, and Microsoft's OneDrive.

2. MAGNETIC STORAGE

Magnetic media stores data by assigning a magnetic charge to metal. This metal is then processed by a read head, which converts the charges into ones and zeros. Historically, magnetic media has been very popular for storing programs, data, and making backups. However, solid state technology is starting to be used more and more, storing programs and data on new devices such as mobile phones and cameras.

There are different types of magnetic storage:

1. Floppy Disk

A **floppy disk** is so called because it consists of a flexible sheet of plastic, coated with iron oxide- a magnetizable material. A floppy disk drive spins at 360 revolutions per minute (rpm), so it's relatively slow.

Although, they used to be very common, as they were a convenient way of transporting files from one computer to another, they not much used anymore.

Floppy disks are written to and read from, through the use of separate floppy disk drives.

2. Zip Drive or Superdisks

Are very similar to floppy disks. Again they are plastic discs coated with magnetic material. The difference between them is that zip disks can store much more. The one shown stores 100MB and you can get them up to 250MB.

Like Floppy disks, zip disks need a specialised zip drive to read and write to the disk.

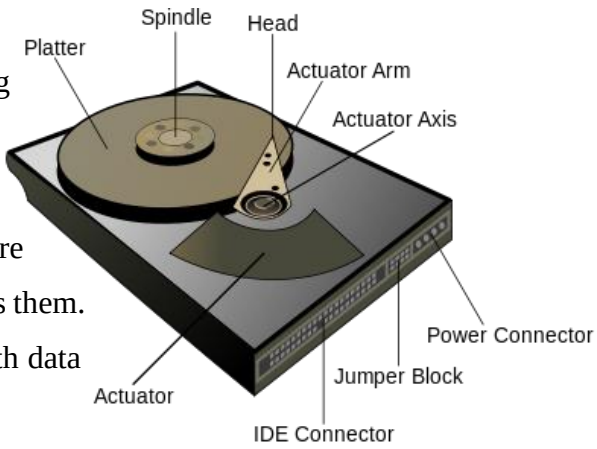
3. Magnetic Tape

Made of a long plastic strip coated with magnetic material, tape is mostly used for making backups. It can store lots of data, but this data is slower to access, because of having to wind through to the information you need slows down he access time. This makes it impractical for use as main storage.
One great advantage of magnetic tape is its cheapness.
Magnetic tape uses sequential or serial access to locate data stored on the tape.

4. Hard disk

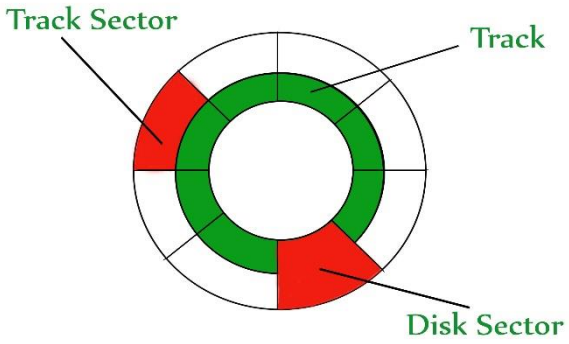
Hard disks are usually found inside computers to store programs and data. They are increasingly cheap and more and more companies are using them to back things up. Hard disks can vary in physical size with some disks getting as small as your thumb. More closely packed platters, greater density of data on each platter to allow for more tracks and cylinders and the ability to write smaller magnetic spots have all been developments in the design of hard disks to increase their storage capacity. The capacity of a commercial disk is currently up to about 4 terabytes allowing users to read and write to them.
They are constructed from several key components:

- **Platter** - Metallic disks where one or both sides of the platter are magnetised, allowing data to be stored. The platter spins continuously, around one hundred times a second, around a spindle while in use. There may be several platters, with data stored across them. The disk is divided into tracks and sectors with data represented by magnetising spots on the disk.



- **Head** - The head reads magnetic data from the platter. For a drive with several platters there may be two heads per platter allowing data to be read from top and bottom of each
- **Actuator Arm** - used to move the read heads in and out of the disk so that data can be read and written to particular locations. They allow you to access data in a random fashion, so you don't need to read your way through the entire disk to fetch a particular bit of information, you can jump right there. Seek time is very low.
- **Power connector** - provides electricity to spin the platters, move the read head and run the electronics
- **IDE connector** - allows for data transfer from and to the platters
- **Jumper block** - used to get the disk working in specific ways such as RAID

Disks need to be **formatted** before you can use them, unless they come preformatted from the manufacturer. When the disk is formatted, the operating system (OS) organizes the disk surface into circular **tracks** and divides each track into **sectors**. The OS creates a directory which will record the specific location of files. When you save a file, the OS moves the read/write head of the drive towards empty sectors, records the data and writes an entry for the directory.



Later on, when you open that file, the OS looks for its entry in the directory, moves the read/write heads to the correct sector, and reads the file in the RAM area. However, formatting erases any existing files on a disk, so do not format disks on which data that you don't want to lose is stored.

The OS allows you to create one or more partitions on your hard drive, in effect dividing it into several logical parts. **Partitions** let you install more than one operating system (e.g. Windows and Linux) on your computer. You may also decide to split your hard drive because you want to store the OS and programs on one partition and your data files on another; this allows you to reinstall the OS when a problem occurs, without affecting the data partition.

The average time required for the read/write heads to move and find data is called seek time (or access time) and it is measured in milliseconds (ms); most hard drives have a

seek time of 7 to 14 ms. Don't confuse this with transfer rate — the average speed required to transmit data from the disk to the CPU, measured in megabytes per second.

Low end computers normally come with a magnetic hard disk drive which reads data at around 75 to 200 MB/sec. These devices use rotating, magnetically-charged platters to store data.

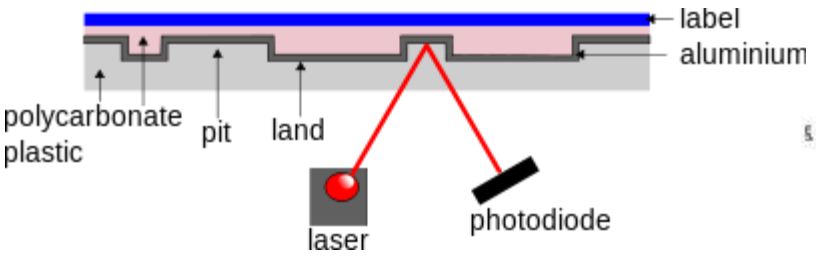
Hard disk drives are still popular because they can store a lot of data with relatively quick access times very cheaply.

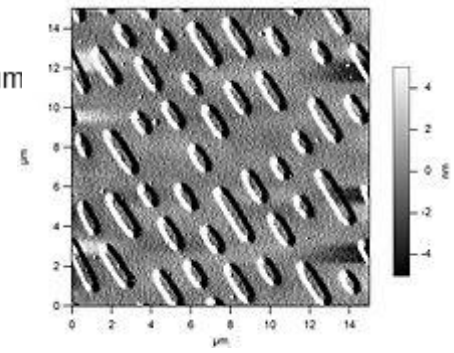
How to protect your hard drive

- Don’t hit or move the computer while the hard drive is spinning. Hard drives are very sensitive to vibration and shocks, especially when they are operating; when the read/write head touches the rotating disk, it can scratch and damage the disk surface. This is known as **head crash**.
- You shouldn't turn your computer off and on quickly. Wait at least ten seconds to ensure that the drive has stopped spinning.
- Check your hard drive regularly for logical and physical errors. To check and repair a drive, you can use a disk diagnosis utility like Windows ScanDisk.
- To minimize the risk of data loss or corruption, you should install an up-to-date virus scanner. You should also **back up** your hard drive regularly.

3. OPTICAL STORAGE MEDIA

In optical storage media information is stored and read using a laser beam. The data is stored as a spiral pattern of pits and ridges denoting binary 0 and binary 1.





Optical media works by creating a disc with a pitted metallic surface. There are several different types of disc out there ranging from 650 MB to 128 GB, with the pits and lands getting closer together for higher volume disks. The principle behind how each of them works is the same.

Optical discs can store data at much higher densities than magnetic disks. They are therefore ideal for multimedia applications where images, animation and sound occupy a lot of disc space. Furthermore, optical discs are not affected by magnetic fields, meaning that they are secure and stable, and can be transported through airport metal detectors without damaging the data. However, optical drives are slower than hard drives.

CDs and DVDs

At first sight, a DVD is similar to a CD. Both discs are 120 mm in diameter and 1.2 mm thick. They also both use a laser beam to read data. However, they are very different in internal structure and data capacity. Ina DVD, the tracks are very close together, thus allowing more tracks. The pits in which data is stored are also smaller, so there are more pits per track. As a result, a CD can hold 650-700MB, whereas a basic DVD can hold 4.7GB. In addition, a DVD can be double-sided and dual layer, with a capacity of 17GB.

CDs come in three different formats:

- CD-ROMs (read-only memory) are read-only units, meaning you cannot change the data stored on them (for example, a dictionary or a game).
- CD-R (recordable) discs are write-once devices which let you duplicate music CDs and other data CDs.
- CD-RW (rewritable) discs enable you to write onto them many times, just like a hard disk.

DVDs also come in several formats:

- DVD-ROMs are used in DVD computer drives. They allow for data archiving as well as interactive content (for example, an encyclopedia or a movie).
- DVD-R or DVD+R can only be recorded on once.
- DVD-RW or DVD+RW discs can be erased and re-used many times. They are used to back up data files and to record audio and video.

The DVD drive used in computers is also called a DVD burner because it records information by burning via a laser to a blank DVD disc. However, a DVD recorder typically refers to a standalone unit which resembles a video cassette recorder. New DVD recorders can play all CD and DVD formats. There are also portable DVD players — handheld devices which let you watch movies or TV, play games and listen to music, wherever you are.

They come with a built-in DVD drive and widescreen (rectangular 16:9 format) LCD display. They usually support multi-format playback - that is, they can play many file formats, including DVD-video, DivX, CD audio discs, MP3 music and JPEG images.

HD-DVD and Blu-ray discs

These two competing formats are expected to replace current DVD as the standard for watching movies at home. On one side are Toshiba, Microsoft and the DVD

Forum, who support the High Definition-DVD (HD-DVD). Sony, Panasonic, Samsung, JVC and many movie Studios are behind the Blu-ray format.

A Blu-ray disc has a capacity of 25GB (single layer), 50GB (dual layer) and 100GB (four layer). Unlike DVDs, which use a red laser to read and write data, Blu-ray uses a blue-violet laser, hence its name. Blu-ray discs can record and play back high-definition television and digital audio, as well as computer data.

4. FLASH MEMORY

The main idea behind **removable storage** is that data can be easily transferred between computers via a portable medium. For many years the diskette (also known as a floppy disk) was the best example of this kind of storage.

In recent years, you are much more likely to see **optical storage devices** such as CD-ROM, CD-R, DVD-ROM, and DVD-R devices being used to store larger software and data archives. These devices can store between 650 MB and 50 GB of data.

But optical devices do have their drawbacks. As you probably know, these discs scratch easily. Also, optical drives have lower performance than hard disk drives, and they can normally only be written to one time with any degree of reliability.

Because of the need for ever greater capacity and performance for removable storage, a new device called the **flash drive** has taken over the industry by storm. Based on semiconductor storage technology, these devices can store up to 64 GB (or greater) of data. Data read and write times are very fast due to USB 3.0 technology.

As is true with most other types of computer equipment, the speed and capacity of removable storage is always increasing, while prices generally decrease for all but the newest technologies.

Flash memory is a type of non-volatile memory that can be electronically erased and reprogrammed. Its name was invented by Toshiba to express how much faster it could be erased in a flash; which means ‘very quickly’

Unlike RAM, which is volatile, flash memory retains the information stored in the chip when the power is turned off. This makes it ideal for use in digital cameras, laptops, network switches, video game 10 cards, mobile phones and portable multimedia players. In addition, it offers fast read access times (although not as fast as RAM), with transfer rates of 12MB per second. Unlike ROM chips, flash memory chips are rewritable, so you can update programs via 15 software.

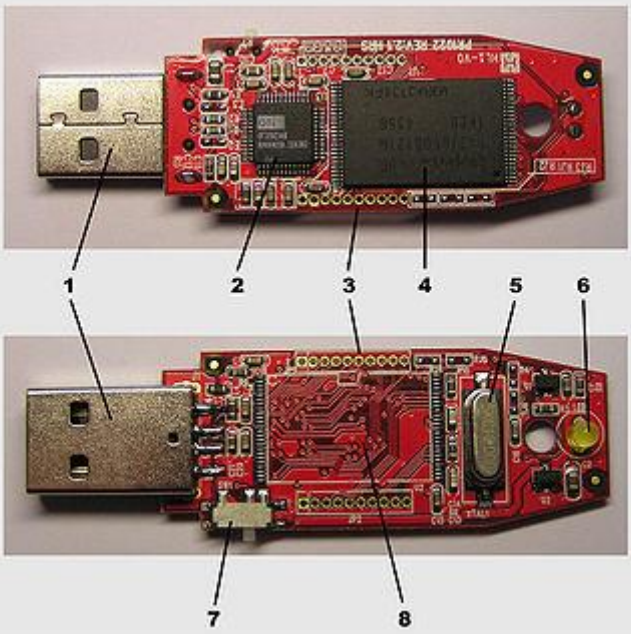
Inside the chip, data is stored in several floating gate transistors, called cells. Each cell traditionally stores one bit of data (1 = erased and 0 = programmed).

New devices have a multi-level cell structure so they can store more that one bit per cell. The chips are constructed with either NOR or NAND gates.

NOR chips function like a computer's main memory, while NAND works like a hard drive. For example, in a camera, NOR flash contains the camera's internal software, while NAND flash is used to store the images.

Flash memory is used in several ways:

- Many PCs have their BIOS (basic input/output system) stored on a flash memory chip so it can be updated if necessary.
- Modems use flash memory because it allows the manufacturer to support new protocols.
- USB flash drives are used to save and move MP3s and other data files between computers. They are more easily transported than external hard drives because they use solid-state technology, meaning that they don't have fragile moving parts that can break if dropped. However, USB flash drives have less storage capacity than hard drives.



Internals of a typical USB flash drive

1	USB Standard-A plug
2	USB mass storage controller device
3	Test points
4	Flash memory chip
5	Crystal oscillator
6	LED
7	Write-protect switch (Optional)
8	Space for second flash memory chip

- **Flash memory cards** are used to store images on cameras, to back up data on PDAs, to transfer games in video consoles, to record voice and music on MP3 players or to store movies on MP4 players. They are as small as a stamp, and capacity can range from 8MB to several gigabytes. They have different connectors and are generally smaller than USB Flash drives allowing for them to be used in cameras, mobile phones and game consoles.

  Some formats include: CompactFlash, Secure Digital, MultiMedia Card, miniSD card, and xD-Picture Card.

  Sony has its own product called the Memory Stick, used in its digital still cameras, video camcorders and the PlayStation Portable. The photos stored in a digital camera can be offloaded to a computer via cable or wirelessly. Another option is to have a flash card reader, permanented connected to your PC; you simply eject the card from the camera and put it into the reader instead of having to plug the camera in.

5. LANGUAGE WORK

Precautions

- ✓ We use the **imperative** to give precautions and warnings.

  Check *your hard drive regularly for logical and physical errors.*

  ... formatting erases any existing fies ona disk, so ***do not format*** *disks on which data that you dont want to lose is stored*

- ✓ We use **should + infinitive** without *to* to give advice or to talk about what we think is right.

  You ***should*** *install an up-to-date virus scanner*

- ✓ We use **shouldn't + infinitive** without fo to give advice or to talk about what we think is wrong.

  You ***shouldn't*** *turn your computer offand on quickly.*

Connectors 2

In addition to the uses of connectors covered in Section 2, we also use connectors for the following purposes:

Indicating addition	Making contrasts	Explaining the results or effects of something	
furthermore in addition besides moreover and	however whereas although but on the other hand	therefore as a result so	thus consequently because

Useful language choosing storage devices

- ✓ For this use, the ... is the most appropriate because...
- ✓ The ... has ... sold choose it for...
- ✓ However, ... is good for... because...
- ✓ In a big company, it would be a good idea to...
- ✓ Well, that depends on...
- ✓ l agree / disagree.

Useful language describing storage devices

- ✓ lt has a storage capacity of...
- ✓ It features ... and...
- ✓ lt supports multiple formats:... and...
- ✓ You can...and...
- ✓ lts battery life is...

Word building

We can create new words from existing words in three main ways:

1. **Affixation** (adding a prefix or suffix)
   - ✓ Adding a prefix:

     volatile → non-volatile

     date → update
   - ✓ Adding a suffix:

     erase → erasable

     install →installation
2. **Conversion** (turning a noun into a verb, or a verb into a noun, etc.)
   - ✓ network (noun) → to network (verb)

   We networked all the PCs in the office.

   We created a network of all the PCs in the office
3. **Compounding** (putting two or more words together)
   - ✓ hand + held → handheld

   I bought a new handheld last week.
   - ✓ Compounds can be written as two separate words (flash card), as two words joined with a hyphen (solid-state), or as one word (handheld). Unfortunately, there are no rules, and some compounds even change spelling over time. For example, web site began as two words, then became hyphenated (web-site) and is now written as one word - website. Always check your dictionary or Google if you are not sure,
   - ✓ In pronunciation, compounds normally have the main stress on the first part, and the secondary stress on the second part, for example ‘video ,game.

a) SELF-ASSESMENT

Select the best definition of the word.

1) **'ROM' or 'read-only memory'**
   a) a type of computer memory known for being volatile (temporary) and fast.
   b) an interface between light and matter that allows for the storage and retrieval of entagled photonic qubits
   c) a type of memory which is known for being non-volatile (permanent) and fast
2) **'RAM' or 'random access memory'**
   b) a type of storage using integrated circuits to store data; examples include RAM, ROM, and flash memory
   c) a type of memory which is known for being non-volatile (permanent) and fast
   d) a type of computer memory known for being volatile (temporary) and fast.
3) **'magnetic storage'**
   a) A storage technique using patterns of charged particles on a metallic surface to store data; examples include hard disk drives, tape drives, floppy disk drives
   b) a cluster of storage devices working together to provide shared network storage.
   c) a type of memory which is known for being non-volatile (permanent) and fast
4) **'optical storage'**
   a) a type of computer memory known for being volatile (temporary) and fast.
   b) a data storage technique using a pattern of markings on a disc that can be read by a laser; examples include CD-ROM, and DVD-ROM technology
   c) a storage device using rotating magnetic platters to quickly store and retrieve digital data
5) **'volatile'**
   a) long-term, persistent, does not require power to retain it's state
   b) an electronic, digital device that stores and processes information
   c) temporary, requires power to retain it's state
6) **'EPROM' or 'erasable programmable read only memory'**
   a) a type of memory which is known for being non-volatile (permanent) and fast
   b) a non-volatile (permanent) memory type that is erasable via ultra-violet light and reprogrammable
   c) a type of storage using integrated circuits to store data; examples include RAM, ROM, and flash memory

7) **non-volatile'**
   a) long-term, persistent, does not require power to retain it's state
   b) an electronic, digital device that stores and processes information
   c) temporary, requires power to retain it's state
8) **'SAN' or 'storage area network'**
   a) a storage device characterized by high speed, no-moving parts, and low energy consumption
   b) a type of storage using integrated circuits to store data; examples include RAM, ROM, and flash memory
   c) a cluster of storage devices working together to provide shared network storage.
9) **'quantum memory'**
   a) an interface between light and matter that allows for the storage and retrieval of entagled photonic qubits
   b) This is dedicated or shared memory set aside specifically for the graphics processor
   c) a storage device characterized by high speed, no-moving parts, and low energy consumption
10) **'hard disk drive'**
   a) a storage device using rotating magnetic platters to quickly store and retrieve digital data
   b) A legacy storage device using magnetic ribbon inside a plastic cassette
   c) a data storage technique using a pattern of markings on a disc that can be read by a laser; examples include CD-ROM, and DVD-ROM technology
11) **'SSD' or 'solid state drive'**
   a) a storage device characterized by high speed, no-moving parts, and low energy consumption
   b) A storage technique using patterns of charged particles on a metallic surface to store data; examples include hard disk drives, tape drives, floppy disk drives
   c) a cluster of storage devices working together to provide shared network storage.

13) 'semiconductor storage'

a) a type of storage using integrated circuits to store data; examples include RAM, ROM, and flash memory
b) a type of computer memory known for being volatile (temporary) and fast.
c) A storage technique using patterns of charged particles on a metallic surface to store data; examples include hard disk drives, tape drives, floppy disk drives

14) floppy disk drive'

a) a type of storage using integrated circuits to store data; examples include RAM, ROM, and flash memory
b) a legacy storage device which can read and write data slowly from a removable magnetic medium (normally 3.5" in diameter and holding 1.44 MB of data)
c) A storage technique using patterns of charged particles on a metallic surface to store data; examples include hard disk drives, tape drives, floppy disk drives

15) 'diskette'

a) a portable storage medium which can hold between 4.7 and 17 gigabytes of data, often used for storing movies, games, and operating systems
b) a portable magnetic storage media enclosed in a plastic sleeve, typically holding 1.4 MB of data
c) a physical transmission device or storage device of information.

16) CD-ROM' or 'compact disc read only memory'

a) a portable storage medium which can hold between 4.7 and 17 gigabytes of data, often used for storing movies, games, and operating systems
b) A USB device used for portable data storage, typically between 1 gigabyte and 1 terabyte in size; also known as a USB drive, jump drive, and even a key drive
c) an optical storage medium which can store approximately 650 MB of read-only data

17) 'flash drive'

a) an optical storage medium which can store approximately 650 MB of read-only data
b) a portable storage medium which can hold between 4.7 and 17 gigabytes of data, often used for storing movies, games, and operating systems
c) A USB device used for portable data storage, typically between 1 gigabyte and 1 terabyte in size; also known as a USB drive, jump drive, and even a key drive

18) 'DVD' or 'digital versitile disc'

a) a portable magnetic storage media enclosed in a plastic sleeve, typically holding 1.4 MB of data

b) an optical storage medium which can store approximately 650 MB of read-only data

c) a portable storage medium which can hold between 4.7 and 17 gigabytes of data, often used for storing movies, games, and operating systems

19) tape drive'

a) a physical transmission device or storage device of information.

b) A legacy storage device using magnetic ribbon inside a plastic cassette

c) a storage device using rotating magnetic platters to quickly store and retrieve digital data

20) BD' or 'Blu-Ray Disc'

a) an optical read-only disc storage media format used for data or movie storage with same dimensions as a standard DVD or CD; holds up to 50 GB or 6 times the storage of a DVD.

b) an electronic, digital device that stores and processes information

c) the largest known public network in the world, connecting millions of computers around the world

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