

# Introduction to Minicomputers

Peripheral Devices



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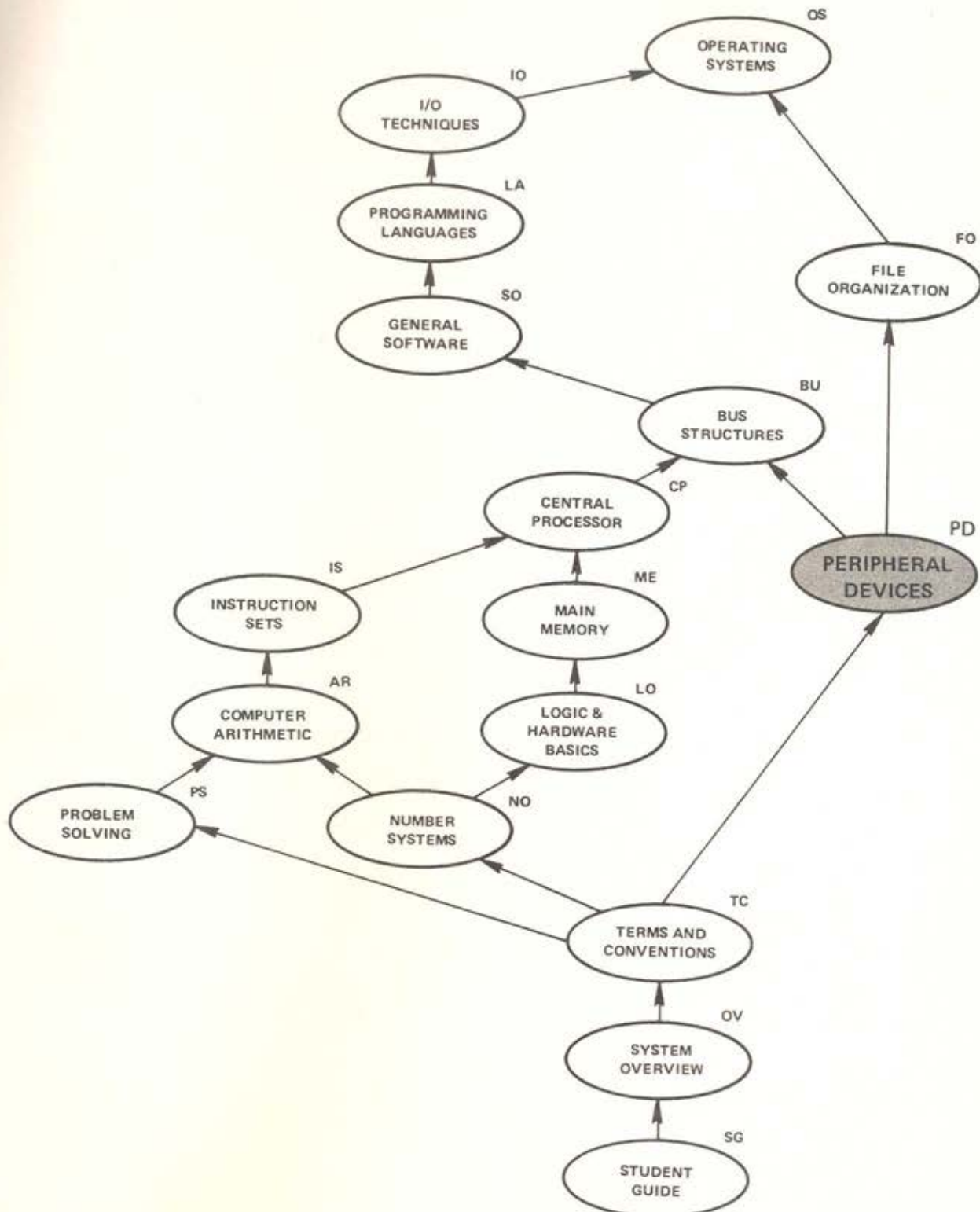
**INTRODUCTION TO MINICOMPUTERS**

**Peripheral Devices**

**Student Workbook**

**Audio-Visual Course by Digital Equipment Corporation**

## COURSE MAP





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# Peripheral Devices

## Introduction

The term "peripheral device" covers a broad area of computer components. In fact, *every* part of the computer system, other than the central processing unit and main memory (the mainframe), is considered a peripheral device. Peripheral devices represent a major cost factor in computer systems.

Input/output units, such as punched card and magnetic tape equipment, are peripheral devices as are all of the auxiliary storage devices, such as magnetic disk and paper tape devices. Many individual peripheral devices can function as combined input and output units and as auxiliary storage devices as well.

Peripherals are not considered integral parts of the computer mainframe, but they constitute a very important part of the computer system and contribute substantially to the power of a computer. Due to the high cost and limited capacity of main memory, the *bulk* of computer storage is allocated to auxiliary storage which is considerably cheaper and has greater storage capacity. The success or failure of a computer application is often directly related to the type of peripheral device chosen for the computer system. Therefore, a thorough understanding of the advantages and disadvantages inherent in the various types of peripheral devices is essential for optimum computer efficiency.

Lesson 1 of this module describes the functional parts of peripheral devices and defines some of the terms associated with them. Lesson 2 concentrates on the devices commonly used to perform input and output functions between the computer mainframe and other machines. Peripheral devices that perform input/output functions between the operator and the computer are discussed in Lesson 3, and Lesson 4 covers the auxiliary storage devices that hold information for the central processor to use at a later time.

## General Functions of Peripheral Devices

### OBJECTIVES

1. Given five peripheral device terms and five functions, be able to match each term with its function.
2. Given the three major parts of peripheral devices and three functions, be able to match each part with its function.

### SAMPLE TEST ITEMS

1. Match each of the following peripheral devices with its function.

Device	Function
Peripheral	_____
Sequential Access	_____
Random Access	_____
On-Line	_____
Off-Line	_____

#### Functions

- a. A device that operates by exchanging information with the mainframe.
- b. A device in which information can be read or written directly without scanning all information that comes before the desired area.
- c. A functional unit of a computer system that performs input, output, or auxiliary storage and is not part of the mainframe.
- d. A device that operates independently from the mainframe.
- e. A device in which information is read from or written onto the medium in an ordered line.



## SAMPLE TEST ITEMS

2. Match each of the following peripheral device parts with its function.

Device Part	Function
Medium	_____
Drive Mechanism	_____
Control Circuit	_____

### Functions

- Oversees the transfer of data into the computer main-frame.
- Physically moves the medium.
- Physically holds information.



Mark your place in this workbook and view Lesson 1 of the A/V program, "Peripheral Devices."

The purpose of peripheral devices is to provide *communication* and *storage* of information between the computer and other machines and between the computer and the people who operate and use it.

### Functional Parts

In general, peripheral devices consist of three basic parts:

- The Medium
- The Drive Mechanism
- The Control Circuit

The *medium* physically holds the information. A punched paper tape is an example of a medium, where the information is represented by holes punched in the paper tape.

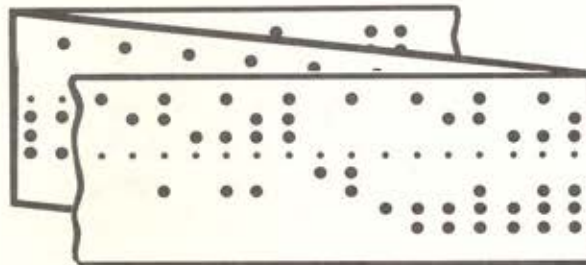


Figure 1 Punched Paper Tape

The *drive mechanism* is the part of the peripheral device that physically moves the medium. In those devices that use paper tape, for example, the drive mechanism *moves* the paper tape and senses for the presence of holes.



Figure 2 Drive Mechanism of Paper Tape Reader

The *control circuit* transfers the data to and from the medium. In paper tape devices, for example, the control circuit converts the information stored on the paper tape, in the form of holes, into the electrical signals required by the computer. The control circuit sends these signals along a cable to the computer mainframe.

The major difference between peripheral devices lies in the choice of medium. The various media currently used for peripheral devices will be covered in this study unit.

### Input/Output Devices

An important part of the data processing operation is entering data into the central processing unit. This function is handled by one of the various *input* devices used in conjunction with the computer. Since the original data is usually not written in a form useful to the computer, the control circuit must convert the data into *bits* which can be utilized by the processor.

The reverse procedure takes place when data is output after being processed by the computer. This time, the control circuit must convert or write the data back to the form specified by the *output* device. If the output device is a printer, the control circuit will convert the data to characters printed on sheets of paper. The drive mechanism then moves the medium. In the case of the printer, the drive mechanism moves (advances) the sheets of paper containing the information, as illustrated in Figure 3.

Frequently, the input and output paper tape devices are both housed within the same unit. An example is the input/output paper tape device shown in Figure 4.

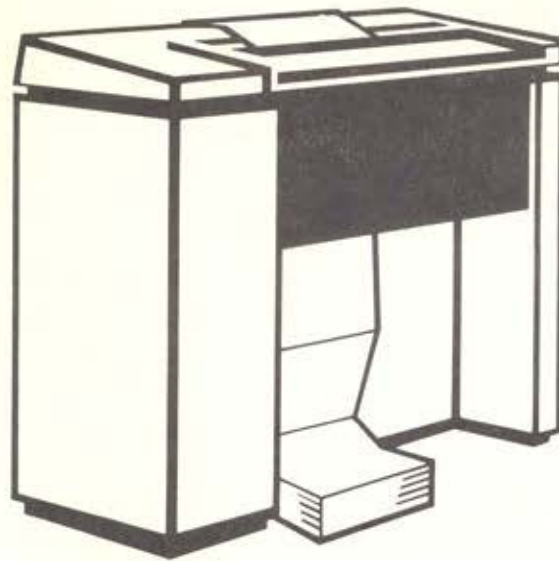


Figure 3 Printer with Paper Output

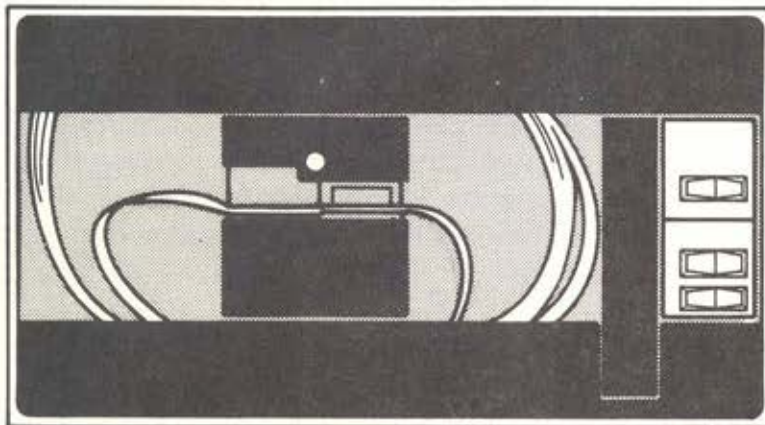


Figure 4 Paper Tape Reader/Punch

### Auxiliary Storage Devices

The function of an *auxiliary storage device* is to hold information for future use by the processor. The control circuit writes data from the processor into the medium used by the auxiliary storage device, such as magnetic disk, and it is kept there until the processor requires the data stored on the disk. Then, the information on the magnetic disk (or any other auxiliary storage medium) can be read into the computer for processing.



## Access Methods

Auxiliary storage devices can be categorized by the way in which they access data. By *access*, we mean to *write* data into or *read* data from the device. There are two different methods of accessing data stored in auxiliary storage: *sequential access* and *direct access*.

*Sequential access* refers to a type of organization in which all data on the medium is stored in linear form, one after the other. Data stored on reels of paper tape, for example, is organized in this manner. Data stored in sequence must also be read in the same sequence. On a reel of paper tape, this entails passing through the entire reel until the specified data is located. Obviously, if the data to be accessed is stored at the end of the storage medium, this could be a relatively time-consuming process. The length of time required to access data stored in an auxiliary storage device is known as *access time*.

Data can also be organized so that *any* location can be directly accessed without reading through all previous locations. Devices that allow this direct method of accessing data are called *random-access* devices. The advantages and disadvantages of these methods will be discussed in the next lesson.

Whether or not peripherals can operate independently from the computer mainframe is another criterion for categorizing them. Some computer peripherals can operate independently; that is, they can be used *without* intervention from the mainframe. This mode of operation is known as *off-line operation*.

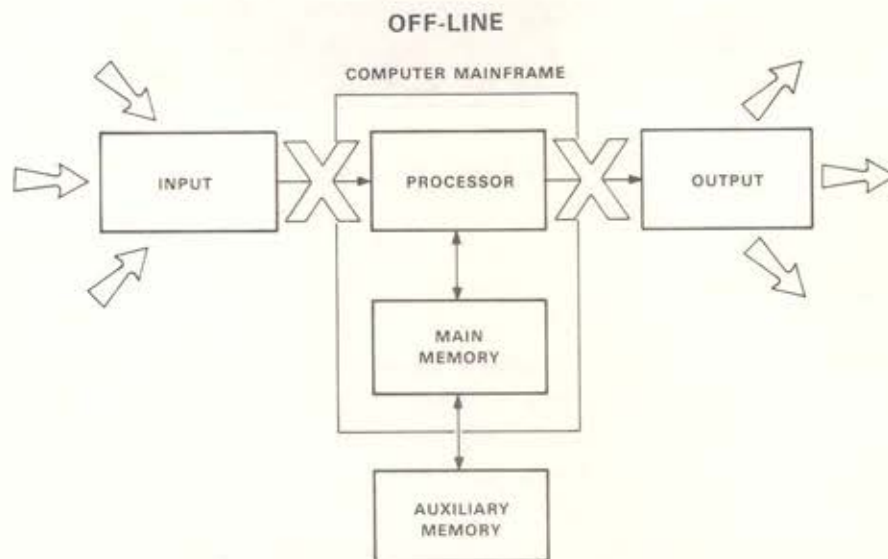


Figure 5 Off-line Operation



Input/output devices such as teleprinters can be used to write data on punched paper tape off-line. However, these units must be connected to the computer when the processor requires the information. While peripherals are *under the control* of the processor, they are said to be operating *on-line*.

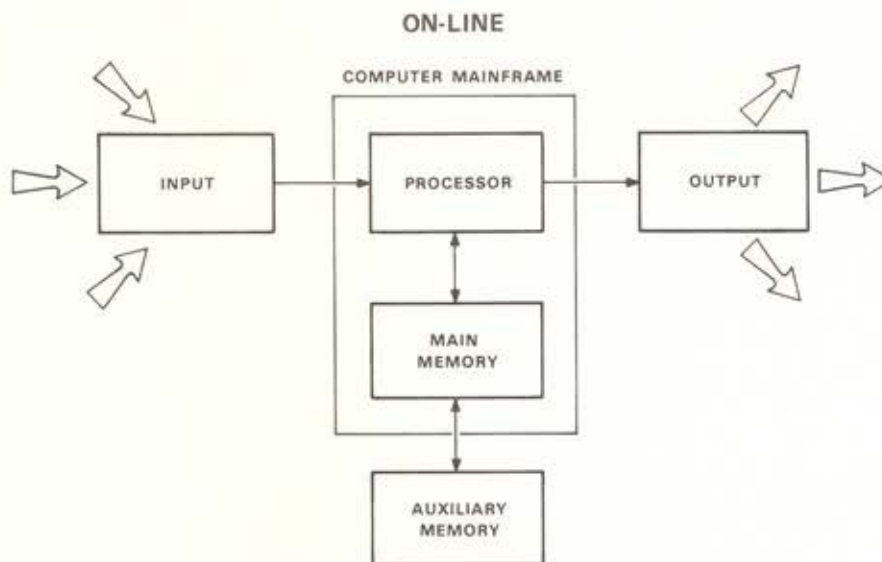


Figure 6 On-line Operation

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## EXERCISES

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1. Explain the purpose of the three basic parts of peripheral devices:

a. The medium

b. The drive mechanism

c. The control circuit

2. Specify whether the following statements are true or false.

	T	F
a. The purpose of peripheral devices is to provide storage of information and communication between the computer and people or other machines.	<input type="checkbox"/>	<input type="checkbox"/>
b. The drive mechanism on a peripheral device physically holds the information.	<input type="checkbox"/>	<input type="checkbox"/>
c. The control circuit converts the information stored on the medium into the electrical signals required by the computer.	<input type="checkbox"/>	<input type="checkbox"/>
d. The major difference between peripheral devices is in the type of control circuit.	<input type="checkbox"/>	<input type="checkbox"/>

---

## SOLUTIONS

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1. Explain the purpose of the three basic parts of peripheral devices:

a. **The medium**

- The medium physically holds the information.

b. **The drive mechanism**

- The drive mechanism physically moves the medium.

c. **The control circuit**

- The control circuit transfers the data to and from the medium.

2. Specify whether the following statements are true or false.

	T	F
a. The purpose of peripheral devices is to provide storage of information and communication between the computer and people or other machines.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
b. The drive mechanism on a peripheral device physically holds the information.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
c. The control circuit converts the information stored on the medium into the electrical signals required by the computer.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
d. The major difference between peripheral devices is in the type of control circuit.	<input type="checkbox"/>	<input checked="" type="checkbox"/>

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### EXERCISES

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3. Which of the following units are classified as peripheral devices?
  - a. input/output devices and auxiliary storage devices
  - b. input/output devices and main memory
  - c. auxiliary storage devices and main memory
  - d. input/output devices, auxiliary storage devices, and main memory.
4. An auxiliary storage device holds data:
  - a. being processed by the computer
  - b. for later use by the computer
  - c. for only a short time
  - d. in the computer mainframe.
5. How is data that is organized for *sequential access* read or written?
  - a. in any order, regardless of the order it appears on the medium
  - b. in blocks, one at a time
  - c. in the same order as it was entered on the medium
  - d. in the opposite order that it was entered on the medium.



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## SOLUTIONS

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3. Which of the following units are classified as peripheral devices?
- ☒ a. input/output devices and auxiliary storage devices
  - b. input/output devices and main memory
  - c. auxiliary storage devices and main memory
  - d. input/output devices, auxiliary storage devices, and main memory.
4. An auxiliary storage device holds data:
- a. being processed by the computer
  - ☒ b. for later use by the computer
  - c. for only a short time
  - d. in the computer mainframe.
5. How is data that is organized for sequential access read or written?
- a. in any order, regardless of the order it appears on the medium
  - b. in blocks, one at a time
  - ☒ c. in the same order that it was entered on the medium
  - d. in the opposite order as it was entered on the medium.

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## EXERCISES

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6. Write in column 2 the letter corresponding to the matching phrase in column 1.

- |                       |   |
|-----------------------|---|
| (a) Random access     | ( ) pertaining to devices that operate independently from the processor             |
| (b) On-line           | ( ) pertaining to devices that store information in linear form                     |
| (c) Off-line          | ( ) pertaining to devices that allow information to be read or written in any order |
| (d) Sequential access | ( ) pertaining to devices that operate under processor control                      |

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## SOLUTIONS

---

6. Write in column 2 the letter corresponding to the matching phrase in column 1.

- |                       |   |
|-----------------------|---|
| (a) Random access     | ( c ) pertaining to devices that operate independently from the processor             |
| (b) On-line           | ( d ) pertaining to devices that store information in linear form                     |
| (c) Off-line          | ( a ) pertaining to devices that allow information to be read or written in any order |
| (d) Sequential access | ( b ) pertaining to devices that operate under processor control                      |

## Machine-Oriented Input/Output Devices

### OBJECTIVES

1. Given ten machine-oriented I/O devices, be able to label those that are input, those that are output, and those that are both input and output devices.
2. Given ten statements describing or comparing various machine-oriented I/O devices, be able to label those statements that are true and those that are false.
3. Given drawings and names of various machine-oriented I/O devices, be able to match each drawing with its corresponding device.
4. Given drawings of media and names of machine-oriented I/O devices, be able to match each device with its corresponding media.

### SAMPLE TEST ITEMS

1. Indicate that each of the following machine-oriented I/O devices functions as an input (I), and output (O), or both an input and output (B) device by writing the correct letter in the space provided.

Device	Function(s)
Magnetic Disk Unit	_____
Paper Tape Reader	_____
.	.
.	.
.	.



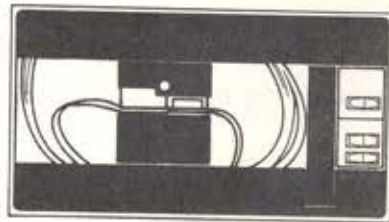
## SAMPLE TEST ITEMS

2. Each of the following statements describes or compares various machine-oriented I/O media. Indicate that each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Magnetic tape is more expensive than magnetic disks.	_____
Both punched cards and floppy disks are low-cost media.	_____
.	.
.	.
.	.

3. Drawings and names of machine-oriented input/output devices are given below. Match each drawing with its corresponding device name by writing the correct letter in the space provided.

a.



b.



Device	Picture
Disk Unit	_____
Paper Tape Reader/Punch	_____

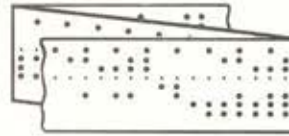
**SAMPLE TEST ITEMS**

4. Match the two media pictured below with the names of their corresponding devices.

a.



b.



Paper Tape Reader/Punch

\_\_\_\_\_

Disk Unit

\_\_\_\_\_

Magnetic Tape Unit

\_\_\_\_\_

Mark your place in this workbook and view Lesson 2 of the A/V program, "Peripheral Devices."

Machine-oriented input/output devices are I/O devices whose media hold information in machine-readable form; that is, in a form that can be utilized by the *computer* or other *machines*.

There are three categories of machine-oriented I/O devices:

- Off-line storage devices
- Analog converters and controllers
- Data communications units

*Off-line storage devices*, the largest group, is comprised of devices whose media are *removable*. The familiar punched card falls into this category, as it can be stored and then returned to a punched card reader when needed.

*Analog converters and controllers* include devices which are electrically connected to machines other than digital computers. These devices are used to control levels in tanks and pipelines, as well as other specialized functions where analog signals must be analyzed, and mechanical equipment must be controlled.

An analog-to-digital converter, sometimes called an A to D converter, is an input device that converts analog signals in the real world to digital approximations that are sent to the computer. In this type of device, the medium is electrical wires that carry analog information to the device. There is no drive mechanism at all because the medium is electrical and connected directly to the control circuit that performs the data conversion and transmission.

The reverse process is performed by output devices called digital to analog, or D to A converters.

The third category, *data communication units*, consists of devices which are connected electrically by telephone lines or other cables to remote computers or remote I/O devices. Modems and data sets are included in this category. Data communication units can be located at the both ends of the telephone links.





Figure 7 Modem

### Off-Line Storage Devices

**Punched Cards** – The card punch is the device that *writes* the information on the punched cards. Its drive mechanism transports the blank cards from a storage bin or hopper through a punch station, where the appropriate data is entered into each card (in the form of a hole or no-hole). Then, the cards are moved to an output bin or hopper. The control circuit converts the data from the mainframe into the signals that activate the punch dies. The punched cards can then be stored until needed, at which time, they can be returned to the *card reader* input bin for reading, or *sensing*, as it is often called.



Figure 8 Card Punch



The *read process* takes place in much the same manner. The drive mechanism in the *card reader* transports the card through a read station where the control circuit converts the punched code into binary signals to the computer.



Figure 9 Card Reader

**Paper Tape** – Paper tape is written on and read in a similar fashion by paper tape devices. Paper tape differs from punched cards only in the medium. Paper tape is a long narrow strip of paper with a far greater storage capacity than an individual card. However, as indicated in Figure 10, the general layout of both media is similar.

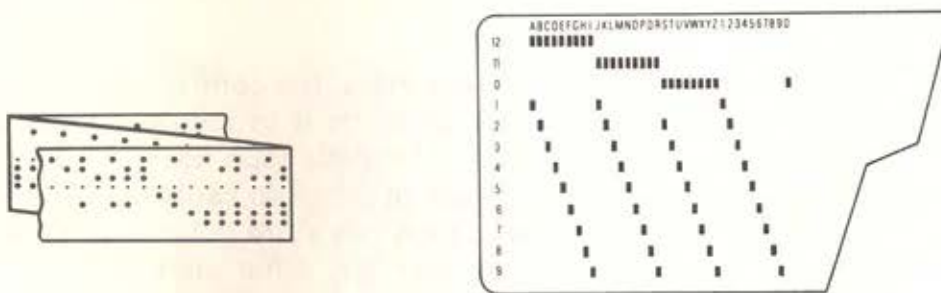


Figure 10 Paper Tape and Punch Card Media

Paper tape requires less storage space than punched cards – the holes are closer together and, therefore, data is more compact than on punched cards. Paper tape is easier to handle and requires less storage space, but card readers and punches operate at speeds faster than tape devices. In addition to holes, cards can also contain human-readable printing. Data stored on cards can be changed easily by replacing one or more cards, while changing data on paper tape necessitates punching a whole new tape. Of course, cards can become separated and out of sequence, unlike paper tape which is one continuous reel. Because paper tape is a sequential access medium, an entire reel must be scanned until the location of the specified data is reached. If the required data is stored at the end of the reel of tape, the access time can be relatively slow.

**Magnetic Tape** – Magnetic tape is another type of tape that is frequently used for off-line storage. It differs from paper tape in that it is constructed of plastic, coated with magnetic material, called iron oxide. Magnetic tape has a number of narrow channels (typical large magnetic tapes use seven or nine channels) called *tracks* on which data is recorded.

Small electromagnets, called *read/write heads*, located above each track on the tape, read or write the data on the tape (depending upon which operation is specified) as the drive mechanism transports the tape. Magnetic tape can be *reused*, another characteristic which distinguishes it from paper tape. However, the write operation is *destructive*. Any data previously written on the tape is automatically destroyed by the write process. To safeguard against unintentional writing on magnetic tape, and thereby destroying data, most devices require the use of a *write protect ring* when a write operation is executed. Tapes may be read as often as necessary without altering the data in any way.

During the *output* process, the control circuit converts data from the computer into electrical signals, which are passed through the read/write heads and magnetize the surface of the tape. Once this write operation is complete, the drive mechanism *rewinds* the tape to its beginning. It can then be removed from the system and stored until it is needed again.

The process is reversed during *input*. Here, the control circuit receives data from the read/write heads, converts it to digital signals, and sends these signals to the computer. Magnetic tape devices can input and output data at speeds far in excess of punched cards or paper tape devices. The large reels of magnetic tape can store millions of bytes of data and require less cabinet space than any other medium.

Because they can be rewritten, magnetic tapes can be changed and edited. Furthermore, there is an industry standard for most magnetic tapes (as there is for most punched cards) which makes it possible to use them interchangeably on computers manufactured by various vendors. They are often called *compatible* media for this reason. Because of its characteristics, magnetic tape is used extensively for *bulk storage*.

**Cassettes** – When storage of smaller quantities of data is preferred, tapes are stored in *cartridges* or *cassettes* which do not require threading through the tape drive and, consequently, are faster and more convenient to use.



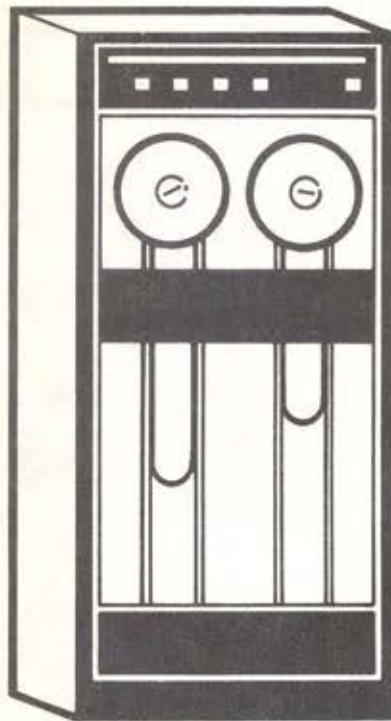


Figure 11 Magnetic Tape Reel on Drive

**Magnetic Disk** – Magnetic disk is another popular magnetic input/output medium. The magnetic disk resembles an ordinary record. Disk units perform both input and output functions just as tape units, but they have the added advantage of being random access devices. The disk drive mechanism spins the disk under an arm that contains the read/write heads. These heads can move back and forth, accessing any part of the disk in the *same amount of time*. Therefore, regardless of the location, every place on the disk can be read or written on at very high speeds.

While disks provide the fastest access speeds available, large magnetic tapes store more information in less space and at lower costs than disks. To store large amounts of data on disks, multiple surfaces on the same spindle are used. These groups of disks on a single spindle are called *disk packs* (see Figure 13).

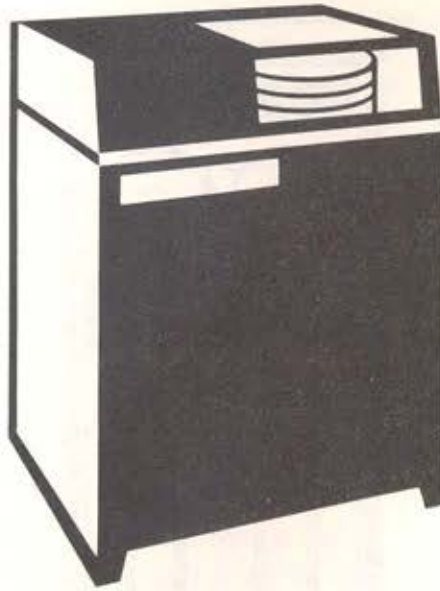


Figure 12 Disk Drive

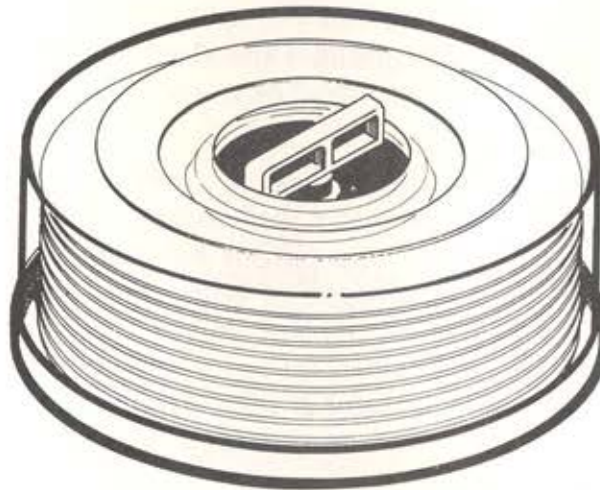


Figure 13 Disk Pack

Like magnetic tape, magnetic disks can be altered and rewritten, but, again, the write process is destructive. Unlike magnetic tape, magnetic disks are not so interchangeable among computers, as disks are often designed for use with a particular brand of computer.



**Floppy Disk** – Floppy disks are a recent development in magnetic disks. Although they are smaller than the traditional rigid disk, or disk pack, and consequently, have a smaller storage capacity, they are gaining popularity because they are considerably less expensive and require less storage space. The medium is a flexible magnetic surface encased in an envelope. Slots in the envelope allow the read/write heads access to the disk surface. Floppy disks are reliable and easy to handle.

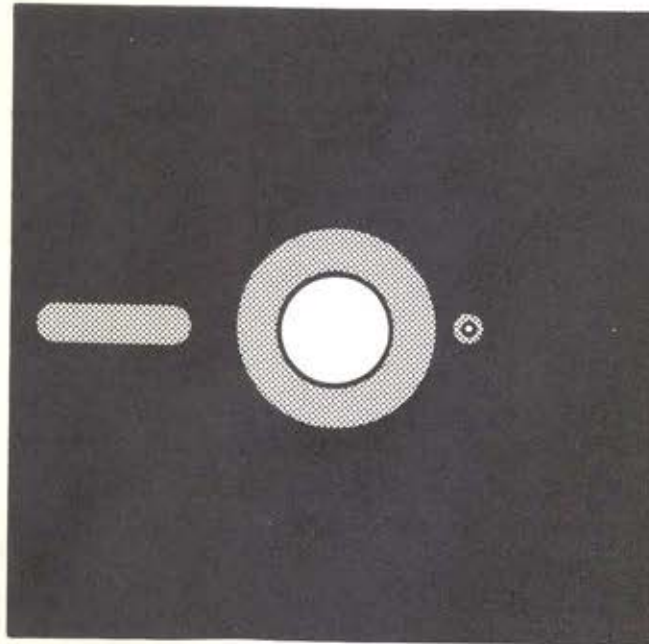


Figure 14 Floppy Disk

Table 1 compares machine-oriented input/output media.

Table 1 Comparison of Machine-Oriented Input/Output Media

	Punched Card	Paper Tape	Magnetic Tape	Magnetic Disk	Floppy Disk
Cost of Media	Low	Low	Medium	High	Low
Storage Capacity	Low	Low	High-Medium	Medium	Medium
Access Rate	Low	Low	High	High	High
Access Method	Sequential	Sequential	Sequential	Direct	Direct
Human Readable	Yes	No	No	No	No
Medium can be Rewritten	No	No	Yes	Yes	Yes
Compact Storage	No	No	Yes	Yes	Yes
Interchangeable among Various Manufacturers' Computers	Yes	Yes	Yes	No	Yes

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## EXERCISES

---

1. What is a machine-oriented input/output device?

2. The three categories of machine-oriented devices are:

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

3. Specify whether the following statements are true or false by checking the appropriate box.

	T	F
a. Off-line storage media consist of analog converters and data communication units.	<input type="checkbox"/>	<input type="checkbox"/>
b. A binary 1 is stored on punched cards and paper tape in the form of a hole; a 0 is represented by the absence of a hole.	<input type="checkbox"/>	<input type="checkbox"/>
c. Data communication units are devices that transfer information between the computer and other devices located at the other end of a telephone line.	<input type="checkbox"/>	<input type="checkbox"/>
d. Reading a punched card by punched card readers is known as sensing.	<input type="checkbox"/>	<input type="checkbox"/>
e. Paper and magnetic media are not considered off-line media.	<input type="checkbox"/>	<input type="checkbox"/>

## SOLUTIONS

1. What is a machine-oriented input/output device?

- A machine-oriented input/output device stores information in machine-readable form; that is, it can be utilized by the computer or other machines.

2. The three categories of machine-oriented devices are:

1. Off-line storage media
2. Analog converters and controllers
3. Data communication units

3. Specify whether the following statements are true or false by checking the appropriate box.

	T	F
a. Off-line storage media consist of analog converters and data communication units.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
b. A binary 1 is stored on punched cards and paper tape in the form of a hole; a 0 is represented by the absence of a hole.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
c. Data communication units are devices that transfer information between the computer and other devices located at the other end of a telephone line.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
d. Reading a punched card by punched card readers is known as sensing.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
e. Paper and magnetic media are not considered off-line media.	<input type="checkbox"/>	<input checked="" type="checkbox"/>



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## EXERCISES

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4. Compare the punched card to paper tape in terms of the following criteria:

a. *Cabinet space required for storing*

b. *Changing or editing data*

c. *Reading and writing speeds*

5. Specify whether the following statements are true or false by checking the appropriate boxes.

	T	F
a. Magnetic tape uses small electromagnets, located above each track on the tape, for both reading and writing data on the tape.	<input type="checkbox"/>	<input type="checkbox"/>
b. Magnetic tape devices are slower at input/output than punched card devices.	<input type="checkbox"/>	<input type="checkbox"/>
c. Cassettes or cartridges are used to store smaller quantities of data than magnetic tapes.	<input type="checkbox"/>	<input type="checkbox"/>

6. Differentiate between floppy disks and traditional disks in terms of cost and storage capacity.

---

## SOLUTIONS

---

4. Compare the punched card to paper tape in terms of the following criteria:

a. *Cabinet space required for storing*

- Paper tape is more compact for storing than decks of punched cards.

b. *Changing or editing data*

- Editing and changing is more difficult with paper tape but can be done with punched cards by replacing the specific cards.

c. *Reading and writing speeds*

- Punched card equipment reads and writes data on punched cards at a faster rate than punched paper tape equipment.

5. Specify whether the following statements are true or false by checking the appropriate boxes.

	T	F
a. Magnetic tape uses small electromagnets, located above each track on the tape, for both reading and writing data on the tape.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
b. Magnetic tape devices are slower at input/output than punched card devices.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
c. Cassettes or cartridges are used to store smaller quantities of data than magnetic tapes.	<input checked="" type="checkbox"/>	<input type="checkbox"/>

6. Differentiate between floppy disks and traditional disks, in terms of cost and storage capacity.

- Floppy disks are considerably cheaper than traditional magnetic disks; however, they have a smaller storage capacity than the larger rigid type of disk.

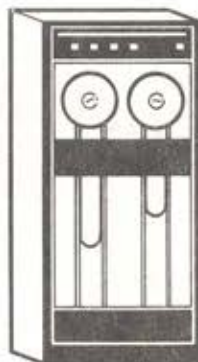
## EXERCISES

7. Label each of the four devices pictured below:

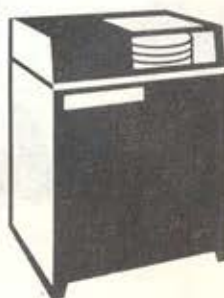
a.



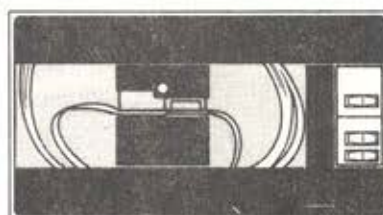
b.



c.



d.



a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

d. \_\_\_\_\_

---

## SOLUTIONS

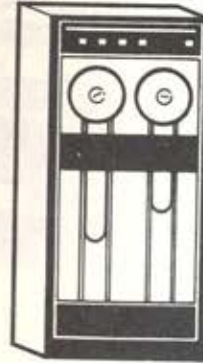
---

7. Label each of the four devices pictured below:

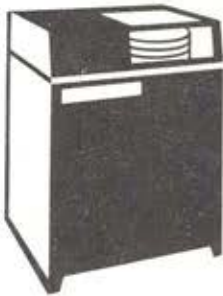
a.



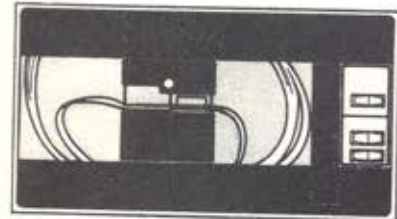
b.



c.



d.



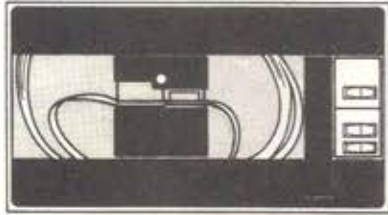
- a. Card Reader
- b. Magnetic Tape Unit
- c. Disk Unit
- d. Paper Tape Reader/Punch



## EXERCISES

8. Match each device pictured below with the name of its medium.

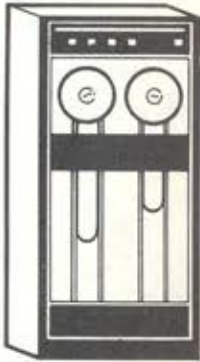
a.



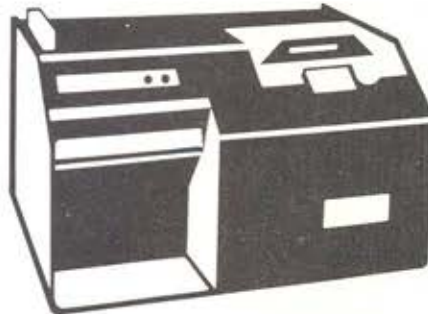
b.



c.



d.



Magnetic Tape

( )

Paper Tape

( )

Card

( )

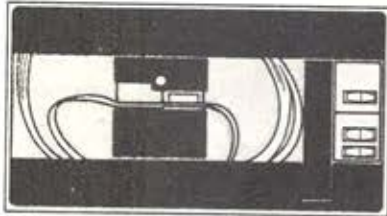
Disk

( )

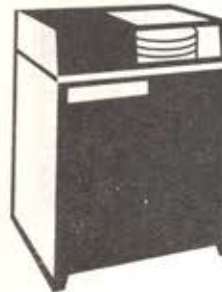
## SOLUTIONS

8. Match each device pictured below with the name of its medium.

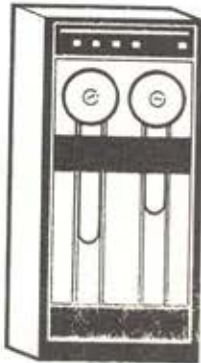
a.



b.



c.



d.



Magnetic Tape

(c)

Paper Tape

(a)

Card

(d)

Disk

(b)

---

## EXERCISES

---

9. Indicate that each of the following machine-oriented I/O devices functions as an input (I), an output (O), or both an input and output (B) device by writing the correct letter in the space provided.

Device	Function(s)
Magnetic Disk Unit	_____
Paper Tape Reader	_____
Data Communication Unit	_____
Card Punch	_____
Floppy Disk Unit	_____
Analog-to-Digital Converters	_____
Paper Tape Punch	_____
Magnetic Tape Unit	_____
Card Reader	_____
Tape Cartridge and Cassette	_____

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**SOLUTIONS**

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9. Indicate that each of the following machine-oriented I/O devices functions as an input (I), an output (O), or both an input and output (B) device by writing the correct letter in the space provided.

Device	Function(s)
Magnetic Disk Unit	<u>B</u>
Paper Tape Reader	<u>I</u>
Data Communication Unit	<u>B</u>
Card Punch	<u>O</u>
Floppy Disk Unit	<u>B</u>
Analog-to-Digital Converters	<u>I</u>
Paper Tape Punch	<u>O</u>
Magnetic Tape Unit	<u>B</u>
Card Reader	<u>I</u>
Tape Cartridge and Cassette	<u>B</u>



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## EXERCISES

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10. Each of the following statements describes or compares various machine-oriented I/O media. Indicate whether each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Magnetic tape is more expensive than magnetic disks.	_____
Both punched cards and floppy disks are low-cost media.	_____
In general, magnetic disks can store twice as much as magnetic tapes.	_____
A deck of punched cards may be accessed either sequentially or directly	_____
Disks are direct-access media.	_____
Punched cards and paper tape have the slowest access rate.	_____
Punched cards and paper tape are the only human-readable media.	_____
Magnetic tapes may be rewritten whereas magnetic disks cannot.	_____
Magnetic tapes require less storage space than punched tape.	_____
In general, tapes are sequential-access media.	_____

---

## SOLUTIONS

---

10. Each of the following statements describes or compares various machine-oriented I/O media. Indicate whether each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Magnetic tape is more expensive than magnetic disks.	<u>F</u>
Both punched cards and floppy disks are low-cost media.	<u>T</u>
In general, magnetic disks can store twice as much as magnetic tapes.	<u>F</u>
A deck of punched cards may be accessed either sequentially or directly.	<u>F</u>
Disks are direct-access media.	<u>T</u>
Punched cards and paper tape have the slowest access rate.	<u>T</u>
Punched cards and paper tape are the only human-readable media.	<u>F</u>
Magnetic tapes may be rewritten whereas magnetic disks cannot.	<u>F</u>
Magnetic tapes require less storage space than punched tape.	<u>T</u>
In general, tapes are sequential-access media.	<u>T</u>

## People-Oriented Input/Output Devices

### OBJECTIVES

1. Given drawings and names of various people-oriented I/O devices, be able to match each drawing with its corresponding device.
2. Given statements describing or comparing various people-oriented I/O devices, be able to label those statements that are true and those that are false.

### SAMPLE TEST ITEMS

1. Drawings and names of people-oriented input/output devices are given below. Match each drawing with its corresponding device name by writing the correct letter in the space provided.

a.



**Device**

Teleprinter  
Display Terminal

b.



**Picture**

\_\_\_\_\_  
\_\_\_\_\_

### SAMPLE TEST ITEMS

2. Each of the following statements describes or compares people-oriented I/O devices. Indicate whether each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Teleprinters and display terminals can both input and output.	_____
Teleprinters, display terminals, and line printers can operate either on-line or off-line.	_____
Line printers produce hard copy output whereas most display terminals do not.	_____
Teleprinters are faster and quieter in operation than display terminals.	_____
Teleprinters, display terminals, and line printers may input via keyboard.	_____
In general, line printers and teleprinters can output at the same speed.	_____
Most teleprinters can output either hard or soft copy.	_____



Mark your place in this workbook and view Lesson 3 of the A/V program, "Peripheral Devices."

Unlike machine-oriented devices which can be understood only by other devices, people-oriented devices transfer data between the computer and the human user. The data is in a form understandable to people, such as *alphabetic characters, digits, pictures, and graphs.*

**Keyboard** – The most commonly used people-oriented input device is the *keyboard* on which the computer user can enter (input) information by depressing keys as on a typewriter. After the key is depressed, the drive mechanism in the keyboard resets the key so that it can be struck again. The control circuit converts the depressed key into the equivalent binary code so that the information can be utilized by the computer.

**Printer** – The most common people-oriented output device is a *printer* that prepares printed paper documents. The printer consists of a drive mechanism that transports the paper and positions the printing head. Upon receipt of a signal from the processor, the control circuit selects the letter to be printed on the paper.

**Teleprinter** – Often, a printing device is *combined* with a keyboard for use as an input and an output device. This type of device, known as a *teleprinter*, looks and operates much like a typewriter. However, internally, it functions as two separate units: a *keyboard* and a *printer*.



Figure 15 Teleprinter

When the teleprinter is used on-line, the keyed information goes directly to the processor which, in turn, *sends back* (or echoes) the same character to the printer, if printing of the input is required. This occurs so rapidly that the operator thinks the keystroke actually activated the printer, when in fact it was the processor that controlled the printing.

**Remote Terminal** – When an input/output device is located *away* from the computer itself, it is known as a *remote terminal* or *station*. Teleprinters are one of the most common computer terminals allowing computer users from various locations access to a single computer system.

**Display Terminal** – Another people-oriented output device known as a *display terminal*, utilizes a screen as its output medium. The drive mechanism in a display consists of charged plates that direct an electron beam which illuminates selected areas of the screen. These types of drive mechanisms are very reliable as they contain no moving mechanical parts. Some display terminals can only produce characters, but many can display graphs and pictures also. Combined with keyboards, they are widely used in place of teleprinters.

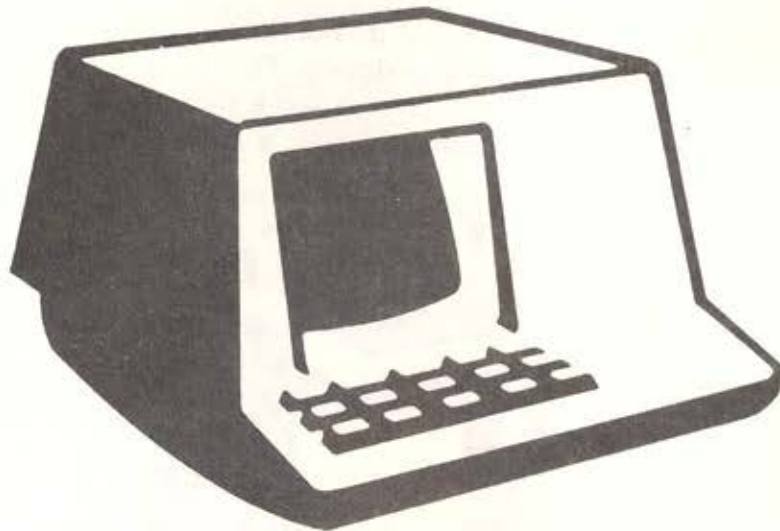


Figure 16 Display Terminal



### Some Additional Points on Printers....

Because central processors operate at far greater speeds than people, most people-oriented peripheral devices can be operated off-line, where the data is transferred to a machine-oriented input/output device. Punched paper tape is a typical medium used for this purpose. After the operator enters the data on the paper tape off-line, the paper tape can be read into the computer using the on-line mode of operation. By using the off-line mode for the slow entering of data into the medium, and on-line for high-speed data transfer to the mainframe, efficient processor utilization is attained. The time interval required for the transfer of data between the processor and a peripheral device is known as the *data transfer rate*.

By using a *high-speed* printer, large quantities of people-oriented output data can be generated on-line for later use. A typical high-speed printer is the *line printer* which prints an entire line of information at a time. Since this printed material is generated at a faster rate than people can read it, the line printer is usually reserved for applications where large quantities of printed matter must be output for *later* use.

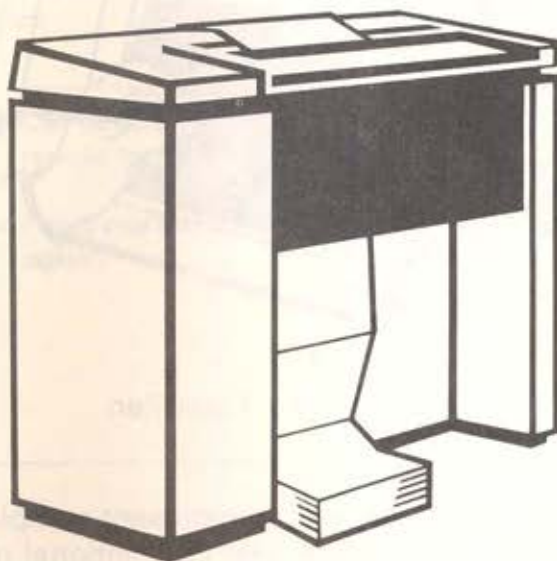


Figure 17 Line Printer

### ...And Displays

Display terminals are becoming increasingly popular because they are faster, more reliable, and much quieter than teleprinters. However, the data they present is transient in nature, producing no permanent or "hard" copy. When new data is displayed, the previous data is forced off the screen. For this reason, they are frequently called *soft copy* devices, and in instances where a permanent record of the output is desired, teleprinters are still required.

Some display terminals have an additional feature. A device known as a *light pen* is provided so that the user can enter data *directly* into the computer from the screen. The input medium in the light pen is the light and dark areas on the display screen. The operator positions the pen on the screen and the control circuit senses the presence of the light pen and translates the input to electrical signals which are sent to the computer.

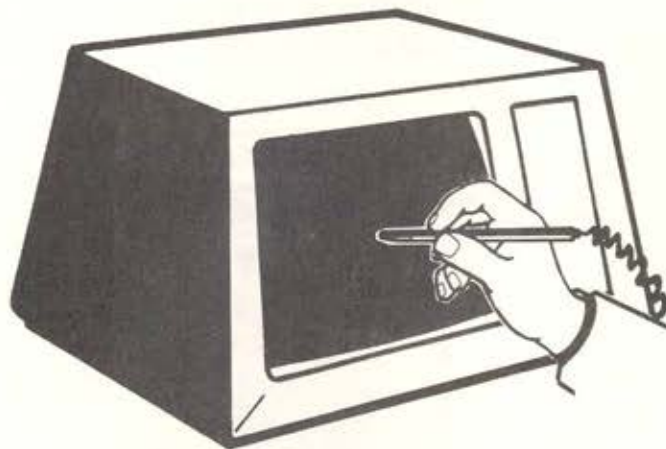


Figure 18 Light Pen

Graphic displays allow the user to represent complex structures pictorially – a substantial advantage over conventional means of describing them with words or equations.



Table 2 summarizes the characteristics of teleprinters, display terminals, and line printers.

Table 2 Characteristics of People-Oriented I/O Devices

Characteristic	Teleprinter	Display Terminal	Line Printer
Function	Input and Output	Input and Output	Output Only
Operating Modes	On-line and Off-line	On-line and Off-line	On-line
Hard Copy Output	Yes	No	Yes
Medium Used	Input: Keyboard Output: Printed Documents	Input: Keyboard Output: Video Display	Output: Printed Documents
Speed	Slow	Medium-Speed	Fast: 300 to 1500+ lines per minute
Comments	<ul style="list-style-type: none"> <li>• Can be used as a remote terminal.</li> <li>• Prints characters serially</li> </ul>	<ul style="list-style-type: none"> <li>• Can be used as a remote terminal.</li> <li>• Faster, quieter, more reliable than teleprinter.</li> <li>• Some can handle graphic information as well as characters.</li> </ul>	<ul style="list-style-type: none"> <li>• Can produce multiple (carbon) copies.</li> <li>• Prints one line (up to 132 characters) at a time.</li> </ul>

---

## EXERCISES

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1. A *medium* frequently used with people-oriented output devices is:
  - a. printed paper
  - b. paper tape
  - c. binary digits
  - d. magnetic surfaces
  
2. When a printing device is combined with a keyboard for use as an input/output device at a location *away* from the computer, it is known as a:
  - a. high-speed printer
  - b. display terminal
  - c. remote terminal
  - d. soft-copy device
  
3. Specify whether the following statements are true or false.

	T	F
a. Most people-oriented peripheral devices are operated rapidly, on-line.	<input type="checkbox"/>	<input type="checkbox"/>
b. The amount of time required for the transfer of data between the processor and a peripheral device is known as data transfer rate.	<input type="checkbox"/>	<input type="checkbox"/>
c. The line printer is a high-speed printer.	<input type="checkbox"/>	<input type="checkbox"/>
d. The display unit is very reliable because the drive mechanism contains <i>no</i> mechanical moving parts.	<input type="checkbox"/>	<input type="checkbox"/>

---

## SOLUTIONS

---

1. A *medium* frequently used with people-oriented output devices is:

- (a) printed paper
- b. paper tape
- c. binary digits
- d. magnetic surfaces

2. When a printing device is combined with a keyboard for use as an input/output device at a location *away* from the computer, it is known as a:

- a. high-speed printer
- b. display terminal
- (c) remote terminal
- d. soft-copy device

3. Specify whether the following statements are true or false.

- |   | T                                   | F                                   |
|---|-------------------------------------|-------------------------------------|
| a. Most people-oriented peripheral devices are operated rapidly, on-line.   | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |
| b. The amount of time required for the transfer of data between the processor and a peripheral device is known as data transfer rate. | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| c. The line printer is a high-speed printer.  | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| d. The display unit is very reliable because the drive mechanism contains <i>no</i> mechanical moving parts.                          | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |

---

## EXERCISES

---

4. Display terminals are gaining in popularity because:
  - a. They are cheaper than other input/output devices.
  - b. They produce a permanent record.
  - c. They are faster, quieter, and more reliable than teleprinters.
  - d. They can be used either on-line or off-line.
  
5. Differentiate between "hard" copy and "soft" copy.
  
  
  
  
  
  
  
  
  
6. The light pen is used to:
  - a. enter data directly on the display screen
  - b. receive data directly from the display screen
  - c. detect electrical signals on a display terminal
  - d. detect magnetic signals on a display terminal



---

## SOLUTIONS

---

4. Display terminals are gaining in popularity because:

- a. They are cheaper than other input/output devices.
- b. They produce a permanent record.
- ☒ c. They are faster, quieter, and more reliable than teleprinters.
- d. They can be used either on-line or off-line.

5. Differentiate between "hard" copy and "soft" copy.

Hard copy refers to a permanent printed record, while soft copy refers to transient data, such as the image on a display terminal, which is not stored for future use.

6. The light pen is used to:

- ☒ a. enter data directly on the display screen.
- b. receive data directly from the display screen.
- c. detect electrical signals on a display terminal.
- d. detect magnetic signals on a display terminal.

---

## EXERCISES

---

7. Label each of the three devices pictured below.

a.



b.



c.



a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

---

## SOLUTIONS

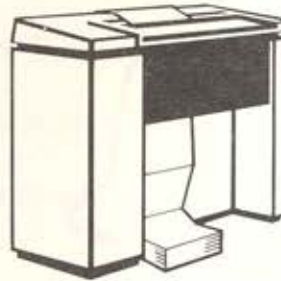
---

7. Label each of the three devices pictured below.

a.



b.



c.



a. display terminal

b. line printer

c. teleprinter

---

## EXERCISES

---

8. Each of the following statements describes or compares people-oriented I/O devices. Indicate whether each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Teleprinters and display terminals can both input and output.	_____
Teleprinters, display terminals, and line printers can operate either on-line or off-line.	_____
Line printers produce hard copy output whereas most display terminals do not.	_____
Teleprinters are faster and quieter in operation than display terminals.	_____
Teleprinters, display terminals, and line printers may input via keyboard.	_____
In general, line printers and teleprinters can output at the same speed.	_____
Most teleprinters can output either hard or soft copy.	_____



---

## SOLUTIONS

---

8. Each of the following statements describes or compares people-oriented I/O devices. Indicate whether each statement is true (T) or false (F) by writing the correct letter in the space provided.

Statement	T or F
Teleprinters and display terminals can both input and output.	<u>  T  </u>
Teleprinters, display terminals, and line printers can operate either on-line or off-line.	<u>  F  </u>
Line printers produce hard copy output whereas most display terminals do not.	<u>  T  </u>
Teleprinters are faster and quieter in operation than display terminals.	<u>  F  </u>
Teleprinters, display terminals, and line printers may input via keyboard.	<u>  F  </u>
In general, line printers and teleprinters can output at the same speed.	<u>  F  </u>
Most teleprinters can output either hard or soft copy.	<u>  F  </u>

## Auxiliary Storage Devices

### OBJECTIVE

Given a table of three types of auxiliary storage devices, three characteristics of data storage, and nine descriptions, be able to match each device/characteristic combination with its description.

### SAMPLE TEST ITEM

The table below is concerned with auxiliary storage devices and their characteristics. Complete the table, writing the correct letter in the space provided.

Characteristic	Moving Head Disk	Fixed Head Disk	Magnetic Tapes
Data Transfer Time	_____	_____	_____
Storage Capacity	_____	_____	_____
Cost per Bit	_____	_____	_____
<b>Data Transfer Time</b>	<b>Storage Capacity</b>	<b>Cost per Bit</b>	
a. Slowest	d. Medium	g. High	
b. Fastest	e. Least	h. Lowest	
c. Medium	f. Most	i. Medium	

Mark your place in this workbook and view Lesson 4 of the A/V programs, "Peripheral Devices."

Auxiliary storage devices provide inexpensive extended storage facilities for a computer system. By adding to the capacity of main memory, these auxiliary devices significantly increase the power of the computer system.

As you recall, main memory is organized as individual computer *words*, each of which can be addressed by the processor. While any data or instructions are being processed, they must, of course, be stored within the main memory. However, due to cost factors, main memory cannot accommodate all the data and instructions that the computer needs. Therefore, additional information is stored in low-cost, large-capacity auxiliary storage devices. Auxiliary storage handles information in *blocks* containing hundreds of words rather than in single computer words that can be addressed individually. These large blocks of information, however, can be moved rapidly into main memory whenever the computer requires them for processing. While the information is being processed in main memory, the processor can address each word individually.

After the information is processed, the processor can clear space in main memory by transferring information back to an auxiliary storage device. In this way, the computer need only accommodate, internally, a small portion of the information it requires to meet all of its data processing needs. The large bulk of information can be kept in an auxiliary storage device and then moved back into main memory when necessary. This process is called *swapping*.

Devices that serve as extensions of main memory are evaluated according to three characteristics:

- Data transfer rate
- Storage Capacity
- Cost

By *data transfer rate* we mean the interval of time required to move information into or from main memory after the central processor makes the request. *Storage capacity* refers to the number of words that an auxiliary storage device can physically hold, and *cost* is calculated in terms of *cost per bit* of available storage.



The most common auxiliary storage device used with minicomputers is the *magnetic disk*. (The disk pack and floppy disk were discussed in Lesson 2 as input/output units.) These disks can be used for auxiliary storage as well as for input/output.

### Disk Media

The medium in all of the disk units is basically similar. It consists of a magnetic surface that is rotated at a high, constant speed. The information is stored on this surface in circular channels called *tracks*. These tracks are further divided into segments called *blocks*, each of which can store hundreds of words of information.



Figure 19 Disk Storage Organization

When information is transferred between main memory and the disk unit, an *entire block* is moved at one time.

### Disk Drive Mechanisms

The disks which are used for *both* input/output and auxiliary storage have only a *single* read/write head per disk surface. This single head is *moved* to the appropriate track where the block of information selected by the control circuit is located. When the drive mechanism stations the head at the selected area on the disk, the head can perform either a write or a read operation. After the disk has been read or written on by the computer, the single read/write head can be *retracted* to allow easy removal of the disk for off-line storage. This type of disk unit is known as the *moving head disk drive*.



The other type of disk unit, the *fixed head disk drive*, is used mainly for auxiliary storage since the disks cannot be conveniently removed from the device. This is because the fixed head disk drive has many read/write heads, one for each track on the disk, and it would be difficult to realign them if they were disconnected to allow removal of the disk. This non-removable disk unit uses the same kind of circular magnetic surface as the removable disk unit. It differs only in the type of drive mechanism that transports information to and from the disk. While the moving head disk utilizes one read/write head to handle the entire surface of the disk, this fixed head disk requires *many* read/write heads, one for *each* track on the disk. The control circuit selects the read/write head corresponding to the track containing the block of information that is to be read or written.

### Comparison of Fixed and Moving Head Disk Units

The major features of the two types of disk units are listed in Table 3.

**Table 3 Fixed Head vs Moving Head Disks**

Characteristic	Fixed Head Disk	Moving Head Disk
Data Transfer Time	Faster	Slower
Storage Capacity	Less	More
Cost Per Bit	Higher	Lower

As the comparison table indicates, fixed head disks are capable of faster reading and writing speeds than moving head disks. This difference in speed is the result of aligning the head with the disk surface at the beginning of the particular block selected for reading or writing. The read/write heads on fixed head disks drives are already aligned above each track, and the operation can be performed as soon as the disk rotates to the proper block. However, on moving head disks, the head must first be *moved* to the proper track and then the disk must rotate until the specified block reaches the read/write head. The response time for a fixed head disk depends only on the *rotation time* of the disk. With the moving head disk, the time required to move or *position* the single head to the desired track must also be included. Therefore, where speed is an important consideration, fixed head disks are preferred. However, since they are not removable, they cannot be used for input/output purposes and are therefore less versatile.

In terms of cost per bit of storage, we can see that the fixed head disk is more expensive. The difference in cost is related to the number of read/write heads required. While moving head disks require only one head to perform reading and writing operations anywhere on the disk, the fixed head disk requires one head for each track. In order to economize on costs, fixed head disks are usually designed with fewer tracks than moving head disks. However, they still have approximately 100 read/write heads and obviously are considerably higher in price than moving head disks. By reducing the number of tracks on a disk, the capacity of fixed head disks is also decreased. Therefore, in terms of storage capacity, moving head disks usually hold more information.

### Magnetic Tapes

Magnetic tapes are also used for auxiliary storage purposes in applications where high speed is not critical and random access is not required. As explained in the preceding section on magnetic tape input/output devices, accessing information stored on magnetic tape can be relatively slow as the tape must be unwound to the desired block of information. However, many applications, such as mailing lists and payrolls, lend themselves very well to sequential access storage as they are always run off in fixed sequence. Furthermore, in terms of storage capacity, magnetic tape is much more efficient than disk units. Magnetic tape also provides lower cost storage than either of the disk types.

Table 4 compares the three types of auxiliary storage media covered in this lesson in terms of speed, capacity, and cost. *Note:* Moving head disks have the *average* characteristics of the devices compared. They are general-purpose devices used for many applications.

**Table 4 Characteristics of Different Auxiliary Storage Media**

Characteristic	Fixed Head Disks	Moving Head Disks	Magnetic Tapes
Data Transfer Time	Fastest	Medium	Slowest
Storage Capacity	Least	Medium	Most
Cost Per Bit	High	Medium	Lowest



## EXERCISES

1. Auxiliary storage extends the capacity of \_\_\_\_\_
2. Specify whether the following statements are true or false by checking the appropriate box.

	T	F
a. Auxiliary storage handles individual words which can be handled by the processor.	<input type="checkbox"/>	<input type="checkbox"/>
b. The processor can operate most efficiently by utilizing a process known as swapping.	<input type="checkbox"/>	<input type="checkbox"/>
c. The cost of auxiliary storage is calculated in terms of cost per bit of available storage.	<input type="checkbox"/>	<input type="checkbox"/>

In exercises 3, 4, 5, and 6, circle the letter that identifies the correct answer.

3. What are fixed head disk drives used for?
  - a. auxiliary storage and input/output
  - b. input/output only
  - c. auxiliary storage only
  - d. storage of current information
4. How is information transferred between main memory and a disk unit?
  - a. one complete block at a time
  - b. one computer word at a time
  - c. the complete contents of the disk at a time
  - d. one track at a time

---

## SOLUTIONS

---

1. Auxiliary storage extends the capacity of main memory.
2. Specify whether the following statements are true or false by checking the appropriate box.
- |   | T                                   | F                                   |
|---|-------------------------------------|-------------------------------------|
| a. Auxiliary storage handles individual words which can be handled by the processor.          | <input type="checkbox"/>            | <input checked="" type="checkbox"/> |
| b. The processor can operate most efficiently by utilizing a process known as swapping.       | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |
| c. The cost of auxiliary storage is calculated in terms of cost per bit of available storage. | <input checked="" type="checkbox"/> | <input type="checkbox"/>            |

In exercises 3, 4, 5, and 6, circle the letter that identifies the correct answer.

3. What are fixed head disk drives used for?
- a. auxiliary storage and input/output
  - b. input/output only
  - ☒ c. auxiliary storage mostly
  - d. storage of current information
4. How is information transferred between main memory and a disk unit?
- ☒ a. one complete block at a time
  - b. one computer word at a time
  - c. the complete contents of the disk at a time
  - d. one track at a time



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## EXERCISES

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5. What is the function of the control circuit on the moving head disk drive?
  - a. to select the appropriate block of information
  - b. to move the read/write head
  - c. to rotate the magnetic surface
  - d. to retract the read/write head for off-line storage
6. Magnetic tapes are popular for auxiliary storage because:
  - a. they are faster than magnetic disks
  - b. they are cheaper and hold more information
  - c. they require very little off-line storage space
7. Give one application where magnetic tape would be preferred over magnetic disk storage. Explain the reason.

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## SOLUTIONS

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6. Magnetic tapes are popular for auxiliary storage because:
- a. they are faster than magnetic disks
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  - c. they require very little off-line storage space
7. Give one application where magnetic tape would be preferred over magnetic disk storage. Explain the reason.
- Any application where an entire list is run off in a fixed sequence would be well suited to *magnetic tape* which has a vast storage capacity and is inexpensive as well. Payrolls and mailing lists are two examples where magnetic tape can be very efficient.

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**EXERCISES**

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8. Fill in the following table using such terms as: fastest, slowest, medium, most, least, highest and lowest.

Characteristic	Fixed Head Disks	Moving Head Disks	Magnetic Tapes
Data Transfer Time			
Storage Capacity			
Cost Per Bit			

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**SOLUTIONS**

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8. Fill in the following table using such terms as: fastest, slowest, medium, most, least, highest, and lowest.

Characteristic	Fixed Head Disks	Moving Head Disks	Magnetic Tapes
Data Transfer Time	Fastest	Medium	Slowest
Storage Capacity	Least	Medium	Most
Cost Per Bit	High	Medium	Lowest



Take the test for this module and evaluate your answers before studying another module.