

МИНИСТЕРСТВО ОБЩЕГО И ПРОФЕССИОНАЛЬНОГО ОБРАЗОВАНИЯ  
РОССИЙСКОЙ ФЕДЕРАЦИИ

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## КОМПЬЮТЕРЫ В БУДУЩЕМ

Английский язык  
для студентов заочной формы обучения

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Цель методических указаний - обучить студентов 1 курса навыкам чтения научно-технической литературы. Данные методические указания способствуют запоминанию новой лексики, развитию техники чтения и навыков реферирования. Каждая тема включает в себя вокабуляр, тексты и упражнения.

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Рецензент *Е.Л.З и м а к о в а*

## PART 1

### COMPUTER PERSPECTIVE

#### Unit One

##### Vocabulary

hardware

compatibility

central processing unit

software

connectivity

equipment

similar

purpose

common

suitable

to arrange

key board

available

non-volatile

to interpret

to execute

activities

to affect

sophisticated

to manipulate

internal

main memory

as well as

that is  
to take place  
in front of  
to look like  
a lot of  
at one time  
to set up

## **TEXT A**

The term computer is used to describe a device made up of a combinations of electronic and electromechanical components. But itself computer has no intelligence and is referred as hardware. A computer or computer system doesn't come to life until it is connected to other parts of system. A computer system is a combination of five elements.

Hardware

Software

People

Procedures

Data-Information

When one computer system is set up to communicate with another computer system connectivity becomes a sixth system component.

Computer Hardware

If at a job interview you are asked about a kind of computer equipment you have used before or what you know about hardware and you don't have an answer you interviewer will probably percept you as a person who doesn't take an active role

in what is going on around you – a perception that could dramatically hurt your chances of getting a job you want.

In today's business world not knowing what computer hardware is and what typical hardware components do is similar to being a taxi driver and not knowing what a car is and that it has components such as an engine, doors, and so on.

Computer hardware can be divided into four categories

Input hardware

Storage hardware

Processing hardware

Output hardware

The purpose of input hardware is to collect data and convert it into a form suitable for computer processing. The most common input device is a keyboard. It looks very like a typewriter keyboard with rows of keys arranged in the typical typewriter layout, as well as the number of additional keys used to enter special computer related codes. Although it isn't the only type of input device available, the computer keyboard is the one most generally used by the business community.

The purpose of the storage hardware is to provide a means of storing computer instructions and data in a form that is relatively permanent non-volatile – that is, the data is not lost when the power is turned off – and easy to retrieve when needed for processing.

The purpose of processing hardware is to retrieve, interpret and direct the execution of software instructions provided to the computer. The most common components of processing hardware are the central processing unit and main memory.

The CPU is the brain of the computer. It reads and interprets software instructions and coordinates the processing activities that must take place. The design of the CPU affects the processing power and the speed of the computer. With a well-designed CPU in your computer, you can perform highly sophisticated tasks in a very short time. Main memory( also called internal memory, primary storage, or just memory) can be thought as an electronic desktop. The more desk surface you have in front of you the more you can place on it. Similarly, if your computer has a lot of memory, you can place more software instructions on it. Having a large amount of memory in your computer also allows you to work with and manipulate great amount of data and information at one time.

The purpose of input hardware is to provide the user with means of view information produced by the computer system. Information is output in either hardcopy or softcopy forms.

### EXERCISES

1) Match each of the following terms to the phrase that is the most closely related:

- a. \_\_\_\_\_ data processing
- b. \_\_\_\_\_ connectivity
- c. \_\_\_\_\_ key board
- d. \_\_\_\_\_ information
- e. \_\_\_\_\_ computer
- f. \_\_\_\_\_ user
- g. \_\_\_\_\_ non-volatile
- h. \_\_\_\_\_ data

1. Someone who doesn't necessarily have much technical knowledge about computers but who makes decisions based on information process by the computer.
2. Equipment made up of a combination of electric and electronic components that uses software to process data.
3. Raw unevaluated data.
4. The product of data processing.
5. Most common type of input device used with computers:
6. The sixth element of a computer system. The term related to two or more computer systems being able to communicate.
7. Said of data that is not lost when the power is turned ff.
8. Processing of data into information.

2) Multiple Choice

1. \_\_\_\_\_ is the product of data processing.
  - a. data
  - b. information
  - c. software
  - d. none of above
2. The most common input device used today:
  - a. motherboard
  - b. central processing unit
  - c. keyboard
  - d. system unit
  - e. semiconductor
3. Which of the following people has the least amount of technical knowledge?
  - a. programmer
  - b. user

- c. system analyst
  - f. computer operator
  - g. computer professional
4. A part of hardware which collect data and convert it into a form suitable for computer processing is:
- a. processing hardware.
  - b. main memory
  - c. the CPU
  - d. input hardware
5. The brain of computer system is:
- a. memory
  - b. the CPU
  - c. motherboard

### 3) Understanding Passage

Decide whether the following statements are true or false by referring to the information of the text. Then make necessary changes so that the false statements become true.

1. The term computer is used to describe a connection of mechanical devices.
2. A computer system is a combination of four basic elements: hardware, software, data and procedures.
3. The sixth element of a computer system is connectivity.
5. Main memory is the brain of the computer.
6. A keyboard is the only type of input device available.
7. The purpose of hardware is to collect data and convert it into a form suitable for computer processing.
8. The more memory capacity-the more software instructions can be placed on it.



#### 4) Understanding Words

a. Refer back to the text and give synonyms to:

1. work \_\_\_\_\_
2. typical \_\_\_\_\_
3. aim \_\_\_\_\_
4. additional \_\_\_\_\_
5. available \_\_\_\_\_
6. permanent \_\_\_\_\_
7. retrieve \_\_\_\_\_
8. execution \_\_\_\_\_
9. activities \_\_\_\_\_
11. internal \_\_\_\_\_
12. main \_\_\_\_\_
13. manipulate \_\_\_\_\_
14. similarly \_\_\_\_\_
15. to influence \_\_\_\_\_
16. ordinary \_\_\_\_\_

5). Refer back to the text and give antonyms to:

1. primary \_\_\_\_\_
2. internal \_\_\_\_\_
3. main \_\_\_\_\_
4. volatile \_\_\_\_\_
5. permanent \_\_\_\_\_
6. common \_\_\_\_\_

6). Make up the sentences of your own using active vocabulary of this chapter.

7). Complete the following sentences using the content of the text.

1.           The           term           computer           is used.....

2. A computer system doesn't come to life until.....
3. A computer system is a combination.....
4. Computer hardware can be divided into.....
5. The purpose of input hardware is.....
6. The most common input device is.....
7. A keyboard looks very much.....
8. The purpose of the storage hardware is.....
9. The CPU coordinates.....
10. You can perform highly sophisticated tasks if.....
11. Having a large amount of memory allows to work.....
12. The purpose of output hardware is.....

# TYPES OF COMPUTER SYSTEM-WHAT'S THE DIFFERENCE

## Unit Two

### Vocabulary

to employ=to use, to apply

fundamental

to vary

processing capabilities

overall

to complete=to finish

to provide

to support

gigantic

to maintain

supercomputer

mainframe

minicomputer

microcomputer

to house=to mount, to place

workstation

to require

storage location

type

generally

chip

semiconductor

voltage

impurity

to be familiar with

at a time

## TEXT A

The differences among computer systems are important to know about if you want to show a potential employer that you have a fundamental knowledge of computers.

Computers come in a variety of sizes and shapes and with a variety of processing capabilities. The earliest computers were quite large because of the crude technologies used-as technological improvements were made in computer components the overall size of computers began to shrink. Today the complete CPU of a computer can be smaller than a postage stamp.

To provide a basis for comparing their capabilities, computers are generally grouped into four basic categories 1)supercomputers-which are powerful giants of the computer world.2)mainframe computers-which are large extremely powerful computers used by many large companies.3)minicomputers-which are the next most powerful.4)microcomputers-which are the least powerful-but which you most likely will be required to use in business.

A supercomputer can handle gigantic amounts of scientific computation. It is maintained in a special room or environment,may be 50.000 times faster than a microcomputer. You probably would have contact with a supercomputer in the areas of defence and weaponry, weather forecasting scientific

research, at one of several large universities. In the next few years, more and more large industries will start using supercomputers.

A mainframe computer is a large computer usually housed in a controlled environment, that can support the processing requirements of hundreds and often thousands of users and computer professionals. If you go to work for an airline, a bank, a large insurance company, a large accounting company you will likely have contact- through your individual workstation-with a mainframe computer

A minicomputer, also known as a midsize or low-end mainframe computer, is similar to but less powerful than a mainframe computer. It can support 2 to about 50 users and computer professionals. Minicomputers and mainframe computers can work much faster than microcomputers and have many more storage locations in the main memory.

The microcomputer is a type of computer that you undoubtedly will be dealing with as a user. Many readers are probably already familiar with the microcomputer also known as a personal computer. They vary in size from small portables, such as laptop computers that you can carry around like a briefcase, to power desktop workstations, such as those used by engineers and scientists.

A microcomputer-generally used by one person at a time- uses a microprocessor chip as its CPU as small as a quarter of an inch square, a chip is made of silicon, a material made of sand. Silicon is referred to as a semiconductor because it sometimes conducts electricity and sometimes does not ("semi" means "partly"),depending on applied voltage and added chemical impurities("dopants").

## EXERCISES

1) Matching Match each of the following terms to the phrase that is the most closely related.

1. \_\_\_\_\_ workstation.
2. \_\_\_\_\_ mainframe computer.
3. \_\_\_\_\_ supercomputer.
4. \_\_\_\_\_ microcomputer.
5. \_\_\_\_\_ minicomputer.
6. \_\_\_\_\_ chip.
7. \_\_\_\_\_ semiconductor.

a Known as a personal computer.

b. A large computer which is usually housed in a controlled environment.

c. A midsize computer, but less powerful than a mainframe.

d. It can handle gigantic amount of scientific computation.

e. Usually used as the CPU in a microcomputer.

f. Can conduct electricity depending upon applied voltage.

g. Provides contact with a main computer.

2). Multiple choice

1. Which of the following is the most powerful type of computer?

- a. supermicro.
- b. superconductor.
- c. microcomputer.
- d. supercomputer.
- e. all of the above.

2. Which of the following terms relates to the main memory?

- a. chip.
- b. storage location.

- c. semiconductor.
- d. all of the above.
- e. none of the above.

3). Understanding passage. Decide whether the following statements are true or false. Make necessary changes so that the false statements become true.

1. Computers, according to their shape and size are divided into four groups.
2. Minicomputers are the most powerful among all kinds of computers.
3. A mainframe computer is a large computer usually housed in a controlled environment.
4. Personal computers are used in business.
5. Silicon is referred to as a semiconductor.

4). Understanding words. Refer back to the text and find

a). synonyms to-1. \_\_\_\_\_ fundamental

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

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

4. \_\_\_\_\_ to house

5. \_\_\_\_\_ to maintain

6. \_\_\_\_\_ to deal with

7. \_\_\_\_\_ to conduct

8. \_\_\_\_\_ to apply

9. \_\_\_\_\_ general

10. \_\_\_\_\_ to support

11. \_\_\_\_\_ type

12. \_\_\_\_\_ to vary

b). antonyms to-1. \_\_\_\_\_ tiny

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

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

5). Practice. Make up the sentences of your own with synonyms and antonyms.

6). Put correct form of the adjective.

1. The \_\_\_\_\_ computers were quite \_\_\_\_\_.

(early, large)

2. Today the complete CPU of a computer can be \_\_\_\_\_

than a postage stamp. (small)

3. Microcomputers are \_\_\_\_\_ among all kinds of computers.

(powerful)

4. Minicomputer is \_\_\_\_\_ than a mainframe computer. (powerful)

5. Mainframes can work \_\_\_\_\_ than microcomputers. (fast)

6. Supercomputers are as \_\_\_\_\_ as mainframes. (powerful)

7. A chip is as \_\_\_\_\_ as a quarter of an inch. (small)

7). Projects. Choose any project you like and speak on it.

1. Determine what types of computers are being used where you work or study. Are microcomputers being used? Minicomputers? Mainframes? All types? What are they being used for?

2. Look in the Job Opportunities section of a newspaper to see if many jobs require applicants to be familiar with using computers. What type of experience is required? If you were now looking for a job, which types of experience would you want to have?



3. Take your own project on the topic spoken above.

## **HARDWARE INPUT HARDWARE**

### **Unit Three**

#### **Vocabulary**

to capture

raw data

on-line processing

batch processing

to retrieve

intervention

media pl. (medium sing.)

to punch

to transcribe

source

via

keyboard

scanner

advantage

reusability

flexibility

to access

entry

#### **TEXT A**

The term input is used to describe the process of capturing or collecting raw data into a form that is usable by the computer for processing. Sometimes the data is processed right away (on-line processing), sometimes hours or days later, or even longer (batch processing). As a result, data is often stored in a computer-usable form where it can be quickly retrieved at the time of processing with little or no human intervention.

**Input Media. What is Data Stored On?**

In data processing, the materials on which the data is recorded are called media. For many years the most widely used media to record input data were paper-based products such as 80-column and 96-column punched cards and punched paper tape. The operator of a keypunch machine transcribes data a source document by punching holes in the cards via a keyboard to a special code.

Paper-based input media are also used with scanners, connected to a computer that can “read” typed or hand written data. The most widely used input media today are magnetic media in tape or disk form. The major advantage of magnetic media are their reusability, low cost, great flexibility for accessing the data during the input process, and high speed compared to punched cards and manual keyboard entry.

## EXERCISES

1). Form the nouns of the following words

flexible

reusable

to scan

to enter

to record

to use

to connect

special

major

to transcribe

2). Refer back to the texts and find

a). synonyms to

to retrieve \_\_\_\_\_

intervention \_\_\_\_\_

to transcribe \_\_\_\_\_

b). antonyms to

advantage \_\_\_\_\_

reusability \_\_\_\_\_

3). Complete the sentences using the content of the text

1. The term input is used to describe.....

2. Processing right away is called.....

3. Processing that takes hours or days is called.....

4. The materials on which the data is recorded are called.....

5. For many years the most widely used media were.....

6. The most widely used media nowadays are....

7. The major advantages of magnetic media are.....

## **Vocabulary**

general-purpose computer

single-purpose computer

direct-entry devices

screen

equipment

sophisticated

dedicated

to convert

appropriate

substantial

research

to compare

to manipulate

convenient

to involve

continuous

to rely on

terminal

generally

## **TEXT B**

Many commonly used input devices to rely on a keyboard and these devices generally fall into two groups: 1) terminals connected to general-purpose computer systems (microcomputers fall into this group also), and 2) dedicated data entry systems, which are specialised, single-purpose systems used for nothing else but entering data.

The nonkeyboard input devices, called direct-entry devices, include optical scanners, mice, light pens, touch screens, and voice recognition equipment, among others.

A computer keyboard is rather sophisticated electromechanical component designed to create special standardised electronic codes when a key is pressed. The codes are transmitted to the computer unit or terminal, where it is analysed and converted into the appropriate computer usable code.

Keyboards come in a variety of sizes and shapes, but most keyboards used have a certain number of features in common: 1. standart typewriter keys; 2. function keys; 3. spcial-purpose keys; 4. cursor-movement keys; 5. numeric keys.

In an effort to increase worker productivity a substantial amout of research is being done in voice recognition-programming the computer to recognize spoken commands.

Voice input devices, or recognition systems, convert spoken words into electronic signals by comparing the electronical patterns produced by the speaker's voice with a set of prerecorded patterns. If a matching pattern is found, the computer accepts this pattern as a part of its standard "vocabulary".

NASA is currently developing experimental space suits that use microprocessors and storage devices to allow astronauts to view computerized displays across their helmet visors. These displays would be manipulated by spoken commands-convenient when you've got both hands busy on an outerspace repair job. But the biggest problems with this thecnology involve limitations on the size of the computer's vocabulary, pronunciation differences among individuals, and the computer's inability to accept continuous speech.

## EXERCISES

1). Form the nouns of the following words

to rely

to recognize

to equip

to transmit

to convert

to increase

to produce

to compare

to vary

to limit

to manipulate

to move

2). Form the adjectives of the following words

to compare

to continue

to convert

to allow

function

to move

experiment

3) Find synonyms to:

sophisticated \_\_\_\_\_

variety \_\_\_\_\_

to increase \_\_\_\_\_

substantial \_\_\_\_\_

research \_\_\_\_\_

convenient \_\_\_\_\_

to involve \_\_\_\_\_

to manipulate \_\_\_\_\_

to convert \_\_\_\_\_

3) Translate the parts of the sentences paying attention to the verbals.

1. The transaction data **stored** on the card can later be read.....

2. As a person **living** in what is now often called “the information” age, you know that.....

3. A computer professional is a person who has had formal education in the technical aspects of **using** computers; a programmer or system analyst or computer operator who is concerned only with **supporting** the computer’s physical functions in **producing** information for the user.

4. With a **well-designed** CPU in your computer, you can.....

5. In today’s business world, not **knowing** what computer hardware is.....

6. Software is made up of a group of **related** programs, each of which.....

7. Applications software can be purchased “off the shelf”-that is, already **programmed**, or **written**.....

8. Silicon conducts electricity, **depending** on **applied** voltages.....

9. .... computer systems, **including** equipment and software.

10. A floppy disk or diskette is a thin plastic disk **enclosed** in a paper or plastic covering.....

4). Answer the questions.

1. What are the groups of input devices relied on a keyboard?
2. What do we call the nonkeyboard input devices?
3. How does a computer keyboard work?
4. What are common features of most keyboards?
5. What's the mechanism of work of voice recognition system?  
What are the disadvantages of using voice input devices?

### **TEXT C**

Data input also involves entering commands and selecting options. The light pen, the mouse, the touch screen and the digitizer tablet were all developed to make this easy. Each of these devices allows the user to identify and select the necessary command or option by moving the cursor to a central location on the screen or tablet and sending a signal to the computer. For this reason they are sometimes called pointing devices and they are used in menu-driven programs.

The light pen uses a light-sensitive photoelectric cell to signal screen position to the computer. Light pens are frequently used by graphic designers, illustrators and drafting engineers.

The mouse is a hand-held device connected to the computer by a small cable. As the mouse is rolled across the desktop, the cursor moves across the screen.

Mouse technology is often used with graphics-oriented microcomputers like the Macintosh.



## EXERCISES

1). Match each of the following terms to the phrase that is the most closely related.

1. \_\_\_\_\_ cursor
2. \_\_\_\_\_ .keyboard
3. \_\_\_\_\_ .digitizer
4. \_\_\_\_\_ .dedicated data entry system
5. \_\_\_\_\_ .mouse
6. \_\_\_\_\_ .intelligent terminal
7. \_\_\_\_\_ .card reader

a. Hardware device that reads the holes in punched cards and transfers the appropriate signals as input to the computer.

b. Sophisticated electromechanical component designed to create special standardized electronic codes when a key is pressed.

c. Terminal that can input and receive data as well as allows users to edit and process data.

d. Input component entirely dependent for all of the capabilities on the computer system to which it is connected.

e. Hand-held input device that is rolled across the desktop to move the cursor on the screen.

f. Allows the user to touch hardware to instruct the computer to perform specialized tasks.

g. This appears on the video display to mark where the next character will be positioned after it is typed.

2). Multiply Choice 1. Which of the following is considered a direct-entry input device?

- a. optical scanner
- b. mouse

c. light pen

d. digitizer

e. all of the above

2. Which of the following types of input media is used much less now than in 1960s?

a. hard disk

b. punched cards

c. magnetic tape

d. floppy disk

e. all of the above

3. Which of the following is required when more than one person uses a central computer at the same time?

a. terminal

b. light pen

c. digitizer

d. mouse

e. none of the above

4. Which of the following is an advantage of magnetic input media?

a. high speed

b. flexibility in accessing data

c. low cost

d. reusability

e. all of the above

5. Which of the following is used only for data entry and storage and never for processing?

a. mouse

b. dumb terminal

- c. microcomputer
- d. dedicated data entry system
- e. all of the above

6. Which of the following is not a direct-entry input device?

- a. keyboard
- b. light pen
- c. digitizer
- d. optical scanner
- e. none of the above

3). Short answers

1. What is the function of a dedicated data entry system?

2. What are some of the current limitations of voice input technology?

3. Describe the different types of keys on a standard microcomputer keyboard and their functions.

4). Projects

1. Using current computer publications such as Speed Technology, research voice recognition input systems. Who is using them? For example, manufacturing? Government? Advertising? Travel industry? In what types of computers? Do you think such systems will become very common in the near future?

## **STORAGE HARDWARE**

### **Unit Four**

## **Vocabulary**

temporarily

permanently

media

access

delete

primary storage

secondary storage

auxiliary

in very general terms

## **TEXT A Storage Fundamentals**

The storage hardware provides the capability to store data and program instructions—either temporarily or permanently—for quick retrieval and use during computer processing. The term media means the materials on which data can be recorded.

The term primary storage refers to the main memory of a computer where both data and instructions are held for immediate access and use by the computer's central processing unit during processing. Although the technology is changing the most primary storage today is considered a volatile form of storage meaning that the data and instructions are lost when the computer is turned off. Secondary storage (or auxiliary storage) is any storage device designed to retain data and instructions (programs) in a more permanent form. Secondary storage is nonvolatile, meaning that the data and instructions remain intact when the computer is turned off.

The earliest way to differentiate between primary and secondary storage is to consider the reason data is placed in them. Data is placed in primary storage only when it is needed for immediate processing. Data in secondary storage remains there until overwritten with new data or deleted and is accessed when is needed.

In very general terms, a secondary storage can be thought of a file cabinet. We store data there until we need it.

### **Data Representation: Binary Code**

The term binary is used to refer to two distinct states – on or off, yes or no, present or absent, 1 or 0.

To store and process data in binary form, a way of representing characters, numbers, and other symbols had to be developed. In other words coding schemes had to be devised as standardized methods of encoding data for use in computer storage and processing. A scheme for encoding data using a series of binary digits is called a binary

Code. A binary digit(bit) is either the character 1(on) or the character 0(off).

Two people contributed greatly to the coding scheme used to record and process data in computer-usable form: Herman Hollerith(1860-1929) and Samuel F.B.Morse(1791-1872).

Herman Hollerith, of U.S. Census fame, developed a binary coding scheme for representing data on paper cards through patterns of punched holes. Morse is responsible for the development of one of the earliest forms of electronic communication- the telegraph. His dream was to break down the information to be communicated into a coding scheme based on electrical pulses. A short pulse was a “dot” and a long pulse a

“dash”. The combined contribution of Morse and Hollerith ( and others) laid foundation for the storage and processing of data in magnetic and electrical form. Several coding schemes for the computer have been adopted that rely on the binary representation. Two commonly used codes are ASCII(pronounced as “as-key”) and EBCDIC(pronounced as “eb-see-dick). The acronym ASCII stands for American Standard Code for Information Interchange, which is widely used to represent characters in microcomputers and many minicomputers. The acronym EBCDIC refers to Extended Binary Coded Decimal Interchange Code, which is the most popular code used for IBM and IBM-compatible mainframe computers.

### **Parity Bits**

The term computer error is often used when a mistake is caused by a person – inputting data incorrectly, for example. However, errors can be caused by other factors such as, dust , electrical disturbance, weather conditions and improper handling of equipment. When such an error occurs, the computer may not be able to tell you exactly what and where it is, but it can tell you that there is an error. How does it do this?- by using parity bits, or check bits. A parity bit is an extra (ninth) bit attached to the end of the bite. Computers can be designed to use an odd-parity scheme. As a user you won't have to determine whether to use an odd-or even-parity scheme. The computer determines this and the system software automatically checks the parity scheme. However, you will have to learn what to do when your computer signals an error.

### **Files and Data Hierarchy**

We have to examine the levels of data, known as the data storage hierarchy. A file is made up of a group of related records. A

record is defined as a collection of related characters or bytes of data. And finally, a bite, or character of data as you know is made up of eight bits.

The files generally falls into two categories (1) files containing data(often referred to generally as data files) and (2) files containing software instructions(often referred to as generally as program files).Data files, in tern, tend to be categorized according to how they are used – as

a transition file;

a master file;

a report file

an output file;

history file(or backup file)

### **How is Data Stored?**

To store data for later use you need two things: a storage medium and a storage device. The process of recording data onto media which is coordinated by software involves four basic steps.

1. After input the data to be recorded by a storage device temporarily resides in main memory.
2. Software instructions determine where the data is to be recorded on the storage medium.
3. The controller board for the storage device positions the recording mechanism over the appropriate location on the storage medium.(For storage on disk the mechanism is referred to in the most cases as 1 read/write head.
4. The recording mechanism is activated and converts electrical impulses to magnetic spots placed on the surface of the medium as required to record the data according to the coding scheme being used (ASCII, for example).

## **Data Storage and Retrieval Method**

Most of us read a novel from the first page to the end of the book in sequence because we have an interest in following the story in the order that the author intended. However, in a catalogue you may wish to locate the information for just a single item. It would take much more time to locate the page you desired if you started at the beginning and read all the pages instead of looking up the item in the index. The same kind of principle applies to the storage and retrieval of data in computer – usable form.

The three principal methods of storing and retrieving the data are:

1. Sequential, meaning that records are stored and retrieved in sequential order.
2. Direct, meaning that records are not stored or retrieved in any special order.
3. Indexed sequential, a combination of the preceding two methods whereby records are stored in sequential order but with an index that allows both sequential and random retrieval.

### **TEXT B Tape Storage Devices**

Data are recorded across the width of a magnetic tape in rows of magnetic spots and spaces divided into columns – also called tracks or channels – that run the length of the tape.

Records can be recorded onto the tape one at a time or groups referred to as blocks.

Another magnetic tape provided a major improvement over punched cards in the secondary storage capabilities of computer systems, it has two major drawbacks. First, the data recorded on the tape cannot be practically altered – that is it cannot be updated



or changed in place. When records need to be changed, added in sequence, or deleted, a completely new tape must be created. Second, the data is recorded on the tape sequentially and can be accessed only sequentially. These limitations make magnetic tape less attractive for applications that require an update-in-place capability and access other than sequential.

However, despite its limitations, magnetic tape is still used widely today in minicomputer and mainframe computer systems. It remains an ideal medium for making portable backup copies of data stored on disk to enable business to recover from a data center disaster.

### **Diskettes: Easy Access**

One of the two most commonly used storage media in business is the diskette, also known as a floppy disk. Like magnetic tape diskettes are made of a special plastic that can be coated and easily magnetized. A disk is enclosed in a protective jacket. A disk jacket has four openings: (1) hub, (2) data access area, (3) write protect notch, and (4) index hole. To store and retrieve data from a diskette, you must place it into a disk drive.

The responsiveness of your computer depends to a great extent on the time it takes to locate the instructions or data being sought and then load a copy into the main memory.

The term access time refers to the average speed with which this is done. The average access time for diskettes ranges from 150 milliseconds (150 thousandths of a second) to 300 milliseconds, depending on the operating characteristics of the disk drive mechanism.

### **Hard Disks: Taking Giant Bytes**

The introduction of high capacity hard disks for microcomputer system solved two serious problems related to the limited storage capacity of diskettes. First, as a business begins to use microcomputers extensively, the amount of software acquired and data collected tends to grow substantially. As a result, the number of diskettes to be handled increases dramatically. Second, the largest file that can be accessed at one time is limited to the capacity of main memory and the storage medium. Hard disks can store much larger files. Hard disk drives for microcomputers can be internal (built into the computer cabinet and nonremovable) or external (outside the computer cabinet and connected to it by a short cable).

Microcomputer hard disk capabilities range from 10 MB to 1,000 MB (1GB) or higher. Hard disks with larger capacity allow the user to store larger files and larger programs than can be used with diskettes. Also the access time of diskettes is longer than that of hard disks.

### **Disk Cartridges**

Removable disk cartridges are an alternative to hard disk units as a form of secondary storage. The cartridges usually contain one or two platters enclosed in a hard plastic case that is inserted into a disk drive much like a music tape cassette. The capacity of these cartridges ranges from 5 to 30 MB, somewhat lower than hard disk units but still substantially superior to diskettes.

**TEXT C** Direct Access Storage. Devices For Large Computer Systems.

The data storage requirements for large computer systems are enormous compared to the needs of microcomputer-based applications. The access time and data transfer rate have to be much faster and the capacity of the disk storage devices must be considerably larger.

Today two main types of direct access storage devices are used with large computers: (1) removable disk packs and (2) fixed disks. Disk packs typically hold 6 to 12 platters that are usually 14 inches in diameter. The capacity of removable disk packs varies by manufacturer and ranges from 150 to 250 MB. A minicomputer system with four disk drives can have one billion characters of data on line – that is available at one time for direct access. The total storage capacity could be dramatically increased by having a dozen or so extra disk packs to be interchanged with the packs in the disk drives.

### **Mass Storage Systems and Optical Disks**

Mass Storage systems are composed of honeycomb-like cells that hold as many as 2,000 data cartridges, each of which can store 50 MB of data.

Mass storage systems are faster than regular tape-reel-based systems but they are slower than disk-only systems because the CPU must locate the cartridges needed and transfer the data to disk or main memory before it can process the data. Another faster kind of mass storage exists – optical disks. The most promising secondary storage technology, optical storage involves the use of a high-power laser beam to burn microscopic spots in an aluminum disk's surface coating. The capacity of optical disk systems is enormous compared with most magnetic disk storage devices. A 5 1/4-inch optical disk – the same size as a diskette – can

store between 800 MB to 1 GB.(One 800 MB optical disk = 13 60 MB tape cartridges = 40 20 MB hard disks = 111 7,2 MB diskettes.)

Following are the three main kinds of optical disks:

1. CD-ROM (compact disk/read-only memory). This optical disk's data is imprinted by the disk manufacturer. The user cannot erase it, change it, or write on the disk – the user can only “read” the data. This type of optical disk is used primarily for making huge amounts of prerecorded data – such as government statistics, encyclopedias, medical reference books, dictionaries and legal libraries – immediately available to the user.
2. WORM (write once, read many). WORM disks are also imprinted by the manufacturer, but the buyer can determine what is written on the disks. Once the disks have been written on, however, they can only be read from then on – again, no changes can be made.
3. Erasable optical disks. Erasable optical disks are an alternative to large capacity hard disks. In contrast to CD-ROM and WORM disks, erasable disks can be changed and erased. Many experts think that optical disk storage will become the most efficient, inexpensive and popular storage method. Some personal computers already have removable, erasable optical disk drives – such as NEXT computer and Tandy 5000 MC, which is compatible with IBM PC/2 microcomputers.

#### EXERCISES

1) Matching Match each of the following terms to the phrases that is the most closely related.

1. \_\_\_\_\_ binary code

2. \_\_\_\_\_ ASCII
3. \_\_\_\_\_ backup file
4. \_\_\_\_\_ byte
5. \_\_\_\_\_ .diskette
6. \_\_\_\_\_ .write/protect notch
7. \_\_\_\_\_ read/write head
8. \_\_\_\_\_ EBCDIC
9. \_\_\_\_\_ sequential storage and retrieval
10. \_\_\_\_\_ hard disk
11. \_\_\_\_\_ .removable disk pack
12. \_\_\_\_\_ tracks
13. \_\_\_\_\_ gigabyte
14. \_\_\_\_\_ cartridge-tape drive
15. \_\_\_\_\_ sector
16. \_\_\_\_\_ direct access

- a. This hardware device is a more efficient alternative to diskettes for backing up the contents of hard disks.
- b. Storage device typically used with mainframe computers that stores between 150 and 250 MB.
- c. Unit of measurement approximately equal to a character.
- d. Pie-shared “wedge” used for storage reference purposes.
- e. A billion bytes.
- f. Circular bands used for storage purposes.
- g. When this is covered data cannot be written onto a diskette.
- h. Copy of an original file.
- i. Scheme for encoding data using a series of binary digits.
- j. Data retrieval method best used in situations in which only a few records in a file need to be accessed.

- k. Direct access storage device used with microcomputers that has a much greater storage capacity than diskettes.
- l. Coding scheme widely used to represent data in microcomputers.
- m. Inexpensive storage device used with microcomputers.
- n. This coding scheme is widely used to represent data in mainframe computers.
- o. This component of a disk drive can convert magnetic spots to electrical impulses and vice versa.
- p. With this approach data is retrieved in the sequence in which it was recorded.

## 2) Multiple Choice

1. Which of the following is a unit of measurement used with computer systems?
  - a. byte
  - b. megabyte
  - c. gigabyte
  - d. kilobyte
  - e. all of above
2. Why do so many microcomputers today have hard disks?
  - a. can be moved easily from one computer to another
  - b. inexpensive
  - c. very high storage capacity
  - d. they are a sequential access storage device
  - e. all of the above
3. Hard disks and diskettes are:
  - a. sequential access storage devices
  - b. direct access storage devices

- c. rarely used with microcomputers
  - d. capable of storing terabytes of information
  - e. none of the above
4. Which of the following is the most appropriate unit for measuring the storage capacity of a hard disk?
- a. byte
  - b. megabyte
  - c. bit
  - d. terabyte
  - e. none of above
5. Which of the following statements is false:
- a. Secondary storage is nonvolatile.
  - b. Primary storage is volatile.
  - c. Secondary storage contains data for immediate processing.
  - d. When the computer is turned off data and instructions stored in primary storage are erased.
  - e. All of above.
6. Which of the following storage and retrieval methods would be well suited to your processing requirements if you only need to retrieve records one at a time and there is no fixed pattern to the requests for data and records?
- a. direct
  - b. sequential
  - c. indexed sectors
  - d. indexed direct
  - e. none of above
7. Which of the following factors would you disregard when determining the storage capacity of a hard disk?

- a. track density
- b. height of the hard disk drive
- c. recording density
- d. number of platters
- e. none of above

3) Understanding words. Refer back to the texts and give synonyms to:

- a. \_\_\_\_\_ limitation
- b. \_\_\_\_\_ to alter
- c. \_\_\_\_\_ updated
- d. \_\_\_\_\_ completely
- e. \_\_\_\_\_ widely
- f. \_\_\_\_\_ sequentially
- g. \_\_\_\_\_ deleted
- h. \_\_\_\_\_ extensively
- i. \_\_\_\_\_ to range
- j. \_\_\_\_\_ to acquire
- k. \_\_\_\_\_ to locate
- l. \_\_\_\_\_ total
- m. \_\_\_\_\_ to determine

antonyms to:

- a. \_\_\_\_\_ width
- b. \_\_\_\_\_ to retrieve
- c. \_\_\_\_\_ to increase
- d. \_\_\_\_\_ enormous
- e. \_\_\_\_\_ direct
- f. \_\_\_\_\_ removable
- g. \_\_\_\_\_ external



h. \_\_\_\_\_ compatible

5) Understanding Passage. Give short answers

1. What is the difference between primary and secondary storage?
2. What are the advantages of a hard disk over a diskette?
3. How is data represented in primary and secondary storage devices?
4. What is a mass storage system?
5. What happens to the data saved in secondary storage when the power to a computer is turned off?
6. How does the direct access storage and retrieval method relate to diskettes and hard disks?
7. Define what a file is by describing the data storage hierarchy?

4) Projects

1. What type(s) of storage hardware is currently being used in the computer you use at university or at work? What is the storage capacity of this hardware? Would you recommend alternate storage hardware be used? Why? Why not?
2. Research one of the newer technologies. How is this technology being applied now? How do you think it will be applied in future?

## **PROCESSING HARDWARE**

### **Unit Five**

## **Vocabulary**

to provide

to fit

register

control unit

execute

to carry out

to convert

machine language

to respond

to interpret

requirement

to involve

arithmetic/logic unit(ALU)

objective

execution cycle

instruction cycle

machine clock

data bus

semiconductor

integrated circuit

to expand

to utilize

buffer

**TEXT A** The Central Processing Unit

The Central Processing Unit (CPU) is the heart of the computer system. It is the most complex computer system component, responsible for directing most of computer system activities based on the instructions provided. As one computer generation has evolved to the next the size of the CPU has become smaller and smaller. The CPU circuitry of a microcomputer called a microprocessor fits on a chip about the size of your thumbnail, or even smaller.

The CPU has two main parts: (1) the control unit and (2) the arithmetic logic unit. The parts of the CPU are usually connected by an electronic component referred to as a bus, which acts as an electronic highway between them. To temporarily store data and instructions, the CPU has special-purpose storage device called registers.

#### Control Unit

The Control unit, a maze of complex electronic circuitry, is responsible for directing and coordinating most of the complex system activities. It doesn't execute instructions itself; it tells other parts of the computer system what to do. It determines the movement of electronic signals between main memory and the arithmetic/logic unit, as well as the control signals between the CPU and input/output devices.

The instructions carried out by control unit are converted by a language processor into a low-level form of instructions the computer can work with – machine language, the only language that the CPU can understand. In machine language data and instructions are represented in binary form and each type of computer responds to a unique version. Once the instructions have

been converted into this form, they can be retrieved from main memory and interpreted by the control unit. According to each specific instruction, the control unit issues the necessary signals to other computer system components as needed to satisfy the processing requirements.

### Arithmetic/Logic Unit

Without the arithmetic/logic unit computers would not be able to do most of the tasks that we find useful. The ALU performs all the arithmetic and logical functions – that is, it adds, subtracts, multiplies, divides, and does comparisons. The objective of most instructions that use comparisons is to determine which instructions should be executed next.

### Registers

A register is a special temporary storage location within the CPU. Registers are very quickly accept, store, and transfer data and instructions that are being used immediately. To execute an instruction, the control unit of the CPU retrieves it from main memory and places it into a register. This typical operations that take place in the processing of instructions are part of either the instruction cycle or the execution cycle. The instruction cycle and the execution cycle together, as they apply to one instruction, are referred to as a machine cycle. The CPU has internal clock that synchronizes all operations in the cycle. The speed is expressed in megahertz(MHz): 1 MHz equals 1 million cycles per second.

### Bus

The term bus refers to an electrical pathway through which bits are transmitted between the various computer components. Depending on the design of a system, several types of buses may be present. For the user, the most important one is the data bus,

which carries data throughout the CPU. The wider the data bus, the more data it can carry at one time, and thus the greater the processing speed of the computer.

### Main Memory

For many years main memory was one of the most expensive computer component to manufacture. However, technology has revolutionized main memory components over the past 40 so years. Their size has been drastically reduced, as they have become less expensive as the manufacturing materials have changed from vacuum tubes to magnetic cores to transistors and finally to the chips we know today. A tiny chip – also called semiconductor or an integrated circuit – revolutionized computer industry. But with each technological advance – which seem to occur almost every day – the microprocessor are becoming more and more powerful.

The principle function of main memory is to act as a buffer between the CPU and the rest of the computer components. The CPU can utilize only those software instructions and data that are stored in main memory. Main memory is random access memory, or RAM –data can be stored in and retrieved at random. Because main memory is a volatile form of storage that depends on electric power and the power can go off during processing, users often save their work frequently onto nonvolatile secondary storage devices such a diskettes or hard disks. In general, main memory is used (1) to store a copy of the main software program that controls the general operation of the computer; (2) to store a copy of the business application software you are using; (3) to temporarily store data that has been input from the keyboard or other storage device unit it is ready for processing; and (4) to

temporarily store data that has been produced as a result of processing it is ready for output or secondary storage.

If you have a microcomputer that needs to have its RAM expanded beyond 640 K to handle new types of software, you can purchase an add-on board, also called an expanded memory board, to “plug in” to the motherboard.

In general, a ROM chip stores instructions necessary to tell a computer what to do when it is first turned on. These instructions are installed by the manufacturer and generally cannot be changed by the user.

Certain types of ROM chips give users flexibility. Programmable read-only memory (PROM) chips allow you to put your own data and programs on them. Erasable programmable read-only memory (EPROM) chips can be changed by using a special ultraviolet light device; however, you have to take EPROM chips out of the computer to change the data and programs on them. Electrically erasable programmable read-only memory (EEPROM) chips can be changed without taking them out of the computer.

The processing power of a computer can be determined using the following factors: (1) addressing scheme, (2) register size, (3) data bus, (4) clock speed, and (5) the instruction set.

### EXERCISES

1). Matching. Match each of the following terms to the phrase that is the most closely related.

- a. \_\_\_\_\_ machine language
- b. \_\_\_\_\_ central processing unit
- c. \_\_\_\_\_ machine cycle

- d. \_\_\_\_\_ RAM
- e. \_\_\_\_\_ main memory
- f. \_\_\_\_\_ ALU
- g. \_\_\_\_\_ add-on memory  
board
- h. \_\_\_\_\_ ROM
- i. \_\_\_\_\_ microprocessor
- j. \_\_\_\_\_ register
- k. \_\_\_\_\_ clock speed
- l. \_\_\_\_\_ semiconductor
- m. \_\_\_\_\_ control unit
- n. \_\_\_\_\_ bus

1. The only language that the CPU understands.
2. Read-only memory.
3. Electronic pathway.
4. Temporary storage location within the CPU.
5. Random access memory.
6. The "brain" of the computer.
7. Instruction cycle and execution cycle together.
8. Hardware component responsible for directing and coordinating most of the computer system activities.
9. Storage area outside the CPU where data and instructions needed by the CPU are held temporarily.
10. Material used in chips to form electric circuits.
11. CPU circuitry of a microcomputer.
12. Refers to the speed with which a computer performs operations.
13. Technology developed so microcomputers could use more than 640 K main memory.

14. Hardware component of the CPU that performs mathematical calculations and logical comparisons.

2). Multiple Choice.

1. Which of the following holds data and processing instructions temporarily until the CPU needs it?

- a. ROM
- b. control unit
- c. main memory
- d. coprocessor chips
- e. none of the above

1. Which of the following are the two main components of the CPU?

- a. control unit and registers
- b. registers and main memory
- c. control unit and ALU
- d. ALU and bus
- e. none of the above

1. Which of the following is used for manufacturing chips?

- a. control bus
- b. control unit
- c. parity chips
- d. semiconductors
- e. none of the above

1. Which of the following is the most characteristic of ROM?

- a. It is measured in megabytes.
- b. It is volatile.
- c. It performs mathematical calculations.



- d. Instructions are stored there permanently.
  - e. none of the above.
1. Which of the following hardware components is the most volatile?
- a. ROM
  - b. RAM
  - c. PROM
  - d. EPROM
  - e. EEPROM
1. Which of the following is used to check for errors in RAM chips?
- a. microprocessor chip
  - b. ROM chip
  - c. parity chip
  - d. EPROM chip
  - e. none of the above
1. Which of the following is used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU?
- a. microprocessor
  - b. register
  - c. ROM chip
  - d. data bus
  - e. none of the above
1. Why is the width of a data bus so important to the processing speed of a computer?
- a. The narrower it is, the greater the computer's processing speed.

- b. The wider it is, the more data that can fit into main memory.
- c. The wider it is, the greater the computer's processing speed.
- d. The wider it is, the slower the computer's processing speed.
- e. The data bus isn't important to the processing speed of a computer.

1. Which of the following terms is the most closely related to main memory?

- a. nonvolatile
- b. permanent
- c. control unit
- d. temporary
- e. none of the above

1. Which of the following affects processing power?

- a. data bus capacity
- b. addressing scheme
- c. clock speed
- d. register size
- e. all of the above

3) Short answers.

- 1. What is the purpose of main memory?
- 2. What is the difference between the traditional ROM chip and some of the newer ROM-type chips (PROM, EPROM, EEPROM)?
- 3. What led to the development of add-on memory boards?
- 4. What is a microprocessor? a semiconductor?

5. Is it faster to retrieve data from main memory than from a disk storage device?
6. What are the main factors affecting the processing power of a computer?
7. What would be a good indication that two computers are incompatible? Why is knowing this important to you?
8. What is the function of the control unit in a computer system? Does every computer require one?

4) Understanding Words. Refer back to the text and find synonyms to:

- a. \_\_\_\_\_ to perform
- b. \_\_\_\_\_ tremendously
- c. \_\_\_\_\_ useful
- d. \_\_\_\_\_ objective (n)
- e. \_\_\_\_\_ at once
- f. \_\_\_\_\_ progress
- g. \_\_\_\_\_ sophisticated
- h. \_\_\_\_\_ to handle
- i. \_\_\_\_\_ to produce
- j. \_\_\_\_\_ to utilize
- k. \_\_\_\_\_ general
- l. \_\_\_\_\_ to install

antonyms to:

- a. \_\_\_\_\_ beyond
- b. \_\_\_\_\_ to reduce
- c. \_\_\_\_\_ frequently

5) Projects.

1. Advances are made almost every day in microprocessor chip technology. What are some of the most recent advances?

In what computers are these chips being used?

How might these advances affect the way we currently use microcomputers? Research the latest advances by reviewing the most current computer magazines and periodicals.

2. Research the current uses of and the latest advances in ROM technology. How do you think ROM technology will affect the way we currently use microcomputers? Will we see a lessened need for storage media?

## **Output Hardware**

### **Unit Six**

#### **TEXT A**

To be effective, information must be produced in a usable form. To achieve this goal, you may need to use more than one output device and output medium, such as a display on a video screen as well as paper and printer. Each type of output device has advantages and disadvantages. There are two basic categories of computer-produced output: output for immediate use by people and output that is stored in computer-usable form for later use by computer (and eventually, by people). Output can be in either hardcopy or softcopy form. Hardcopy, as defined earlier, refers to information that has been recorded on a tangible medium such as paper or microfilm. Softcopy generally refers to the output displayed on a computer screen.

The main hardcopy output devices are printers and plotters. Printers are categorized according to whether or not the image produced is formed by physical contact of the print mechanism with the paper. Impact printers make contact; nonimpact printers do not. A letter-quality printer, like a typewriter, press fully formed characters against the ribbon. A dot-matrix printer uses separate pinlike hammers to form characters out of dot patterns.

The high volume output requirements of most large computer installations cannot be satisfied by dot-matrix or letter-quality printers. Large computer systems often use special high-speed printers, called line printers, because they print a whole line at a time.

The main categories of nonimpact printers are ink-jet printers, thermal printers, and laser printers. These printers make much less noise than impact printers, but they cannot be used to generate carbon copies. Laser printers work somewhat like photocopying machines. They print a page at a time and can produce very high quality images, so they are often used for graphics.

A plotter is most often used for producing graphics because it can output free-form drawings on paper in colour.

The main softcopy output devices are cathode-ray tube (CRT) video screens and flat video screens. Computer output microfilm/microfiche systems and voice output systems are sometimes considered to be softcopy output systems, but we categorized them as hardcopy.

The most notable disadvantages of CRT's are their large size, their high rate of power consumption, and their fragility. The disadvantages of the CRT and rising interest in portable and laptop computers led to the development of flat screen

technology, which is becoming a favoured alternative to the CRT. The most common types of flat panel displays are liquid crystal display (LCD), electroluminescent (EL) display, and plasma display.

As with input and storage, care must be taken to ensure that output is responsibly generated, shared and disposed of. Control methods should be established to ensure that only authorized users see sensitive output and that output is properly secured.

### EXERCISES

#### 1). Matching

Match each of the following terms to the phrase that is the most closely related.

1. \_\_\_\_\_ plotter
  2. \_\_\_\_\_ CRT
  3. \_\_\_\_\_ impact printers
  4. \_\_\_\_\_ raster scan rate
  5. \_\_\_\_\_ liquid crystal
  6. \_\_\_\_\_ resolution
  7. \_\_\_\_\_ laser printer
  8. \_\_\_\_\_ nonimpact printers
  9. \_\_\_\_\_ monochrome monitor
  10. \_\_\_\_\_ pixel
  11. \_\_\_\_\_ voice output system
  12. \_\_\_\_\_ output controls
- a. Rate at which data can be sent to the electron gun to control its movement, positioning or firing.
  - b. Specialized hardcopy output device designed to produce high-quality graphics in a variety of colours.

- c. Image clarity.
- d. The higher this is, the better the image quality will be on video display.
- e. Cathode-ray tube.
- f. Monitor that can display more than one colour on a solid background.
- g. Printers that strike the characters against ribbon on paper when they print.
- h. A few advantages of this type of printer are very high speed, low noise level, and high image quality.
- i. A glowing phosphor, or picture element.
- j. These are usually established within an organisation to ensure that output is viewed only by authorised users.
- k. Component of a computer that talks to you.
- l. This type of display technology is often used in laptop computers.

## 2). Multiple Choice

- 1. Which of the following is used to insure the high quality of computer output?
  - a. voice output systems
  - b. output controls
  - c. computer output microfilm
  - d. liquid crystal display
  - e. none of the above
- 1. Which of the following technologies will you likely see in laptop computers?
  - a. voice output systems
  - b. output controls

- c. computer output microfilm
  - d. liquid display
  - e. none of the above
1. Which of the following can be output by a computer?
- a. graphics
  - b. voice
  - c. text
  - d. computer-usable information
  - e. all of the above
1. Output hardware is often categorized according to whether it:
- a. is expensive.
  - b. requires a large amount of electricity to work.
  - c. produces hardcopy and softcopy.
  - d. can fit on a desktop.
  - e. none of the above.
1. Large computer systems typically use:
- a. dot-matrix printers.
  - b. daisy wheel printers.
  - c. ink-jet printers.
  - d. line printers.
  - e. all of the above.
1. To produce high-quality graphics (hardcopy) in colour, you would want to use a :
- a. RGB monitor.
  - b. plotter.
  - c. ink-jet printer.
  - d. laser printer.



e. all of the above.

### 3). Projects

1. Prepare an outline that indicates all the factors a user should consider when he or she is preparing to buy a printer.

2. Review some of the current computer publications relating to printers. What is new in printer technology? Is this technology typically used with microcomputers? Mainframe computers? All types of computers?

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