**COMPUTER HARDWARE**

**Computer hardware** refers to the physical and tangible parts of the computer system.

OR: describe the physical components of a computer that can be touched and seen like keyboard, printers, mouse, e.t.c

**Examples of hardware components**

1. Keyboard
2. Printers
3. Mouse
4. Monitor
5. System unit e.t.c

**Examples of internal hardware components (components inside the system unit)/internal components of computer hardware**

1. RAM (Random Access Memory)
2. Power supply
3. Motherboard
4. Hard disks
5. CPU(Central Processing Unit)
6. 6.ROM chips

**TERMINOLOGIES**

**1. System configuration** refers to the connection and setup of hardware and software components to form a complete functioning computer. The basic parts that make up a functioning personal computer are: the system unit, monitor, keyboard and mouse.

**OR system configuration** describes the way the physical elements of a computer ad its peripherals are interconnected.

2**. Computer peripherals/Peripheral devices** are all devices being attached /connected to the computer e.g keyboard, monitor, printers, mouse, scanner, etc

**CATEGORIES OF COMPUTER HARDWARE**

INPUT DEVICES

These are hardware components that allow a user to enter data and instructions into a computer.

**According to the type of data they input, they can be grouped into the following:**

1. Text input devices
2. Pointing input Devices
3. Imaging input Devices
4. Gaming input Devices
5. Audio input Devices
6. Biometric input Devices and
7. Other Specialized input devices

**A) TEXT INPUT DEVICES**

**Text** is a general word for all characters such as letters, numerical digits, symbols and marks that combine to form words, sentences, paragraphs and so on.

**Examples of Text input devices**

1. The keyboard,
2. Voice Recognition Equipment
3. OMR and Barcode readers
4. OCR and Optical readers
5. MICR readers
6. RFID readers
7. Magnetic Strip Card Readers, etc.

**THE KEYBOARD**

A keyboard is an input device, consisting of a set of keys (buttons) used to operate a computer. Each press of a key corresponds to a single written character of text, but to produce some symbols

NB **A keyboard is the main and most reliable computer input device**

**TYPES OF KEYBOARDS**

1. QWERTY keyboards. These have the 6 alphabets (Q, W, E, R, T, Y) in the first row of the keyboard.
2. AZERTY keyboards. These have the 6 alphabets (A, Z, E, R, T, Y) in the first row of the keyboard

**The keyboard is divided in five (5) main sections namely**

: i) type writer area ii) function keys iii) numeric pad iv) cursor keys v)special purpose keys.

**1) The type area.** This consists of keys button that are labeled A-Z used to construct document. The numbers 0-9 are also part of the typewriter area keys.

**ii) Function keys/programmable keys.** They are labeled F1 to F12. These keys are normally used to issue commands.

iii) **Cursor movement keys** are used to move the cursor around the screen. The cursor is the symbol on video screen that shows where the text character that is input will be positioned.

iv) **Numeric keypad.** It combines cursor keys, number labeled buttons, and other special purpose keys

When you turn the “num lock” key off your microcomputer system assumes that the keys will be used for cursor movements

When the “num lock” key is on, you can use the number keys.

v) **Special purpose keys.** They include:

1. shift key
2. caps lock key
3. Num lock key
4. Enter ( return) key
5. Back space key
6. delete key
7. control (Ctrl) key
8. page up( pg up) key
9. page down( pg Dn) key

1. **Caps lock Keys.**  It is used to lock characters A to Z to uppercase position when pressed once.

To release the upper case mode you press caps lock key once again.

NB the caps lock light comes on when locked in uppercase and off when in lowercase.

**2 Enter key**

* it is used to confirm to the computer whatever is typed i.e when command is issued it can only be executed after pressing enter key.
* In other operations like word processing, it helps in starting a new paragraph by striking the Enter key once.

3. **Back space key.** It is used to erase the character to the left creating spaces as it does so. In other words,it erases the typed text leftwards.

4. **Delete key.** Is used to erase typed text right wards.

**5. Shift key**. This is used to shift the alphabetical keys **A** to **Z** to uppercase mode when the caps lock key is off and vice versa. For all the other keys in the typewriter area, holding the shift key down, causes the characters shown at the upper portion to be obtained.

**6. Alt key (Alternate key)**. This key is used to change or alternate the function of other pressed keys

**7. Tabulation (Tab) key**. This places data in columns with smooth margins, moves the cursor from one field to another in a table, adds a new row on the table (place the cursor in the last row and press Tab key to add new row), Shift+Tab moves the cursor to the previous field in the table.

**NB Method of Connection of keyboard**; The keyboard can be connected to the system unit through the USB or PS/2 ports.

**NB Terminals** is a device that consists of keyboard, video display screen, and a communication line to a large (usually mainframe) computer system.

OR A terminal is a device with a monitor and key board. The term terminal can also refer to any device that sends and receives computer data.

**There are two types of terminals**

i) **Dump terminal** it can be used only to input data and to receive information from a computer system. NB dump terminal cannot do any processing on its own.

ii) **Smart terminal** also known as x-terminal. it can input, output, and sometimes processing capability and RAM. Example of it is point of sale terminals in supermarket.

**Uses of terminals**

**i) An EPOS (Electronic Point Of Sell)**

Terminal is used to lead purchase at the point where the consumer purchases the produce or services

**ii) EFTPOS (Electronic Fund Transfer Point of Sell)**

Terminal are able to transfer funds from a customer bank account direct to a retile out lets account after reading the customer debit card. Automatic teller machines attached to host computer through a telephone network

**Functions of a Keyboard**

1. It is used to input data into a computer.
2. It can be used to command the computer to perform an operation using the special purpose keys
3. It is a major interface between the computer and the user which enables the two to communicate effectively

**Advantages of Using Keyboards for Data Input**

1. It is not necessary to buy additional equipment since computer systems are supplied with keyboards
2. Entering data and instructions with keyboards is generally faster than with pointing devices.
3. Keyboards are more reliable and usually produce fewer errors than other input devices.

**Disadvantages of Using Keyboards for Data Input**

1. It takes a lot of time to practice in order to type quickly and accurately.
2. Typing speeds are still very slow when compared with computer speeds
3. The process of data input is slow due to the slow typing speed of the user.

**2. Voice Recognition Equipment**

Voice Recognition Equipment converts spoken words to text.

Computers with Speech recognition do not actually understand speech, but they are programmed to recognize a vocabulary of words, which can range from two words to millions of words.

**Advantages**

* No typing of data is necessary.
* Voice recognition can be used by people whose hands are disabled.
* Dictating text is faster than typing.
* Voice Recognition systems are also ideal for the blind.

**Demerits of text input by speech Recognition**

* Error rate is high, depending on user’s accent.
* Words with the same pronunciations (Homophones) like see and sea cannot be distinguished
* Speech Recognition does can’t work in noisy environment
* It requires the user to speak in a writing style, i.e. even pronouncing the marks such as comma.

**3. *Optical mark recognition (OMR)***

* *Optical mark recognition (OMR) devices read hand-drawn* marks such as small circles or rectangles
* A person places these marks on a form, such as a test, survey, or questionnaire answer sheet.
* The OMR device first reads a master document, such as an answer key sheet for a test, to record correct answers based on patterns of light;

**4. Bar-code readers**

* A *bar code reader is an optical* reader that uses laser beams to read bar codes that are printed on items usually in super markets.
* A bar code is an identification code that normally consists of a set of vertical lines and spaces of different widths.
* The bar code represents some data that identifies the item and the manufacturer.

**Advantages of Barcode Readers**

* The process of data entry is fast and accurate.
* Barcodes can be printed by normal printing methods
* There is no need to write down or key in the name of the item or its actual price and other details

**Disadvantages of Using Barcode Readers**

* Only numbers can be easily coded
* Barcodes cannot be read directly by people.

***5. Optical character recognition (OCR)***

* Isa an input device that reads pre-printed characters in a particular font (typeface design) and converts them into digital code.

**6. Magnetic Strip Card Readers**

* A *magnetic stripe card reader reads the magnetic stripe on the back of credit* cards, bank ATM cards, and other similar cards.
* Exposure to a magnet or magnetic field can erase the information and contents of a card's magnetic stripe.

**B) POINTING DEVICES**

A pointing device is an input device, which allows users to move a pointer and make selections on the computer screen.

OR These are input devices that allow a user to input continuous and multi-dimension data into a computer.

**Examples of pointing devices**

* Mouse
* Stylus pen & digitizing tablet
* Cordless Mouse
* Trackball
* Touchpad
* Light pen
* Touch Screen
* A Track Point

**1. The Mouse**

The mouse is a hand held device that lets you point to and make selections of items on your screen.

Most mice have got two or more buttons, i.e. left button, scroll wheel and right button.

**Advantages of Using a Mouse**

* A mouse is user-friendly for computer beginners.
* A mouse is easy and convenient to use with a graphical user interface
* Using a mouse to select items or move to a particular position on the screen is faster than using a keyboard.

**Disadvantages of Using a Mouse**

* It is not easy and convenient to input text with a mouse.
* Issuing commands using a mouse is slower than using a keyboard
* It needs practice to control the mouse properly
* A mouse usually requires a flat surface to operate. It also needs more desk space to operate.

**NB. Method of Connection**; The mouse can be connected to the system unit through the USB or PS/2 ports

**Mouse Techniques and Language**

* Point. To move the mouse until the on-screen pointer is over a particular area.
* Click. To press and release the left mouse button quickly. A click selects an item on the screen.
* Right click. To press and release the right mouse button quickly. This brings a menu with options to choose from
* Double click. To press & release the left mouse button twice consecutively. This opens a file, or starts a program
* Drag. To press and hold down the left mouse button, while moving the mouse, to move the on-screen pointer to a new location on the screen. This moves the selected item to a new location.
* Drop. To release the left mouse button after a drag. Therefore, *drag and drop* moves the selected item and places it in a new location.
* Scroll. This brings the hidden items into view if the window contains more items than can fit in the visible work area.
* Mouse pointer. Is a small arrow-like graphic, on a computer screen that shows the position of a mouse. The mouse uses the mouse pointer to select, move and control data items on the screen.

**2. STYLUS PEN & DIGITIZING TABLET**

* Stylus pen- The pen lets you draw on what is called a digitizing tablet that mirrors the surface area of the computer screen.
* The pen is useful for drawing since drawing graphics with a mouse tends to be somewhat difficult.

**3. TRACKBALL** is a movable ball, on top of the stationary device, that is rotated with fingers or a palm of the hand. A trackball is like a mouse turned upside-down.

**4. TOUCHPAD**

Is a surface that is sensitive to pressure and motion.

When you move your finger tips across on the pad, the pointer moves in the same direction. Common on laptop computers

**5. LIGHT PENS**

Is a pointing device that can detect the presence of light. It allows the user to point to displayed objects, or draw on the screen, in a similar way to a touch screen but with greater positional accuracy.

**6. TOUCH SCREENS**

* A touch screen is a touch-sensitive input and display device. Users can interact with these devices by touching areas of the screen.
* E.g Many ATMs (automated teller machines) have touch screens.

**Advantages of Touch Screens**

1. They do not need as much desk space as a mouse, since they are built into the monitor
2. They can use either buttons or taps of the pad for clicking
3. They have finer resolution.

**Disadvantages of Touch Screens**

1. The hand becomes tired faster than when using a mouse since there are no supports.
2. They are tiresome if many choices must be made
3. They take a lot of screen space for each choice, since fingers are bigger than cursors.

**7. TRACK POINT**

A Track Point, also called a pointing stick, is a cursor control device located in the middle of the keyboard between the G, H, and B keys. The Track Point is operated by pushing in the general direction the user wants the cursor to move.

**8. JOYSTICK & GAMEPADS**

A joystick is a pointing device with a vertical lever mounted on a base. Joysticks and gamepads are also known as ***game controllers***. Joysticks are used for ultrasound scanners in hospitals, computer games like driving games, flight simulators and controlling machines

***QUESTION: Name any two computers impute devices other than a keyboard and mouse.***

**C) IMAGING DEVICES**

Imaging input Devices are devices that input images such as still photos, motion pictures, graphics, video etc. into the computer for processing.

**Examples of Common Imaging devices**

1. Image scanner
2. Digital Camera
3. Digital video (DV) camera
4. Camcorder Web cam

**1. IMAGE SCANNER**

* A scanner is a light-sensing input device that converts hardcopy documents, drawings, or pictures to an electronic version (softcopy), which can then be stored on a disk.
* The electronic version of scanned material is in the form of rows and columns of dots called a *bitmap*
* Each dot on a bitmap consists of one or more bits of data.

**Common types of scanners include:**

* Flatbed scanner
* Pen or handheld scanner
* Sheet bed scanner
* Drum scanner.

**2. DIGITAL CAMERA**

* A digital camera allows users to take pictures and store the photographed images digitally instead of storing on a traditional film.

**Advantages of Using a Digital Camera over Ordinary Film Cameras**

* It saves money for buying films and developing costs in the long run
* Images taken using a digital camera can be viewed and even edited
* Unwanted images can be deleted immediately after the preview

**Disadvantages of a Digital Camera**

* Digital cameras are normally expensive than ordinary film cameras with similar functionality.
* Photo printing cost for digital cameras is generally higher than that for ordinary film cameras

**3. DIGITAL VIDEO (DV) CAMERA**

* A *digital video (DV) camera, by contrast records* video as digital signals instead of analog signals.

**4. CAMCORDER**

This is a light weight video camera that records data in digital form onto a storage device such as a videotape.

**5. WEB CAMERA (Webcam)**

A *Web cam, also called a PC video camera, is a* type of digital video camera that usually sits on top of the monitor. Some laptop computers have built-in Web cams.

**Webcams enable users to:**

* capture video and still images,
* send e-mail messages with video attachments,
* add live images to instant messages,
* broadcast live images over the Internet,
* and make video telephone call

**CCTV CAMERAS** (***Closed Circuit Television Cameras***)

These produce images or recordings for surveillance purposes, and can be either video or digital still cameras. They are installed on the building, and they forward their input to the computer they are connected to. They are majorly used for security purposes (surveillance) in supermarkets, stores, factories, banks and in big offices.

**GAMING INPUT DEVICES**

***Gaming input devices are devices specifically designed to be used for playing computer games***

1. *Examples Include:*
2. *Gaming keyboard*
3. *Gaming* wheels
4. Joysticks
5. Game pad
6. Light guns
7. Dance pad
8. Motion sensing game controllers

***1. Gaming keyboard***

* *Gaming keyboards* typically include programmable keys so that gamers can customize the keyboard to the game being played.

**2. Gaming wheels**

* A gaming wheel is a steering wheel-type input device. Users turn the wheel to simulate driving a vehicle using programs on a computer.

**4. Joystick**

* Joystick- Consists of a stick that pivots on a base and reports its angle or direction to the device it is controlling. Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer.

**5. Gamepad**

* A *gamepad controls the movement and actions of players or objects in video games or computer games.*

**7. Dance pad.** A *dance pad is a flat electronic device divided into panels that users press with their feet in response to instructions from a* music video game.

* These games test the user’s ability to step on the correct panel at the correct time, following a pattern that is matching with the beat of a song.

**E) AUDIO INPUT DEVICES**

* ***Audio input*** *is the process of entering any sound into the computer* such as speech, music, and sound effects.
* To enter sound into a computer, it must have a sound card.
* Audio input devices are plugged into a port on the sound card.

**Examples of audio input devices include**

* Microphones,
* Tape players,
* CD/DVD players,
* MIDI devices
* Dictaphone,E.t.c

**1. Sound Card**

A device that can be slotted into a computer to allow the use of audio components for multimedia applications. Without a sound card, Audio input and output is not possible

**2. Microphones**

A microphone is an instrument for converting sound waves into electrical energy variations, which may then input into the computer for processing, recording or audio playback.

**3. MIDI devices**

* *MIDI (musical instrument digital interface) is* the standard that defines how digital musical devices represent sound electronically.
* MIDI devices such as electronic pianos allow users to record and edit music

**4. Dictaphone**

* This the earliest device most commonly used to record speech for later playback or to be typed into print.
* It was established by Alexander Graham Bell in Washington, D.C. in 1881.

**BIOMETRIC INPUT DEVICES**

A *biometric device translates a biological personal characteristic into a digital code that is stored or compared with a digital code stored in the* computer

**Common biometric devices include:**

* Fingerprint scanner
* Face Recognition systems
* Hand geometry systems
* Signature verification systems
* Iris Recognition systems

**1. Fingerprint scanner**

A fingerprint scanner captures curves and indentations of a fingerprint.

**2. Face Recognition systems**

A *face recognition system captures a live face image and compares it with a stored image to determine if the person is a* legitimate user.

Some buildings use faces recognition systems to secure access to rooms.

***3. Hand geometry system***

* Biometric devices measure the shape and size of a person's hand using a *hand geometry system.*
* Day-care centers use this system to verify parents who pick up their children.

**4. Signature verification systems**

* A signature verification system recognizes the shape of your handwritten signature, as well as measures the pressure exerted and the motion used to write the signature.

***5. Iris recognition system***

* These are devices that use *iris recognition technology* to read patterns in the iris of the eye.

**G) OTHER SPECIALIZED INPUT DEVICES**

* There are many other special input devices that are used for doing special customized tasks. Some of them include:
* Remote Control
* Sensors e.t.c

**1. Remote Control**

* Remote control devices emit a beam of infrared light, which carries data signals.
* Remote control is commonly used with TVs but many laptop computers being produced come with remotes and a form of input device, which allow you to operate the laptop from a distance**.**

**2. Sensors**

Chemical responses to the physical environment or movement can be converted to electrical signals by devices known as sensors, which input them it to the computer for processing.

Various sensors can be used to measure heat, light, pressure, acidity, oxygen concentration, water flow, etc.

When sensors are located at some distance from the computer system, they are known as *Remote Sensors.* **Examples of sensor** applications include; freezers and chillier cabinets in buildings, smoke sensors, among others.

**PROCESSING HARDWARE**

Devices inside the system Unit:

1. The system Unit
   * Definitions, Components and parts.
2. The Motherboard
   * Definitions, Components and parts.
3. The Central Processing Unit CPU
   * + Definitions, Components and parts.
4. Memory (internal/primary storage)
   * RAM and ROM, Memory Cache, CMOS,
   * Units of Measuring Computer Memory
   * Computer Data representation & numbering systems

**PROCESSING DEVICES**

**Processing devices are the computer electronic components and chips housed in the system unit.**

**A. THE SYSTEM UNIT**

This is a metallic case containing the electrical components of the computer that carry out processing function. ***The components of the system unit include***: motherboard, power supply, drives, CPU, CMOS battery, RAM chip, BIOS chip, heat sink, and peripheral device interfaces (Internal hardware components)

**POWER SUPPLY**

This controls the power of different components. It converts the Alternating Current (AC) to Direct Current (DC) that can be used by the internal components in the system unit. The power supply contains a fan that provides a cooling system in it.

**HEAT SINK**

This is a mechanical component for providing a cooling system to the processor. All electronic circuits produce heat generated by the movement of electrons. Therefore, an effective cooling system is necessary to avoid damaging the computer hardware.

**NB: DRIVES**

A drive is a device that reads data from a storage medium and writes data to a storage medium**. Examples of drives include**; Compact disk drive (CD drive), Digital Versatile Disk drive (DVD Drive), Floppy Disk Drive (FDD), Hard Disk Drive (HDD), and Zip Drive.

**COMPONENTS INSIDE THE SYSTEM UNIT WHICH CAN BE REPLACED OR UPGRADED**

1. The CPU (When the Computer is Slow)
2. RAM chip (When the Computer is Slow)
3. Hard disk drive
4. CD and DVD Drive

**A) The motherboard**

* This is a flat circuit board where the other electronic components in the system unit are attached.The motherboard is alsothe system board or circuit board or main board.
* It houses the CPU, controller circuitry, bus, RAM, expansion slots for additional boards, and ports for external devices. In addition, it contains the CMOS, other ROM chips, BOIS chips and support chips providing varied functionality.

**COMPLEMENTARY METAL-OXIDE SEMICONDUCTOR (CMOS)**

CMOS is a special memory for storing a computer’s configurations including time and date. It is powered by a special battery known as the ***CMOS battery*** similar to that of a digital watch, which resides on the motherboard.

**Configurations Held in the CMOS**

1. Current date, time, and power saving settings
2. Floppy disk and hard disk drive types
3. Nature and type of keyboard, mouse,
4. CPU information, and RAM size
5. Serial and parallel port information
6. Plug and play information

**BIOS CHIP**

The BIOS chip is a type of permanent memory (ROM) which holds instructions, which tell the computer how to load its operating system and helps the operating system to manage other computing resources. It is usually marked “BIOS” on the motherboard. **Basic Input Output System (BIOS);** refers to the instructions and data in the BIOS chip that control the boot process and the computer hardware.

**FUNCTIONS OF BIOS**

1. BIOS performs POST during the booting process and controls all the aspects of the boot process
2. Providing the computer with the basic instructions to control devices in the system
3. Locating any BIOS codes on expansion cards and executing them
4. Producing audio and video errors codes, when there is a problem during the POST
5. Locating a volume or boot sector from any device to start the operating system

**Expansion slots and Adapter cards**

* An *expansion slot is a socket on the motherboard that* can hold an adapter card.
* An *adapter card, also called* expansion card, is a circuit board that increases the capabilities of the system or provides connections to peripherals.
* Some motherboards include all necessary capabilities and do not require adapter cards.
* Adapter cards are used for many supplemental capabilities, such as more memory, higher-quality sound devices, a modem, extra ports, or graphics capabilities.

**Commonly used adapter cards and their functions**

|  |  |
| --- | --- |
| 1. **Ada pter Card** | 1. **Purpose** |
| 1. **Sou Sound card** | 1. Connects speakers or a microphone |
| 1. **MIDI card** | 1. Connects musical instruments |
| 1. **Net Network interface card (NIC)** | 1. Connects other computers |
| 1. **Video card** | 1. Connects a monitor |
| 1. **USB card** | 1. Connects USB devices |
| 1. **TV tuner card** | 1. Allows viewing of television channels |
| 1. **Video capture card** | 1. Connects a video camera |
| 1. **Mo Modem card** | 1. Converts telephone or cable analog signals to digital and vice versa |
| 1. **FireWire card** | 1. Connects FireWire devices |

***Plug and Play (PnP)***

* ***PnP refers to the computer’s***capability to automatically configure adapter cards and other peripherals as you install them when the computer is still running.

**Buses**

These are electronic channels that are used to transfer instructions data between the different components inside the CPU and those outside the CPU.

* The bus is a common electrical path that *enables data flow between the various system components.*
* A *bus allows the various devices inside and* attached to the system unit to communicate with each other.

**All buses consist of two parts:**

* ***The data bus*** *which transfers* actual data bits and
* **The address bus** which transfers information about where the data should go in memory**.**

**T*he types of buses includ*e**:

1. Data bus. This is a two-way bus which carries data going into the CPU and the results coming out.
2. Address bus. This is a one-way bus which carries addresses from the CPU to the memory or other devices

Control bus**. This carries control signals which control the operations of the CPU**

**Ports**

**A *port*** *is the point at which a peripheral attaches the* system unit.

* Through a port, the peripheral can send data to or receive information from the computer.

**Common ports**

* **A serial port** is a type of interface that connects a device to the system unit by transmitting data one bit at a time. It usually used to connect devices that do not required fast data transmission rates, such as a mouse or keyboard.
* **Parallel ports** allow the parallel transmission of data; that is, several bits are transmitted simultaneously. These ports provide the interface for such devices as high-speed printers.
* ***USB (Universal Serial Bus)*** *ports are used in high-speed device interfaces.*
* Bluetooth ports use radio waves to transmit data between two devices, without using cables.

**Connectors.** A *connector joins a cable to a port.* *A connector at one* end of a cable attaches to a port on the system unit, and a connector at the other end of the cable attaches to a port on the peripheral.

* Most connectors are available in one of two genders: male and female.
* Male connectors have one or more exposed pins.
* Female connectors have matching holes to accept the pins on a male connector.

***Power Supply and Cooling Technology***

* The power supply is the component of the system unit that converts the wall outlet AC to DC power
* Built into the power supply is a fan that keeps the power supply cool.

**A heat sink** is a small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components such as a processor

**C) THE CPU**

* The *central processing unit (CPU) is a chip that* interprets, carries out the basic instructions and manages most of a computer's operations.
* It is at times referred to as the ‘**brain’ of the computer** OR It is also known as the **microprocessor or the processor.**
* It has two basic sections: the control unit (CU) and the arithmetic/logic unit (ALU), which work together to perform the processing operations.
* *Other CPU components are the Registers and the System Clock.*

**PARTS OF A CPU**

The CPU is made up of five parts, namely; control unit, arithmetic and logic unit, registers, buses, and the *System* clock.

**CONTROL UNIT**

* The *control unit is the component of the processor that directs and* coordinates most of the operations in the computer.
* It interprets each instruction issued by programs and then initiates the appropriate action to carry out the instruction.
* For every instruction, the control unit repeats a set of four basic steps called the **machine cycle steps:**

***The control unit has the following functions***;

1. It directs the flow of information between the CPU and memory.
2. It decodes input instructions during the machine cycle.
3. It controls which instructions the CPU will do next

**ARITHMETIC AND LOGIC UNIT (ALU)**

* The ALU performs the arithmetic, comparison, and logical operations in a computer.
* It performs the execution step of a machine cycle.
* *Arithmetic operations include addition,* subtraction, multiplication, and division.
* *Logical operations work* with conditions and logical operators such as AND, OR, and NOT.

**FUNCTIONS OF THE ARITHMETIC AND LOGIC UNIT (ALU)**

1. It performs the arithmetic operations in the CPU, i.e. addition, subtraction, multiplication and division
2. It performs the logical comparisons of values, e.g. greater than, equal to, less than, less or equal, not equal

**REGISTERS**

This is the part of the CPU that stores data and instructions being processed temporarily. Types of registers are:

1. Program counter register. It holds the address of the memory location from which the next instruction is to be fetched
2. Current instruction registers. This holds the instruction being executed.
3. Instruction decoder registers. This interprets instructions being held in the current instruction register.
4. Accumulator. This holds the data items to be processed and the result of the ALU

Types of registers

* Instruction register, which contains the instruction being executed;
* Address register, which keeps track of where a given instruction or piece of data is stored in memory;
* Storage register, which temporarily holds data taken from or about to be sent to memory;
* The Accumulator, which collects the result of computations;

**A SYSTEM CLOCK**

This component of the CPU times the sequential release of the processed data. It controls the speed of the CPU.

* The system clock generates electronic pulse or ticks at a fixed rate, which set the operating pace of components in the system unit.
* Each tick is called a ***clock cycle,*** *which affects* machine cycle time.
* The faster the clock, the more instructions the CPU can execute per second.

**CLOCK SPEED.**This refers to the speed at which a processor executes instructions

Clock speed is measured in hertz.

**DESIGNS OF A CPU**

* Complex Instruction Set Computing (CISC). This is used in computers that can work on a variety of instructions at a relatively low speed, i.e. mainframes.
* Reduced Instruction Set Computing (RISC). This is used in computers that can work on few instructions at a relatively high processing speed, i.e. microcomputers

**DATA PROCESSING IN THE CPU**

Some processors support ***parallel processing*** while others support ***pipelining***. **Parallel processing** is where a single instruction is simultaneously executed by multiple processors. **Pipelining** is where the microprocessor begins executing the next instruction before the current instruction has been completed, i.e. several instructions are in the pipeline simultaneously, each at a different processing stage.

**Multiprocessing**, is a technique which involves the use of more than one processor in a system to execute instruction

**MACHINE CYCLE**

This is a series of operations required to process a single instruction.

**Or,** it refers to the steps performed by the computer processor for each machine instruction received.

***The stages of the machine cycle include***;

1. Fetching. This is the collecting of data and instructions from the main memory. The time taken for the control unit to collect instructions from the main memory is called instruction time
2. Decoding. Is the process of translating instructions into a form that a computer can understand and process
3. Executing. Is the process of executing/implementing the command
4. Storing. Is the process of writing the processed results into memory

**TYPES OF PROCESSORS**

* Intel chips. Examples; 8086, 8088, 80188, 80286, Pentium 1, Pentium MMX, Pentium Pro, Pentium 2, Pentium 3, Pentium 4, Core 2, Dual-Core, Core i3, Core i5, Core i7
* Motorola chips. For apple, Macintosh computers
* AMD chips. (AMD - Advanced Micro Devices)
* Cryx chips

**Types of memory *(/INTERNAL OR PRIMARY MEMORY***)

The system unit contains two types of memory: volatile and nonvolatile.

* The contents of *volatile memory are lost when* the computer power is turned off.
* *The contents* of nonvolatile memory are not lost when power is turned off.
* RAM is the most common type of volatile memory.
* Examples of nonvolatile memory include ROM, flash memory, and CMOS.

***RANDOM ACCESS MEMORY (RAM***

This is the memory that stores data, instructions and information temporarily while the computer is processing. It is also called user memory or main memory. The contents of RAM can be altered, deleted, copied and read.

**FUNCTIONS OF RAM**

1. It holds data being processed
2. It holds the instructions to be followed during data processing
3. It holds data and information after it has been processed
4. It holds the operating system and other instructions used in booting during and after the booting process

**Types of RAM**

1. Static RAM (SRAM). This is a type of Ram that enables data to be stored as long as power supply continues. It does not require periodic refreshing
2. Dynamic RAM (DRAM) This is a type of RAM where data is lost even when power supply continues. It requires periodic refreshing

3. **Magneto resistive RAM (MRAM),** stores data using magnetic charges instead of electrical charges. MRAM has greater storage capacity, consumes less power, and has faster access times.

4**. Virtual RAM (VRAM):** Modern operating systems can use spare storage space on the hard disk as if it is working memory and this is referred to as Virtual memory or Virtual RAM

**READ ONLY MEMORY (ROM)**

This is a type of computer memory which contains programs and instructions that are built in the computer at the time of manufacturing. A computer has non-volatile in-built instructions, it has to know what to do when switched on and those instructions are resident on ROM.

**Examples of Data Stored in ROM**

1. Manufacturer of the computer and the date when the computer was manufactured.
2. Model name and model number of the computer
3. Predetermined configurations for some of the hardware that will be added onto the computer.
4. The execution instructions when you turn on the computer

**ROM Chips**

ROM chips in a microcomputer contain instructions used to transfer information between keyboard, screen, printer, and other peripherals and the processor. There are three types of ROM chips used, namely;

1. **Programmable Read-Only Memory (PROM)** *is a blank ROM chip on which you can permanently place data and programs.*

**2. Erasable programmable Read-only Memory (EPROM).** This is a ROM chip that can be written on and erased using strong rays of ultraviolet light.

3. **Electrically Erasable Programmable Read-only Memory (EEPROM.).** This is a ROM chip that is designed to be modified by the user more than once. It is electrically erased making it possible to erase and write to it.

**DIFFERENCES BETWEEN RAM AND ROM**

|  |  |
| --- | --- |
| **RAM** | **ROM** |
| 1. Volatile, temporally | 1. Non Volatile, permanent |
| 2. Contents lost when power goes off | 2. Contents remain when power goes off |
| 3. Read and Write | 3. Read Only |
| 4. Can be increased | 4. Can’t be Increased |
| 5. Not installed at Factory | 5. Installed at Factory |

**NB Memory cache.** A cache is a relatively small block of very fast memory designed for the specific purpose of speeding up the internal transfer of data and software instructions.

* Cache uses internal storage technologies that are much faster than conventional RAM.
* Cache speeds up processing time because it stores frequently used instructions and data.

**Flash memory**

* Flash memory is a chip also that keeps its contents when the power is shut off.
* Flash memory can be erased electronically and reprogrammed.
* Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents.

**COMPLEMENTARY METAL-OXIDE SEMICONDUCTOR (CMOS)**

CMOS is a special memory for storing a computer’s configurations including time and date. It is powered by a special battery known as the *CMOS battery* similar to that of a digital watch, which resides on the motherboard.

**Configurations Held in the CMOS**

1. Current date, time, and power saving settings
2. Floppy disk and hard disk drive types
3. Nature and type of keyboard, mouse,
4. CPU information, and RAM size
5. Serial and parallel port information
6. Plug and play information

**STORAGE HARDWARE**

***Computer storage*** refers to the ability of a computer to keep data or information in its memory.

**A Storage medium** is the physical material on which a computer keeps data.

**A computer uses primary memory and secondary memory to store data.**

* (i) **PRIMARY MEMORY** such as RAM provides a small amount of temporary storage area for the data and instructions required by the CPU for processing.
* (ii) **SECONDARY MEMORY** is used by Computer systems to store larger amounts of data, and information more permanently than allowed with primary memory.
* When a user issues a command to start an application program, the operating system locates the program in secondary storage, and loads it into primary memory.

**DEFINITION OF TERMINOLOGIES**

* **Access time*,*** *is a measure of the amount of time it takes a storage* device to locate an item on a storage medium.
* Access time. Refers to how quickly the data the user is looking for can be located in the storage device
* **Transfer rate** *is the* speed *with which data, instructions, and information move to and from a device.*
* *Transfer rates for storage are stated in KBps (kilobytes per second)*
* Cache. This is a type memory which stores files and data which have been recently read from the hard disk into main memory.
* Speed of a storage device refers to how fast the disk spins. Faster disk spins lead to faster data transfers
* Data transfer rate refers to how fast the computer can transfer information into memory
* Storage capacity of a storage media is the amount of data (in bytes) a storage medium can hold.
* Reading. Is the process of transferring data, instructions and information from a storage medium into memory
* Writing. Is the process of transferring data, instructions and information from memory to a storage medium
* I/O device (Input/output device). Is a device that can transfers data to or from a computer. E*xamples of I/O devices includ*e; hard disk drive, floppy disk drive, CD drive, zip drive and DVD drive.
* A track is a narrow recording band that forms a full circle on the surface of a disk.
* A sector is a pie-shaped section on a track, and is capable of holding 512 bytes of data.
* A cluster is the smallest unit of space used to store data. A cluster consists of a few bytes.

**ACCESS MODE OF A STORAGE MEDIA**

Access mode refers to a way of retrieving data stored on a storage medium. There are two types of access;

1. Random access. This is immediate access to data and information regardless of the order of storage. e.g. access provided by hard disk, CDs, DVDs.
2. Sequential (serial) access. This is access to data and information in the order of storage, e.g. access provided by magnetic and cartridge tapes.

PRIMARY STORAGE DEVICES

Primary storage holds all instructions and data needed for processing. It also called internal memory.

Primary memory is divided into two, namely; RAM (Random Access Memory) and ROM (Read Only Memory)

**SECONDARY STORAGE DEVICES**

This type of storage stores data and instructions that are not immediately required by the CPU. Examples of secondary storage media include; compact disk (CDs), floppy disks, magnetic tapes, Secondary storage is also known as backing store or auxiliary storage.

**CATEGORIES OF SECONDARY STORAGE MEDIA**

There is a wide variety of storage devices in the following categories.

* (A) Magnetic storage media, or
* (B) Optical media and
* (C) Other Types of Storage Media such as
  + Punched Cards
  + USB flash drive
  + Flash memory cards
  + Photographic film , Microfilm and Microfiche

**(A) Magnetic storage media**

These are storage devices which store data using a combination of magnetic fields.

**Common examples of magnetic media include:**

* 1. Magnetic tape
  2. Floppy disk,
  3. Zip and Jaz disks
  4. Hard disks

**(i) Magnetic tape**

* Magnetic tape is a magnetically coated ribbon of plastic capable of storing large amounts of data and information at a low cost.
* Tape storage requires sequential access, i.e. data must be accessed in the order in which it is stored.

**Demerits of Magnetic tapes**

* Random data access is not possible.
* Magnetic Tape Data storage has a limited shelf life of about 2 years only.

**(ii) Floppy disk (diskette)**

A *floppy disk, or diskette, is a portable, inexpensive* storage medium that consists of a thin circular, flexible plastic disk with a magnetic costing enclosed in a square-shaped plastic shell.

To store information on a floppy disk, one needs to have a floppy disk drive (FDD). It is usually designated **Drive A** in the computer.

A standard floppy disk is 3.5-inches wide and has storage capacities up to 1.44 MB.

Before you can write on a new disk, it must be formatted.

***Formatting*** *is the process of preparing a disk for reading and* writing by organizing the disk into storage locations called tracks and sectors

**Advantages of Using Floppy Disks**

1. Floppy disks are portable and cheap
2. Data on a floppy disk can be accessed randomly
3. The floppy disk can be *write-protected*, thus, cannot be modified accidentally.
4. Floppy disks can be used to transfer data from one computer to another

**Disadvantages of Using Floppy Disks**

1. Floppy disks are not durable due to dust and dirt and can be destroyed by magnetic fields
2. Access time of a floppy disk is slow
3. Storage capacity of floppy disks is limited (only 1.44 MB)
4. They are expensive per megabyte

**Care for diskettes (Floppy Disks)**

* A floppy disk should not be exposed to heat, cold, magnetic fields and dust.
* Never leave diskettes in the disk drive. Diskettes should be rolled up and stored in pencil holders.
* Diskettes should not be inserted or removed from the drive while the red light is flashing.
* Avoid touching the inner magnetic strip of the diskette.

**(iii) Zip drive**

* The Zip drive is a medium-capacity removable disk storage system with capacities of 100 MB to 750 MB that was introduced by Iomega in late 1994. However it was never popular enough.
* Zip drives fell out of favor for mass portable storage during the early 2000s due to emergence of much better USB flash drives CDs, and DVDs.

**(iv) The Jaz drive**

* Similar the the Zip drive, The Jaz drive was a removable disk storage system, introduced by the Iomega company in 1995.
* The Jaz disks were originally released with a 1 GB capacity.
* The rising popularity and decreasing price of CDs and DVDs greatly hurt the success of the Jaz Drive and the Jaz line was ultimately discontinued in 2002.

**V. Hard disks**

* Current personal computer hard disks have storage capacities from 160 GB to 1 TB and more.
* A *track is a narrow recording band that* forms a full circle on the surface of the disk. The tracks are further divided into sectors.
* **A cluster**, also called allocation unit, consists of two to eight sectors of space used to store data.

Sometimes, a sector has a fault and cannot store data. When you format a disk, the operating system marks these bad sectors as unusable.

**Advantages of Hard Disks over Floppy Disks**

1. Hard disks provide far larger storage capacities than a Floppy Disks
2. Hard disks have much faster access times than floppy disks
3. Hard disks are cheaper than floppy disk per megabyte
4. They are more reliable than floppy disk, since they provide a better protection to data against dust and dirt
5. Hard disks have random access to data and information.

**Disadvantages of Hard Disks over Floppy Disks**

1. Hard disks are not portable (except removable hard disk which is more expensive)
2. Data becomes less secure if left on the hard disk
3. Head crash may occur due to extreme shock or contaminations
4. They are expensive compared to floppy disks and priced according to storage capacity

**TYPES OF HARD DISKS**

* **An Internal hard disk** is fixed in the system unit and usually stores the operating system required for the computer to work.
* **An *external hard disk*** *is a separate free-standing hard* disk that connects with a cable to a USB port or FireWire port.
* **A *removable hard disk*** *is* a hard disk that you insert and remove from either a dock or a drive.
* **An *Internet hard drive,*** *also called online storage, is a service on the Web that provides storage to computer* users, usually for a minimal monthly fee.

**Care for Optical Disks**

* The following should be done for the safety of data on Optical disks:
* Do not expose the disc to excessive heat or sunlight
* Do not eat, smoke or drink near a disc.
* Do not stack disks.
* Do not touch the underside of the disk.
* Always store the disc in a jewel box when not in use
* Always hold a disc by its edges.
* Do not drop the disk to the ground.
* Don't bend the disk.

**CATEGORIES OF OPTICAL DISKS**

* Two general categories are CDs and DVDs, with DVDs having a much greater storage capacity than CDs.

Examples of Optical Disks include:

* *CD-ROM (compact disc read-only memory)*
* The contents of standard CD-ROMs are written by the manufacturer and only can be read and used. A typical CD-ROM holds from 650 MB to 1GB of data**,**

***Picture CD***

* A *Picture CD is a compact disc that only contains digital photographic images saved in the jpg file format.*
* *You can* purchase Picture CDs that already contain pictures.

***CD-R (compact disc-recordable)***

* *CD-R (compact disc-recordable) is a technology that allows you to write on a compact disc using your own computer’s* CD-R drive.
* Once you have recorded the CD-R, you can read from it as many times as you desire.
* However, you cannot erase the disc's contents.

**CD-RW (compact disc-rewritable)**

* A CD-RW (compact disc-rewritable) is an erasable multisession disc that you can write on multiple times.
* Reliability of the disc tends to drop, however, with each successive rewrite.
* To write on a CD-RW, you must have a CD-RW drive and CD-RW software.
* A CD-RW drive has a lower read and write speed as compared to CD-Rs

**Magneto-optical (MO) disk**

* This is a hybrid disk that combines the best features of magnetic and optical disk technologies.
* It has the erase and rewrite capabilities of magnetic disks, but it also has the very high-volume density capabilities of optical disks.
* MO disks are not popular because they are too expensive, and not as reliable as magnetic media.

**DVDs**

* *DVD-ROM (digital video disc-ROM). A DVD-ROM is an* extremely high capacity compact disc capable of 4.7 GB
* In order to read a DVD-ROM, you must have a DVD-ROM drive, which can also read CD ROMs.

**High Capacity DVD formats**

* A *Blu-ray Dics-ROM (BD-ROM) has storage capacities* of up to 100 GB.
* The *HD (high-density) DVD-ROM has storage capacities* up to 60 GB.
* A mini-DVD that has grown in popularity is the *UMD (Universal Media Disc), which* can store up to 1.8 GB of games, movies, or music.

***Other Types of Storage Media***

**1. Punched Cards**

* A punched card, IBM card, or Hollerith card is a piece of stiff paper that contains digital information represented by the presence or absence of holes in predefined positions.
* They were used through the 20th century in unit record machines for input, processing, and data storage.

***USB flash drive***

* A USB flash drive is a flash memory storage device that plugs in a USB port on a computer
* USB flash drives are convenient for mobile users because they are small and lightweight enough to be transported in a pocket.

USB flash drives have become the mobile user's primary portable storage device, making the floppy disk nearly outdated.

***Flash memory cards***

* Flash memory cards are a type of solid-state media, which means they consist entirely of electronic components and contain no moving parts.
* Common types of flash memory cards include Memory Stick, Compact Flash (CF), Smart Media, miscroSD, miniSD, Picture Card, etc.
* They are commonly used in electronic devices such as digital cameras and mobile phones

**Photographic film**

* Photographic film is a sheet of plastic such as polyester coated with a light sensitive emulsion that is used to record and store photographs.
* When exposed to light, it forms an invisible image.

***Microfilm and Microfiche***

* These are media used to store microscopic images of documents on roll or sheet film.
* The images are recorded onto the film using a device called a computer output microfilm recorder.
* The stored images are so small they can be read only with a microfilm or microfiche reader.

**Care and Maintenance of Optical Storage Devices**

1. Always store the discs (CDs and DVDs) in a jacket or jewel box if not in use.
2. Always hold the disc by its edge.
3. Never touch the underside of the disc and avoid bending or folding the disc
4. Never stack discs on top of each other
5. Never expose the discs to excessive heat, sunlight and liquids
6. While labelling, use soft tip pens, not pencils or ballpoint pens

**Advantages of Optical Storage Devices**

1. They are more potable than hard disks or floppy disks
2. They have a larger storage capacity than a floppy disk
3. Their average access time is faster than that of a floppy disk
4. They are used to transfer data from one computer to another easily
5. It is the safest form of storage, if you do not attack it with a sharp or heavy object.
6. They are cheap and readily available.

**Disadvantages of Optical Storage Devices**

1. A mere crack can easily fail the optical device from writing or reading
2. Some kinds of optical devices are read only, e.g. CD-ROM and DVD-ROM
3. The access time of optical devices is slower than that of a hard disk.

**ADVANTAGES OF PRIMARY MEMORY**

1. Primary memory is fast because it is accessed electronically and no mechanical components are involved
2. It can be addressed directly by the CPU.
3. It has a faster access time; therefore it is faster than secondary memory

**DISADVANTAGES OF PRIMARY MEMORY**

1. Most primary memory is volatile, except ROM, flash memory and CMOS
2. Primary memory is expensive and its storage capacity is usually limited compared to secondary storage.
3. Primary memory has low storage capacity.

***Question what the Difference between Primary and Secondary memory***

|  |  |
| --- | --- |
| **Primary memory** | **Secondary memory** |
| 1. it stores data/instruction temporarily | **1.** it stores data/instruction permanetly |
| **2.** it is limited on its storage capacity | **2.**it can store large amount of data |
| **3.** its contents can directly be accessed by the CPU | **3.**its contents cannot be directly be accessed by the CPU |

***Question why do people prefer to use flash disk over floppy disk today?***

**OUTPUT DEVICES**

**Output** is data that has been processed into a useful form called information.

* Computers generate several types of output, depending on the hardware and software being used and the requirements of the user.

**An output device is** any type of hardware component capable of conveying information to one or more people.

* Commonly used output devices include (A) Display devices, (B) printers, (C) Audio Output Devices and (D) Other.

**Categories of Computer output.**

While working with a computer, a user encounters four basic categories of output:

1. **Text,** (characters that are used to create words, sentences, and paragraphs)
2. **Graphics** (non text information such as drawings and charts),
3. **Audio**(music, speech, or any other sound)
4. **Video** (full-motion images played back at various speeds)

**(A) Display Devices/ VDUs**

* A display device is an output device that visually conveys text, graphics, and video information.
* Information shown on a display device often is called soft copy, because the information exists electronically and is displayed for a temporary period of time. Display devices are also known as (Visual Display Units (VDUs)
* Commonly used display devices include (i)CRT Monitors, (ii) LCD Monitors, (iii) Plasma monitors , (iv) Projectors, (v)Headgears and (vi)LED displays .

THE MONITOR

This is a video display output device that shows images generated from a computer without producing a permanent record can be displayed

**TYPES OF MONITORS**

These include; Cathode ray tube (CRT) monitors, Liquid crystal display (LCD) monitors, and Plasma monitors

A video card is required to display data onto a monitor. *Types of video cards include;*

* MDA - Monochrome Display Adaptor. This displays only one colour against a different colour background
* CGA - Colour Graphics Adaptor. This adaptor displays images in a variety of colours
* EGA - Enhanced graphics adaptor
* VGA - Video Graphics Array: 640 x 480 pixels
* SVGA - Super Video Graphics Array: 800 x 600 pixels
* XGA - Extended Graphics Array: 1024 x 768 pixels

**A *video card*** is a printed circuit board attached to the mother board inside the system unit for controlling output to a display screen. A ***VGA cable*** is the one used to connect the system unit to the monitor, to transfer the video signal from the system unit to the monitor so that it

**CRT Monitors**

* A CRT (cathode ray tube) monitor is a desktop screen that contains a large sealed glass cathode-ray tube.
* Inside the CRT, an electron beam moves back and forth across the back of the screen.
* This causes dots on the front of the screen to glow, producing an image on the screen.
* Each dot consists of a red, a green, and a blue phosphor, which combine to make up a pixel.
* A pixel is a single point in an electronic image.
* It is advisable to always sit 1 meter way from CRT monitors because they produce electromagnetic radiation, posing a health risk.

**Advantages of CRT Monitors**

1. They produce fast and rich colour output
2. Images can be viewed from a wide angle
3. They are cheaper than LCD monitors
4. They do not break easily

**Disadvantages of CRT Monitors**

1. They emit electromagnetic radiations (EMR) that cause eye defects. EMR is a magnetic field that travels at the speed of light. EMR only travels a short distance, so users should sit at an arm’s length from the monitor
2. They consume a lot of power than the LCD monitors
3. They occupy more desk space
4. They are heavy hence not portable.

**Flat-Panel Displays**

* A flat-panel display is a lightweight display device with a shallow depth and flat screen that typically uses LCD (liquid crystal display) or gas plasma technology.

**Examples of flat -panel displays include LCD monitors, and plasma monitors.**

* Many are widescreen, ie much wider than they are tall.
* Screens are measured diagonally from one corner to the other. Common sizes are 17”, 19”, 20”, 22”, 24” and 27”, 45” and 65 inch screens

**Advantages of LCD Monitors**

1. They consume less power compared to CRT monitors
2. They emit less electromagnetic radiations
3. They occupy less space and they are not heavy hence portable

**Disadvantages of LCD Monitors**

1. They are more expensive than CRT monitors
2. Images are viewed from a narrow angle
3. They can easily break

**FUNCTIONS OF THE MONITOR**

1. It displays the progress or output of the user’s commands and this helps to decide on the next step
2. It makes the computer a productive and interactive tool due to its instant visual feedback
3. It makes computing to be a continuous process due to its ability to provide constant visual feedbacks

**DETERMINANTS OF THE QUALITY OF A MONITOR**

* Resolution. This refers to the sharpness and clarity of an image. The higher the resolution the better the image quality. Resolution is often expressed in dots per inch (dpi)
* Dot pitch. Is the vertical distance between each pixel on the screen. A *Pixel* is a single point in an electronic image. The greater the number of pixels used to represent an image, the better the image quality.
* Refresh rate. Is the speed at which the monitor redraws images on the screen, it is measured in hertz. A high-quality monitor should provide a refresh rate of at least 75 hertz.
* Screen size. This is measured in inches. Common sizes include: 14 inches, 17 inches, and 21 inches.

**Data Projectors**

* A data projector takes the image that displays on a computer screen and projects it onto a large screen or wall so that an audience of people can see the image clearly.
* For example, many classrooms use data projectors so that all students easily can see an instructor's presentation on the screen.
* Presence of excess light affects data projectors and so they perform well in dark rooms.

**T*he following are the types of projectors***;

1. LCD projectors. These use liquid crystal display technology to produce lower-quality images.
2. DLP (Digital Light Processing) projectors. These use thousands of tiny mirrors on a small chip which reflect light, along with a spinning colour wheel, to project the image. DLP projectors can produce better images even in a bright place.
3. CRT projectors. These are the original and arguably, still offer the best picture. CRT projectors use three large tubes to project the image, in a way similar to a standard Television

**Head mounted display (HMD) / headgear**

* A headgear is made up of two tiny display and sound systems that channel images and sound from the source to the eyes and ears, thus presenting a stereo three dimensional sound effect in the virtual world.
* The wearer may also put on a body suit that senses the body movement and relays the data into the virtual reality system which in turn adjusts the position of the user in the system.

**LED displays**

* A LED display is a flat panel display, which uses light-emitting diodes as a video display.

**More Terms associated with Display Devices**

* **1. Resolution** is the number of horizontal and vertical pixels in a display device. A higher resolution uses a greater number of pixels and thus provides a smoother, sharper, and clearer image. Resolution is measured in dpi (dots per inch)
* **2. Dot pitch, aka pixel pitch,** is the distance in millimeters between pixels on a display device. Text created with a smaller dot pitch is easier to read.

**Printers**

A printer is a device that produces a hard copy output such as text and graphics on a physical material like paper.

* Printed information (hard copy) exists physically and in a more permanent form than a soft copy on a display device.
* Printers with different speeds, features, quality, and capabilities are available in a range of prices.

**CATEGORIES OF PRINTERS**

Impact and non impact printers.

**IMPACT PRINTERS**

* An impact printer forms characters and graphics on a piece of paper by a striking mechanism against an ink ribbon that physically contacts the paper.
* Impact printers are noisy because of this striking activity.
* Large Businesses use impact printers because these printers can withstand dusty environments, vibrations, and extreme temperatures.
* Commonly used types of impact printers include Daisy wheel, dot-matrix , Braille and line printers.

**Daisywheel printer**

* This is a kind of impact printer where characters are arranged on the ends of the spokes of a wheel.
* Low speed and noise are its disadvantages. The speeds are between 20 to 90 characters per second (cps)

**Dot-matrix printer**

* A dot-matrix printer produces printed images when tiny wire pints on a print head mechanism strike an inked ribbon like in a type writer.
* Dot matrix printers provide cheap but low quality printing.

**Advantages of Dot Matrix Printers**

1. They can withstand dusty environments, vibrations and extreme temperatures.
2. They can print various font styles and any graphics stored in the computer memory
3. They are cheap and fast

**Disadvantages of Dot Matrix Printers**

1. Dot matrix printers are generally noisy because of the striking mechanism
2. Their print heads suffer from overheating due to prolonged hitting of the print medium
3. They normally need special paper known as a stencil

**Braille printers**

* A Braille printer, commonly known as a Braille embosser, is an impact printer that renders text as tangible dot cells which are felt and read by the blind. .
* Once a copy produced, printing further copies is often quicker by means of a device called a "thermoform", which produces copies on soft plastic.

**Line printers**

* A line printer is a high-speed impact printer that prints an entire line at a time.
* The speed of a line printer is measured by the number of lines per minute (lpm) it can print.
* Some line printers print as many as 3,000 lpm.
* Mainframes, servers, or networked applications, such as manufacturing, distribution, or shipping, often use line printers.

**NON-IMPACT PRINTERS**

* A nonimpact printer forms characters and graphics on a piece of paper without actually striking the paper.
* Some spray ink, while others use heat or pressure to create images.

**Commonly used nonimpact printers are ink-jet printers, laser printers, thermal printers, plotters, and mobile printers.**

**Ink-jet printer**

* An ink-jet printer forms characters and graphics by spraying tiny drops of liquid ink onto a piece of paper.
* The print head mechanism in an ink-jet printer contains ink-filled print cartridges.
* Each cartridge has very many small ink holes, or nozzles.

**Laser printer**

* A *laser printer* is a high-speed, high quality nonimpact printer.
* Operating in a manner similar to a copy machine, a laser printer creates images using a laser beam and powdered ink, called *toner*, which is packaged in a cartridge.
* When printing a document, laser printers process and store the entire page before they actually print it. For this reason, laser printers sometimes are called *page printers*.
* Storing a page before printing requires the laser printer to have a certain amount of inbuilt memory.

**Thermal printers**

* A thermal printer generates images by pushing heated pins against a coated heat-sensitive paper.
* Basic thermal printers ar e cheap, but the print quality is low and the images tend to fade over time.
* Thermal printing technology is, however, ideal for use in small devices e.g. ATM receipt printers.

**Plotters**

* Plotters are printers used to produce large, high-quality, vector graphic drawings such as blueprints, maps, posters, and signs.
* These printers are usually very costly, and are used in specialized fields such as engineering, and graphic art.
* They use ink-jet printer technology, on a much larger scale, to print professional quality displays.

**Mobile Printers**

* A mobile printer is a small, lightweight, battery powered printer that allows a mobile user to print from a notebook computer, Tablet PC, PDA, smart phone or other personal mobile device while traveling.
* Mobile printers mainly use ink-jet, thermal, wax-transfer, or dye-sublimation technology**.**

**Advantages of Non-Impact Printers over Impact Printers**

1. Since they do not hammer the ribbon, they are more quiet than the impact printers.
2. They are faster in their operations compared to impact printers.
3. They produce better quality output compared to impact printers

**Disadvantages of Non-Impact Printers over Impact Printers**

1. The initial cost of purchasing these printers is higher than that of impact printers
2. They use ink which is hazardous to human life
3. Their printing materials are very costly

**TERMS ASSOCIATED WITH PRINTERS**

* **1. Toner** is a powder used in laser printers and photocopiers to form the printed text and images on the paper.
* **2. dpi. (Dots per inch)** is a measure of the number of individual dots printed in a line within the span of 1 inch (2.54 cm). The DPI value correlates with image resolution.
* 3**. hard copy** is a permanent reproduction, on the form of a physical object, of any media suitable for direct use such as paper.
* **4. Page orientation** is the way in which a rectangular page is focused on for normal viewing.
* The two most common types of orientation are *portrait* and *landscape*.
* **A page in portrait orientation** is taller than it is wide, with information printed across the shorter width of the paper.
* **A page in landscape orientation** is wider than it is tall, with information printed across the widest part of the paper.

**Factors considered when selecting a printer**

1. The price
2. Cost of consumable items e.g cartridge, paper to be used.
3. Volume of printing expected
4. The manufacturer

**AUDIO OUTPUT DEVICES**

* Audio output devices are the components of the computer system that produce music, speech, or other sounds, such as beeps.

**Common Audio Output Devices include:**

* Computer Speakers
* PC Internal Speakers
* Headphones and Earphones

**1. Computer Speakers**

* Computer Speakers typically have tone and volume controls, allowing users to adjust settings. Some Computer Speakers use Wireless technology.

**2. PC internal Speakers**

* Most personal computers have a small internal speakers that basically output beeps and low-quality sound.

**3. Headphones and Earphones**

* In a crowded computer laboratory environment, speakers might not be applicable.
* Instead, users can plug head-phones or earphones in a port on the sound card, in a speaker, or on the front of the system unit.

**OTHER OUTPUT DEVICES**

* There are very many kinds of emerging output devices. Some are both input and output devices.

**Examples include:**

* Fax (or facsimile) machine
* Interactive whiteboard.
* Machine Tools.
* LED displays.
* Multifunction peripherals.

**1. Fax (or facsimile) machine**

* A fax machine is a device that transmits and receives typed or hand written documents over telephone lines.
* A stand alone fax machine scans the original document, converts the image into digitized data, and transmits the digitized image.

**2. Interactive whiteboard (IWB)**

* An interactive whiteboard is a touch-sensitive device, resembling a dry-erase board, which displays the image on a connected computer screen.
* Interactive whiteboards are used frequently in classrooms as a teaching tool.

**Three basic technologies exist for displaying computer images on an interactive whiteboard:**

* **(1) front projection:**   
  a separate projector displays an image from the computer screen on the interactive whiteboard;
* **(2)rear projection:**   
  a projector built into the back of interactive whiteboard displays an image from the computer screen on the whiteboard; and
* (3) **An interactive whiteboard** fits over an LCD screen or a plasma display.

**Machine Tools**

* A machine tool is a machine for shaping metal or other rigid materials, usually by cutting, boring, grinding, or shearing. .

**3. Multifunction peripheral (MFP)**

* A multifunction peripheral (MFP) is a device that performs a variety of functions that would otherwise be carried out by separate peripheral devices.

**As a rule, a multifunction peripheral includes at least two of the following:**

* A printer
* A scanner
* A photocopier
* A fax machine

**Merits and Demerits of MFPs**

**Advantages of a multifunction device are that**

* It takes up less office space.
* It is significantly less expensive than if you purchased each device separately.
* The major disadvantage of the machine is that if it breaks down you lose all functions.

**HARDCOPY**

This is printed output. It can also be described as information on a tangible medium, e.g. on paper, piece of cloth and plastic card. Examples of hardcopy producing devices include; printers, plotters and facsimile machine.

**SOFTCOPY**

This is information displayed on the screen. It can also be described as information on an intangible medium. All data displayed on the monitor or projector is softcopy. Therefore, the monitor and projector are examples of softcopy producing devices.

**Advantages of Hardcopy over Softcopy**

1. Information cannot be easily changed without trace.
2. It can be read offline, i.e. without a computer.
3. It is cheaper than softcopy which requires a computer to read
4. Hardcopies last longer if stored in a safe place compared to softcopy

**Advantages of Softcopy over Hardcopy**

1. Softcopy is easy to carry
2. Softcopy can be shared with many people in a short time
3. Softcopy can easily be edited
4. Softcopy can easily be formatted
5. Softcopy can be easily stored and cannot be easily damaged by weather changes

**DATA CODING STANDARDS**

*The American Standard Code for Information Interchange* (ASCII). This is an 8-bit data coding standard for converting data from human form to a format a computer understands, i.e. Binary format and vice-versa. Another data coding standard is *Extended Binary Coded Decimal Interchange Code* (EBCDIC).

**UNITS OF DATA STORAGE/MEMORY SIZE**

1. BIT. Refers to binary digit which is the basic unit of computer data. A bit is represented by either a 0 or a 1
2. NIBBLE. This is a group of four bits, e.g. 0010
3. BYTE. This is a group of eight bits. It is the standard unit of measurement of computer data.
4. WORD. One word consists of 16 bits or 2 bytes.

**CONVERSION FROM ONE UNIT TO ANOTHER**

1 Nibble = 4 Bits

1 byte (B) = 8 Bits

1 Character = 8 Bits

1 Word = 16 Bits = 2 Bytes

1 Kilobyte (KB) = 210 Bytes ≃ 1,000 Bytes

1 Megabyte (MB) = 220 Bytes ≃ 1,000,000 Bytes = 1,000 KB

1 Gigabyte (GB) = 230 Bytes ≃ 1,000,000,000 Bytes = 1,000 MB = 1,000,000 KB

1 Terabyte (TB) = 240 Bytes ≃ 1,000,000,000,000 B = 1,000 GB = 1,000,000 MB = 1,000,000,000 KB

**Units of Measuring Computer Memory**

* The smallest unit of measuring Computer Memory is a BInary digiT (Bit)
* Binary digits are the numbers 1 and 0 which can be represented in a computer by switching voltage on and off.
* Eight little bits make one BYTE.
* The storage capacity of computers (RAM and ROM) and that of auxiliary storage units like disks are generally given in bytes.
* One BYTE stores approximately one character.
* Kilobyte (1K or 1 Kb) is 210 = 1024 bytes. (Approximatelly 1 thousand bytes)
* Megabyte (Mb) is 210 = 1024 Kilobytes or 220 bytes, (Approximatelly 1 million bytes)
* Gigabyte (GB) is 210 = 1024 Megabytes or 230 bytes, (Approximatelly 1 billion bytes)
* Terabyte (TB) is 210 = 1024 Gigabytes or 240 bytes, (Approximatelly 1 trillion bytes)
* Other higher prefixes are [Peta](http://en.wikipedia.org/wiki/Peta-)(250), [Exa](http://en.wikipedia.org/wiki/Exa-)(260), [Zetta](http://en.wikipedia.org/wiki/Zetta-)(270), [Yotta](http://en.wikipedia.org/wiki/Yotta-)(280), approximaltely equal to 1015, 1018, 1021, and 1024 bytes respectively.
* NB In computing today, the approximatiom 1024 to 1000 has brought about confusion and many manufacutures quote a disk with 1,000,000,000 bytes as 1 GB (109) instead of 1,073,741,824 bytes **(230)**

**Examples and Exercises**

1. How many bits are required to store the following words?

* a) COMPUTING
* b) BOYS’ SCHOOL
* c) 36oC
* d) U.N.E.B

Q.2 Does a text document with 1,000,000 characters fit onto a 1.4 MB floppy disk?

Q. 3Arrange the elements below in terms of their relative size in ascending order**:**

* + Character> Document> Page> Word> Paragraph
  + Gigabyte>Kilobyte>Megabyte>Bit>Byte

**Q.4 Convert:**

* **(i**) 200 kb to bits
* (ii) 5,120,000 Bytes to Megabytes
* (iii) 2GB to kb

**Answer Q4**

* (ii) 5,120,000 Bytes to Megabytes
* Ans: 1MB = 1000Kb=1,024,000bytes
* Therefore, 1 byte = MB
* So, 5,120,000 bytes = X5,120,000
* =5MB
* (iii) 2GB to kb Ans: 2,000,000

**Computer Data representation & numbering systems**

* Humans understand decimal (base ten) just because they have ten counting fingers.
* Digital electronics (computers) understand binary because binary consists of only two digits which correspond to the two power states. 0 representing electrical charge OFF and 1 representing electrical charge ON.

Octal (base 8) and Hexadecimal (base 16) number systems are used to represent complex binary data in a more compact form.

**Binary numbering system**

* Binary is a numbering system that is a series of 1s and 0s only.
* The idea of binary was created in the 1600s.
* Binary has been used in nearly everything electronic; from calculators to supercomputers.
* Machine code language is in binary digits.

**Binary Coding Schemes**

* A binary coding scheme is a method used for representing all of the digits, letters, special characters, and control characters available to a digital computer using a combination of bits 0 and 1.
* The off/on 0s and 1s are arranged in such a way that they can be made to represent each character uniquely.
* In a binary number, a digit 0 or 1 is called a bit. For example, 1001 is a 4-bit binary number, and, 11000110 is an 8-bit binary number.
* There are three commonly used binary coding schemes: ASCII, EBCDIC and Unicode

. **Converting from binary to decimal**

* 1. Multiply each bit of the binary number by its corresponding bit-weighting factor .
  2. Sum up all of the products in step (a) to get the decimal number.
* Eg: Covert 1011 binary to Decimal
* Soln: 1011 binary = 1x23 + 0x22 +1x21 +1x20 +

=8+0+2+1

=11

**Converting from binary to decimal**

* 1. Divide the decimal number by 2; and record the remainder.
  2. If the quotation is zero, the conversion is complete. Otherwise repeat step (a) using the quotation as the decimal number. The new remainder is the next most significant bit of the binarynumber*.*

1. **Convert 235 decimal to binary code**

|  |  |  |
| --- | --- | --- |
| **B** | **N** | **R** |
| **2** | **235** | **1** |
| **2** | **117** | **1** |
| **2** | **58** | **0** |
| **2** | **29** | **1** |
| **2** | **14** | **0** |
| **2** | **7** | **1** |
| **2** | **3** | **1** |
| **2** | **1** | **1** |
| **2** | **0** | **-** |

1. **So, 235 decimal = 11101011 binary**