



COMPUTER HARDWARE

Introduction to Computer Hardware



Computer Hardware for High School Student

Introduction to Computer Hardware

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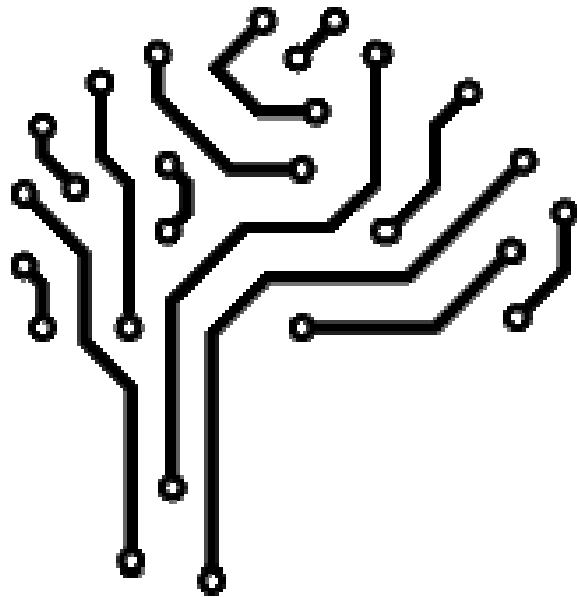
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ABSTRACT

In today's world, every field contains and uses a part of technology. For being a part of the current system, every student should know basic information about computers despite their interesting areas. This book provides information about computer and hardware history and the main components of hardware for high school students to prepare them for the digital world.



GLOSSARY

BIOS: A series of computer instructions that control input and output operations in firmware.

EIDE (Enhanced Integrated Drive Electronics): Drive that interfaces that transfer data faster than original standards.

Floppy Disk: A hardware device that reads data and storage information.

Memory: Memory refers to a computing system which is used to store information for use on a computer hardware device.

Operating System: A system that manages computer hardware.

PCI (Peripheral Component Interconnect): A local network bus to connect hardware devices to a computer.

Punch Card: A card formerly used to program computers.

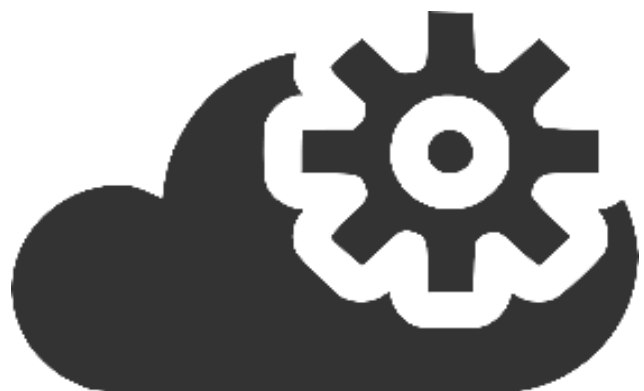
ROM (Read-only memory): A non-volatile type of memory used in computers and other electronic devices.

Super Disk: A storage disk that faster and greater than floppy disk.

Zip Disk: A zip disk is a computer disk that is identical to floppy disk, but capable of storing more data.

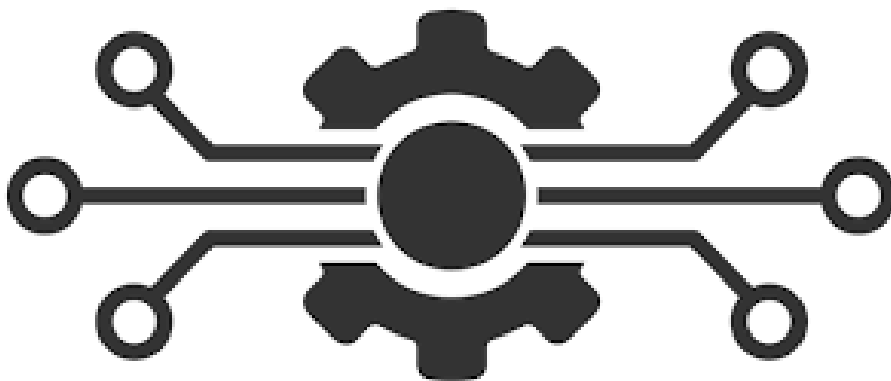
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Objectives

High school students will be able to define computer hardware, explain basic information about computer system and hardware history, and classify each components of hardware correctly with their functions to improve their computer skills in future.



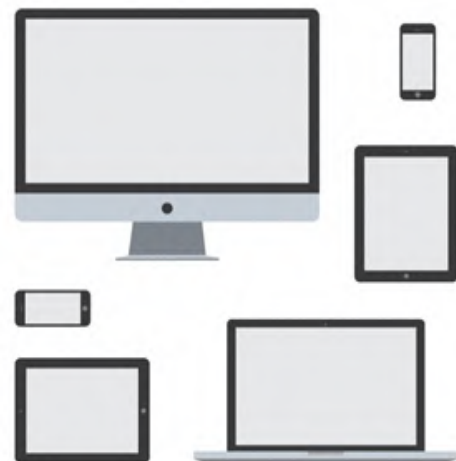
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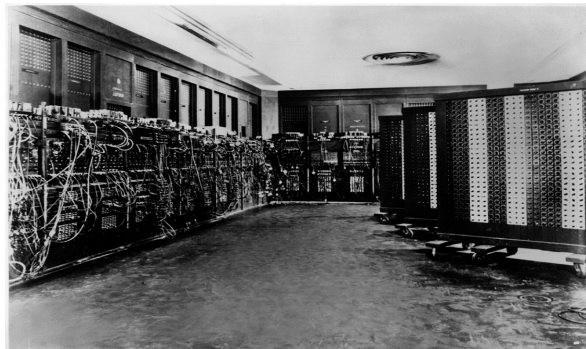
1. What is a computer?

In today's world, computers are involved our lives more than usual. Think about its role today. Students and teachers use it to do certain tasks such as homework, writing a document, searching resources, sending e-mails, making presentations, and attending online meetings. People can use a computer for searching, playing games, shopping, and paying bills at home. At work, people use a computer to store their data, manage their tasks, communicate, and so on. Toward these examples, computers cannot only do one job; they can make various tasks because of their several features such as programmability.

A computer can be defined as a machine that running programs, doing calculations, and making decisions with using digital logic. With this definition, we can also consider smartphones, tablets, navigation systems, and other devices as a computer. Everything that a person can do in a computer related to hardware and software terms which are the essential parts of a computer. More information about the term hardware is provided in the coming chapters.



The first essential computer was the massive ENIAC (Electrical Numerical Integrator and Calculator) Machine invented by John W. Mauchly and J. Presper Eckert at the University of Pennsylvania in 1943. The machine could use 10 decimal digits for a word and use almost 18,000 vacuum tubes that require 167 square meters (1800 square feet) of floor space.



The ENIAC

The first personal computer (PC) was the MITS Altair 8800. The Altair 8800 was a pack PC that quickly turned into the top pick of specialists hoping to get a PC all their own. Ed Roberts and his organization, MITS (Model Instrumentation Telemetry Systems), built up this first PC pack. In any case, like about all early individual computers, the Altair 8800 did not have an off-the-shelf application computer program, and users had to type their program themselves utilizing the Basic language interpreter. In 1976, Steve Jobs and Steve Wozniak developed Apple I that considered the first personal computer.



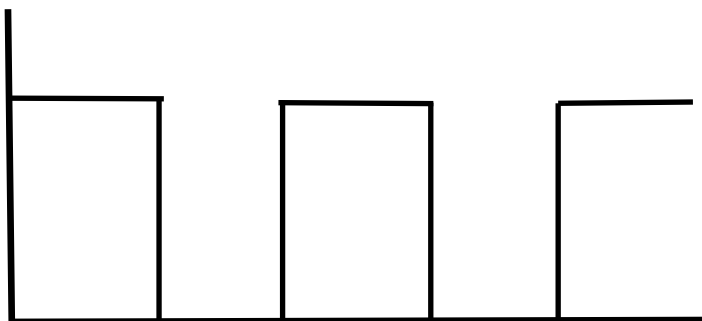
The MITS Altair 8800



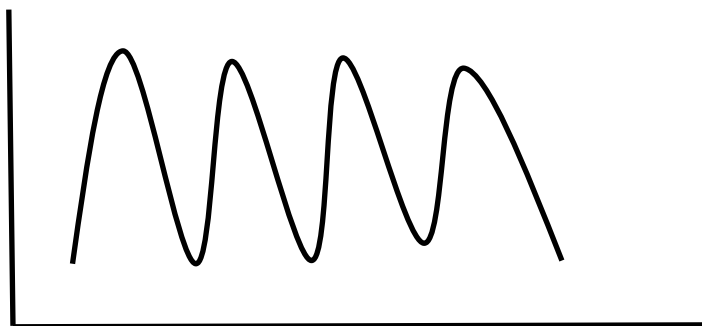
Apple II

There are two different types of computers. Digital and Analog. A digital computer stores data and runs its operations using numeric (digital) representation (usually binary numbers); an analog computer performs this using analogy quantities such as electronic voltages.

- The world used to depend completely on analog processes, machinery, and communications for its functions. The variables that characterize an analog system may have an infinite number of values. Traditional telephones transmit voice over the copper wire using analog signals.
- In digital systems, the variables that are characterized only occupy a fixed number of discrete values. Computers and cable modems are examples of digital devices. Digital devices are gradually replacing analog devices, and they make it easier to do everyday tasks.



Digital Signals



Analog Signals

Significant Inventions in Computer History

Year	Event
1890	The punch card system was designed to process information for the 1880 U.S. Census by Herman Hollerith.
1941	Scientists Atanasoff and Clifford Bery designed a computer that capable of doing 29 equations simultaneously. This is the first computer able to store data on its memory.
1943	The first computer, ENIAC, was invented by John W. Mauchly and J. Presper Eckert.
1947	The first known transistor was invented by William Shockley, John Bardeen , and Walter Brattain.
1950	The first computer language, COBOL, was developed by Grace Hopper.
1963	Douglas Engelbart patents the mouse pointing device.
1971	Intel introduced the 4004 microprocessor.
1971	IBM introduces the floppy disk.
1974	Intel released the 8080 microprocessor.
1976	Steve Wozniak and Steve Jobs build Apple I.
1977	Microsoft Corporation formed by partners Bill Gates and Paul Allen. Apple Computer produces Apple II.
1979	VisiCalc, the first killer application, was released. Intel produced the 8088 microprocessor.

Significant Inventions in Computer History

Year	Event
1982	Commodore 64 computer and The Compaq Portable PC was introduced. Intel produced the 80286 microprocessor.
1985	Intel released the 80386DX. PC CD-ROM drives were made. Microsoft Windows 1.0 were released.
1990	Microsoft Windows 3.0 was released.
1996	Google was developed by Sergey Brin and Larry Page at Stanford University.
1999	Wi-Fi became a part of the computing language, and users begin connecting to the Internet without wires.
2001	Apple introduced the Mac OS X operating system.
2005	YouTube, a video sharing platform, was founded. Google acquires Android, which is an operating system.
2006	Apple introduced the first Intel-based, dual-core mobile computer MacBook Pro.
2009	Microsoft launched Windows 7.
2010	Apple revealed the iPad, which change the consumers' point of view towards media and jumpstarting the dormant tablet computer segment.

Checkpoint 1.1

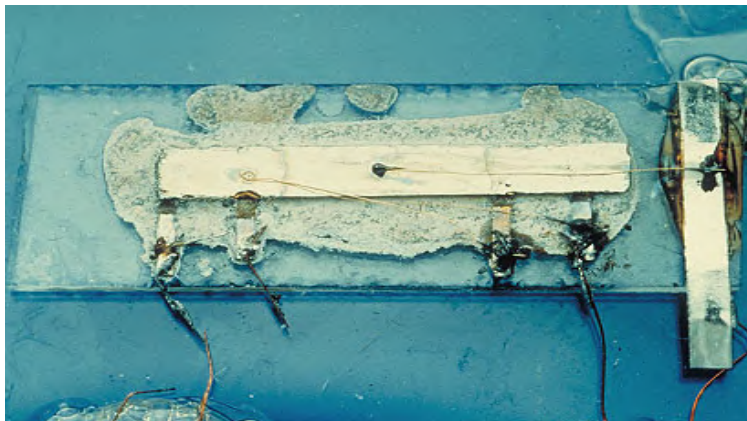
1. According to your use of computer in your daily life, make your definition of computer.
2. Define digital and analog computers.

Checkpoint 1.1

3. According to timeline in the history of computer, try to estimate three significant event for next 2 years.

2. History of Hardware

The historical background of hardware beginning in 1960 is set apart by the change from vacuum cylinder to strong state gadgets, such as the semiconductor. By 1959 discrete semiconductors were viewed as adequately dependable and economical that they made different vacuum tube PCs uncompetitive. PC's main memory gradually moved away from magnetic core memory gadgets to solid-state static and dynamic semiconductor memory, which significantly decreased the cost, size, and force utilization of PCs.



Jack Kilby's microchip

The mass expansion in the use of PCs quickened with 'Third Generation' PCs. These mostly depended on Jack Kilby's creation of the integrated circuit (or a microchip), beginning around 1966 in the business market. The first integrated circuit was created in September 1958, and PCs utilizing them started to show up in the mid-1960s. The integrated circuit allowed the improvement of a lot more tiny PCs. The minicomputer was a massive innovation during the 1960s and 1970s. It carried figuring capacity to more individuals through a more convenient actual size and expanding the PC vendor field.

The base of the fourth generation was the innovation of the microchip by Intel. Microprocessor-based computers were limited in their capability and speed and were unable to minimize the minicomputer. Processing power and storage limits have developed past all recognition since the 1970s; however, the hidden technology has remained essentially the equivalent of large-scale integration (LSI) or very-large-scale integration (VLSI) microchips, so it is broadly regarded that the majority of today's computers belong to the fourth generation.

Microprocessors

The world's first commercial microprocessor, the 4004, was released by Intel on November 15, 1971. It was created for a Japanese adding machine organization called Busicom as an option to designed hardware. Yet, PCs were created around it, with quite a bit of their processing capacities provided by one little microprocessor chip.

- The 4004 was only capable of 60,000 instructions per second (MIPS).
- Recognized as a milestone in the development of modern computers.
- It was a 4-bit processor.
- It became well-known when it was utilized on the Pioneer 10 space probe in 1972.
- It ran a product called the Busicom calculator.
- The 4004 lead a way to design personal computers.



The 4004 by Intel

Checkpoint 2.1

1. Who was the inventor of the first integrated circuit?
2. What are the features of first microprocessor?
3. What is the importance of microprocessors on fourth generation?

3. Components of Hardware

The term hardware refers to the physical parts of a computer that a computer is made of. A computer is not a single gadget; it has several components that run the system. Like different parts of a book, such as the cover page, glossary, and objectives, every part of a computer plays its role and creates a system. These are the major components of a computer:

- The Central Processing Unit (CPU)
- Motherboard
- Primary Memory
- Secondary Storage Devices
- Input Devices
- Output Devices

The Central Processing Unit (CPU)

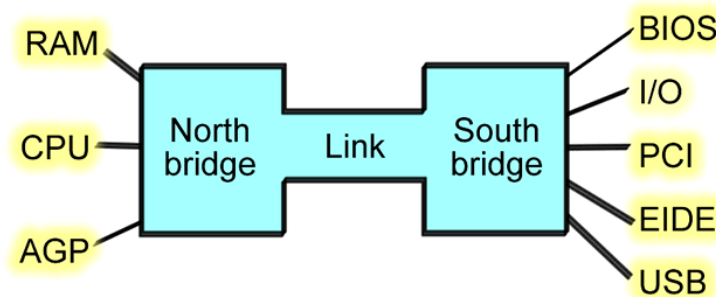
The Central Processing Unit is the most essential component of a computer because the CPU is the part of a computer that actually runs programs, and without it, a computer cannot run the software. The earliest known CPUs were massive electrical components like switches and vacuum tubes. Now, CPUs are small and powerful chips called microprocessors, which were designed in 1971 by Intel.



CPU

Motherboard

Motherboard (The Main Printed Circuit Board) contains and controls the components that responsible for processing data, including microprocessors, chipset, memory sockets, expansion bus, RAM, parallel and serial ports, mouse and keyboard connectors, AGP slots, and IDE, EIDE, or SCSI controllers. Also, external devices like printers, hard disks, CD-ROMs are controlled by the motherboard. Except the all of these components, the motherboard contains two more essential components called Northbridge and Southbridge, which are chipsets. Their function is to control the communication of other components in the motherboard. While Northbridge controls fast communication in the motherboard among CPU, RAM, and slots, Southbridge controls all other parts. When the communication continues, the transmission of electrical signals is controlled by traces that thin conductors or circuits on the motherboard that work together for a specific purpose. In addition to all these components, a group of circuit traces that work together to move current or data between components on a motherboard called bus.



To choose a well functional motherboard, customers should pay attention to the brand (Intel or AMD) and model processors, the board supporters, chipset and memory speeds, expansion slots (type and how many needed), and hard drive controllers. Also, while replacing or installing a motherboard, especially be careful with processors which, are very sensitive. Do not push pins and avoid the connection of electricity.



Motherboard

Primary Memory

Every process a computer does ,and all of the information it forms is put away in its memory sometime recently and after they are passed to the CPU. A computer's memory is made up of electronic components in which the computer temporarily stores data and instructions. Technically, memory like hard drive, floppy disks, ROM, CMOS, and RAM, can be named any computer that stores data or instructions on the computer. The most common primary memory device is RAM, which means random access memory. RAM is the place that stores data to enable CPU and other components to read and easily access the information. While users are executing a program, a copy of data is saved into RAM even if the secondary storage devices are working. The most important reason to use RAM in a computer is, RAM can transfer data to the CPU faster than secondary storage devices. Without RAM, all data and instruction would be read from disk drives, which causes the deceleration of a computer's speed.

RAM is faster than all other storage devices such as hard disk, floppy disk, and CD-ROM. It is known that accessing data from a hard disk takes 8 to 16 milliseconds, but with RAM, the number decreases to 50 to 80 nanoseconds. In addition to comparing speed with seconds, RAM is also measured with Hertz (Hz). See the list below and compare the size and units.

Unit	Size	Description
Bit	One binary digit	Stores either a binary 0 or 1
Byte	Eight bites	One character
Word	16 to 64 bites	Numeric values and addresses
Kilobyte (KB)	1 thousand bytes	About one page of double-spaced text
Megabyte (MB)	1 million bytes	About the size of a short book
Gigabyte (GB)	1 billion bytes	1,000 short books
Terabyte (TB)	1 trillion bytes	An entire library
Petabyte (PB)	1 quadrillion bytes	Just about all the libraries in Turkey

Table: RAM Units of Measure



RAM

Secondary Storage Devices

Secondary storage devices are able to hold data for long periods, even if the computer is not working. Almost every computer is sold with at least one hard drive inside the case in today's world. Hard drive disks and floppy drive disks are the most common secondary storage devices. However, in time, computers with floppy disk drives started to disappear and were replaced with Zip disks, super disks, and other removable storages. Not only hard drive disks and floppy disks are secondary storage devices. USB (Universal Serial Bus) drives and cloud storage, which stores data via the Internet in a server, are also secondary storage devices.

Hard Disk Drives

The hard drive can be considered as an innovative personal computer. The first known hard disk was designed in 1950, about 20 inches and capable of only keep a few megabytes of data. Up to now, logic under the hard disk designed has not changed much, although its current performing capability. There are many different types of hard drives on the market, which approximately have similar physical components. Typically, the difference between the various drive forms and models is in the modules, materials in their form, and the way of place together. See the list below essential parts of the disk drive:

- Disk platters
- Read/write heads
- Head actuators
- Air filter
- Logic board
- Connectors and jumpers



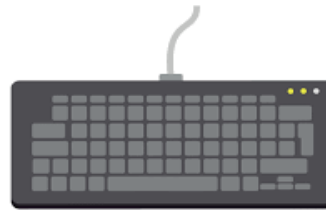
Hard Disk Drive

Input Devices

Input is every data collected from users or other devices. The component that collects input from outside is called input devices. Using input devices, the user manages and commands the computer's activity and enters data into it. Keyboard, mouse, touchscreen, scanner, digital camera, headphones, optical drives, and microphones are examples of input devices.



Scanner



Keyboard

Output Devices

The output is every data produced by the computer for users or other devices. Outputs might be an image, a report, or a list. The produced data is represented and controlled by output devices while sharing it with users. Common output devices are monitor, printer, speaker, video displays, disk drives, and CD recorders.



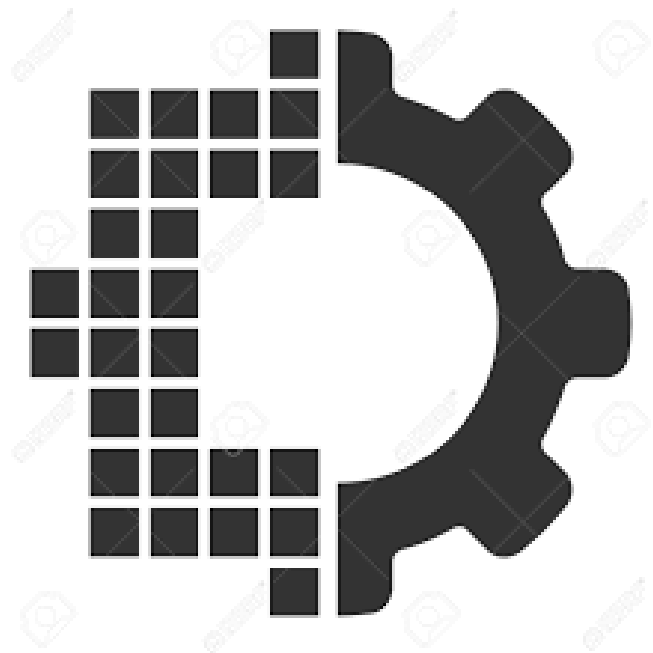
Monitor



Printer

Checkpoint 3.1

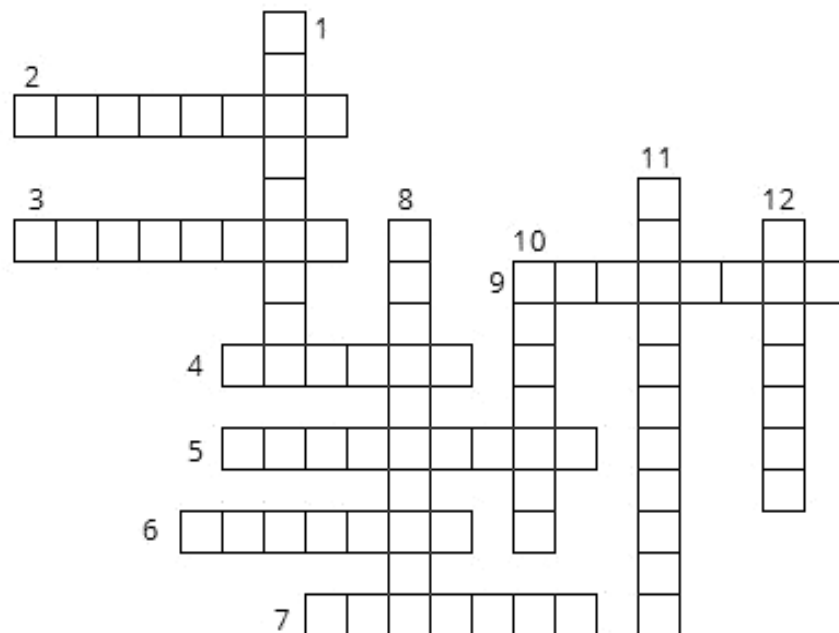
1. What is the hardware?
2. What are the major components of hardware?
3. What part of the computer runs the program?
4. Explain the CPU's working process.
5. List five components of the motherboard.
6. What is the difference between Northbridge and Southbridge?
7. Which features of the motherboard should be considered before buying a new one?
8. What feature of RAM makes it so common?
9. Write the size of the given units. Byte, kilobyte, gigabyte, petabyte.
10. Name two secondary storage devices?
11. Explain the role of input and output devices. Then give one example for each device.



Fill the crossword given with the answers of questions in the above.

Questions

1. Component that stores your all data.
2. Physical parts of a computer.
3. Device that used to input data.
4. Storages space in a computer.
5. A device that used to hear sound coming from the computer.
6. Screen that shows data from computer.
7. A device that receives audio input from the computer's sound card and produce audio output.
8. A device that captures audio by converting sound waves into an electrical signal.
9. A set of instructions, data or programs used to operate computers and execute specific tasks.
10. A device that converts printed documents into digital file formats.
11. A circuit board that contains all of the computer system's main components.
12. A device that produces a paper or hard copy from computer.



Answer Key

Checkpoint 1.1

1. Opinion question.
2. A digital computer stores data and runs its operations using numeric (digital) representation (usually binary numbers); an analog computer performs this using analogy quantities such as electronic voltages.
3. Opinion question.

Checkpoint 2.1

1. Jack Kilby
2. The 4004 was only capable of 60,000 instructions per second (MIPS) . Recognized as a milestone in the development of modern computers . It was a 4-bit processor.
3. Microchips minimize the limited capacity of computers, which lead to the fourth generation computer.

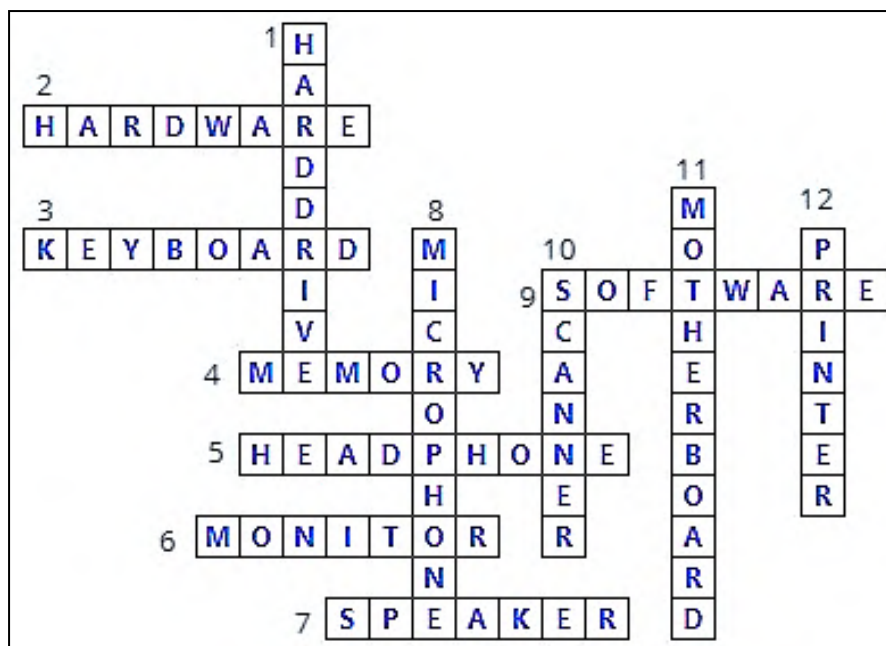
Checkpoint 3.1

1. All physical parts of a computer.
2. The central processing unit (CPU), motherboard, primary memory, secondary storage devices, input devices, output devices.
3. CPU
4. Fetch-Decode-Execute cycle. Read the instruction for CPU, determine which instruction will be performed, and execute the program or instruction.
5. Microprocessors, chipset, memory sockets, expansion bus, RAM, parallel and serial ports, mouse and keyboard connectors, AGP slots, and IDE, EIDE, or SCSI controllers.

Answer Key

Checkpoint 3.1

6. While Northbridge controls fast communication among CPU and main memory, Southbridge is responsible for all other components of motherboard.
7. Brand and model processors, the board supporters, chipset and memory speeds, expansion slots, and hard drive controllers.
8. Beign fast
9. Byte = 8 bites, Kilobyte= 1 thousand bytes, Gigabyte= 1 million bytes, Petabyte= 1 quadrillion bytes
10. Hard disk drive, floppy drive, USB, and cloud storage.
11. Input devices take data from users and other devices, output devices prduce data for users and other devices. Input devices: Keyboard, mouse, touchscreen, scanner, a digital camera, headphones, optical drives, and microphone. Output devices: Monitor, printer, speaker, video displays, disk drives, and CD recorders.



REFERENCES

Gaddis T. (2007) Starting Out with Programming Logic and Design

<https://www.academia.edu/39779809/>

Starting_Out_With_Programming_Logic_And_Design_4th_Edition_Tony_Gaddis_Solutions_Manual

Gilster R. (2001) PC Hardware: A Beginner's Guide, Berkeley, CA: Osborne/McGraw-Hill

<https://abiiid.files.wordpress.com/2010/12/pc-hardware-a-beginners-guide.pdf>

Karbo M. And Eli Aps (2005) The PC and Its Motherboard, Chapter 27

<http://www.karbosguide.com/books/pcarchitecture/chapter27.html>

Linde N. (1992) The Machine That Changed The World, "Inventing the Future" and "The Paperback Computer"

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[Reading03.htm#:~:text=First%20Computers&text=The%20first%20substantial%20computer%20was,like%20previous%20automated%20calculators%2Fcomputers.](https://homepage.cs.uri.edu/faculty/wolfe/book/Readings/Reading03.htm#:~:text=First%20Computers&text=The%20first%20substantial%20computer%20was,like%20previous%20automated%20calculators%2Fcomputers.)

