**Explorations of Technology - Hardware Notes**

**Component # 1 – Computer Case**

I. Form Factor (size)

A. The case must be able to fit the motherboard (circuit board) that is going to be put inside it.

B. The case must also be able to fit the power supply inside it.

B. Different Form Factors

1. ATX (Towers)

2. MicroATX (Desktops)

II. Drive Bays

1. Need to have room for hard drives and optical drives in your case.

**Component # 2 - Power Supply**

1. Watts - Maximum amount of power your power supply can provide
	1. Certain components will have a wattage requirement and if your power supply doesn't provide enough, your system may fail to function properly, turn itself off, or fail to boot.
	2. Components that typically require power from power supply
		1. Motherboard
		2. CPU Power
		3. Graphics card
			1. More powerful graphics cards may require more than power connector.
	3. 850W means 850 Watt power supply
	4. Typically a 500W power supply will handle the needs of even high end computer systems.
	5. However, if you make use of elite or multiple graphics cards, you may need higher wattage.
	6. Form Factor - We have power supplies to fit different case sizes: ATX, Micro-ATX
2. 80 PLUS Certification
	1. Must match certain industry guidelines for power efficiency to get this "stamp of approval".
	2. Bronze, Silver, Gold, Platinum and Titanium levels (in order of quality)
3. Overvoltage Protection
	1. If the voltage hits a certain level, the power supply will shut itself off to save internal components.
	2. Some cheap power supplies may not have this feature and that is a risk.
	3. This will typically result from nearby lightning strikes.
4. Types of Power Supply Connections – Be able to identify its name and what it powers from the image

|  |  |  |
| --- | --- | --- |
| Name | What It Powers | Image |
| 4-pin Berg | Floppy Disk Drives | floppy power cable |
| 4-pin Molex | Older hard drives and optical drives | 4 Pin peripheral power cable |
| 20-pin ATX main power | Older motherboards | 20 pin ATX main power cable |
| 24-pin ATX main power | Newer motherboards | 24 pin ATX main power cable |
| 20+4 pin ATX main power | Adaptable to fit new and old motherboards | 20+4 pin ATX main power cable |
| 4-pin CPU power | Older, less powerful CPUs | 4 pin ATX +12 volt power cable |
| 8-pin CPU | Newer CPUs | 8 pin EPS +12 volt powercable |
| 4+4 pin CPU power | Adaptable to fit newer and older CPUs | 4+4 pin +12 volt power cable |
| 6-pin PCI Express power | older, less powerful video cards | 6 pin PCI Express power cable |
| 8-pin PCI Express power | newer, more powerful video cards | 8 pin PCI Express power cable |
| 6+2 pin PCI Express Power | Fits both new and old video cards | 6+2 pin PCI Express power cable |
| SATA power cable | Fits newer hard drives and optical drives | SATA power cable |



**Component # 3 - Motherboard**

1. Form Factor - Size of the Motherboard
	1. ATX - Full Size
	2. MicroATX - Smaller version of ATX
	3. Make sure your case and power supply match the form factor of your motherboard!
2. CPU Sockets
	1. Sockets fit only specific CPUs , so choose a CPU that fits into the socket type on your motherboard!
	2. Ex: Intel core 57 Sky Lake CPU fits in an LGA 1151 socket on a motherboard.
3. Chipset - A set of chips on the mobo that works with the CPU to control memory and connected peripherals.
	* 1. Intel Chipsets
			1. North Bridge/South Bridge Chipset - 2006
				1. North Bridge

Raised chipset located near the CPU (Faster)

Handles memory (RAM) and graphics (Graphics Card)

* + - * 1. South Bridge

Flat, square chipset, further from CPU (Slower)

Handles Input/Output (I/O) - USB, Audio

* + 1. AMD Chipsets (Radeon Series Cards)
			1. Crossfire - Technology that allows multiple graphics cards (Radeon series) to be used to improve graphics potential
		2. NVIDIA Chipset (GeForce Series Cards)
			1. SLI
				1. Feature that connects multiple graphics(GeForce) cards to your motherboard.
				2. With 2 graphics cards, each card draws half the screen.
1. Memory (DIMM Slots)
	1. Number of DIMM Slots - how many different slots are there for you to add RAM?
	2. Number of pins - How long or how many data connectors are on each stick of RAM?
		1. DDR1 to DDR3 - 240 pins
		2. DDR4 - 288 pins
		3. Laptop RAM has fewer pins that desktop RAM - Example: DDR3L - 208 pins
	3. Maximum Memory - What is the maximum RAM supported by the motherboard? (GB)
	4. Memory Standard - What speed of RAM will the motherboard support?
		1. DDR1, DDR2, DDR3, DDR4 – (Double Data Rate) - Transfers data twice per clock cycle
2. SATA Connectors
	1. Provide power to optical and hard drives
	2. There are different versions of SATA. The highest version number will be the fastest. (SATA 3.3)
3. Video Cards – Fit into motherboard slots. Make sure your motherboard has a matching slot type.
	1. Current video card slot type is PCI Express (PCI-e)
	2. Similar to SATA connectors, there are versions of PCI-e. (1.0, 2.0, 3.0, 4.0)
	3. Size of PCI-e slot is show after the version number (x1, x4, x8, x12, x16, x32)
		1. Most current video cards fit in PCI-e 3.0 x16 expansion slots

**Component # 4 - CPU** - AKA "The brains"

I. Processor Speed

 a. How many times per second a CPU can process data, measured in GHz(gigahertz).

b. Currently the fasted CPU operates at 4.2 GHz, meaning 4.2 billion actions per second.

c. CPUs can be overclocked, meaning by adding voltage we can make it work faster than it was designed.

II. Socket

 A. Motherboard slot type must match the socket type of the CPU. (See motherboard for example)

III. Data Path

 A. How many bits of data the CPU can receive each "tick" of the clock.

 B. 32 bit or 64 bit. 64 bit is highly recommended. This will be the same as your version of Windows.

 C. Original Nintendo as 8 bit system. PS4 is 128 bit system.

IV. Multi-core

 A. Current CPUs actually hold several processor cores in a single container. (2 to 8 cores)

 B. These are called dual-core, triple core, quad-core, six-core or 8-core CPUs.

V. Integrated Graphics

 A. Some CPUs have an integrated chip for handling graphics.

 B. Most current processors do have Integrated Graphics.

 C. If you have a dedicated graphics card, you would most likely not use this CPU feature.

VI. Intel CPU Families - Core i7, Core i5, Core i3, Atom, Celeron, Pentium

VII. AMD CPU Families - APU, FX , Phenom, Athon, Sempron

**Component # 5 - RAM**

I. Fits in a motherboard DIMM slot.

II. Pins – Make sure the number of pins on your RAM matches the number of pins in your motherboard DIMM slots.

 A. Number of contact points on the RAM through which data can flow.

 B. Laptop RAM has fewer pins.

 C. DDR4 has 288 pins

 D. DDR1 - DDR3 has 240 pins.

III. DDR - Double Data Rate

 A. RAM reads/writes data twice per clock cycle, effectively doubling the data transfer rate.

 B. There are currently four versions of DDR, DDR1 to DDR4.

 C. Each version is faster than its previous, while consuming less power.

 D. Laptop DDR ends with "L". Example DDR3L

IV. RAM Channels

 A. Single Channel - Only one RAM stick can be accessed at a time.

 B. Dual, Triple, Quad Channel - 2, 3 or 4 RAM sticks can be accessed at the same time.

V. RAM Speed

 A. The frequency (how many times per second) in which data can be pulled from the RAM.

 B. It is measured in MHz.

 C. Make sure your motherboard and RAM are able to operate at the same speed to maximize efficiency.

**Component # 6 - Optical Drives**

1. Connection Types
	1. SATA - Most popular for internal optical drives
	2. USB - Some external Optical drives connect via USB ports.
2. Form Factor (Size) - Optical Drives are a standard 5.25" wide, though the height of the drive will vary.
	1. All optical drives are the same size (5.25") due to the disks all being the same size.
	2. Laptops may use a slimmer (shorter) drive to conserve space.
3. Burner vs. Read Only
	1. Burners allow you to write data to the disk, as well as read data.
	2. Some cheaper optical drives are read only. (No burn)
4. Optical Formats
	1. CD (Compact Disk)
		1. Can store about 700MB of data or 74 minutes of audio (music usually)
		2. The original CD-ROM could read data at approximately 150 KBps.
		3. As faster CD-ROM were released, their speed was listed as 2X, 4X,etc…
		4. 2X means it reads twice as fast as the original CD-ROM, or 300 KBps
		5. 52X is fastest CD-ROM Drive which is about 7.6 MBps
		6. CD-ROM Drives cannot read DVD or Blu-ray disks.
	2. DVD - (Digital Video Disk)
		1. Can store about 4.7 GB of data
		2. First DVD could read/write at approximately 1.5 MBps
		3. Similar to CD-ROM, we use 3X to display how must faster than the original it can run
		4. 18X is fasted DVD-ROM drive, which is about 27 MBps
		5. DVD-ROM drives cannot read Blu-ray disks, but can read CD-ROM disks
	3. BD - (Blu-ray Disk)
		1. Can store 25 GB of data
		2. Similar to CD-ROM, we use 3X to display how must faster than the original it can run
		3. First Blu-ray could read at 4.5 MBps
		4. Fastest Blu-ray drive currently is 12X, which is about 54 MBps
5. Single/Double Layer
	1. Double Layer disks have two separate writeable layers, effectively doubling the storage capacity
	2. Requires special disks
6. Internal vs. External

**Component # 7 - Hard Drives**

A hard drive stores data that is kept even when the computer is powered down. The disk rotates and a head will read or write the data to the disk.

I. Storage Capacity

 A. Data storage on a hard drive is measured in bits and bytes.

 B. There are 8 bits in 1 byte. It takes about 1 byte to store one character of information

 C. (KB) kilobyte - 1,000 bytes (1 thousand bytes)

 D. (MB) megabyte - 1,000,000 bytes (1 million bytes)

 E. (GB) gigabyte - 1,000,000,000 bytes (1 billion bytes)

 F. (TB) terabyte - 1,000,000,000,000 bytes (1 trillion bytes)

 G. Most hard drives are measured in GB or TB.

II. RPM

 A. Revolutions per Minute –How fast the disk spins.

 B. The faster it spins, the faster the location to be read from or written to is found and less latency occurs.

 C. RPM Speeds

 1. 7200 rpm – Most desktop PC operate at this speed.

 2. 5400 rpm – Most laptops run at this speed. It is slower to preserve battery power.

 3. 10000 rpm – Western Digital produces a “Raptor” hard drive that runs at an accelerate rate.

 4. 15000 rpm – Some server hard drives spin faster due to the amount of requests for data.

III. Form Factor (Size)

 A. 3.5” – These are traditional hard drives.

 B. 2.5” – These are designed for laptops and Solid State Drives (SSD)

IV. Internal vs. External

 A. Internal

 1. Hard drive will be located in a drive bay and provided power from the power supply.

 2. It will connect directly into the motherboard though a SATA connection.

 B. External

 1. Hard drives connect to the computer through either a USB or eSATA (external SATA)port

 2. An external hard drive will usually require its own power, unless it connects to an eSATAp port.

V. Connection Types/Speeds

 A. USB

 1. USB can be used to supply both power and data.

 2. These are used for external hard drives only.

 3. USB Speeds

 a. USB 1.0 – 12 Mbps

 b. USB 2.0 – 480 Mbps

 c. USB 3.0 - 5 Gbps

 d. USB 3.1 – 10 Gbps

C. SATA

1. SATA 3.0, 3.1 – Max speed is 6 Gbps

2. SATA 3.2, 3.3 – Max speed is 16 Gbps

4. eSATA – External SATA – External drive connects through an eSATA port and provides its own power.

5. eSATAp – External SATA with power – Uses the same external SATA port for both data and power.

VI. Solid State Drives (SSD)

 A. Work like a Flash Drive

 B. No moving components, less heat

 C. Run silently - No spinning the disk

 D. Less susceptible to damage due to fewer moving parts.

Comparing SSDs and Traditional Hard Drives

|  |  |  |
| --- | --- | --- |
|  | **SSD** | **Traditional** |
| **Cost** | $.45 per GB | .05 per GB |
| **Start-up Time** | Instant | Takes several seconds to "rev" up to speed |
| **Read** | Instant | Has to "spin" to proper part of the disk where data is stored |
| **Overall Speed** | Full SATA speed potential | Full SATA speed potential - latency of moving the diskRPM helps minimize latency, but doesn't remove it |
| **Storage** | Most SSD are under 1 TB | Can be up to 4 TB |

**Component # 8 - Video Card**

Graphics cards are added to many current computer systems to allow for improved graphics performance. Most computer users that game heavily or work with rendering/producing high quality video will purchase a graphics card to speed up their computer and allow for maximum visual performance.

1. Sources for Graphics

A. Motherboard

 1. The task of drawing graphics can be performed on the motherboard. (No video card)

 2. Video handled by the motherboard is often called "on-board video".

 3. On-board video can be disabled in BIOS.

 4. On-board video causes more stress to the motherboard because it must take resources from other connected components and devote them to the drawing process.

B. CPU

 1. Also known as "Integrated graphics"

 2. Not all CPUs have "integrated graphics" feature.

 3. Preferred over mobo graphics since CPU doesn't need to send graphics info anywhere to process it.

 4. Today's top CPUs have the graphics capability as many mid-range dedicated graphics cards.

 5. Most current laptops use CPU integrated graphics.

C. Dedicated Graphics Card

1. Hard core gamers will build computer systems with dedicated graphics cards.

2. Dedicated graphics cards have their own RAM, power, cooling and GPU (graphics processing unit).

3. Dedicated graphics cards offload the graphics work from the CPU and system RAM.

II. SLI/Crossfire

 **A.** Nvidia offers a technology called SLI that allows a computer to utilize more than one video card.

 **B.** AMD offers a similar technology called CrossfireX.

 **C.** It is recommended that two identical cards are used in these configurations as the system will use the specs of the lesser of the cards inserted.

 D. You must be certain to purchase a motherboard that supports SLI or CrossfireX.

III. Power Supply

 A. When buying a dedicated graphics card, you have to plan for the extra power that will be consumed.

 B. High-end graphics cards require more wattage than any other component.

 C. A 500 watt power supply is the minimum with mid-range graphics cards.

 D. For higher-end graphics cards, a 750 watt power supplied is recommended, but use the wattage calculator if you intend to SLI or Crossfire with high end graphics cards.

IV. Memory

 A. Current cards have their own RAM in the range of 128MB to 8GB.

V. Graphics Card Slot Types

 C. PCI-Express (PCI-e)

 1. Three different versions (PCI-e 1.0 to PCI-e 4.0)

 2. Cards are backward compatible with older PCIE slots, but the performance will be capped.

VI. Output Ports

A. There are three main types of output ports on graphics cards:

 **1.** VGA

 **2.** DVI

 **3.** HDMI

 4. DisplayPort

 **B.** Make sure your monitor has the appropriate input port to match your graphics card

 **C.** You may need an adapter to convert from VGA to DVI, etc…

**Component # 9 - Cooling Components**

I. Heat sink

 A. Heat sinks are positioned on top of the CPU.

 B. They are typically made of copper and conduct rising heat from the processor.

 C. Heat sinks are designed to fit CPU sockets, so be certain you purchase a matching heat sink.

 D. Heat sinks often come with the CPU as part of a package deal.

II. Thermal Paste

 A. Thermal paste is a silver compound that is spread between the CPU and the heat sink.

 B. Its purpose is to improve the conduction of heat from the CPU into the heat sink.

 C. Often a pre-applied layer of thermal paste is provided with the CPU, on the heat sink.

III. CPU Fans

 A. Typically, on top of the heat sink is a fan that will blow the heat captured by the heat sink away from the CPU

 B. These fans are usually powered by motherboard 3 pin connector.

 C. Some PSU will have fan power connectors.

IV. Liquid Cooling System

 A. For high-end gaming computers, liquid cooling will keep your CPU running at a cooler temperature.

 B. Your heat sink is replaced by a liquid cooling system.

 C. Essentially, there is a radiator and two sets of tubes, running to/from the CPU.

 D. The liquid cooling system has its own heat sink, that rests atop the CPU.

 E. This special heat sink has water/coolant running through it. The heat from the CPU will be drawn into the water and brought to the radiator, where it is released into the air and blown out of the computer with fans.

 F. Make sure your CPU socket is compatible with your liquid cooling system.