1. Working On Your Computer

Computers contain a lot of delicate parts and have a lot of electricity flowing through them. It is imperative that you take certain precautions when working on your machine to protect it and yourself.

- Unplug your computer before opening it, especially the power cable.
- Use an anti-static bracelet or occasionally touch the case with both hands to discharge. A static shock can fry most components.
- Never open the power supply unit.

It is also wise to clean your computer on occasion. Dust will often collect inside, which can contribute to the system heating up. Use condensed air to blow away the dust particles.

2. The Case

Cases house components and shield them from the elements, such as water, dust, and static. They also help create an environment that can control the temperature. Most have rails and slots that allow components to connect and rest. They come in different sizes, and these mainly correspond with different families of motherboards.

Motherboards determine what components can connect to your computer, but cases also play a role. For instance, you can't fit a power supply that is 5 inches wide into a case with only 3 inches to spare, although the motherboard would still be able to accept the plug.

The most common case size today fits **ATX** (Advanced Technology eXtended) motherboards: **Full-Tower** (about 8x20 inches) and the **Mid-Tower** (about 8x18 inces). The **Mini-ITX/ Small Form Factor** (not much bigger than 6.7 square inches) is also common, but does not fit an ATX motherboard.

3. The Motherboard

All components connect to the motherboard.

Motherboards determine the type of processor and memory supported along with any extra components via slots and sockets.

Motherboards come in a variety of sizes with different numbers and types of slots.

- **ATX** (12x9.6 inches) typically come with 4 RAM slots and a number of expansion slots, like the PCi Express port which is employed for add-ons like graphics cards.
- **EATX** (12 x 13 inches) typically come with 6 RAM slots and plenty of expansion slots. Some even have an additional socket for a second processor.
- **Micro-ATX** (9.6x9.6 inches) typically have 2-4 RAM slots and a few expansion slots as well.
- **Mini-ITX** (6.7x6.7 inches) have 2 RAM slots and may have a single expansion slot.

Slots often have different shapes or notches in them to prevent similar but different components from being installed. This is called "keying."

There are many plugs on the motherboard that accept cables from the power supply unit. One of the most important is the wide 20(+4) plug, called so because 4 of the cables are usually able to detach. This cable provides the motherboard with most of its power.

When plugging or unplugging power cables make sure they are snug! Keying helps ensure this is done, but arcing can be very damaging to a computer.

Motherboards also house many cylindrical transistors, which temporarily retain power. You can identify a failed transistor by a domed top or if it popped.

Motherboards house plugs to accept cables transmitting data as well.

- **IDE** (Integrated Drive Electronics) and EIDE (Enhanced IDE) cables are wide ribbon cables with 40 pins. These cables are often keyed and labeled to indicate the first pin.
- **SATA** (Serial Advanced Technology Attachment) cables are much thinner and transfer data much faster than IDE or EIDE cables. Most modern computers just use these.

SATA cable

Motherboards house a **BIOS** (Basic Input Output System) ROM chip, which contains data that allows components to communicate.

ROM (Read Only Memory) is memory that cannot be overwritten or updated. However, modern BIOS chips can be updated via special software or instructions. In the past you'd have to replace the chip.

Motherboards house **CMOS** (Complementary Metal Oxide Semiconductor) **RAM**, which keeps inventory of components connected to a computer and simple information like the date and time.

RAM (Random Access Memory) is "volatile" which means that it only retains data while it has a charge. To prevent this component from losing data, they come with coin batteries.

4. External Ports and Cables

The motherboard will contain ports that can accept cables that can transfer data and sometimes power. These cables transmit data at different rates and in different ways.

Cards can be installed into the motherboard in order to add extra ports.

USB: *Universal Serial Bus*. All USB devices should come with "Plug and Play" which allow drivers to automatically be detected and installed, making USBs very user friendly. USB devices can range from flash drives to keyboards, to hard drive enclosures to monitors. Depending on the type of port USBs can transfer from 12 megabytes per second (USB 1.0) to 5 gigabytes per second (USB 3.0).

The device end of the USB comes in several varieties in order to fit within smaller devices.

PS/2: A port used for the mouse and keyboard. These have been made obsolete with the advent of the USB, but are still commonly seen, though it is likely you will not find them on your new computer.

CAT5: *Category 5 twisted pair cable*. This cable is able to transfer 100 megabytes per second of Ethernet data, and is used to provide your computer with a network connection. If it looks familiar that's because your phone cable is a CAT2; related but not able to carry data at as high speeds, capping at 5 megabytes per second.

VGA: *Video Graphics Array*. This cable transmits a video signal to the computer. VGA supports 16 colors and a resolution of 640 x 480. Super VGA (SVGA) supports 16 million colors and a resolution of 1280 x 1024 and uses the same connector (the DB15).

HDMI: *High Definition Video Interface*. It transfers up to 48 gigabytes per second and supports a resolution of 1920 x 1200 but can go even higher, with certain cables capable of producing a resolution as high as 7680 x 4320 (called 8K). HDMI is able to transmit audio data in addition to video and is now more commonly installed right into the motherboard due to its small size. Some modern computer even come without a VGA port in favor of HDMI.

If your computer does not have an HDMI port you may be able to install one with a video card. There are also many converters that allow you to connect two different cables to join devices, such as VGA to HDMI.

DVI: *Digital Visual Interface*. DVI is designed to support multiple input formats (DVI-Integrated, DVI-Digital Only and DVI-Analog Only), which have different female layouts allowing for versatility in the port. The resolution of a DVI connection can max out at 2560 x 1600 if using a dual link connection.

DisplayPort. A display port cable is unique in that it transmits data similar to how an Ethernet or USB cable transmits data. DP 1.4 cables transmit data at a rate of 32.4 gigabytes per second and can produce a resolution as high as 7680 x 4320.

5. The Power Supply Unit

The PSU (Power Supply Unit) takes AC power provided from an outlet and converts it to DC current, which your computer can use.

It is wise to be familiar with basic electricity terms when dealing with the PSU:

Volt: The electrical potential of a system.

Ohm: Electrical resistance. Dry human skin has a resistance of around 100,000 Ohms, but wet or broken skin is only 1,000 ohms. This is why you feel nothing when touching a 9volt battery, but may get a small shock if you licked it.

Amp: The electrical current or rate of flow.

Watt: Unit of power, 1 joule per second. This measures the amount of work that can be done.

Each component in your computer consumes a certain amount of power (Watts). Have too little power and your system will not be able to run or may "brown out", which can seriously damage a system.

One of the specs PSUs are identified by is their wattage. This only measures the energy can provide, not what it pumps into a system. That means that you can connect a 1200W PSU into a system that only needs 120W with no damage (other than to your wallet).

> Store bought PCs tend to come with PSUs with wattage just above what their system demands, 200W-350W. It is a good idea to upgrade your PSU. I personally use a 600W PSU.
>
> PSUs tend to be noisy. Upgrading your PSU can help eliminate this issue as higher end PSUs tend to be almost silent.

PSUs deliver power through separate cables leading into different keyed plugs.

- 20 (+4) plug provides the main power for the motherboard, and contains the green cable responsible for starting the system.
- The peripheral cable has four wide pins and powers components like CD drives.
- The 12V2DC plug, or PCI plug, powers components on the motherboard like GPUs and fans.
- Serial ATA cables power Hard Drives, and have been adopted for other components like DVD players.

Cables on the PSU are colored to indicate the voltage that should it should carry

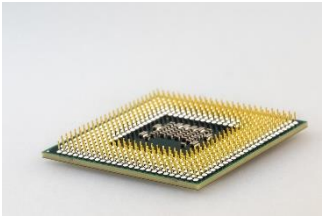
- Yellow= 12VDC
- Red= 5VDC
- Orange= 3.3VDC

If you suspect a PSU is failing, you can use a multi-meter to check. You want to check that the voltage is correct and that the current is consistent. Since you are working with electricity be careful. You may want to just upgrade instead. A quality 500W PSU can cost as little as $100.

PSUs may be modular, hardwiring some cables and allowing the user to plug in others to the PSU itself, or fully modular, allowing the user complete control over what cables come out of the PSU. These reduce space wasted by unused cables and allow the user to easily connect new cables as needed.

PSUs come in many different sizes in order to accommodate different cases. Most cases are designed to house ATX PSUs, but if you have a small form factor computer you may need a smaller PSU like the LFX, or one shaped like an L, like the CFX v3.

6. The Processor



Processors are abbreviated CPU for Central Processing Unit. They perform calculations and handle instructions, determining several important factors of a computer in doing so, such as the amount of memory a system can support and the speed at which the system runs.

A processor's speed is measured by how many tasks it can complete tasks per second, represented in Megahertz (MHz). 1 MHz per second is equivalent to 1,000,000 tasks per second. That's actually terrible by today's standards. For instance, the Intel Core i5 runs at 3.7 GHz (Gigahertz), which is 3,700,000,000 tasks per second.

Another important spec for processors is cache. Cache is a bank of memory that a processor can write data to after completing a task in order to speed up the process the next time it needs to do that task. In older computer cache was installed separately from the processor, but now cache is embedded within the processor itself.

Processors can also support having multiple cores, which contain both a CPU and cache. Cores are independent from one another, exponentially increasing the amount of tasks a computer can do. Processors can be dual, triple, or quad core.

You are limited as to what processor your computer can support by the type of socket installed on the motherboard.

Processors are installed directly into the motherboard via a socket. It is important to keep a processor cool, so there are often cooling measures applied directly to the processor.

Thermal Paste: This paste is applied directly to the top of the processor, and draws away heat. It is usually placed in between another measure.

Heat Sink: A series of metal pins that break up the surface area and draw heat away from the processor

Fan: These are usually paired with a heat sink and sit on top of the processor.

Liquid Cooling: A series of tubes pump liquid through a computer to keep it cool. While effective, there is a significant risk should the system leak.

At the time of writing the latest generation of Intel desktop processors include the i3 (4 cores, 4 GHz, 8MB L3 cache), the i5 (6 cores, 3.7 GHz, 9MB L3), the i7 (8 cores, 3.7GHz, 12MB L3), and the i9 (8 cores, 3.6GHz, 16MB L3). Another major manufacturer of processors is AMD, their latest processor family is called the Zen 2.

There are different processors for desktops, laptops, mobile devices, and servers to suit their different demands. For instance, a processor that needs less power is often desirable on a laptop so that the battery lasts longer.

7. The Hard Drive

The Hard Drive is where your computer writes most of its data and where your Operating System (OS) is housed.

The section of the Hard Drive housing the OS is often labeled the C:/ drive. It is possible to break the HDD down into several artificial sections in order to create new drives. This is called "partitioning."

Data is measured in units of memory called a **Byte** (B). You can consider 1 byte to represent a single letter.

- **1 Kilobyte** (KB) = 1,024 bytes (about 2 or 3 paragraphs)
- **1 Megabyte** (MB) = 1,024 KB (about 4 200 page books)
- **1 Gigabyte** (GB) = 1,024 MB (about 4,473 200 page books)
- **1 Terabyte** (TB) = 1,024 GB (about 4,581,298 200 page books)

Hard Drives currently come in two varieties: HDD and SSD.

An **HDD** (Hard Disk Drive) is a solid case protecting a series of discs stacked on top of each other with a head that moves to sections of the discs to read them. It is very similar to a vinyl record player.

At the time of writing, HDD capacities range on average from 250GB – 20TB.

An **SDD** (Solid State Drive) is newer technology and uses memory chips for storage. They do not need as much power, make as much noise, and are much faster than HDDs.

At the time of writing, SDD capacities range from 120GB - 30TB.

At the time of writing SDD technology is still fairly expensive. A 1TB SSD costs between $100-$150 whereas a 1 TB HDD costs between $40-$60. An HDD in the $100-$150 price range will be between 4-6TB or so.

Many cases have slots for multiple Hard Drives that can be used for additional storage space. Hard Drives can also be connected via USB cables and enclosures (cases that provide protection and power) and used externally.

If your computer breaks down you can recover your information by extracting the Hard Drive and using it with a replacement system!

8. Removable Storage

Optical Disc Drive: The optical disc drive is able to read and in some cases write to optical discs with a laser. The type of disc your drive can read depends on the kind of drive installed.

CD-ROM: *Compact Disc*. Able to hold upwards of 700MB or 80 minutes of audio data.

DVD: *Digital Video Disc*. Able to hold 4.7GB of data. DVDs are able to be dual layered to increase the data they can hold to 8.5GB.

Blu-Ray: Gets its name from the blue laser used to read it. Able to hold 25GB or 50GB if dual layered.

Discs and drives will be labeled to indicate how they can be used

R (CDR): *Recordable*. You can write to this disc, but once you do you cannot override or remove the data.

RW (DVD-RW): *Rewritable*. You can write to this disc, override and remove data by formatting it. Please note that formatting a disc will remove all of the information on it.

RE (*BD-RE*): Recordable Erasable. You can write and delete data from the disc.

Flash/Thumb Drives: A storage device that takes advantage of plug and play to be easily installed and removed from computers. These will be assigned a drive letter upon being recognized by your computer.

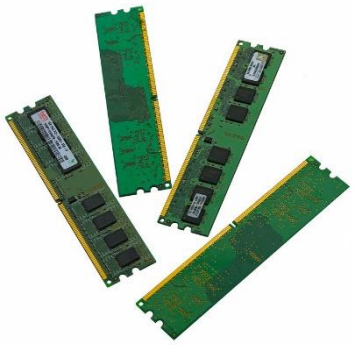
SD Cards: Secure Digital Cards. These come in a wide variety of sizes and are designed to store data for small devices like cell phones and digital cameras which can usually be connected to a computer via USB for access.

9. RAM

Random Access Memory (RAM) is volatile memory that your computer writes information to temporarily. The more RAM a system has the more it can do without being encumbered.

If a computer runs out of RAM when performing a task it will try to write to the HDD as a substitute. The HDD will not be able to read or write at the same rate as RAM, so performance will suffer.

It is fair to summarize that more RAM = more speed.



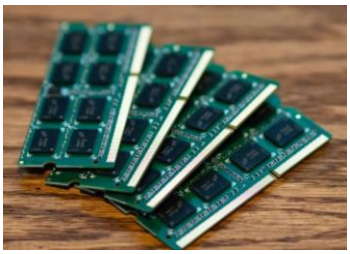
RAM is designated by its module standard, data transfer rate, and capacity (for example: 8GB DDR3-1866 is a DDR3 module with a capacity of 8GB and a transfer rate of 1866 mega-transfers per second).

You can figure out what RAM you need by looking up your computer or motherboard model.

Dynamic RAM (DRAM) is the most common RAM used today. RAM is keyed, so the kind you'll need depends on the motherboard and processor you have installed. DRAM are designed to be installed into in 3 types of modules: DIMM, SODIMM, and UniDIMM.

DIMM stands for Dual Inline Memory Modules, referring to the sets of memory chips along both sides of the card. DIMMs are long and narrow with pins along one long edge.

SODIMM stands for Small Outline Dual Inline Memory Moduals and are intended for laptop computers. They are narrower than DIMMs but slightly taller, using less pins than DIMMs and taking up less space as well.



UniDIMMs are similar to SODIMMs but are not as tall and only support DDR3 and DDR4.

DDR (Double Data Rate) is the type of DRAM you'll most likely encounter, and there are currently 4 module standards: DDR, DDR2, DDR3, and DDR4.

DDR: Caps at 200MHz and uses 184 pins. Comes in DDR-200, DDR266, DDR-333, and DDR-400.

DDR2: Caps out at 266MHz and uses 240 pins. Comes in DDR2-400, DDR2-533, DDR2-667, DDR2-800, and DDR2-1066.

DDR3: Caps out at 266MHz and uses 240 pins, but needs less power than DDR2. Comes in DDR3-800, DDR3-1066, DDR3-1333, DDR3-1600, DDR3-1866, and DDR3-2133.

There are additional DDR3L and DDR3U variants which can function on low voltage. If a system needs one of these it will not accept DDR3.

DDR4: Caps out at 400MHz and uses 240 pins, and needs less power than DDR3. Comes in DDR4-1600, DDR4-1866, DDR4-2133, DDR4-2400, DDR4-2666, DDR4-2933, and DDR4-3200.

Your motherboard determines the modules your system can accept, and your processor determines the maximum amount of memory and transfer rates that can be recognized.

Another popular form of RAM is VRAM, which stands for Video RAM. VRAM is installed via GPUs or Graphics Processing Unit which is a card that handles processing graphics, relieving a tremendous burden from other system resources and allowing a computer to render demanding displays, like a computer game or virtual reality.