220-1101 Hardware Study Guide

General Information - Hardware concepts are one of the most heavily emphasized areas of IT assessed on the CompTIA A+ 1101 exam. Around **25%** of the questions on the test pertain to this area. You'll need to be highly competent in identifying, using, and connecting hardware components and devices. The recent increase in remote work also makes it necessary to know about different devices that support that workforce. As you study, keep in mind that nearly all the questions (**86%**) about hardware will begin with a **scenario**.

Basic Cable Types: Connectors, Features, and Purposes - You must be able to describe different cable types and their characteristics and uses, including connector types, features, and purposes.

Network Cables - are used to connect devices such as computers to networking equipment. There are **three primary types** of network cable: **coaxial**, **twisted pair**, and **fiber**. A cable is the medium through which data is transferred from one device to another.

Copper - is the most common medium used in both coaxial and twisted-pair cables. Categories are used to describe performance ratings of twisted-pair cables. Commonly referred to as Cat cables, Category 1 through 8 exist, but for the purposes of the CompTIA A+ exam, we are only concerned with the **most common ratings, Category 5 through 6a**, and their corresponding transmission speeds and distance limitations. All Cat cables 2 through 8 are composed of four pairs of twisted-pairs totaling eight individual cables in one cable sheath.

Cat 5—**Category 5** cables have a transmission rate of up to 100 Mbps over a max distance of 100 meters.

Cat 5e—**Category 5e** cables have a transmission rate of up to 1 Gbps over a max distance of 100 meters due to the separation of the four sets of twisted pairs from one another and an increased number of twists in the cable pairs. This results in less interference.

Cat 6—**Category 6** cables have a transmission rate of up to 10 Gbps over a max distance of 55 meters.

Cat 6a—**Category 6a** cables have a transmission rate of up to 10 Gbps but have an increased distance capability of up to 100 meters.

Coaxial—is a single copper-cored cable contained in an inner insulation layer. This inner layer is further contained in a wire mesh conductor. The entire cable is then further protected in an outer insulation layer. Coaxial cables are not as commonly used in modern networks, but some usage may still be seen with cable and satellite devices. Coaxial cables are specified by the **Radio Guide (RG) system**. For the purpose of the test, you need to be familiar with **RG-6**, which is made of a solid copper core used with satellite/cable modems, and **RG-59**, which is made of a solid copper core and used for cable television.

***Twisted Copper Pair* -** is a twisted pair cable made of copper. The cable consists of pairs of individual wires twisted into pairs that are then twisted together. The cable is contained within an insulated jacket. **Ethernet cables** are twisted pairs. There are two types of twisted copper pairs: shielded twisted pair (STP) and unshielded twisted pair (UTP).

***Unshielded Twisted Pair* -** (UTP) is made of two to four pairs of twisted wires. The pairs of wires in UTP cables are twisted in direct contact with one another. Each wire in twisted pairs is contained within an insulating layer, preventing copper from directly touching copper.

***Shielded Twisted Pair* -** (STP) is made of two to four pairs of twisted wires. Each pair is contained in a layer of braided foil sheathing before being twisted with the other pairs in the cable. This reduces electrical interference. STP is used in Cat 7 and Cat 8 cables.

Direct burial—is the practice of burying cables underground. Direct burial cables should be STP cables with an extra waterproof sheathing. It is recommended that direct burial be between six and eight inches underground in a protective PVC pipe and placed away from any other lines that contain electrical current.

Plenum - is a **Teflon-type covering** used to cover all types of network cables. Plenum is used in cables that may be exposed to extreme heat or have the possibility of releasing gasses into a ventilation system, such as in ceilings.

Optical - is a transmission method that depends on light pulses for data transfer.

Fiber—refers to the small strings of flexible glass that are used for optical data transmission. Referred to as **fiber optic cables**, a fiber is surrounded by a rubberized coating and provides transmission speeds from 100 Mbps to 10 Gbps over a max distance of several miles. Fiber is immune to both **electrical interference** and **wiretapping**. There are two basic types of fiber: single-mode and multimode. **Single-mode** fiber carries only one light path, typically sourced by a laser. **Multimode** carries multiple light paths and is sourced by an LED. Single-mode has a much longer transmission distance than multimode.

T568A/T568B

Twisted pair wires are **color coded** for proper referencing. T568A and T568B are the two standards used for RJ-45 wiring connectors. The **T568A standard** is green/white, green, orange/white, blue, blue/white, orange, brown/white, and brown. The **T568B standard** is orange/white, orange, green/white, blue, blue/white, green, brown/white, and brown.
Peripheral Cables - attach peripheral devices to a computing device. They are used to attach things like printers, keyboards, monitors, and USB devices.
USB 2.0—The **universal serial bus 2.0** standard has a max speed of 480 Mbps and is referred to as **Hi-speed**.
USB 3.0—The **USB 3.0 standard** has a max speed of 5 Gbps and is referred to as **SuperSpeed**.
Serial—**cable** is built for serial communications with a corresponding serial connector on the end. The most common serial connection type is **DB9**, which has nine pins.
Thunderbolt—is a combination of PCI Express 2.0 x4 and DisplayPort 1.x technology. Thunderbolt was designed primarily for video transmission but can be used by other peripheral devices as well. There are **four Thunderbolt standards** labeled 1 to 4 with Thunderbolt 1 and 2 terminating in a Mini-DisplayPort connector and Thunderbolt 3 and 4 terminating in a USB-C connector.
Video Cables - is designed to transmit data to visual display units.
HDMI—The **high-definition multimedia interface** cable is capable of handling higher motion-picture frame rates and digital audio on a single cable. The most common connector type for an HDMI cable is the **Standard A HDMI** cable which has 19 pins.
DP—**DisplayPort** was developed to use less power than previous video cables. DisplayPort is backward compatible with VGA and DVI. DisplayPort is also capable of transmitting both video and audio signals. A standard DP cable has two hooks on it to lock the cable into place.
DVI—The **digital visual interface** cable was developed to address the shortcomings of analog video transmission. DVI cables are capable of transmitting digital video signals to display units. The **three DVI connector standards** are DVI-A for analog connection only, DVI-D for digital connection only, and DVI-I for both analog and digital signals. DVI cables are typically white.
VGA—The **video graphics array** cable is the oldest video standard still in use today. A VGA cable is **strictly analog** and is typically blue in color.
Hard Drive Cables - cables/connectors connect internal components to the motherboard. Hard drive connections, known as **drive interfaces**, can be either **on-board or off-board**. Their attachment standard is based on the hard drive's requirements and consists of circuitry and a header, or port.
SATA—**Serial advanced technology attachment** is the **most common** type of drive interface. A standard SATA cable is internal and flat with a **terminating connector** that can only fit into the motherboard connection port in one way. A SATA data cable has **seven pins**, while a SATA power cable has **15 pins**. SATA revisions 1.0, 2.0, 3.0, and 3.2 support speeds of 1.5 Gbps, 3 Gbps, 6 Gbps, and 16 Gbps, respectively.
SCSI—**Small computer system interface** is a type of hard drive connector that is most commonly used for **storage device connection**. SCSI cables can be either ribbon cables or round cables containing 50, 68, or 80 wires. Up to 16 devices, including the motherboard or SCSI controller card, may be connected to one SCSI cable or **daisy-chained** together.
eSATA—The **external SATA** cable, as the name suggests, is **external** to the housing. Standard eSATA cables are for data transmission only and do not provide power. An eSATA that provides power is called Power over eSATA, eSATA+, eSATAp, or eSATA/USB.
IDE—**Integrated drive electronics** cables, renamed **parallel advanced technology attachment (PATA)**, are 40-pin flat data cables with a colored strip along one edge to indicate the location of pin 1. There are three separate connectors on a PATA cable, one for power and two for drives.
Adapters - is a device that converts one type of connection or cable technology to another, such as a DVI-to-VGA, DVI-to-HDMI, or USB-to-ethernet.
Connector Types - Connectors are installed at the terminating points of cables to provide connection to compatible components and peripherals. The connector type used depends on the type of cable and the desired receptacle compatibility.
RJ11—A **registered jack (J)** is a **standard for telecommunication network interfaces** for voice and data equipment connection to a service provider or carrier. RJ11 is used with twisted pair cables to connect four to six wires to traditional telephone lines of modems.
RJ45—is used with twisted pair cables for eight-wire connections. A twisted pair cable with RJ45 connectors is commonly called an **ethernet cable**.
F-type—An connector (or just **F connector**) is used with coaxial cables for cable and satellite data connections.

ST—A **straight tip** connector is a **bayonet style** connector used with fiber optic cables.
SC—A **subscriber connector** is a push/pull-style connector used with fiber optic cables.
LC—A **lucent connector** is a push/pull-style connector used with fiber optic cables that is half the size of an SC, making it more suitable for office and data center usage.
Punchdown block—is an electrical connection device that allows for multiple copper wires to be "punched down" or inserted into a slot providing insulation as well as electrical connection to attached wires.
Micro USB—connector is the **smallest** USB connector type, contains **five pins**, and is **direction dependent**.
MiniUSB—is the **second smallest** USB connector type, contains **five pins**, and is **direction dependent**.
USB-C—is the most recent USB connector type containing **24 pins** in an **oval** shape, allowing for **reversible connection**.
Molex™— is an older **two-piece** pin-and-socket interconnection type used for drive connections.
Lightning port—is an **eight-pin Apple** proprietary connector type that has **reversible** orientation.
DB9—is a **trapezoid**-shaped nine-pin connector arranged in **two rows of four and five pins**. It is used for serial connections to network device consoles or management ports.
Installing the Appropriate RAM - You must be able to identify and install different RAM types. These questions will be scenario based.
RAM Types - Random access memory is the memory bank for data currently in use by a computer or device. RAM memory is temporary. There are numerous types of RAM.
Virtual RAM –is space on a hard drive that can be allocated when additional memory is requested from an application. This space on the hard drive is also known as a **swap file** or a **paging file**.
Small Outline Dual Inline Memory Module (SODIMM) - are commonly found in laptops where space is at a premium and come in 100-, 144-, 200-, 204-, and 260-pin configurations. SODIMM defines the physical form factor of the module.
Double Data Rate 3 (DDR3) - is **faster than DDR2** and has 30% **less power consumption**. It comes in 240-pin DIMM and 204-pin SODIMM. Double data rate (DDR), as the name implies, doubles the transfer rate of memory. DDR2 further increases the speed by two. DDR and DDR2 are legacy technologies and no longer used in modern devices.
Double Data Rate 4 (DDR4) - is **faster than DDR3** and has **less power consumption**. It comes in 288-pin DIMM and 260-pin SODIMM.
Double Data Rate 5 (DDR5) - doubles the speed of DDR4 to 6.4 Gbps with improved power efficiency at 1.1 volts and is available in **up to 128 GB** modules.
Error-Correcting Code (ECC) RAM - has **logic built in** to detect and correct single-bit memory errors. For each byte (eight bits) of memory, a parity bit is set that will allow the logic to detect and **correct an error in a single bit** of each byte. The logic would not correct an error in any byte with more than one bad bit.
Single-Channel - memory transfers data in chunks the same size as the system bus's bandwidth.
Dual-Channel - memory occurs when the memory controller **coordinates two memory banks** to work in conjunction with one another as a synchronized set when communicating with the CPU, doubling the size of the data transfer.
Triple-Channel - memory **coordinates three memory modules** for communication with the CPU.
Quad-Channel - memory **coordinates four memory modules** for communication with the CPU.
Storage Devices - are physical components used to store data and files that a computer system needs to operate. You must be able to identify and install different storage devices. Questions about these will be scenario based.
Hard Drives - is a **non-volatile storage device** designed for **quick access**. It is also known as a **hard disk drive (HDD)** or a **conventional drive** and uses a magnetic spinning internal platter to store memory.
Speeds - The speed at which a HDD operates is measured by the number of **revolutions per minute (rpm)** that the platter of an HDD spins. Higher speeds use more energy and increase heat production. There are four HDD speeds: **5,400 rpm**, **7,200 rpm**, **10,000 rpm**, and **15,000rpm**.
Form Factor - refers to the **physical size of the hard drive**. Both form factors contain the same connectors.
2.5"—2.5" hard drives are typically used in **laptops**. 2.5" hard drives can be mounted in a 3.5" form factor slot with the use of a converter kit.
3.5"—3.5" hard drives are typically used in **desktop** computers.
SSDs - A solid-state drive is a **flash memory technology** that contains no moving parts. Flash memory is a form of nonvolatile read/write memory. Nonvolatile memory **retains data when power is removed**. Flash **erases data in blocks**, rather than at the byte level. An SSD uses a series of NAND chips to store memory. SSDs can be made in smaller form factors than HDDs and are capable of much higher speeds.
Communications Interfaces

Communication interfaces are the method through which an SSD communicates with the motherboard and other components.
NVMe—**Non-volatile memory express** is an open-source standard used to optimize data transfer and can support speeds up to 3.5 GBps.
SATA—The **serial AT attachment** interface is the slowest of the SSD interfaces.
PCIe—**Peripheral component interconnect express** offers faster speeds than SATA but slower than NVMe.
Form Factors - of the SSD are the shape and size of the SSD.
M.2—is a form factor for SSDs. It is 22 mm wide and can vary in length, with the most common lengths being 80 mm and 60 mm. It is referred to as "gumstick memory" because its size is similar to a stick of gum. M.2 drives plug into an M.2 slot on a motherboard.
mSATA—**Mini-serial ATA** is a form factor for SSDs. mSATAs have a 30-mm wide, 52-pin connector and use the SATA interface for communication. mSATAs can be either 30 mm x 50.95 mm or 30 mm x 26.8 mm.
Drive Configurations - Storage devices can be configured for high availability so that if one disk in an array of disks fails, data is not lost. The most common configuration is known as redundant array of independent (or inexpensive) disks (RAID).
Redundant Array of Independent/Inexpensive Disks (RAID) 0, 1, 5, 10
There are different RAID configurations, known as RAID 0, 1, 5, 10, that provide different levels of data protection. **Striping** is a method of storing part of the data on each drive in an array. **Mirroring** is keeping a full copy of a disk on another disk.
RAID 0: offers striping of data only; no redundancy; good performance
RAID 1: offers mirroring of data only; requires more storage space to store full copies of data
RAID 5: offers striping with parity; minimum of three drives; ability to calculate missing data and rebuild
RAID 10: offers striping and mirroring for full redundancy; minimum of four drives
Removable Storage - devices are not contained internally but externally and can be relocated.
Flash Drives - are removable storage devices that are capable of containing a large quantity of information in a **non-volatile, small, and portable** form. Flash memory devices include SD cards, USB flash drives, and optical cards.
Memory Cards - is a **flash memory** device that can **store data in a non-volatile state**. Common memory card form factors include SD, CF, micro-SD, mini-SD, and xD.
Optical Cards - are **flash storage** devices that store data through the use of **lasers** on spinning discs. Examples of optical cards include CDs, DVDs, and BDs.
Motherboards, Central Processing Units (CPUs), and Add-on Cards - The motherboard provides the circuitry by which all parts of a computer communicate with each other, from the processor to the power supply. Every part of a computer interacts with the motherboard in some fashion. You should be able to install and configure motherboards, as well as the CPUs and add-on cards you plug into them, in a given scenario.
Motherboard Form Factor - describes the physical characteristics of the motherboard.
Advanced Technology eXtended (ATX) - Older variants contain a **20-pin Molex power connection**, while newer models contain the **24-pin Molex power connection**. Standard ATX motherboards measure 12" x 9.6". Micro-ATX is a little bit smaller than the ATX and does not have as much expansion ability.
Information Technology eXtended (ITX) - is a series of significantly smaller form factor boards that were created by VIA Technologies™. **Mini-ITX** is the largest of the ITX form factors, with a size of 6.7" x 6.7".The **Nano-ITX** measures 4.7" x 4.7". The **Pico-ITX** measures 3.9" x 2.8". The **mobile-ITX** measures 2.4" x 2.4".
Motherboard Connector Types - that determine what can be connected to them.
PCI—**Peripheral Component Interconnect** was introduced by Intel™ in the 1990s. This replaced older 8- and 16-bit expansion slots with a 32-bit slot.
PCIe—**PCI express** sends data in a serial stream at higher speeds than conventional PCI. It has superseded PCI.
Power connectors—The power connector of a motherboard is a special **24-pin** connection point through which a motherboard receives electrical power.
SATA—The **serial ATA connector** is used to connect a hard drive or optical drive.
eSATA—An **external SATA** is a connection type that allows for external devices to connect directly to the motherboard using a SATA connection.
Headers—is a motherboard connection type that allows for external components, such as lights and buttons, to connect directly to the motherboard. Examples of components connected to headers are the power button and light, the reset button, drive activity lights, audio jacks, and USB ports.

M.2— (pronounced M dot 2) is not technically a connection or bus type but rather a form factor. M.2 supports SATA, USB, and PCIe buses.
Motherboard Compatibility - Motherboards only work with compatible components. Components dependent upon motherboard compatibility include bus architecture, chipsets, expansion slots, memory slots, CPUs, power connectors, non-volatile storage, firmware, CMOS batteries, and front panel connectors and headers.
CPU Sockets - is the space on the motherboard designed to hold the CPU that contains a specific pin grid array dependent upon the motherboard.
Advanced Micro Devices, Inc.™ (AMD) - Specific AMD CPUs must run with specific AMD chipsets. The motherboard manufacturers may vary.
Intel™ - Specific Intel CPUs must run with specific Intel chipsets. The motherboard manufacturers may vary.
Server - motherboards are typically capable of **housing multiple processors** with expanded memory and networking capabilities. Most server motherboards are **ATX sized** and specifically designed to fit within the server chassis.
Multi-socket - motherboard is a motherboard that has **more than one CPU socket**.
Desktop - motherboard can be either **ATX or ITX** and typically contains **one CPU socket**.
Mobile - A motherboard can be a standard small form factor motherboard but are more commonly specifically designed to fit the needs of the manufacturer with the CPU soldered into the motherboard.
Basic Input/Output System (BIOS)/Unified Extensible Firmware Interface (UEFI) settings
The **basic input/output system (BIOS)** is, arguably, one of the most important aspects of a computer. You need to have a good understanding of system BIOS and how to modify the settings. Understand the importance of selecting the proper **boot sequence** and how BIOS provides low-level drivers that allow the operating system to interact with various hardware components. Comprehend the various stages in the boot sequence, the **system POST**, and the role BIOS plays in loading the operating system. The CompTIA A+ questions about BIOS require that you assess a scenario to choose the best answer.
The Unified Extensible Firmware Interface (UEFI) is an updated booting program which connects the firmware of a computer to the operating system. UEFI is faster than BIOS, but it is not widely available on all computer devices. UEFI forgoes the self-test process, which increases its speed. UEFI is capable of handling drives larger than 2TB and more than four primary partitions. However, most devices still use the BIOS system.
Boot Options - You can set the sequence of devices to boot from in the boot option settings. You usually boot from the **hard drive**, but you may want to boot from an **optical drive** or **flash drive**. The boot sequence tells the BIOS where to look to load the operating system. It will proceed down the list in the order configured until it finds an operating system to load.
USB Permissions - can be set in the BIOS and specify the permissions that USB devices have on a device.
Trusted Platform Module (TPM) Security Features
The Trusted Platform Module is a dedicated security coprocessor or cryptoprocessor that can be configured for **booting authentication**.
Fan Considerations - Fans provide airflow within a computer to keep components cool during operation. Fan considerations include fan location, front or rear, and fan dedication, such as power supply exhaust, CPU, chipset, video card, or memory module fans.
Secure Boot - ensures that the OS and drivers are **authorized** versions without malicious code before loading them.
Boot Password - The **supervisor or admin password**, if enabled, requires a password to view and set all BIOS settings. The **user or system password** allows minor changes such as time and date or boot options to be set.
Encryption -A key can be set to access an encrypted hard drive. If set, that key must be used for decryption, even if the drive is moved to another computer.
TPM - The Trusted Platform Module is a **security chip** that stores cryptographic keys used by the BIOS or UEFI in booting authentication.
Hardware Security Module (HSM) - is a security device that can create, manage, and store encryption keys.
CPU Architecture - is the rules by which a CPU communicates with other components.
x64/x86 - platform uses **CISC technology** (CISC is an instruction set architecture [ISA]) that is designed to work with **either 64 or 32 bits** of data at a time. Working with 64 bits is referred to as x64 while working with 32 bits is referred to as x86.
Advanced RISC Machine (ARM) - processor uses RISC ISA (RISC stands for **reduced instruction set computer**). ARM is also known as an **Acorn RISC** machine and is in direct competition with Intel and AMD x64-based CPUs.

Single-core - is the part of the CPU that reads and executes instructions. As the name implies, a single-core CPU has one core. Most of today's CPUs have multiple cores.
Multicore - is the part of the CPU that reads and executes instructions. Multicore CPUs have more than one core. This allows different threads of instructions to be run simultaneously, with each core running one thread, resulting in faster performance. A **dual-core** processor will run faster than a single core, but not quite twice as fast. There are also **quad-core**, **eight-core**, and other types of multicore processors.
Multithreading - occurs when a CPU is able to run multiple threads at once. A thread is the string of instructions that the CPU runs. Hyper-threading technology (HTT) is a form of simultaneous multithreading marketed by Intel.
Virtualization Support - Modern CPUs support virtualization in hardware. AMD refers to virtualization support in their products as AMD-V, while Intel refers to virtualization support as Virtualization Technology (VT).
Expansion Cards - can be attached to a motherboard through **expansion slots**. An expansion slot can be used to expand the capabilities of a computer. You must use expansion cards that are compatible with the expansion slots available.
Sound Card - Add-on sound cards are used to **improve the sound capabilities** beyond the motherboard's sound capabilities. A musician, composer, or audiophile may choose to upgrade their computer's sound with an add-on card.
Video Card - control the graphics that are displayed. This function may be provided by an add-on card or it may be on-board, meaning built into the motherboard.
On-board—video cards typically provide good graphics features and specifications. It serves the purpose for most users, but some users, like gamers or graphic designers, may need better graphics.
Add-on card—video cards have their own **graphics processing unit (GPU)**. They are used to improve the graphics capabilities beyond what the on-board video provides.
Capture Card - is an expansion device that **converts video signals to digital** that can then be uploaded to the internet.
NIC - A network interface card (NIC) is a device that provides a device with the capability to **connect to a network**, typically the internet. A NIC can be either an **on-board or add-on** card and may be either **wired or wireless** connections.
Cooling - Components on motherboards and add-on cards generate heat, especially CPUs and GPUs. There are several types of cooling mechanisms to remove heat from a computer.
Fans - are used to **move air** through a computer to remove heat. Fans are positioned in the case to allow air to pass between the inside of the case and the outside. Fans are also used on individual components to provide extra cooling. They are sometimes integrated with a heat sink.
Heat Sink - are devices that conduct heat and have the effect of increasing the surface area of a component.
This **removes heat** from the component more quickly than fans alone. Some heat sinks have fans built into them.
Thermal Paste/Pads - The quality of contact between a component to be cooled and the heat sink used to cool it will impact how effectively it is cooled. Thermal paste and thermal pads conduct heat and are used between the component and heat sink to **make the best thermal-conductive connection**.
Liquid - For high-performance computers, air cooling may not be enough. Liquid cooling is more effective at **transferring heat** away from components. **Distilled water** is the most commonly used liquid. Liquid cooling systems include a tank for the liquid, a radiator, a water pump, and a cooling block that attaches to the component being cooled. These components may be in the computer or outside in a separate unit that connects to the computer.
Power Supply - convert AC power to the DC power that computer components run on. There are different types of power supplies to fit different types of computers. Each power supply has specific features related to capacity and connectors. You must be able to select the proper power supply type and features needed in any given scenario.
Input 110-120 VAC vs. 220-240 VAC - The input to a power supply is provided by the power company. This is the power available at a wall outlet. In North America and some other parts of the world, **110 volts AC - 120 volts AC** is supplied. Other countries supply **220 volts AC - 240 volts AC**. So, power supplies are designed to accept either or both of these inputs. You may find power supplies that accept only one or the other voltage, but most accept both. Some have a switch to set for the correct input. Others accept either input without having to set a switch.
Output 3.3V vs. 5V vs. 12V - The power supply **converts the AC power input to DC power** that supplies the computer's components. Most power supplies provide +5V and +12V. Others may also provide -12V, -5V, and +3.3V. You may see more than one connector for a specific output. For example, you may see two +12V outputs, each with its own connector. Each output is called a **rail**, so in this example, there would be two +12V rails.
20-Pin to 24-Pin Motherboard Adapter - Most power supplies provide DC output power on a standard 24-pin connector, also called the **ATX power connector**, which plugs into the motherboard. The connector is keyed so that it can only plug in one way, ensuring that the proper voltages are supplied to the right pins. Specific pins are designated to supply +5V, +12V, -12V, and 3.3V.

Redundant Power Supply - is a **secondary power supply** that provides power to a device in case of power failure.
Modular Power Supply - is a power supply that is **not permanently attached** to the device. This provides the potential for additional power connections to the device.
Wattage Rating - or **power rating**, is the total capacity of the power supply. This must be high enough to meet the total power demands of all components in the computer. The number and **types of devices or components** in any given computer determine what wattage rating is needed for the power supply. They also determine what **types of connectors** are needed to ensure that you can connect the power supply to each device. The **type of case** the computer is in also needs to be considered to ensure that the power supply physically fits properly.
To determine the wattage requirement of the power supply, add all of the wattage ratings of the individual components. Your power supply's wattage must meet or preferably exceed that total value. The connectors needed are determined by the connector types used on the devices to be powered. For example, if you have an older ATX motherboard, it has a 20-pin power connection, while newer models contain the 24-pin Molex power connection.
The power supply you select obviously must physically fit into the case. It also needs long enough cables from the power supply to reach the components.
Multi-Function Devices/Printers and Settings - You must be able to identify, deploy, and configure multi-function devices and printers with the appropriate setting. The questions about these concepts will be scenario based.
Properly Unboxing a Device and Setup Location Considerations - When installing a multi-function device or printer, read the **manufacturer's instructions** first. The next step is to evaluate the **needs of the user**, the **demands** that will be placed on the device, and the most appropriate **location** for maximized efficiency. When **unboxing** the device, be sure to open the box on a stable flat surface. Avoid banging or dropping the device. Lift the device out in the proper orientation to avoid tipping the device, which is particularly important with printers that use tinder cartridges.
Use Appropriate Drivers for the OS - Most devices will come with **easy installation media**. Windows devices will automatically recognize a device upon connection and powerup. Install the appropriate **driver** for the OS and the device. Install any **updates** for the appropriate drivers.
Printer Control Language (PCL) vs. PostScript - are two printer communication languages. **PostScript** is an older technology and is device independent, which allows for print jobs to result in the same output regardless of the printer used. **PCL** is a newer and more common printing language that is device dependent. This means that the printer itself is responsible for some of the printing data, which may result in slightly different outputs depending on the printer used.
Device Connectivity - A printer's interface is the hardware and software that a printer uses to connect with devices or a network. The hardware interface used by a printer is commonly called the **port**. A printer can only be used with the correct interface.
USB - is the **most common** wired connection method for printers. A USB port will allow for the connection of a physical USB cable to the appropriate device.
Ethernet - Printers that are designed to work on a network will have an **RJ-45 ethernet** connector. They connect to the network with an ethernet cable, just as a computer would. They are easily shared since they are connected directly to the network.
Wireless - connections to printers may be made via **Bluetooth**, **802.11**, or a **direct ad hoc** connection.
Public/Shared Devices - Devices can be shared by multiple users over wired or wireless connections. Users can connect directly to a printer or through a **print server** or **cloud** printing service. Small office/home office (SOHO) devices can be made available and shared with anyone on a network. This is true for devices that are connected directly to the network or connected to a computer. If a printer is connected to a computer, then the operating system must be configured to make the printer available to users on the network.
Printer Share - is the process of providing access to a printer to other computers and devices on a network.
Print Server - sits on the network and handles printing requests from users. It can **spool** (temporarily store) requests for printers that are busy, allow prioritization of print jobs, and delete jobs after they've been sent. Print servers may be **separate devices or integrated** into the printer.
Configuration Settings - are the settings within a printer that can be optimized to best suit the needs of the users. Configuration settings can be accessible to all users or restricted to authorized users only.
Duplex - Enabling duplex mode causes the printer to **print on both sides** of the paper.
Orientation - There are two options for orientation: portrait or landscape. In **portrait mode**, the top of the page is the shorter dimension. This is how pages are typically printed. In **landscape mode**, the top of the page is the longer dimension. Spreadsheets and slides are often printed in landscape mode.
Tray Settings - control how the printer manages the individual paper trays in the device.

Quality - Print quality settings control resolution and color. **Resolution** is expressed in **dots per inch (dpi)**. Higher resolutions provide better quality printouts. **Color settings** control how vivid the color output is.
Security - Giving access to users over the network raises concerns over **data privacy**. Steps must be taken to ensure that users cannot read other users' print jobs.
User Authentication - Users can be required to authenticate to print servers. They typically authenticate at one of **two security levels: user or administrator**. Users are limited to printing and managing their own print jobs. This prevents other users from seeing or interfering with other users' print jobs. Administrators can manage all print jobs.
Badging - is a function that can be used for the security of a printer. An attached badge scanner is used to access secure printing functions.
Audit Logs - keep a record of all print jobs along with the originating location of the print jobs for later auditing.
Secured Prints - are printouts that **require authentication** at the physical printer before a print job commences. This ensures that the intended recipient of the print must be present to reduce the likelihood of another unauthorized user from grabbing or seeing a sensitive print.
Network Scan Services - are hardware and software functions designed to input or scan documents. Scans taken on a printer or scanning device can be set to record the scanned information in a specified manner.
Email
Scan to email occurs when a printer/scanner is instructed to send the scanned image or document to a specific email address or group of addresses, typically in a PDF file.
SMB
Scan to folder is the process of sending a scanned document or image to a specified folder. The protocol used by the printer/scanner to send data to a network folder is secure message block (SMB).
Cloud Services
Scan to cloud occurs when a printer/scanner is instructed to send a scanned image or document to a specified cloud location or service and is supported by popular cloud services, such as Google Drive, OneDrive, and Dropbox.
Automatic Document Feeder (ADF)/Flatbed Scanner - There are two primary types of scanners. An **automatic document feeder (AFD)** is a scanning device that allows for multiple pages to be scanned automatically through the use of a feeder, eliminating the need to manually change the document being scanned. A **flatbed scanner** is a scanning device that requires manual placement of a document to be scanned onto a flat scanning surface with a closable lid.
Printer Consumables - are the components of a computer that require replacement. You must be able to install and replace printer consumables. These questions will be scenario based.
Laser - printers create **high-quality** printouts using a complex process. The component that actually "draws" the image is a laser. It works with other components to transfer that image to the paper.
Imaging Parts - Laser printers have the following specific imaging parts.
Imaging drum—The laser draws the page image onto the imaging drum.
Fuser assembly—The fuser assembly applies pressure and heat to bond the toner to the paper.
Transfer Belt—Used in color laser printers, the transfer belt transfers the page image from the imaging drum to the paper.
Transfer roller—Used in black-and-white laser printers, the transfer roller transfers the page image from the imaging drum to the paper.
Pickup rollers—Rubber pickup rollers feed paper from the paper tray through the printer.
Separation pads—To ensure that only one page is fed at a time, separation pads separate the page being fed from the pages underneath it.
Duplexing assembly—To print on both sides of the paper, the duplexing assembly will flip the paper over.
Imaging Process - of a laser printer specifies the process the printer follows to produce an image.
Processing—Before any actual printing is done, the image of the full page is placed into memory.
Charging—A high negative charge is applied to the imaging drum.
Exposing—The laser draws the image of the page onto the imaging drum by exposing it to the laser light. The tightly focused laser light removes the negative charge from the imaging drum (neutralizing it), leaving the rest of the drum negatively charged.
Developing—The negatively charged toner is transferred to the imaging drum. Since the drum is also negatively charged, the toner will only stick to the areas that have been neutralized by the laser.
Transferring—The transfer roller or transfer belt transfers the toner from the drum to the paper.
Fusing—A fusing roller uses heat and pressure to bond the toner to the paper.

Cleaning—Any residual toner is cleaned off of the imaging drum.
Maintenance - Laser printers tend to be expensive, so regular maintenance must be done to keep them running well for a long time. Manufacturers make this fairly easy for common maintenance tasks like replacing toner. Other tasks require more knowledge and skill.
Replace toner—Toner is used for each print job, so it must periodically be replaced. Toner comes in a **toner cartridge** that is easily replaced by the user.
Maintenance kit—Printer manufacturers recommend replacing certain parts periodically. They provide these parts in maintenance kits. They may include the fuser assembly, transfer belt, transfer roller, pickup rollers, and/or separate pads.
Calibrate—Calibration is done to keep the page image sharp and accurate. This may be done on a periodic basis and when parts are replaced. Each printer will have its own calibration process.
Clean—Toner is a fine powder that will leave residue in the printer. Keeping the inside of the printer clean will keep it running well and prevent loose toner from showing up on printouts.
Inkjet
Inkjet printers create **high-quality** printouts, though the **resolution can be less**than that of laser printers. They are also much **less expensive**. They create the page image by spraying ink dots onto precise points on the paper. Several components work together to transfer the page image to the paper.
Imaging Parts - Inkjet printers have the following specific imaging parts.
Ink cartridge—Ink is stored in ink cartridges that supply ink to the print heads. There may be a **separate cartridge** for each of the standard colors used—cyan, magenta, yellow, and black. Some inkjet printers use a **combined color cartridge** with cyan, magenta, and yellow ink, plus a black ink cartridge.
Print head—The print head draws the ink from the cartridge and ejects it onto the paper. Some printers combine the ink cartridge and the print head into a single unit.
Roller—Paper is fed through the printer by the roller.
Feeder—Paper may be fed from either a simple paper tray or a feeder. Most feeders have adjustments to allow you to feed papers of varied sizes.
Duplexing assembly—The duplexing assembly flips the paper over so that you can print on both sides. It is not found in all inkjet printers.
Carriage belt—The carriage holds the print heads and gets moved into position so the print heads can eject the ink onto the proper spot on the paper. The belt moves the carriage into position so the print heads can eject the ink onto the proper spot on the paper.
Calibration - is done to keep the page image sharp and accurate. This may be done on a periodic basis and when parts are replaced. The printer should be calibrated whenever a print head or ink cartridge is replaced. Each printer will have its own calibration process.
Maintenance - Inkjet printers require **minimal** maintenance, which is easily done using features available through the printer's menus or software. To determine if maintenance is needed, test pages specifically designed to point out flaws can be printed from the printer's menus or software.
Clean heads—Printer heads can get clogged over time. Cleaning the heads can be done by selecting a menu option or through the printer's software. When initiated, the printer will run through a head-cleaning process.
Replace cartridges—When the ink in a cartridge has been used up, the cartridge must be replaced. A calibration should be done after replacing a cartridge.
Calibrate—is done to keep the page image sharp and accurate. This may be done on a periodic basis and when parts are replaced. The printer should be calibrated whenever a print head or ink cartridge is replaced. Each printer will have its own calibration process.
Clear jams—Paper may get jammed in the printer as it is fed through. It may be cleared manually by simply pulling it out. Some printers provide a way to run just the feeder, either manually by turning a wheel or by running the feed motor.
Thermal - printers use **chemically treated thermal paper** that changes color when heated. It is the heat, rather than ink, that transfers the image to the paper. Thermal printers are simple and **inexpensive**. Common uses are for receipts and shipping labels. The image printed is sensitive to light and heat, so it **will fade over time**.
Imaging Parts - Thermal printers have the following specific imaging parts.
Feed assembly—The feed assembly feeds the thermal paper through the printer.

Heating element—The heating element heats specific areas of the thermal paper as it scrolls by. The heated areas darken to create the image.

Special Paper and Heat Sensitivity

Thermal paper is chemically treated paper that changes color when heated. This makes the print out vulnerable to damage or degradation when exposed to heat.

Maintenance - Maintaining thermal printers is simpler than other types of printers. There are fewer moving parts and **no ink**.

Replace paper—Thermal paper comes in **rolls** of various sizes. Replacing the paper is a simple matter of removing the empty roll and inserting the new roll. There is a button or wheel that can be used to feed the paper into the printer after the new roll is inserted.

Clean heating element—The heating element should be cleaned periodically to ensure proper heat transfer to the paper. Isopropyl alcohol is typically used as the cleaning agent. Some printers come with a pen or pad to make it easier to access the heating element for cleaning.

Remove debris—Paper fragments and dust will accumulate in the printer over time. This debris should be removed as needed. A commonly used method is to blow out the debris with **compressed air**.

Impact - printers use a **matrix of pins** to strike an ink ribbon to transfer ink to the paper. The most common type is the **dot-matrix** printers. A unique feature of impact printers, as compared to other printers, is that they can **print multiple copies simultaneously** using carbonless or no carbon required (NCR) paper.

Imaging Parts - have the following specific imaging parts.

Print head—The print head is a row or rectangular matrix of metal pins. The pins that strike the ink ribbon form the character to be printed.

Ribbon—The ribbon holds the ink that is transferred to the paper by the print head during printing.

Tractor feed—The tractor feed feeds the paper through the printer.

Impact Paper - is simply paper made for impact printers. It may come on a roll or as fanfold paper in single-ply, duplicate, or triplicate. Duplicate and triplicate paper transfers the image through to all copies simultaneously.

Maintenance - There is little required on impact printers. In most printers, these items can all be replaced by the user.

Replace ribbon—Ribbon replacement is usually a simple task. The new ribbon should be taut, leaving no slack.

Replace print head—The pins in a print head can get bent or broken, so the print head will eventually need to be replaced. The print head does get hot due to the friction of rapidly moving parts, so care must be taken to ensure it **cools down** before touching it. It is held in by a lever that must be released to remove the old print head.

Replace paper—Paper replacement requires a bit more effort than in other types of printers. The paper has holes along the side that are placed into the tractor feed. These must be aligned so that the paper feeds properly. Also, since the paper is continuous, as opposed to separate sheets, the top of the page must be lined up properly.

3-D Printer - is not technically a printer but a **fabrication machine** through a process called additive manufacturing. A three-dimensional object is created by adding layers of filament or liquid resin on top of one another to produce a specified output.

Filament - is a **plastic** substance used by 3D printers to create an object. A 3D filament printer's components include the frame, the printing plate or print bed, the extruder, the cooling fan, the printed circuit board (PCB), and the filament. Filament comes on a **spool**. The main three things to consider when choosing a filament type are the size, type, and color.

Resin - is a **liquid** substance contained in a reservoir used to build a specified object. The resin is hardened by a UV light layer by layer to create the object. 3D resin printers are also referred to as stereolithography/digital light processing printers (SLA/DLP).

Print Bed - is the **plate** on which the object will be printed. In a filament printer, the print bed is located at the bottom of the printer with the printer creating the object from the bottom up. The print bed on a resin printer is often located at the top of the printer with the printer creating the object from the top down, appearing to rise from the printer.