**A1 | Types of computer systems:**

* **Multi-functional devices:** – **Computer systems that perform multiple functions**. For example: some **printers** can include a **built-in scanner**. This scanner is often located on top of the device, which can be used as a photocopier. As a result, this one device can **print, photocopy and scan documents**.
* **Mobile devices:** – These are **also multifunctional devices**. Most common mobile device is a smart phone. it consists of multiple features that can perform multiple functions. For example, **a camera,** which is used to take photos/video. A **microphon**e, allows the input of speech for phone calls. A **GPS**, can be used to locate the phone/apps that uses maps. Nowadays, the development of mobile devices **is almost as powerful as a PC**. They have **good internet connection** and **a long battery life**. They are extremely **portable**.
* **Wearable Computers:** – **small highly portable** technology systems that are designed to be worn by a user. For example, smartwatches, fitness trackers.
* **Modular Smartphones:** – a smartphone that contains **different components and features** that can be **changed by the user** in order **to change the functionality of the device**. For example: Project Ara)
* **Personal Computers:** – These are most likely **desktop computers/laptops** used in a **working environment** or **by individuals located at home**. In a working environment, these personal computers carry out tasks that is **useful for an organisation**. Furthermore, it will include the use of useful **software programs** such as **word, spreadsheets, databases and programming languages**. Desktop computers are **usually left in an office** and have **a cabled connection** to a network. Laptops are **portable** and can connect to a network **wirelessly**. Laptops are useful for individuals that wants the **flexibility** to work at any given location. For example, home or on the move.
* **Servers:** – These are **physical or virtual** computer systems that run a **network operating system** such as Microsoft Window Server. Used to **control** the network and allows users to **log into workstations** (client systems). Servers control the network from a **centralized point** and often in a **client-server model**, which is a structure that separates workloads between clients and servers. Servers **provide access to resource sharing facilities**. Severs are available in all **types of sizes** in order to meet the **requirements** of different sized organisations. These are **powerful** computers that hold a **lot of memory** and **disc space**. They also have a lot of **duplicated internal components,** which makes them **expensive**, in order to make them more **reliable and efficient**.
* **Single Board Computers:** **– small and inexpensive complete computers** such as a Raspberry PI. These are designed to be used within **development projects** and in **education**.
* **Other devices:** digital cameras, games consoles, home entertainment systems, navigation aids

**A1 | The Purpose, Features and Uses of Internal Components Used in a Computer System:**

* **Central Processing Unit: (CPU)** – This is often known as a processor. The purpose of the CPU is to process data. This is where all the searching, sorting, calculating and decision takes places within a computer system. The performance of the CPU can depend on a various number of features. Such as: Number of cores/threads, clock speed and the size of cache.
* **Graphical Processing Unit: (GPU)** – This is a specialised circuit that handles the graphics and image processing of a computer system. They relieve the processing load on the CPU, which allows it to focus on other tasks. Some CPUs will have integrated basic GPUs. However, for better graphics performance, a dedicated GPU is used. The performance of the GPU can depend on a various number of features. Such as: Number of cores/threads, clock speed and the size of cache.
* **Memory**: This refers to a device that is used to store information for immediate use in a computer system:

1. **Random Access Memory (RAM)** This is used as the main memory in a computer system. It can be read and written to. It is also volatile, meaning it will lose its contents when the power is switched off. RAM is where all data, files and programs are stored while there are in use. When software applications, documents and files are opened, they are copied from secondary storage to the RAM. They stay in the RAM until they are closed. The CPU can access RAM quicker compared to secondary storage. However, RAM is slower than the CPU cache.
2. **Read-Only Memory: (ROM)** ROM stores the boot sequence instructions. This is everything the CPU needs to access in order to boot and load the operating system. ROM is a special memory chip that can store data without power. It is non-volatile.
3. **Cache:** This is very fast memory located within the CPU, which stores regularly used data so the CPU can access it quickly the next time it is needed. This means that it has a constant supply of data to process. This is important as in comparison to cache, accessing RAM is a very slow operation. This means by storing frequently accessed data and instruction in cache, we can avoid the process of accessing RAM.
4. **Virtual Memory**: When the RAM is overloaded or full, the computer needs to relocate programs that not have been recently used to the secondary storage. This process takes time as secondary storage data speeds are much slower. However, when it is done, the system will perform a lot faster.

* **Motherboard:** This is also known as the Mainboard. This is a printed circuit board that connects CPU to inputs, outputs and storage. This will usually have ROM pre-mounted on it. It allows system components to connect and communicate with each by a central circuit.
* **Secondary Storage:** This is the long term, non-volatile storage of data. As RAM is volatile, any data or programs currently being stored there will disappear once the power is lost. This is when secondary storage comes in. Secondary storage is used to store a copy of programs and data that need to be kept long term.

**Data Capacity** – This is how much data a device can store. The term ‘Bit’ is the smallest unit of data that can be stored. It is often referred as a ‘Binary Digit’. The value of a bit can either be 0 or 1.

Ranking Order of Capacity:

1. Bit
2. Nibble (4 Bits)
3. Byte (8 Bytes)
4. Kilobyte (1024 Bytes)
5. Megabyte (1024 Kilobytes)
6. Gigabyte (1024 Megabytes)
7. Terabyte (1024 Gigabyte)
8. Petabyte (1024 Terabyte)

* **Hard Disk Drive (HDD)** – This is an example of magnetic storage. The value of each bit of data is represented as a positively or negatively charged magnetic particle. These particles are part of a magnetic disk called the platter.

**Accessing Data:** Data is stored magnetically in small areas called sectors within circular tracks. A magnetic read/write head is used to access sectors while the platter spins.

**Features / Properties:**

1. Has moving parts
2. Although the HDD is generally reliable as it lasts for a long time. But any device with moving parts will be subject to wear and tear.
3. Not robust. Can be damaged by shocks and vibrations
4. Low cost. Magnetic media is very low cost per gigabyte (low cost per unit capacity)
5. High capacity. Can store large quantity of data in a compact way. An ideal choice for archives and home computers

**Magnetic tapes** – Used for archiving (backups) due to the fact they have much greater storage capacity when compared to HDDs. They come in plastic cassettes, which contains reels of tape. A cassette requires a special tape-drive for read/writing. Tape is read and written sequentially. This means that it reads/writes from the beginning to the end. (or stopped by the computer) This means tape is very slow when finding specific data stored on it. However, it has a fast read/write speed once it is in the correct place to begin reading/writing.

* **Solid State Drives (SSD)** – This is an example of Solid State Storage. They are made up of flash memory. Flash memory stores the value of each bit in a semi-conductor chip. They have no moving parts.

**Accessing Data:** - Data can be assessed randomly. This means that any piece of data can be accessed in a constant amount of time. This is achievable due to the no moving parts.

**Features/Properties:**

1. **Good Reliability** - Solid state drives are robust. They have no moving parts. This means that they are not easily damaged by shocks or vibrations.
2. **Degradable -** SSD have a limited number of read/write cycles. They can only be flashed (rewritten) a certain number of times before they start to degrade.
3. **High Speed** - Solid State Media have very fast read/write times compared to magnetic and optical storage media
4. **High Cost** - Solid State Media have a higher cost-per-gigabyte compared to magnetic media. A person may pay more for the increase in performance. For example, faster data access speeds.
5. **Good capacity** – They have a good capacity, but not on the scale compared to magnetic media.

|  |  |
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| **Advantages of Hard Disk Drives:** | **Advantages of Solid State Drives:** |
| HDDs are cheaper compared to SSDs | One of the most expensive form of secondary storage |
| Both can come in high capacity, but HDDs are higher | SSDs do not need to be defragmented while HDDs tend to need to be defragmented to boost performance |
| HDD have a longer read/write life than SSDs as SSDs can only be flashed (written) a certain number of times before they being to degrade | SSDs are much faster compared to HDDs due to the fact that SSDs have no moving parts |
|  | SSDs are more shock-proof than HDD, therefore they are robust whereas HDDs are not |
|  | HDDs make some noise while SSD are silent |

* **Cooling:** - This is an essential requirement in a computer system to prevent the device from overheating. The CPU can reach average temperatures of 70 degrees. The use of computer cooling is required to the waste heat produced by computer components in order to keep components within permissible operating temperatures. There are two main ways to cool a computer:

1. Cooling fans – air cooling is a process of lowering air temperature by dissipating heat. It provides increased air flow and reduced temperatures with the use of cooling fins or fans that move the heat out of a casing, such as a computer case.
2. Heat sink – This is a passive heat exchange that transfers the heat generated by an internal computer component to a fluid medium, often air or a liquid coolant. It is then dissipated away from the device, therefore allowing the regulation of the device’s temperature at optimal levels.

* **GPS Receivers** - This is a L-band radio processor capable of solving the navigation equations in order to determine the user position, velocity and precise time (PCT), by processing the signals broadcasted by GPS satellites.

1. GPS stands for ‘Global Positioning System’
2. It is a network of about 30 satellites orbiting the Earth at an altitude of 20,000km
3. At least four GPS satellites are ‘visible’ (meaning above you) at any given time
4. Each satellite transmits information about its position and the current time at regular intervals, which then these signals are sent at the speed of light to a GPS receiver. This is then used to calculate how far away each satellite is based on how long it took for the transmission to arrive.
5. The GPS receiver can pinpoint your location using a process called trilateration
6. Trilateration is a process of determining absolute or relative locations of points by measurement of distances, using the geometry of circles, spheres or triangles. ( visit this website for a better description <http://www.physics.org/article-questions.asp?id=55> )

* **Image Capture** – This is the process of where an electronic device is used for creating digital representation of an image. For example, image sensor – a sensor in a digital camera (or smartphone) that converts light into an image

**A1 | Factors Affecting the Choice, Use and Performance of Internal Components:**

* **CPU Factors:**

1. **Instruction Set** – This is built-in code that informs the CPU how to operate. This is something coded into the CPU when it is manufactured, which cannot be changed. The processor’s architecture an instruction set determine how many cycles, or ticks, are needed to execute a given instruction
2. **Clock Speed** – This is the speed at which the processor can execute instructions. The faster the clock, the more instructions the processor can complete per second.
3. **Size of On-Board Cache** – This enables the CPU to access repeatedly used data directly from its own on-board memory. Accessing RAM is a slow operation, so by having a large cache size, we can avoid the process of accessing the RAM. This makes the CPU faster at executing instructions/processing data.
4. **Cost** – Some CPUs are more expensive than others. It is more likely that more expensive CPUs will perform better compared to cheap ones.

* **HDD Factors:**

1. **Capacity** – The capacity of a drive may not be as large as it is highlighted to be. This is because some manufactures usually treat 1GB as 1000MB, not 1024MB
2. **Transfer Rate –** This is the data read/write speed of the hard drive
3. **Rotational Speed** – This is the maximum amount of revolutions that a hard drive’s platter can complete in one minute (Revolutions per minute RPM). This can affect the transfer rate of the HDD
4. **Cost** – Some hard drives are more expensive than others. It is more likely that expensive Hard drives will perform better and have a larger capacity compared to cheaper ones.

* **SSD Factors:**

1. **Degradability** – How long would it take the SSD to reach its limited number of times that it can be flashed (rewritten)
2. **Capacity** - The capacity of a drive may not be as large as it is highlighted to be. This is because some manufactures usually treat 1GB as 1000MB, not 1024MB.

* **Availability** – If an organisation requires a new computer system to be up and running in a short term of time in order for employees to be productive, then there is no point in waiting for an internal component that will not be available for a couple of months.
* **Environmental Concern** – Buying a computer system with a more powerful CPU will require more power in order to operate. It will also cause it to get warmer. Purchasing least power-intensive components can save organisations from extreme costs and reduce the amount of power being used.

**A1 | The Hardware Used in Computer Systems:**

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| **Input Devices:** | **Output Devices:** | **Storage Devices:** |
| **Keyboard** – a panel of keys that operate a computer | **Screens** (Monitors) – a flat panel or area on an electronic device on which images and data are displayed | **USB flash drives** – a small external flash drive that can be used with any computer that have a USB port |
| **Touch Screen** – a display device which allows the user to interact with a computer by touching areas on the screen | **Projectors** – a device that is used to project rays of light, especially an apparatus with a system of lenses for projecting slides or film on to a screen | **Memory cards** – a small, flat flash drive used especially in digital cameras and mobile phones |
| **Pointing Devices** (Mouse, stylus, touch pad) – a device used to control the movement of a cursor on a computer screen | **Printers** (2D/3D) – a machine for printing text or pictures, especially one linked to a computer | **Hard drives** (internal and external) – a disk drive used to read from and write to a hard disk |
| **Graphics Tablet** – a device that allows users to ‘draw’ in a similar way to using paper and pen | **Actuators** – a device that causes a machine or other device to operate | **Optical drives** – allows a computer to read/write a range of optical discs such as DVDs, CDs and Blu-ray |
| **Microphone** – a device for converting sound waves into electrical energy variations, which may then be amplified, transmitted or recorded | **Motors** – a machine that supplies motive power for a device with moving parts | **Magnetic tape drives** – a storage device that makes use of magnetic tape as a medium for storage. |
| **Scanner** (2D/3D) – a device for examining, reading or monitoring something | **Accessibility Devices** - assistive technology are devices that provide support for user with additional needs. For example: screen readers, speakers |  |
| **Cameras** – a device for recording visual images in the form of photographs, film or video signals |  |  |
| **Sensors** – a device which detects or measures a physical property and records, indicates, or otherwise responds to it |  |  |
| **Accessibility Devices** – assistive technology are devices that provide support for user with additional needs. For example: foot mouse, braille keyboard |  |  |

**A1 | Factors Affecting Choice of Hardware:**

* **User Experience** – the overall experience of a person using a product such as a website or computer application, especially in terms of how easy or pleasing it is to use

1. **Example:** An individual looking to upgrade their smartphone will base their decisions on previous experience and may be looking for additional or enhanced features. Such as better memory capacity.
2. **Ease of use** – Hardware that is easy to use or more likely to save time is going to be preferred by most people.
3. **Performance** - The level of desirable of performance will vary depending on whether the technology is to be used for pleasure, business or academic research. The variety of functions that a device can perform is also a factor.
4. **Availability –** Whether a hardware device is immediately available can influence our choices. We may make alternative selections if our first choice is out of stock.
5. **Accessibility** – Accessibility or adaptability of technology may dictate hardware choices. For example: If the user requires specialist devices such as touchscreens

* **User Needs** – Different Users have different needs. These different of needs will design a criteria people will use to make hardware choices:

1. **Compatibility** – whether if two things are able to exist or occur together without problems or conflict. (whether two or more things that need to connect and interact with one another do so properly)
2. **Specification –** A description, often detailed, of the design of a hardware device. It can give details of the user interface that the device should use, the processing power or the amount of RAM.
3. **Cost –** Businesses allocate budgets for their computer systems. This will include maintenance and upgrades. The cost will vary depending on the specification and quality of manufacture.
4. **Efficiency -** The efficiency of a computer system must reflect user needs and is determined by the quality of the hardware components used.
5. **Implementation –** Choosing hardware for a computer system can depend on the speed of its implementation.
6. **Time Scale** - The time allowed for or taken by a process or sequence of events.
7. **Testing** – finding out how well something works
8. **Migration to new systems** – The process of migration needs to be straightforward and reliable
9. **Productivity** – Businesses very often make a decision to upgrade, change or implement new hardware to increase productivity. Productivity is a measurement based on the quantity of work executed in a period of time
10. **Security** – Making sure the hardware chosen is in a state of being free from danger or threat.

**A1 | Data Storage and Recovery Systems:**

* **Redundant array of independent/inexpensive disks (RAID)** – a system of using lots of storage drives to provide fail safes by spreading data across multiple drives.

1. Used when more than one secondary storage device is used inside the same computer system
2. RAID puts multiple secondary storage devices together to improve on what single secondary storage device can do on its own. It can increase a computer systems speed.

* **Software-Based RAID** – This is feature of the operating system. It doesn’t require any special hardware and usually has a lower performance compared to hardware-based RAIDs.
* **Hardware-Based RAID** – a feature of the hard drive controller. It is configured outside of the operating system and usually invisible to it. This type of RAID is designed for speed and has high performance.
* **Hot-swappable Drives –** These are drives that can be added and removed while the system is running. The connection is ‘hot’. This is often used within a drive chassis, which is the use of two or more drives. This makes it easy to repair as you can replace a drive while the system is running. This can maintain a RAIDs 100% uptime.

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| **RAID Number:** | **Description:** | **Tolerance:** | **Number of Drives:** |
| **RAID 0** | Striping – block level striping only. File blocks are split between two or more physical drives. High performance as data can be written quickly. | No/zero redundancy, a drive failure breaks the array. This means that all but one drive can fail. | 2+ |
| **RAID 1** | Mirroring – File blocks are duplicated between two or more physical drives. High disk utilization as every file is duplicated. This means that the required disk space is doubled. | High redundancy. Drive failure does not affect data availability | 2+ |
| **RAID 5** | Block level striping with parity error correction to enable rebuilding with spread read/write. It is an efficient use of disk space, files are not duplicated but space is still used for parity | High redundancy. Data is available after drive failure. Parity calculation may affect performance. | 3+ |
| **RAID 6** | Block level striping with double parity error correction to enable rebuilding data with sored read/writes | High Redundancy. Data is available after drive failure. Double Parity calculation may affect performance | 3+ |
| **Nested RAID** (RAID 1+0 or RAID 10) | Has the speed of striping and redundancy of mirroring (the best of both worlds) - | High redundancy – it requires a minimum of four disks and stripes data across mirrored pairs. As long one disk in each mirrored pair is functional, data can be retrieved. | 4+ |

* **RAID Level Striping Definition:**

1. Block level striping divides the data into 512KB blocks with each stored onto one of the drives
2. Byte level striping uses the same technique. But divides the data into bytes
3. Bit level striping divides the bytes into bits for storage

* **Mirroring Definition:** Saving the identical copies of data. If a drive fails, a good copy of the data can be brought back from the mirror.
* **Parity Error Correction:** An error checking technique by which an extra bit is placed at the end of each byte to make the number of 1s in the byte and bit an even number. This is called even parity. A similar technique is called odd parity.
* **Hamming Code Error Correction:** This is used in RAID systems to utilise parity bits to rebuild corrupted data.
* **Network Attached Storage (NAS) –** A dedicated file storage that enables multiple users to retrieve data from a centralized disk capacity. This acts as a single file server and can be used as an alternative to cloud storage. It will have multiple hard drives in a RAID configuration

1. Data is stored at a centralized location
2. Allows file sharing
3. Allows Scalability - the property of a system to handle a growing amount of work by adding resources to the system
4. Practical
5. Used in homes and small to medium sized businesses
6. Reliable
7. Affordable
8. If the NAS fails, then the rest of the devices connected will not be able to access the data

* **Direct Attached Storage (DAS) –** A digital storage that is attached directly to a computer or server

1. Simplest out of NAS and SAN
2. Easy to use – Specialist assistance is not needed
3. High performance – Data access is fast
4. Versatile – able to adapt or be adapted to many different functions or activities
5. Economical - inexpensive
6. Efficient – achieving maximum productivity with minimum wasted effort

* **Storage Area Network (SAN) –** A secure high speed data transfer network that provides access of consolidated block-level storage. A SAN makes a network of storage devices accessible to multiple servers. SAN devices appear to server as attached drives, which eliminate traditional bottlenecks.

1. Aimed towards bigger businesses as more demand is needed
2. Reliable
3. Has high performance
4. Huge storage capacity
5. Require more equipment
6. expensive