1. Explain the concept of a memory hierarchy:
2. Registers:

* Speed: Fastest 1ns - 2ns
* Cost: Most expensive
* Use: Stores the most critical data for the CPU to use right away.

1. Level 1 Cache (L1 Cache):

* Speed: Very fast 3ns - 10ns
* Cost: Expensive
* Use: Holds frequently used data to speed up processing.

1. Level 2 Cache (L2 Cache):

* Speed: Fast 25ns - 50ns
* Cost: Less expensive than L1
* Use: Stores data not in L1 but still needed quickly.

1. Main Memory (RAM):

* Speed: Moderate 30ns - 90ns
* Cost: Cheaper than cache
* Use: Holds data and programs currently in use.

1. Hard Drive:

* Speed: Slow 5ms – 20ms
* Cost: Affordable
* Use: Long-term storage of files and programs.

1. Optical Disk (e.g., CD/DVD):

* Speed: Slower 100ms – 5sec
* Cost: Cheap
* Use: Archival storage, not used frequently.

1. Magnetic Tape:

* Speed: Slowest 10sec – 3min
* Cost: Cheapest
* Use: Storing large amounts of data for a long time, usually offline.

1. The L1 cache is faster than the L2 cache and the L1 cache is smaller than the L2 cache. Because it is fast enough to keep up with the CPU's speed, fits on the limited space of the CPU chip, remains cost-effective, and provides quick access to essential data, maintaining overall efficiency.
2. A page fault occurs when a program tries to access memory that isn't currently in RAM, prompting the operating system to load the required memory from disk into RAM. While essential for efficient memory management and enabling virtual memory, excessive page faults can degrade system performance, a condition known as thrashing.