GRADE 9 COMPUTER SCIENCE — QUICK REVISION NOTES

Unit 4 · Chapter 17: HARDWARE

1. THE STORED PROGRAM (VON NEUMANN MODEL)

- **Von Neumann architecture** — a computer where program instructions are stored in memory together with data (both are just binary numbers).
- Every computer needs 4 things in common: **Input, Output, Storage, Processing.**
- **CPU** (Central Processing Unit) — does all the processing. **RAM** — main memory that temporarily stores data & instructions. They connect via a **bus** (a group of wires) — also linked to Input/Output devices.

2. TYPES OF MAIN MEMORY

KEY MEMORY TYPES

RAM (Random-Access Memory): Volatile temporary store for running programs & data; lost when power is off.

ROM (Read-Only Memory): Non-volatile; stores firmware (e.g. BIOS/UEFI) that starts the computer; cannot be changed.

Cache memory: Small, very fast, expensive memory (SRAM) between CPU and RAM — stores frequently used data to avoid the CPU waiting (avoids the 'bottleneck'). Levels: L1 (fastest/smallest) → L2 → L3.

Virtual memory: 'Pretend' extra memory — the OS swaps data between RAM and the hard disk when RAM is full. Too much swapping = disk thrashing = slower performance.

3. THE FETCH–DECODE–EXECUTE CYCLE

- **Fetch:** Control unit puts next instruction's address on the address bus → memory sends the instruction back along the data bus into a register.
- **Decode:** Control unit works out what the instruction means and signals the right CPU parts.
- **Execute:** The instruction is carried out (e.g. by the ALU). This repeats continuously while the computer is on.
- **Key CPU parts:** Control Unit (CU) organises everything · Arithmetic/Logic Unit (ALU) does maths & logic · Registers = tiny, super-fast storage spots (Accumulator, Program Counter, Current Instruction) · Clock synchronises all actions (speed measured in GHz).
- **3 buses:** Address bus (carries memory locations) · Data bus (carries the actual value) · Control bus (carries read/write signals).

4. FACTORS AFFECTING CPU PERFORMANCE

Factor	Effect on Performance
Clock speed	Higher GHz = more instructions processed per second, but produces more heat.
Number of cores	More cores = can multitask or run parallel processing (but not all tasks can be split up).
Size & type of cache	Bigger/faster cache = less waiting for RAM = faster processing.

5. SECONDARY STORAGE

- Non-volatile, permanent, cheaper & bigger capacity than RAM — needed because RAM loses data when power is off.

Type	How it Works	Examples
Magnetic	Magnetised particles (N/S poles) represent 1s and 0s on spinning platters.	Hard disks, tape
Optical	Reflective/non-reflective pits & lands on a disk read by laser light.	CD, DVD, Blu-ray
Solid-state	Electrons trapped in tiny pools on a microchip (NAND flash) — no moving parts.	USB sticks, SD cards, SSDs

- **Cloud storage:** data stored remotely on internet servers (e.g. Google Drive). Pros: access anywhere, auto backup, no transfer needed. Cons: needs internet, security/privacy concerns.

6. EMBEDDED SYSTEMS

- A computer built into a bigger device to do ONE specific job (not general-purpose).
- **Examples:** washing machines, traffic lights, car engine systems, toasters, games consoles.
- Usually cheap, low-power, with a program permanently stored in firmware (ROM/flash).
- **Internet of Things (IoT):** everyday embedded devices connected to the internet so they can communicate & be controlled remotely (e.g. smart fridge, smart heating).

✔ **EXAM TIP:** Remember the cycle — Fetch, Decode, Execute — and be ready to explain WHY cache/multicore/clock speed each improve performance, and WHEN to choose magnetic vs optical vs solid-state storage.

Why cache, multicore, and clock speed each improve performance

- **Clock speed** – The clock sends out regular electronic "ticks," and the CPU starts processing a new instruction on each tick. A higher clock speed (measured in GHz) means more ticks per second, so more instructions get processed in the same amount of time. *Limitation:* higher clock speeds generate more heat, and transistors can only switch so fast.
- **Number of cores (multicore)** – Each core is essentially a mini CPU with its own control unit and ALU. More cores let the computer either run several programs at once (**multitasking**) or split one big

task across cores to work on it simultaneously (**parallel processing**). *Limitation:* not all tasks can be split up — if step 2 depends on the result of step 1, the cores can't work on them at the same time, so you don't always get a straight speed multiplier.
- **Size and type of cache** – The CPU can process data far faster than RAM can supply it, which creates a "bottleneck." Cache is small but very fast memory (SRAM) sitting between the CPU and RAM that stores instructions/data the CPU is likely to need again soon. A bigger cache means a higher chance the CPU finds what it needs *without* waiting on the slower RAM, which speeds up processing.

When to choose magnetic vs optical vs solid-state storage

Situation	Best choice	Why
Large backups, everyday storage (e.g. a PC's main drive)	**Magnetic** (hard disk)	Cheapest per gigabyte, huge capacity
Distributing/sharing a fixed set of files (e.g. software, movies) or something that must not be edited	**Optical** (CD/DVD/Blu-ray)	Cheap to produce/copy, works in any compatible player, good for read-only distribution
Portable use, devices needing durability, speed, or resistance to knocks (e.g. USB stick, phone storage, laptop SSD)	**Solid-state**	No moving parts (won't get damaged if dropped/moved), faster access, smaller and lighter — but more expensive per GB and has a limited number of rewrites