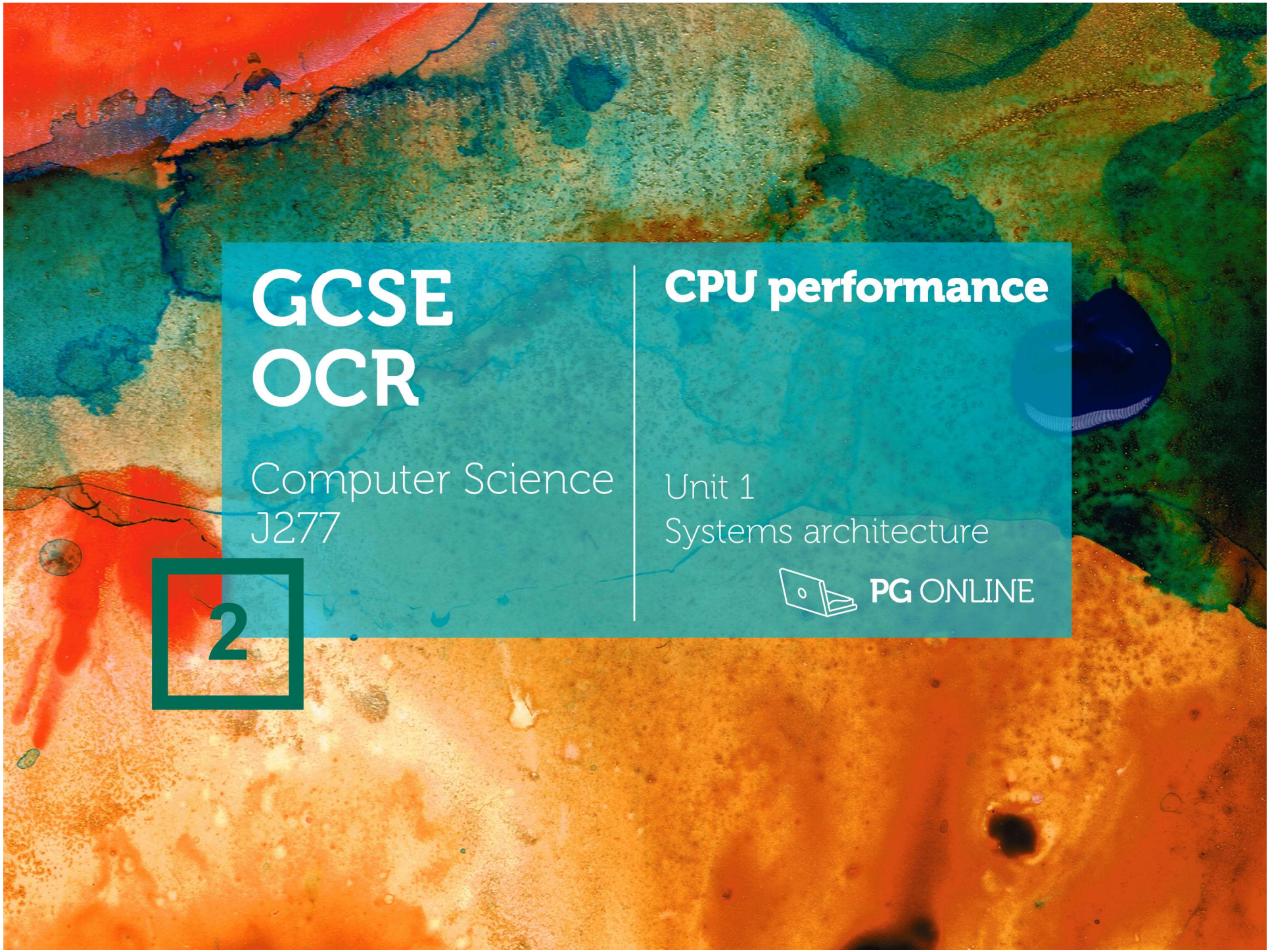
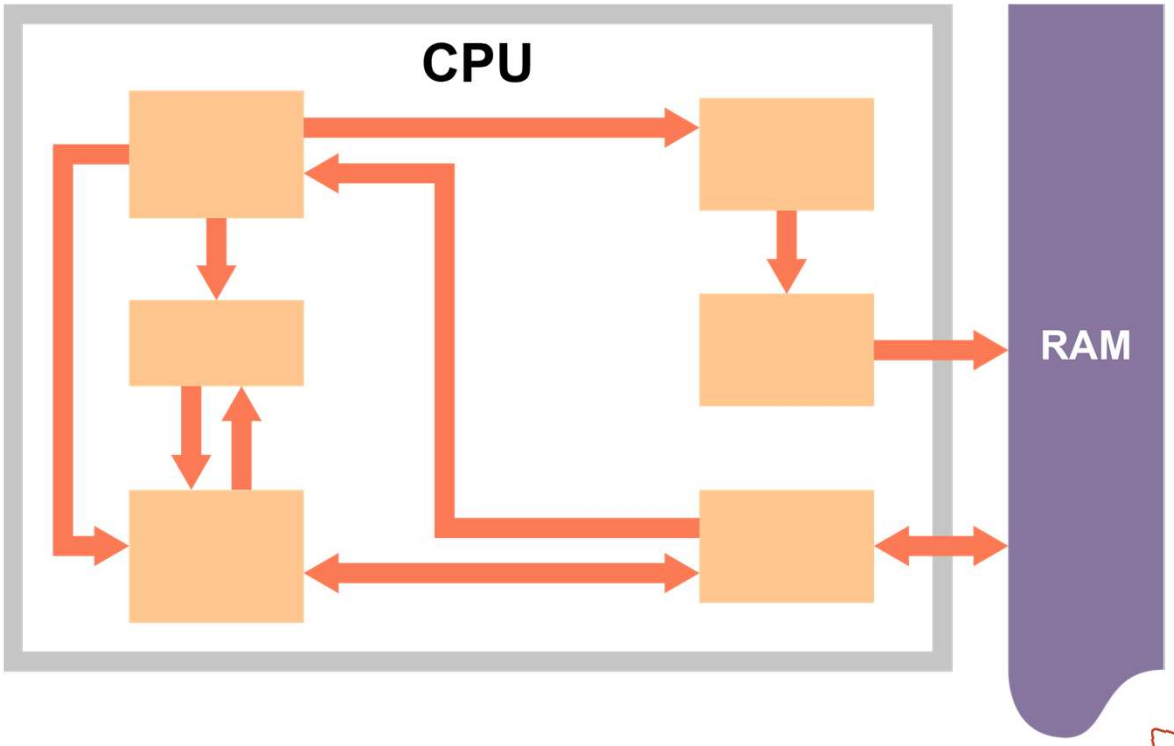

GCSE
OCR
Computer Science
J277
2
CPU performance
Unit 1
Systems architecture
PG ONLINE

Objectives

- Understand the function of cache in the CPU
- Describe how common characteristics of CPUs affect their performance including:
  - Clock speed
  - Cache size
  - Number of cores
- Explain the purpose and give examples of embedded systems

Starter - recap

- Name at least **five** components inside a CPU
  - What is the purpose of each component?



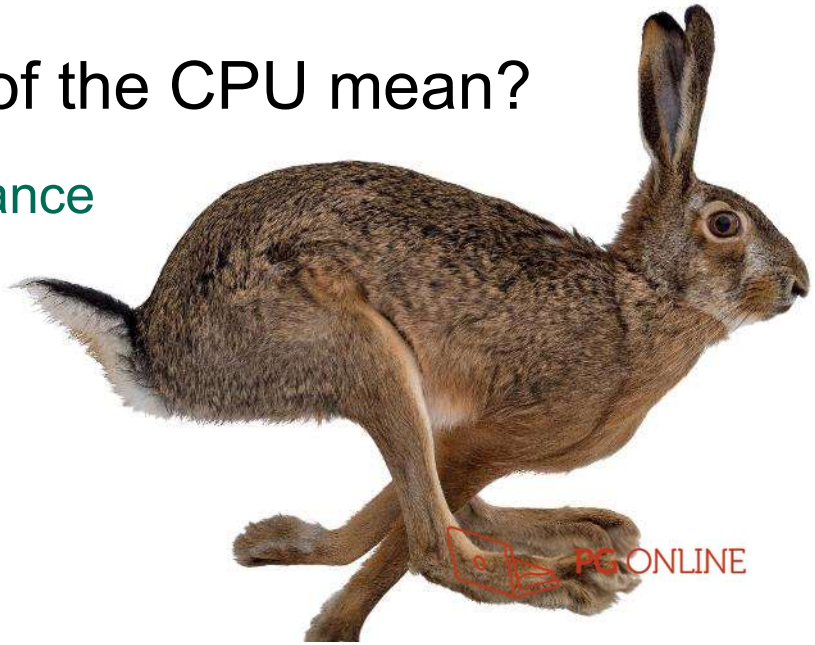
Starter

Answers

- Components in a CPU
  - **Control unit (CU)** – decodes the instructions; controls the timing of operations in the CPU
  - **Arithmetic Logic Unit (ALU)** – performs arithmetic and logic operations
  - **Registers** – including **PC** (program counter) for the next instruction; **MAR** (memory address register) for the memory location of data to be fetched; **MDR** (memory data register) data retrieved from RAM; **Accumulator** (ACC) stores the results from the ALU

What affects CPU performance?

- The following are three of the most common factors which can affect a CPU's performance
  - Clock speed
  - Processor cores
  - Cache
- What do each of these parts of the CPU mean?
  - How can they affect the performance of the CPU



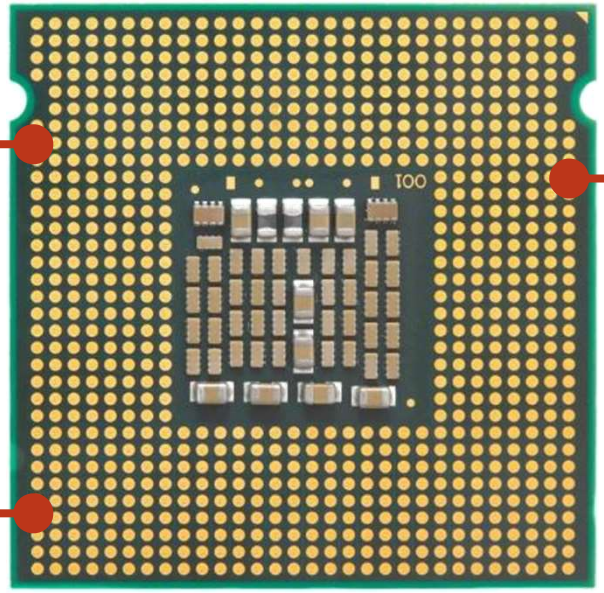
Factors affecting CPU performance

Clock speed

Cycles per second measured in hertz (Hz)

Number of cores

The number of duplicate processing units (cores) placed in one CPU



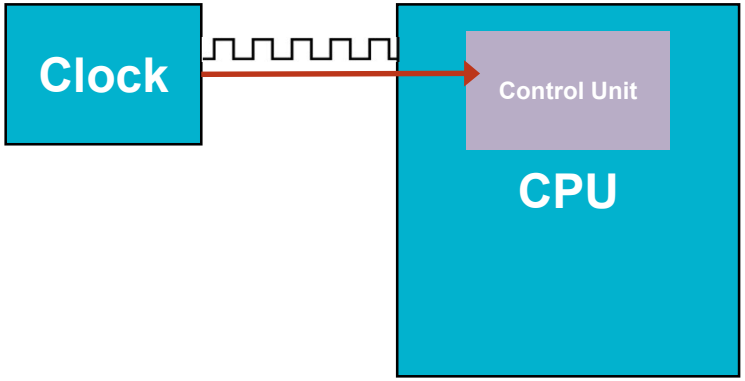
Cache size

Memory on the CPU that is faster than RAM but slower than registers

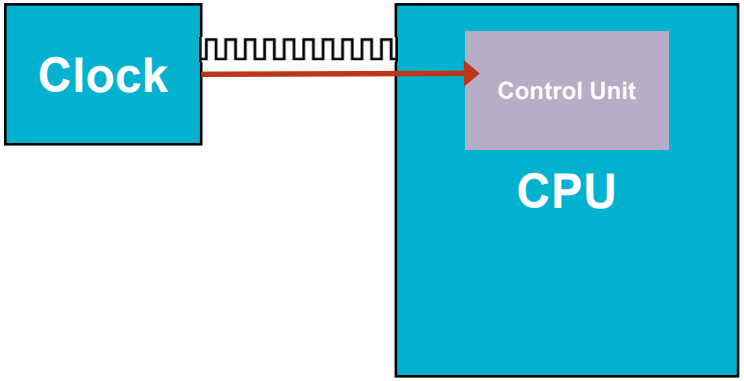
Clock speed

- Everything in a computer happens on the pulse of the internal clock
  - Therefore, the faster the clock speed, the faster the instructions are processed

Clock speed 1GHz



Clock speed 2GHz



Processor Speed

- One cycle per second = 1 hertz (Hz) = 1 instruction carried out each second
- 1 kilohertz (kHz) = 1000 cycles per second
- 1 Megahertz (MHz) = 1,000,000 cycles per second
- 1 Gigahertz (GHz) = 1,000,000,000 cycles per second
  - How fast is your computer's processor?
  - Remember, a 1 GHz processor is performing one billion cycles per second

Multi-core processors

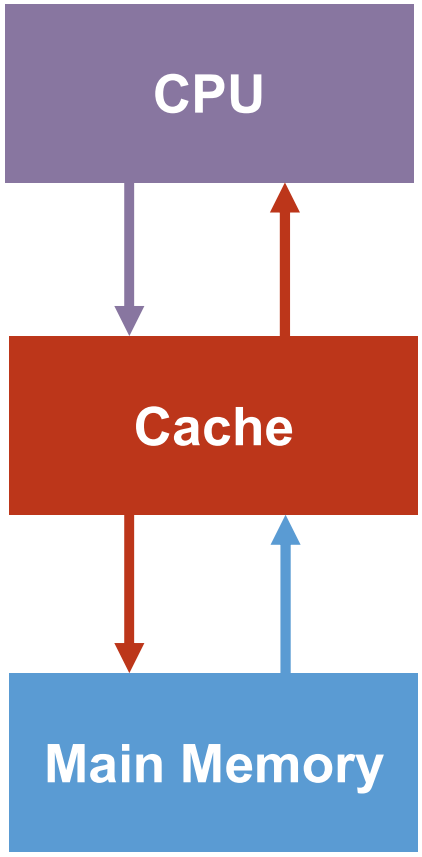
- A dual-core processor has two processors in the same integrated circuit, linked together
  - A dual-core processor has the potential to perform twice as many instructions, however, it doesn't always perform at this rate as software may not be able to take full advantage of both cores
- A quad-core processor has four linked processors
  - Which processor would you prefer, a dual-core 1GHz, or a 3GHz single core processor?

Effect on speed

- A quad-core processor working on many different tasks simultaneously, under ideal conditions can be up to four times faster than a single-core processor
  - If the computer is running a single program, it is not necessarily any faster, since the program may have been designed to only run on one core

Cache memory

- Cache is a small amount of very fast, expensive memory in the CPU
- It can be accessed faster than regular main memory (RAM)
  - Why is this useful for frequently used data?



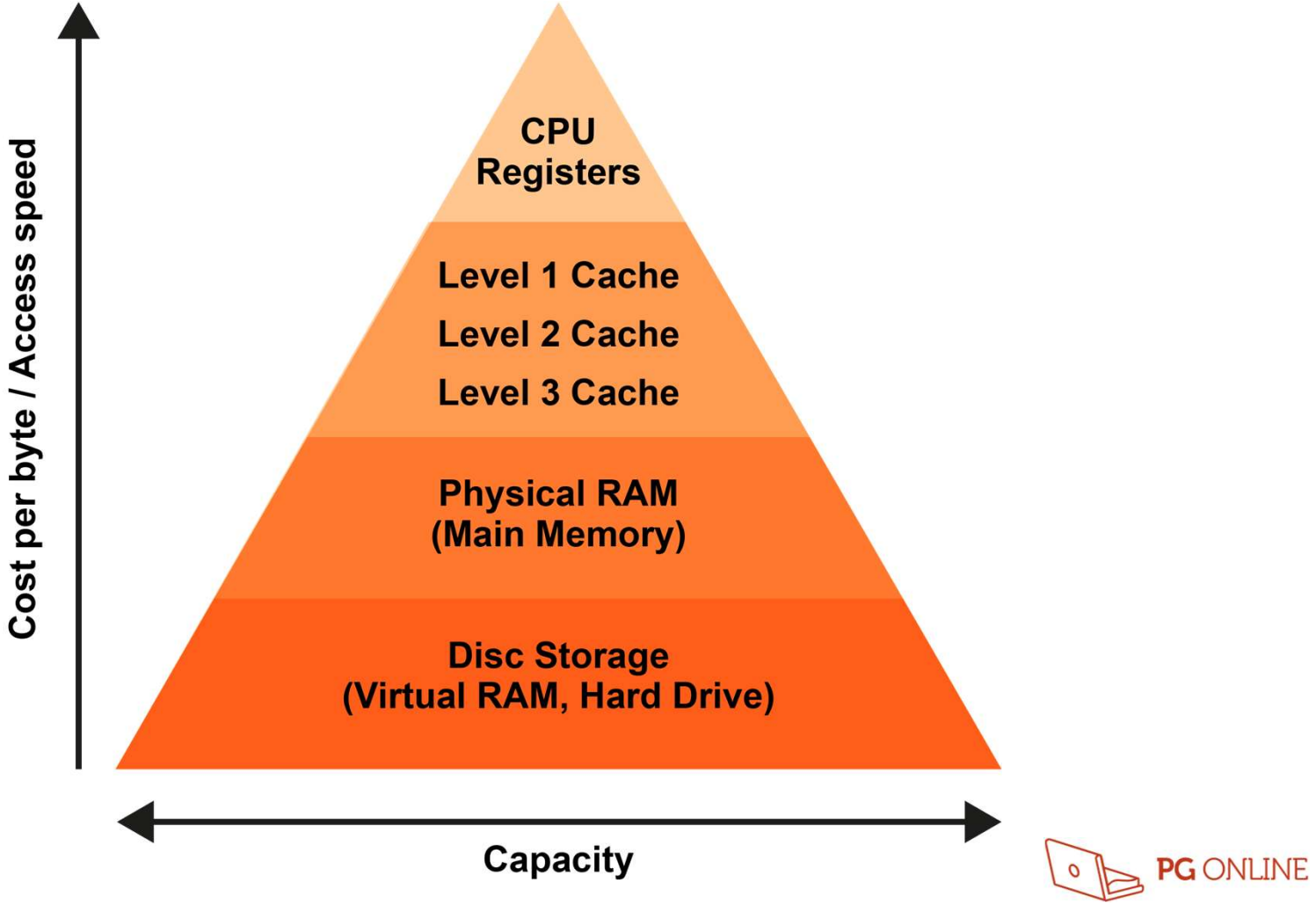
Effect on speed of cache

- RAM is relatively slow memory to access and it is further away from the processor than cache
  - It takes longer to retrieve an instruction or data from RAM than from cache
- Program instructions and data that are fetched are stored in cache in case they are needed again soon
  - If you have a ‘while’ loop in a program, for example, having all the instructions in the loop in cache speeds up execution

Levels of cache memory

- There are different ‘levels’ of cache:
  - **Level 1 cache** is extremely fast but small (between 2-256KB), located on the CPU. Each core will have its own level 1 cache
  - **Level 2 cache** is usually also given to each core. It is very fast, but a little slower than level 1 cache. The typical size is 256KB-8MB
  - **Level 3 cache** is the slowest type of cache, but still faster than RAM. It is usually located on the CPU and stores 4MB-50MB. The cache is shared between all the cores on the processor

Levels of cache memory



The benefits of cache

- The data used most often by the CPU is held in Level 1 cache so is available extremely quickly
  - In most systems, Level 1 cache is used about 50% of the time, with Level 2 cache being accessed about 90% of the time
  - This greatly reduces the time that the CPU has to wait for data from main memory
- The size of the Level 2 cache is a major factor in determining the performance of the CPU

Which is (theoretically) faster?

1. A dual core processor running at 2.7GHz with 4MB of shared cache memory
2. A quad core processor running at 1.5GHz with 8MB of shared cache memory
3. A single core processor running at 3.2GHz with 2MB of cache memory
4. A dual core processor running at 3.2GHz with 4MB of shared cache memory

Calculate the maximum number of cycles per second in each case and rank them in order of performance

Worksheet 2

- Complete **Task 1** on **Worksheet 2**

Embedded systems

- Do these devices have inputs, processes and outputs?
  - Could they be classed as computers?
  - Why or why not?

Embedded computers

- An embedded computer is a single microprocessor that includes RAM, ROM and a CPU
  - An embedded computer is frequently used to control a device using simple inputs

Embedded systems

- Without embedded systems, a digital device would not be able to perform specific functions
  - For example, a dishwasher wouldn't know when to heat the water, or a satnav wouldn't know how to communicate with a satellite
  - What embedded functions do cars use?

Car embedded systems

Answers

- Some examples of embedded systems in cars include:
  - Cruise control
  - Engine cooling fan
  - Interior fans and temperature
  - Interior lighting
  - Rear cameras and remote parking
  - Infotainment systems (entertainment / information / satnav)
  - Engine control unit (ECU)

Worksheet 2

- Complete **Task 2** on **Worksheet 2**

Plenary

1. Name **three** common factors which affect the performance of a CPU
2. What do each of these factors mean?
3. What is an embedded system?
4. Name **three** examples of an embedded system

Plenary

Answers

1. Clock speed, number of cores, cache size
2. **Clock speed** – the number of fetch-execute cycles per second; **number of cores** – the number of processing units on each CPU; **cache** – memory that is faster than RAM and slower than the registers, normally located on the CPU
3. A computer system that is used to control mechanical or electrical systems
4. Satnav, microwave, dishwasher, burglar alarm, washing machine, digital watch…

Copyright

Licence agreement