Computer Structure

Computer Architecture

All computers perform the same tasks:

- take **input** from a device that converts real-life information into binary
- **process** that data in the processor
- **output** the results using a device that will take the binary data and turn it back into real-life information

Computer Instructions

All processes carried out by the computer are broken down into **instructions** – in fact the programs that you write are lists of instructions for the computer to execute.

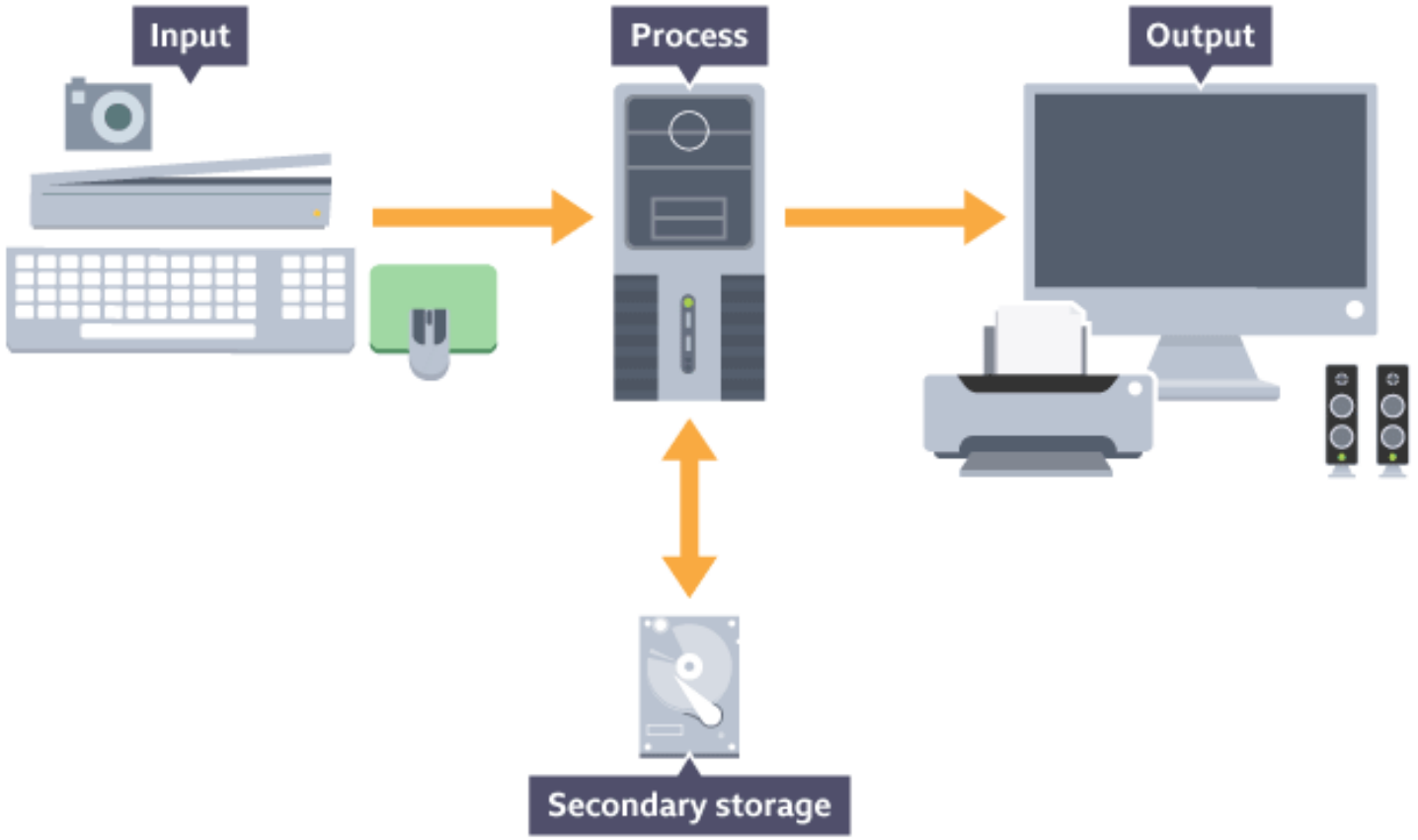
Each instruction is a sequence of 0s and 1s (called **machine code**) that describes an operation that the computer needs to perform, such as “add”.

Basic Computer Architecture

Watch this video to understand basic computer architecture.

Basic Computer Architecture

We will be looking at each of these components in more detail.



Input and Output Devices

Input and output devices are often known as peripheral devices.

Input Devices	Output Devices
Keyboard	Monitor
Touchscreen	Headphones
Webcam	Speakers
Microphone	Projector
Mouse	3D Printer

Memory

Memory, sometimes referred to as **main memory**, holds the data and programs that are in use by the computer.

In general, the more memory a device has, the more programs can be run at once, and the better the computer performs.

Memory vs Backing Storage

When talking about memory, this is not referring to storage devices that are used to store your files

Backing storage is used to store your files, and can include hard disks, USB sticks or even cloud storage.

Files from backing storage can be loaded into main memory if they are going to be used by the computer.

Memory

Most computers contain a mix of different types of memory, both of which you need to know for National 5:

- ROM (Read-Only Memory)
- RAM (Random Access Memory)

ROM is a small part of main memory, with a few basic programs needed to start up a computer.

RAM is the largest part of main memory and is used to hold more complex programs, like the operating system, programs currently in use and any user data.

ROM

Read Only Memory (ROM) is used to store a small part of the operating system, called the bootstrap loader.

When the computer is switched on, the bootstrap loader checks the backing storage devices to find the operating system. Once it's found it is loaded into RAM.

ROM is described as non-volatile, which means that the data held on ROM is not lost when the computer is switched off.

RAM

Random Access Memory (RAM) is used to store all programs that are currently is use, including the operating system.

RAM is described as volatile, which means all data and programs held in RAM are lost when the computer is switched off. As RAM cannot store its contents without power, programs and data are stored permanently on backing storage devices, such as hard drives.

You can add RAM to you machine to improve the performance of the computer. Increasing RAM allows more programs to be run at the same time.

RAM vs ROM

RAM	ROM
RAM stores the programs and associated data of the programs currently in use	ROM stores a small part of the operating system called the bootstrap loader
The data in RAM is read/write so it can be changed	ROM is read-only and cannot be changed
All data stored in RAM is lost when then computer is switched off	Data on ROM is not lost when the computer is switched off

RAM vs ROM

This video by BBC Bitesize helps to explain the differences between RAM and ROM – note that you do not need to know about virtual memory for National 5.

Central Processing Unit

The processor in a computer is also called the **central processing unit** (CPU). The CPU is the main component of any computer.

The CPU is made up of smaller parts, and is responsible for:

- fetching and executing instructions from memory
- performing arithmetic calculations
- performing logical operations
- controlling read, write and clock lines

CPU Clock

All of the operations inside the CPU are synchronised by an electrical pulse called the **clock**. The clock speed gives an indication of how quickly the processor can complete tasks.

Modern CPUs have a clock speed of over 1GHz, meaning that over a billion instructions can be carried out every second.

Central Processing Unit

The CPU is made up of 3 components:

- control unit
- arithmetic and logic unit
- registers

Control Unit

The **control unit** is responsible for co-ordinating processes:

- responding to input and output devices
- managing the clock signal to keep actions in time
- fetching instructions and data from the main memory
- decoding instructions and deciding which part of the processor to send them to
- executing instructions

Arithmetic Logic Unit

The **arithmetic logic unit** (ALU) performs all mathematical or logical decisions:

- performs comparisons on numeric values e.g. answer > 2
- makes decisions based on logic e.g. AND, OR and NOT
- performs all mathematical calculations

Registers

Registers are small, fast, memory locations on the CPU.

Registers can only store a few bytes, so data that is not immediately needed will be transferred to main memory (RAM) until it is required.

Registers

Registers store information that is necessary for processes to execute successfully. This information could include:

- memory addresses of data or instructions that are needed
- the current instruction being decoded
- data that will be needed by the ALU to carry out calculations
- the results of calculations

Machine Code

Machine code is the language that a computer understands (e.g. 1s and 0s).

Machine code is very difficult for humans to read and understand, so when we program we use a high-level programming language instead.

A high-level programming language, such as Python, is English-based so that it's easy for humans to understand and to identify and fix issues. However, we then need to translate this high-level source code into machine code that can be understood and run by the computer.