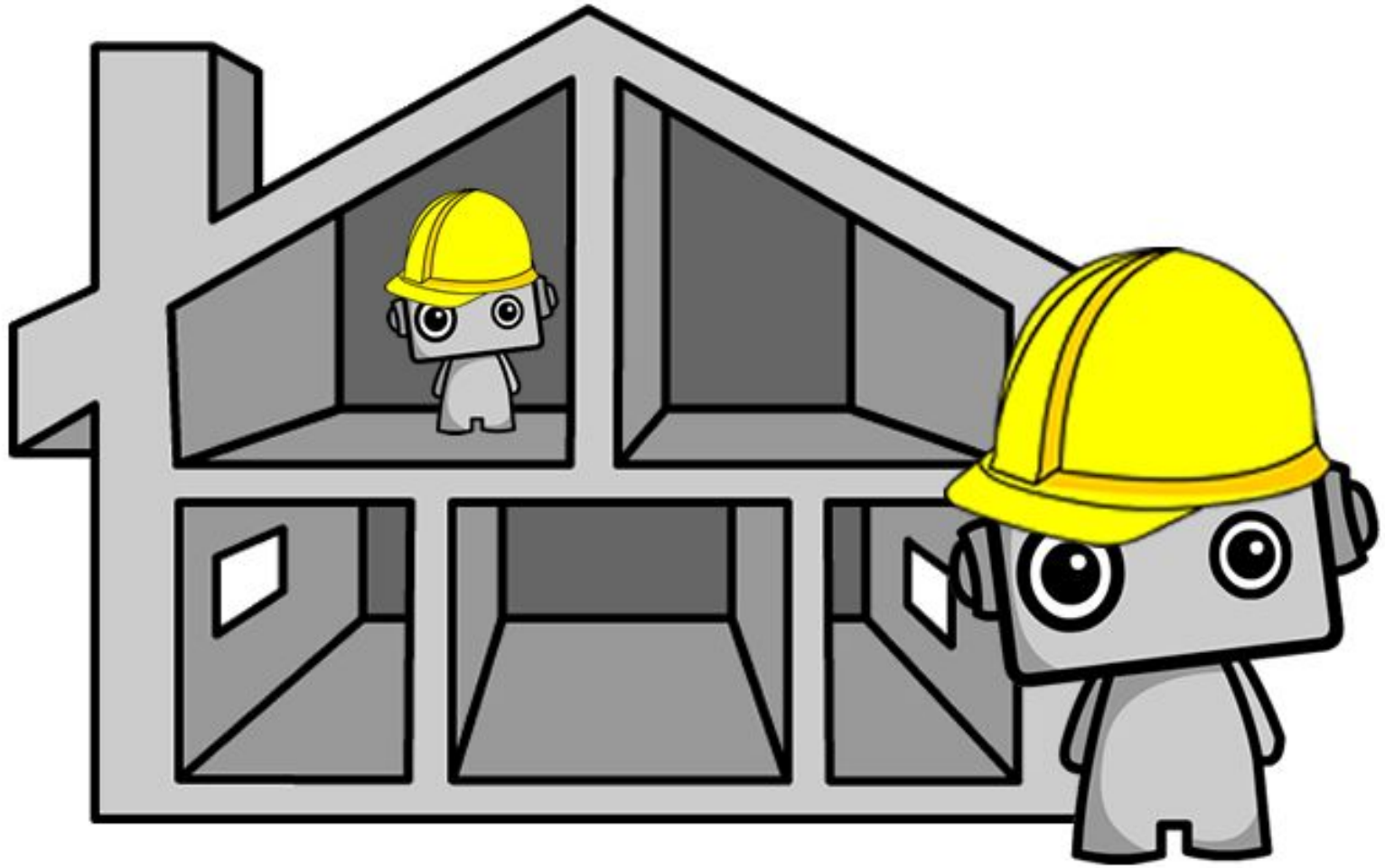
Computer Systems

System Architecture



Von Neumann architecture

Learning Objectives

- 11.3.2.1 describe the interaction of CPU with peripheral devices
- 11.3.2.2 describe the purpose of CPU components, system bus and main memory

Assessment criteria

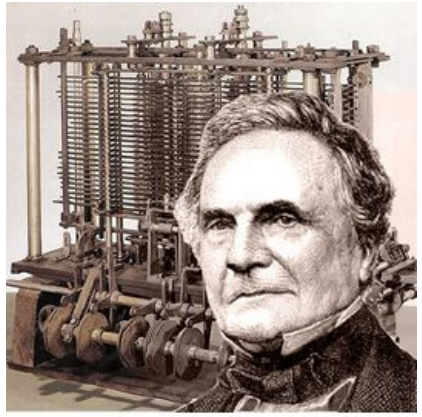
- ***Knows the main components of CPU and their purpose.***
- ***Can indicate the main elements of the CPU.***
- ***Knows about the address bus, data bus, control bus and their functions.***

Starter: Early Computers

Did you know that the history of computers dates back to the 1800s?

Place the following key events in the correct order on the timeline;

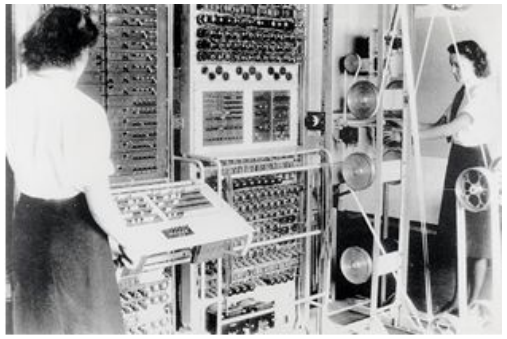
1800s → **1940s**



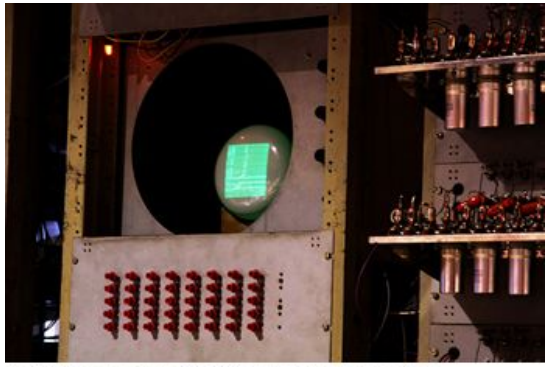
Early Mechanical Computers
The first computers were designed by Charles Babbage in the mid-1800s

1930s: Electro-Mechanical Computers
Electro-mechanical computers generally worked with relays and/or vacuum tubes, which could be used as switches.

The Zuse Z1, built by Konrad Zuse in 1938 a binary electrically driven mechanical calculator with a 22-bit floating point value adder and subtracter, with some control logic making it capable of more complex operations such as multiplication and division.



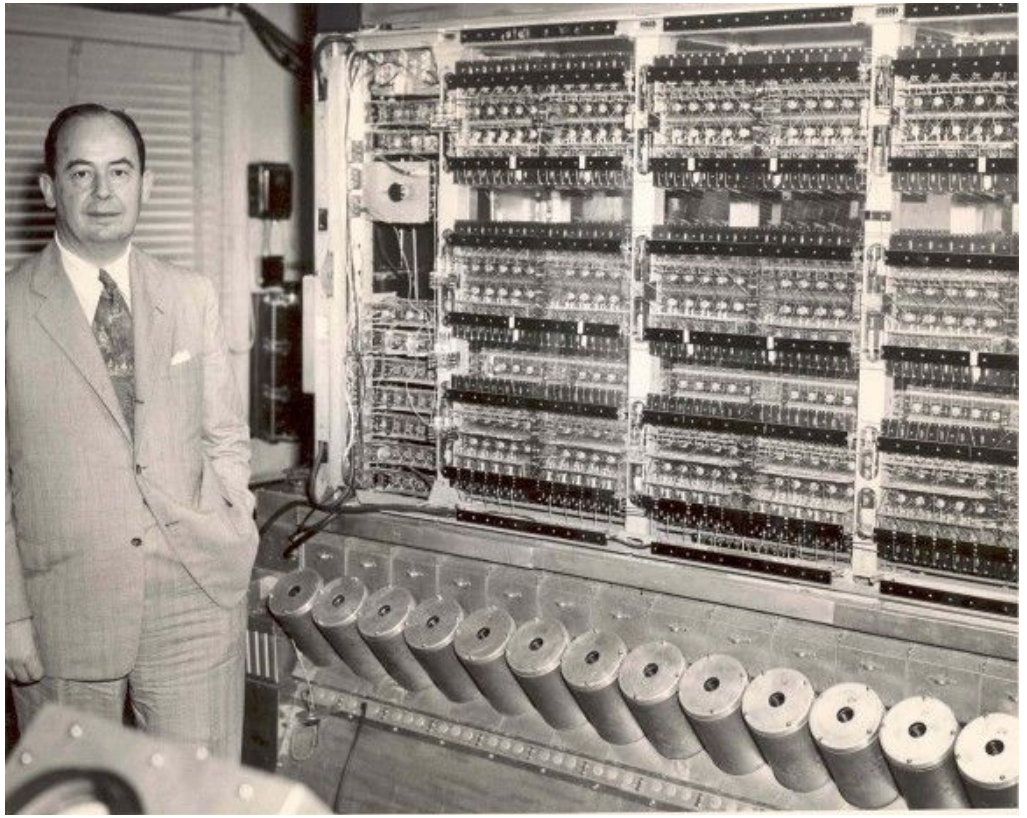
1940s: Electronic Computers
The first electronic computers were developed during the World War II, with the earliest of those being the Colossus. The Colossus was developed to decrypt secret German codes during the war.



In 1948 "The Baby" (officially known as the Manchester Small-Scale Experimental Machine) was the first computer to use the Williams Tube, a type of random access memory (RAM).

How Von Neumann Architecture changed the world of computers

- The very first computers could not store programs; they were input by setting switches.
- Jon Von Neumann developed the concept of the stored program computer in the 1940s.
- A Von Neumann based computer is one that;
  - Uses a single processor.
  - Uses one memory for both instructions and data. A von Neumann computer cannot distinguish between data and instructions. It 'knows' only because of the *location* of a particular bit pattern in RAM.
  - Executes programs by doing one instruction after the next in a sequential manner using a fetch-decode-execute cycle.



http://s7.computerhistory.org

All this is only possible through the use of a Central Processing Unit (CPU)

How does Von Neumann Architecture work?

Watch the video located on this webpage: http://www.bbc.co.uk/education/guides/zmb9mp3/revision/1

Answer the following questions: (Handout 1)

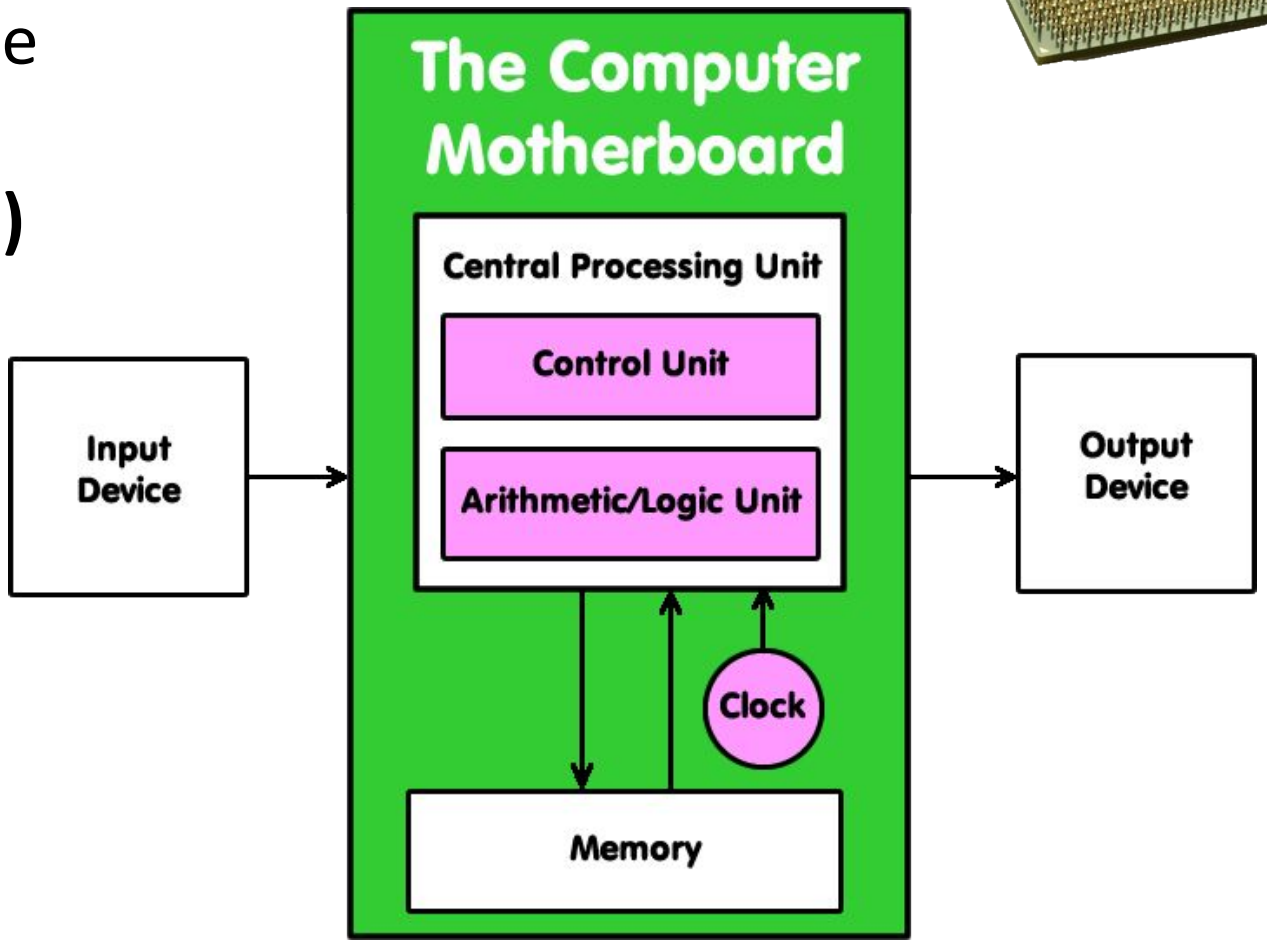
Question	Answer
1. What are the key hardware components required within Von Neumann Architecture?	
2. Name the two types of memory used within computers? What are the characteristics of each type of memory?	
3. What is the impact of having more memory available when playing a computer game?	
4. What is the role of an input device? Give an example.	
5. Briefly describe what the CPU does.	
6. How does the speed of a CPU affect the running of an application e.g. a computer game?	
7. What is the role of an output device? Give an example.	

See NOTES for answers…

Von Neumann in detail: Components of the Processor

The processor responds to and processes the instructions that drive the computer. It contains the following components:

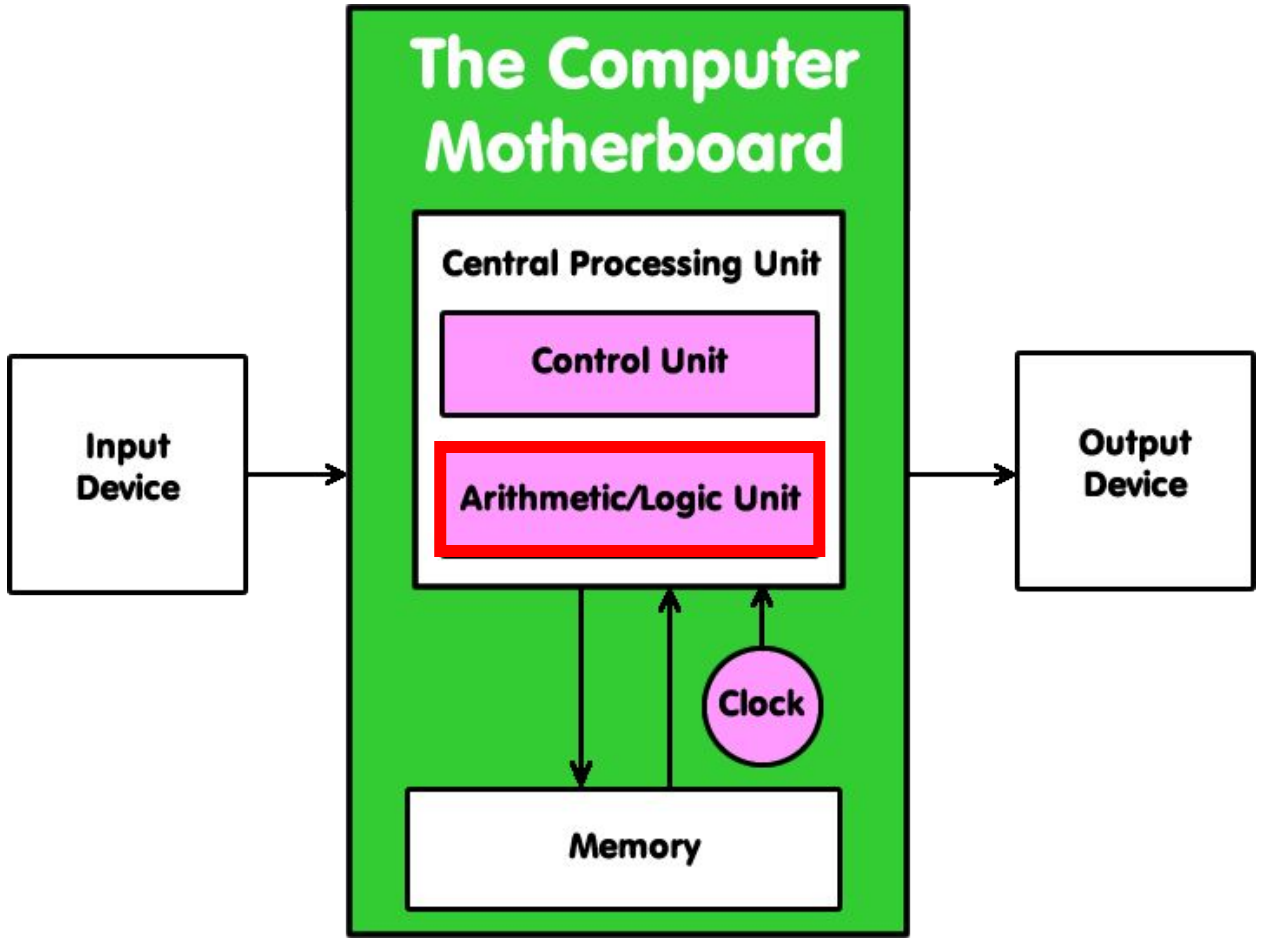
- **The Arithmetic Logic Unit (ALU)**
- **Control Unit (CU)**
- **Clock**
- **Bus**



The CPU: Arithmetic & Logic Unit (ALU)

The ALU carries out the following functions:

- **Logical operations**: Boolean operations, e.g. AND, OR and NOT
- **Shift operations**: The bits in a computer word can be shifted left or right by a certain number of places.
- **Arithmetic operations**: These include addition, subtraction, multiplication and division.



A **word** is a fixed-sized piece of data handled as a unit by the instruction set or the hardware of the processor. **Word length** is the number of bits in the internal data path of a **processor**.

Task: ALU Operations

Which of the ALU operations would be best suited for the following tasks: **Logical**, **Shift** or **Arithmetic**? (handout 2)

Task	Most suitable ALU operation
Adding together two binary numbers	
Checking if an argument is TRUE or FALSE	
Subtracting one binary number from another	
Multiplying one binary number by another	
Checking if an action has repeated a specific number of times	
Moving a computer word two places to the left	

See NOTES for answers…

Task: ALU or Control Unit? (handout 3)

Place the following statements into the correct category - ALU or Control unit:

Arithmetic & Logic Unit (ALU)	Control Unit

Sends and receives control signals from other computer devices.

Some of the logical operations are as follows: comparison between numbers, letter and or special characters.

terprets instructions

Handles multiple tasks, such as fetching, decoding, execution handling and storing results

Guides data f different com

Some of the operations are as follows: addition, subtraction, multiplication and division.

Responsible for performing all logical and arithmetic operations.

Controls sequential instruction execution

Regulates and controls processor timing

Responsible for the following conditions: Equal-to conditions, Less-than condition and greater

Task: **Von Neumann puzzle** (handout 4)

Learners to stick the pieces to create the Von Neumann Architectural block diagram.

Learners who finish this activity before time should describe the Von Neumann architecture.

Fetch-execute cycle (handout 5)

Learners to read about fetch-execute cycle followed by peer discussion

Learners to attempt task in handout 6

Question and Answer

Divide the learners in groups of 3-4. Groups to take turn in asking each other questions, related to the operations of the processor. You may adopt an awarding method to encourage competition.