Cambridge IGCSE

Computer Science

Section 1

1

Binary systems

Data representation

MCQ Computing

GS – 09/2021

Objectives

- Recognise the use of binary in computer systems
- Define the terms bit, nibble, byte, kilobyte, megabyte, gigabyte, terabyte
- Understand that data needs to be converted into a binary format to be processed by a computer
- Convert positive denary whole numbers (0-255) into 16-bit binary numbers and vice versa
- Use binary in computer registers for given applications

Vocabulary

- **Data**
- **Analogue**
- **Digital**
- **Denary**
- **Binary**
- **Register**
- **Bit**
- **Byte**
- **Kilobyte**
- **Megabyte**
- **Gigabyte**
- **Terabyte**

What is this symbol? Why?

Understanding binary

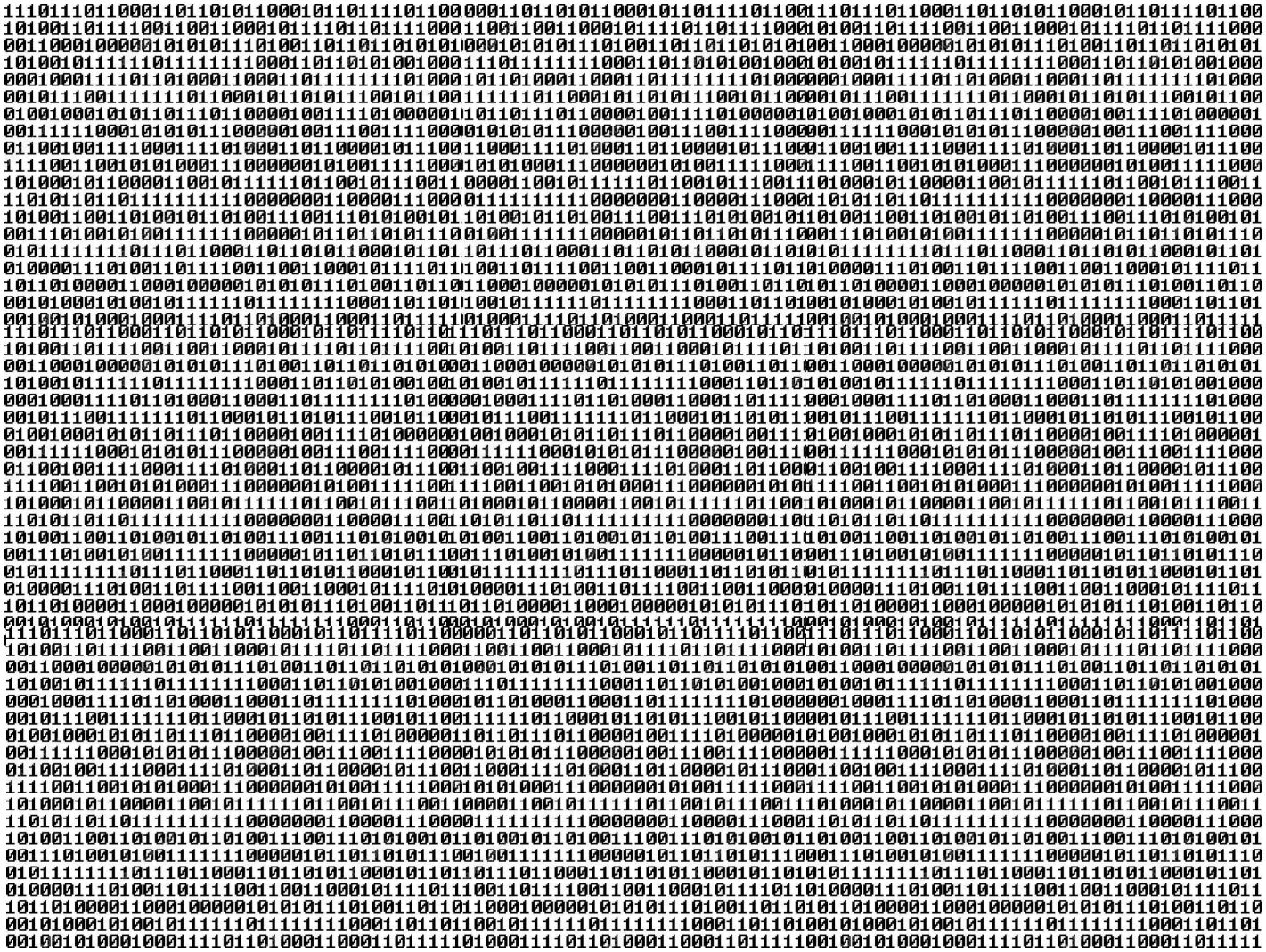
- Computers understand only two things: power on, or power off
- This is represented by switches, and computers are essentially calculators made up of billions of switches
- Power on = 1
- Power off = 0

Binary number system

- Computers use a binary number system consisting of only 0s and 1s
- Everything that a computer needs to process must be converted into a binary format
- This format is used for storing numbers, text, images, sound and program instructions

We see this …

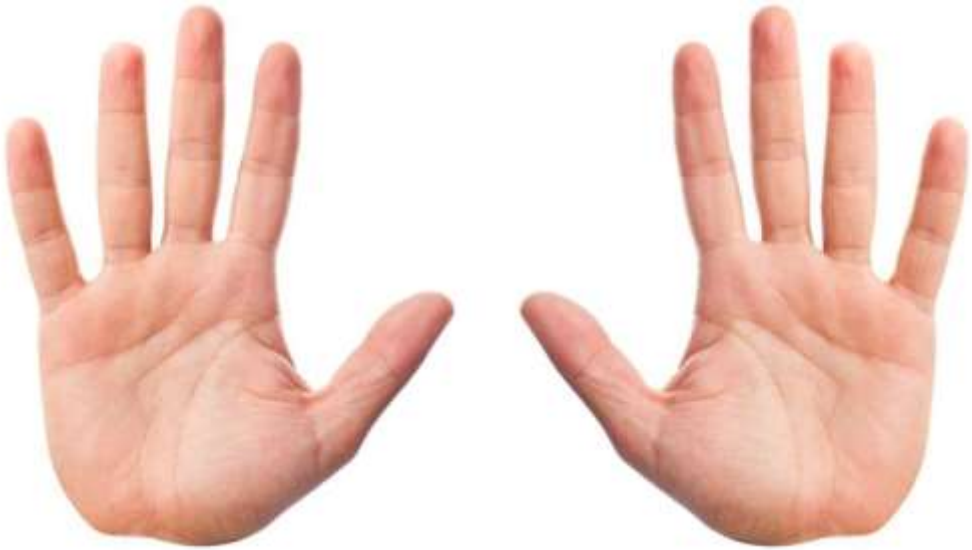
What does a computer see …



What does a computer see …

Binary and denary number systems

- Denary is a base 10 number system with 10 digits 0-9
- Why 10 digits?



- Binary is a Base-2 system with 2 digits, 0 and 1

Numbers with the denary system

Thousands, Hundreds, Tens and Units

10^3	10^2	10^1	10^0
1000	100	10	1
2	**7**	**0**	**3**

$2 \times 1000 + 7 \times 100 + 0 \times 10 + 3 \times 1 = 2703$

1 0 0 1 0 1 1 0

Binary works in exactly the same way

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	**0**	**0**	**1**	**0**	**1**	**1**	**0**
1x128	0x64	0x32	1x16	0x8	1x4	1x2	**0 x 1**
128 +	0 + 0		+16	+ 0	+ 4 + 2		+ 0

Binary to denary conversion

- What is:

128	64	32	16	8	4	2	1
0	**0**	**1**	**1**	**1**	**0**	**0**	**1**

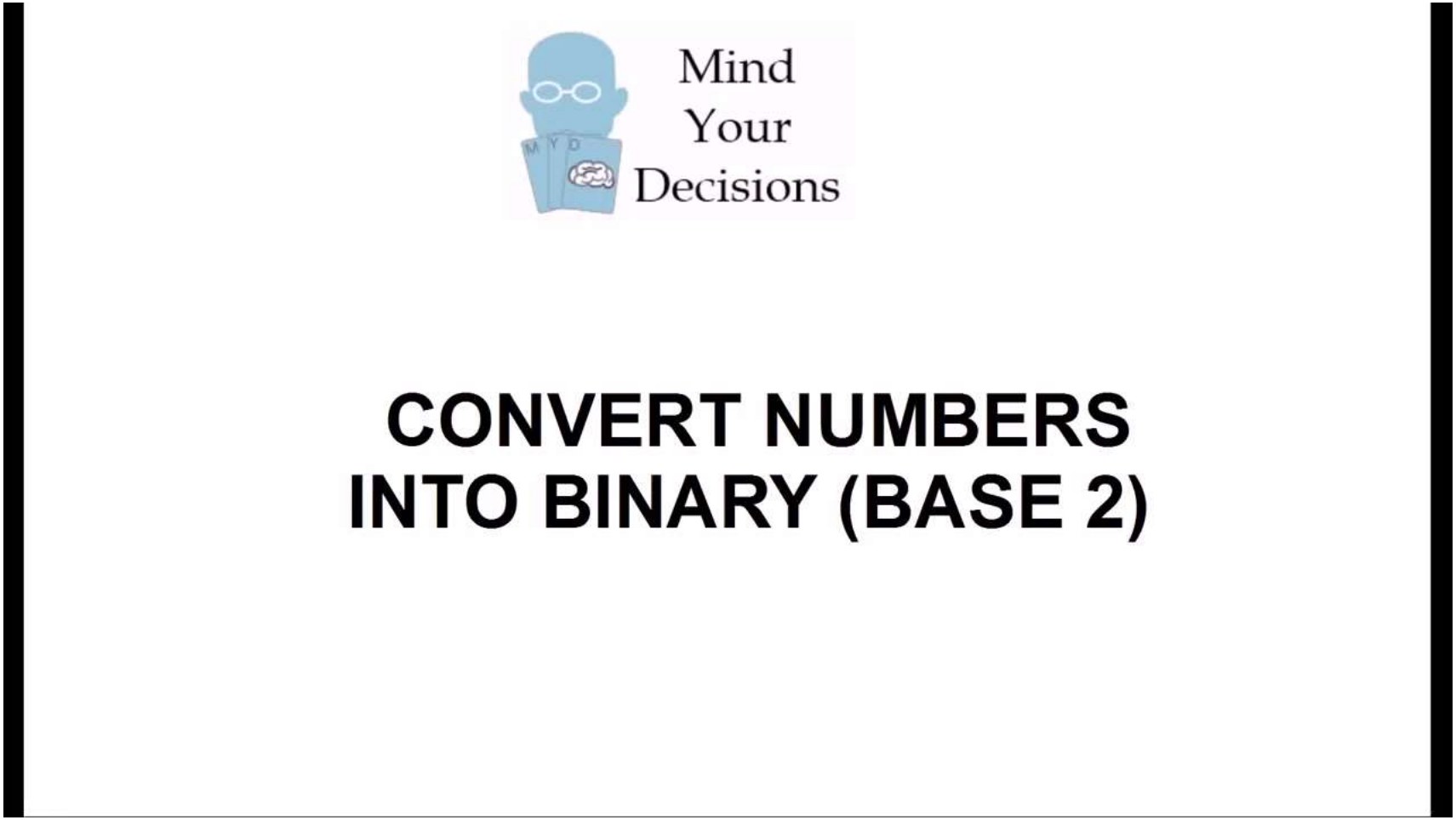
Denary to binary

- Convert 28 to binary:
- Method
  - Working right to left, write out the numbers 1, 2, 4, 8 and so on doubling each time to 128

128	64	32	16	8	4	2	1
0	**0**	**0**	**1**	**1**	**1**	**0**	**0**

- 28 has a 16 in it, leaving 12. 12 is 8 + 4

There are different methods of doing this ...



Convert the following numbers

- 230
- 1001 1100
- 143
- 1100 0011

Binary Game

- https://studio.code.org/projects/applab/iukLbcDnzggoxuu810unLw

Bits and bytes

- 1 bit = a single 0 or 1
- 1 nibble = 4 bits (or half a byte)
- 1 byte = 8 bits
- 1 kibibyte (1 KiB) = 1024 bytes
- 1 mebibyte (1 MiB) = 1024 KiB (or 1024x1024 bytes)
- 1 gibibyte (1 GiB) = 1024 MiB
- 1 tebibyte (1 TiB) = 1024 GiB
- 1 pebibyte (1 PiB) = 1024 TiB
- 1 exbibyte (1 EiB) = 1024 PiB

A sense of scale

File	Size
One character of text	1 byte
A full page of text	30 KB
One small digital colour photograph	3 MB
Music CD	600 MB
A DVD	4.5 GB
Hard disk	1 TB

Bits and bytes

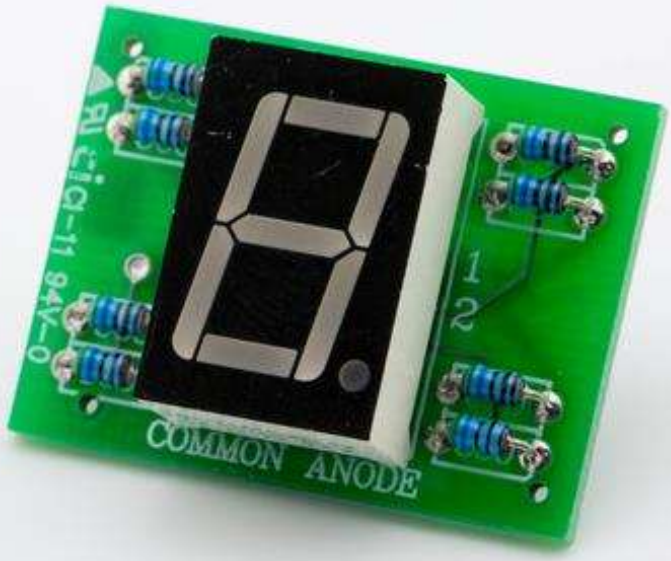
- 1 KB = _____
- 1 GB = _____
- 1 bit = _____
- 1 MB = _____
- 1 byte = _____
- 1 nibble = _____
- 1 TB = _____

Binary representation

Number of Switches (Bits)	Possible combinations or states
1	2
2	4
3	
4	
5	
6	
7	
8	

Digital displays

- A standard numeric display uses 7 (or 8) segments
- Each segment is given a binary value
- Based on the binary values, lights are switched on or off to create a recognisable number

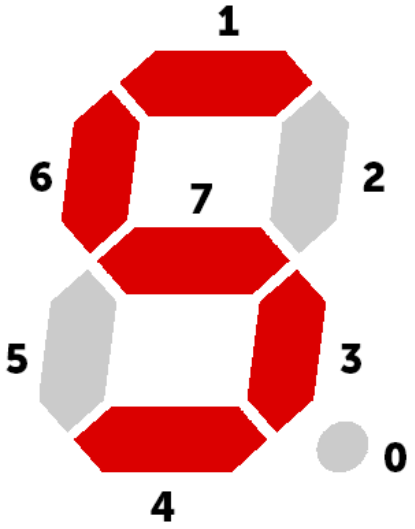


Binary in digital displays

- A register of 8 bits is used to store and determine the state of each segment (including the decimal point - 0)

Display Register

7	6	5	4	3	2	1	0
1	**1**	**0**	**1**	**1**	**0**	**1**	**0**



- What number would be represented if the register value was **11001100**?

Registers in industry

- Registers can also be used to hold the state of a machine
  - A robotic arm may have eight possible movements
  - The register values below extend and lower the arm whilst opening the claw

Rotate left	Rotate right	Open claw	Close claw	Extend arm	Retract arm	Raise arm	Lower arm
0	**0**	**1**	**0**	**1**	**0**	**0**	**1**

Plenary

- For your exam you need to be able to:
  - explain why computers use binary to represent any kind of data
  - give examples of the different types of data that computers can hold
  - convert numbers 0 - 65,535 to binary and vice versa
  - define bit, byte, kilobyte, megabyte, gigabyte, terabyte
  - understand how registers are used in applications

Homework:

- Complete Tasks 1, 2 and 3
- Read book pages ...
- Learn vocabulary
  - Data
  - Analogue
  - Digital
  - Denary
  - Binary
  - Register
  - Bit
  - Byte
  - Kilobyte
  - Megabyte
  - Gigabyte
  - Terabyte

- **Data** raw facts and figures, before processing
- **Analogue** continuous smooth changing data in the form of a wave. eg sound
- **Digital** data in the form of 1s and 0s, that can be read by computer
- **Denary** using Base 10
- **Binary** using Base 2
- **Hexadecimal** using Base 16
- **Register** very fast memory location in the CPU, used to store data in the execution of instructions. eg MAR - Memory Address Register

Adding Binary Numbers

Overflow Errors

An overflow error will occur if the value is greater than, for example, 255 in an 8-bit register.

A computer or a device has a predefined limit that it can represent or store, for example 16-bit.

An **overflow error** occurs when a value outside the limit of a register is produced.