

GCSE OCR

Computer Science
J277

1

Units of data storage and binary numbers

Unit 2
Data representation



PG ONLINE

Objectives

- Define the terms bit, nibble, byte, kilobyte, megabyte, gigabyte, terabyte and petabyte
- 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 8-bit binary numbers and vice versa

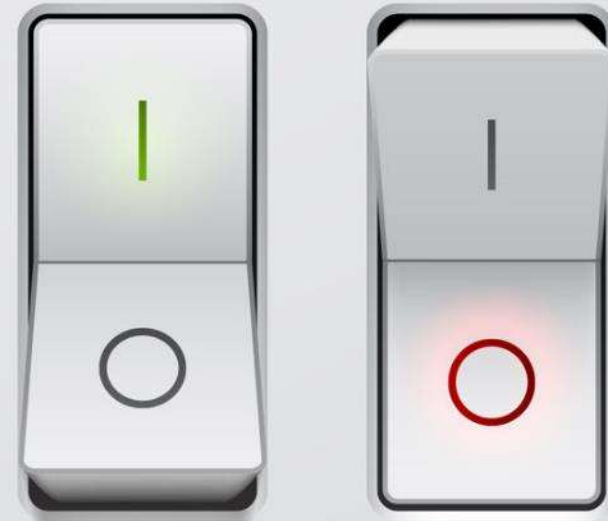
Starter

- What is this symbol?
 - What numbers is it made from?
 - How many states does it control?



Understanding binary

- Computers understand only two states: 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

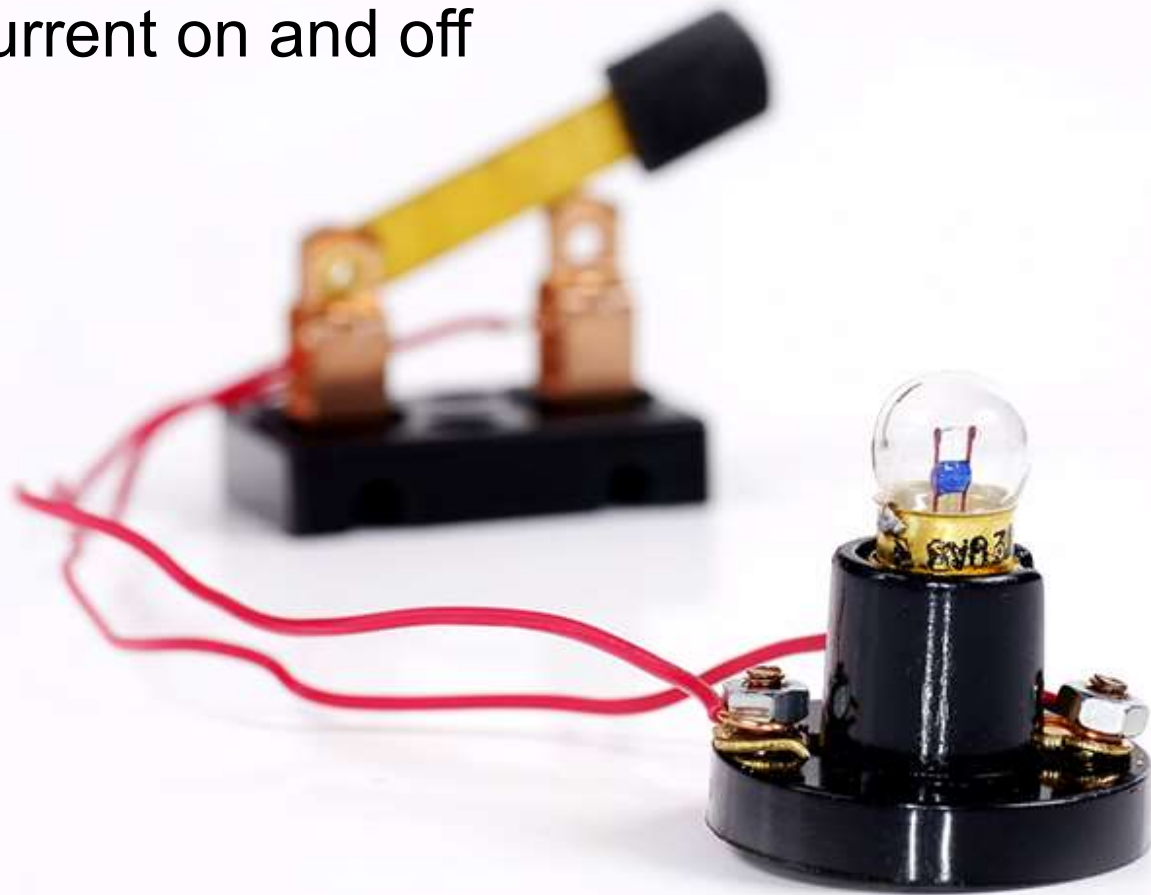


Binary number system

- 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

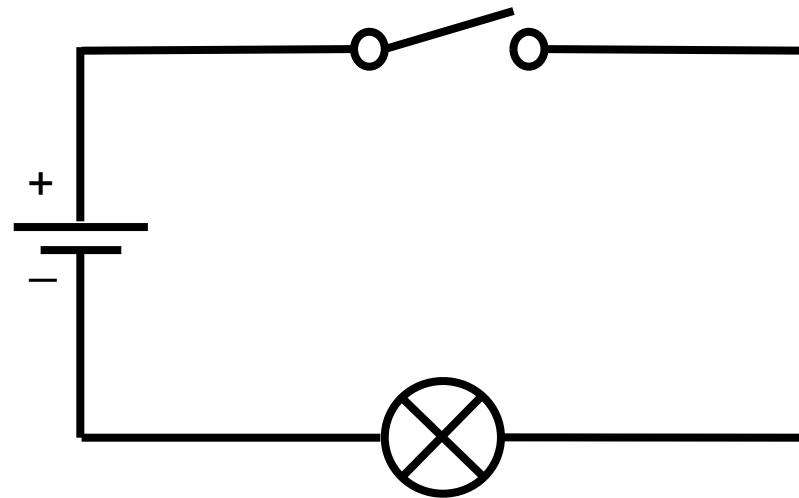
Creating a circuit

- Computers comprise billions of switches to turn current on and off



Circuits

- Use the keywords below to explain how this electrical circuit works:



Battery **Switch** **Lamp**

Bits and bytes

- Many units are used for data storage in computers
 - 1 bit = a single 0 or 1
 - 1 byte = 8 bits = 1 character of text
 - (A nibble = 4 bits or half a byte)
 - 1 kB (kilobyte) = 1000 bytes
 - 1 MB (megabyte) = 1000 kB or 1000x1000 bytes
 - 1 GB (gigabyte) = 1000 MB
 - 1 TB (terabyte) = 1000 GB
 - 1 PB (petabyte) = 1000 TB
- Make a mnemonic for k, M, G, T and P

Units

Answers

- One suggestion
 - Kites – kilo
 - Make - mega
 - Great – giga
 - Toy – tera
 - Planes - peta



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 capacity	650 MB
DVD capacity	4.5 GB
Hard disk capacity	1 TB

Binary representation

- How many combinations or states can each of the number of switches given produce?

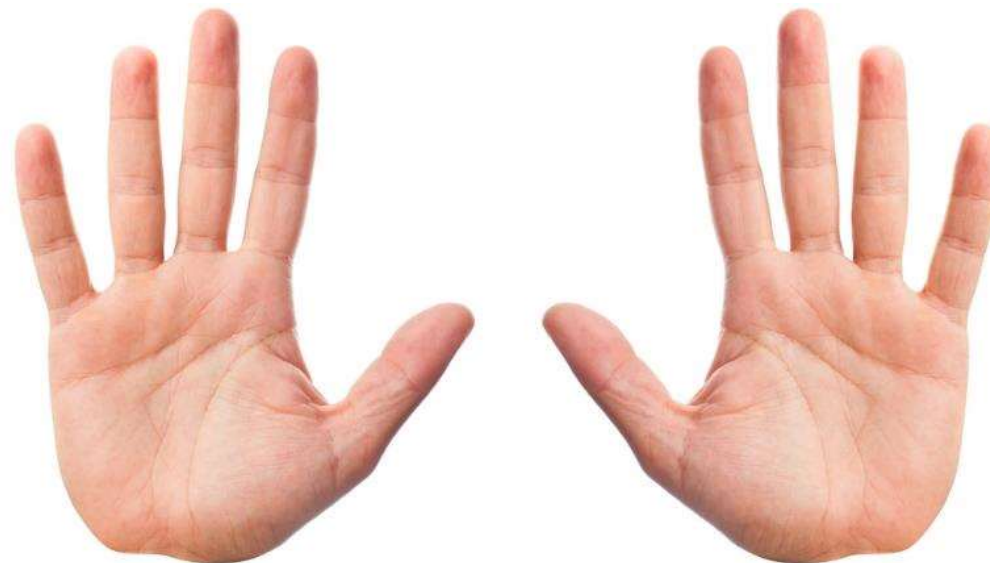
Number of Switches (Bits)	Possible combinations or states
1	2
2	4
3	
4	
5	
6	
7	
8	

Binary representation

Number of Switches (Bits)	Possible combinations or states
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256

Binary and denary number systems

- Denary is a base 10 number system with 10 digits 0-9
 - Why do we usually use 10 digits?
- Binary is a base 2 number system with 2 digits, 0 and 1



Numbers with the denary system

Thousands, Hundreds, Tens and Units

1000	100	10	1
2	7	0	3

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

Binary works in exactly the same way

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

$$1 \times 128 + 1 \times 16 + 1 \times 4 + 1 \times 2 = ?$$

Binary to denary conversion

- What is:

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

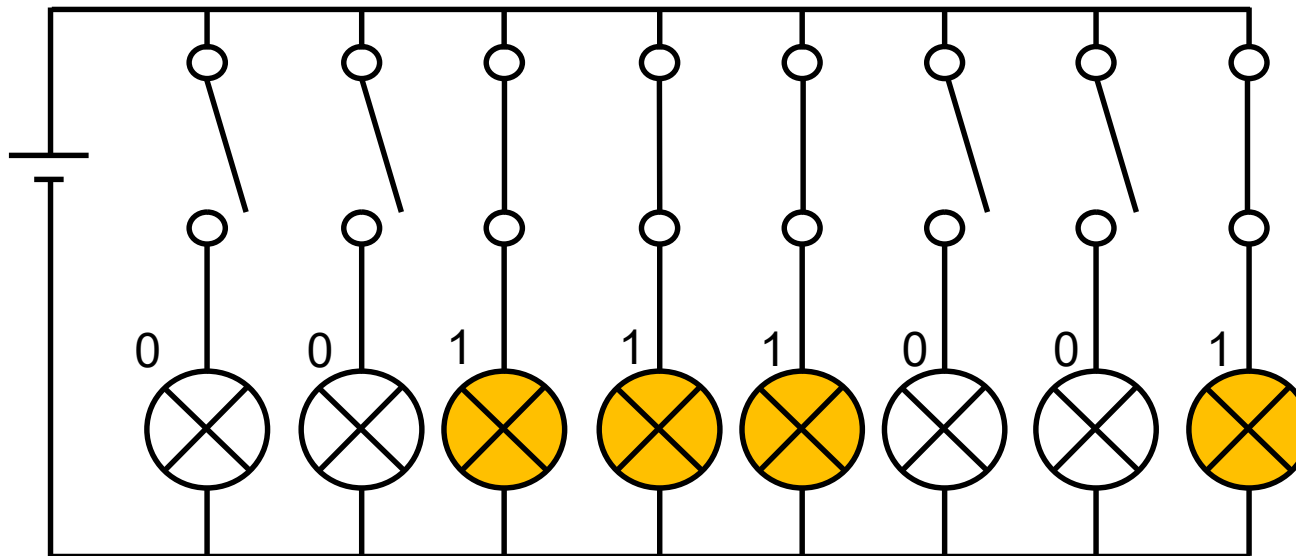
Most and least significant bit

- The most significant bit (MSB) is the bit with the largest value
 - This is the bit that is furthest to the left
- The least significant bit (LSB) is the bit with the smallest value
 - This is the bit that is furthest to the right

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

Representing values

- Consider the same byte value 0011 1001
 - This is represented in denary as 57
 - As an electrical circuit this could be represented as:



Worksheet 1

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



Denary to binary

- How do you 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

- 128, 64 and 32 are all greater than 28, so put a zero for these
- Put a 1 in the 16 column, $28-16=12$
- Put a 1 in the 8 column, $12-8=4$
- Put a 1 in the 4 column, $4-4=0$ so put zero in other columns

Representing large integers

- 1 byte (8 bits) can represent the numbers between 0 (0000 0000) and 255 (1111 1111)

$$2^8 - 1 = 255$$

- What is the largest number that can be held in 16 bits?
- What is the largest number that can be held in 32 bits?

Larger numbers

Answers

- The largest number that can be held with 16 bits is:
 - $2^{16} - 1 =$
 - $65\,536 - 1 =$
 - 65 535
 - (The range of numbers from 0 to 65 535 can be stored in a 16 bit number)
- The largest number that can be held with 32 bits is:
 - $2^{32} - 1 =$
 - $4\,294\,967\,296 - 1 =$
 - 4 294 967 295

Representing large integers

- Computers used to use two bytes to represent an integer
 - Older versions of Microsoft Excel used to have only 65,536 rows (from 1 to 65,536)
 - The rows will have been addressed with a two byte integer
- Nowadays, they mostly use four bytes
 - Programmers need to consider the maximum numbers that can be stored by the type of integer they are using

Worksheet 1

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



Plenary

- In pairs:
 - Which numbers are stored in one bit?
 - How many bits are there in a nibble and a byte?
 - What are the units after a kilobyte?
 - What is zero in binary?
 - What is 255 in binary?
 - What is 39 in binary?

Plenary

Answers

- In pairs:
 - Which numbers are stored in one bit? 0 and 1
 - How many bits are there in a nibble and a byte?
Nibble = 4 bits, byte = 8 bits
 - What are the units after a kilobyte?
megabyte, gigabyte, terabyte, petabyte
 - What is zero as an 8 bit binary number? 0000 0000
 - What is 255 in binary? 1111 1111
 - What is 39 as an 8 bit binary number? 0010 0111

Copyright

© 2020 PG Online Limited

The contents of this unit are protected by copyright.

This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it are supplied to you by PG Online Limited under licence and may be used and copied by you only in accordance with the terms of the licence. Except as expressly permitted by the licence, no part of the materials distributed with this unit may be used, reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic or otherwise, without the prior written permission of PG Online Limited.

Licence agreement

This is a legal agreement between you, the end user, and PG Online Limited. This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it is licensed, not sold, to you by PG Online Limited for use under the terms of the licence.

The materials distributed with this unit may be freely copied and used by members of a single institution on a single site only. You are not permitted to share in any way any of the materials or part of the materials with any third party, including users on another site or individuals who are members of a separate institution. You acknowledge that the materials must remain with you, the licencing institution, and no part of the materials may be transferred to another institution. You also agree not to procure, authorise, encourage, facilitate or enable any third party to reproduce these materials in whole or in part without the prior permission of PG Online Limited.