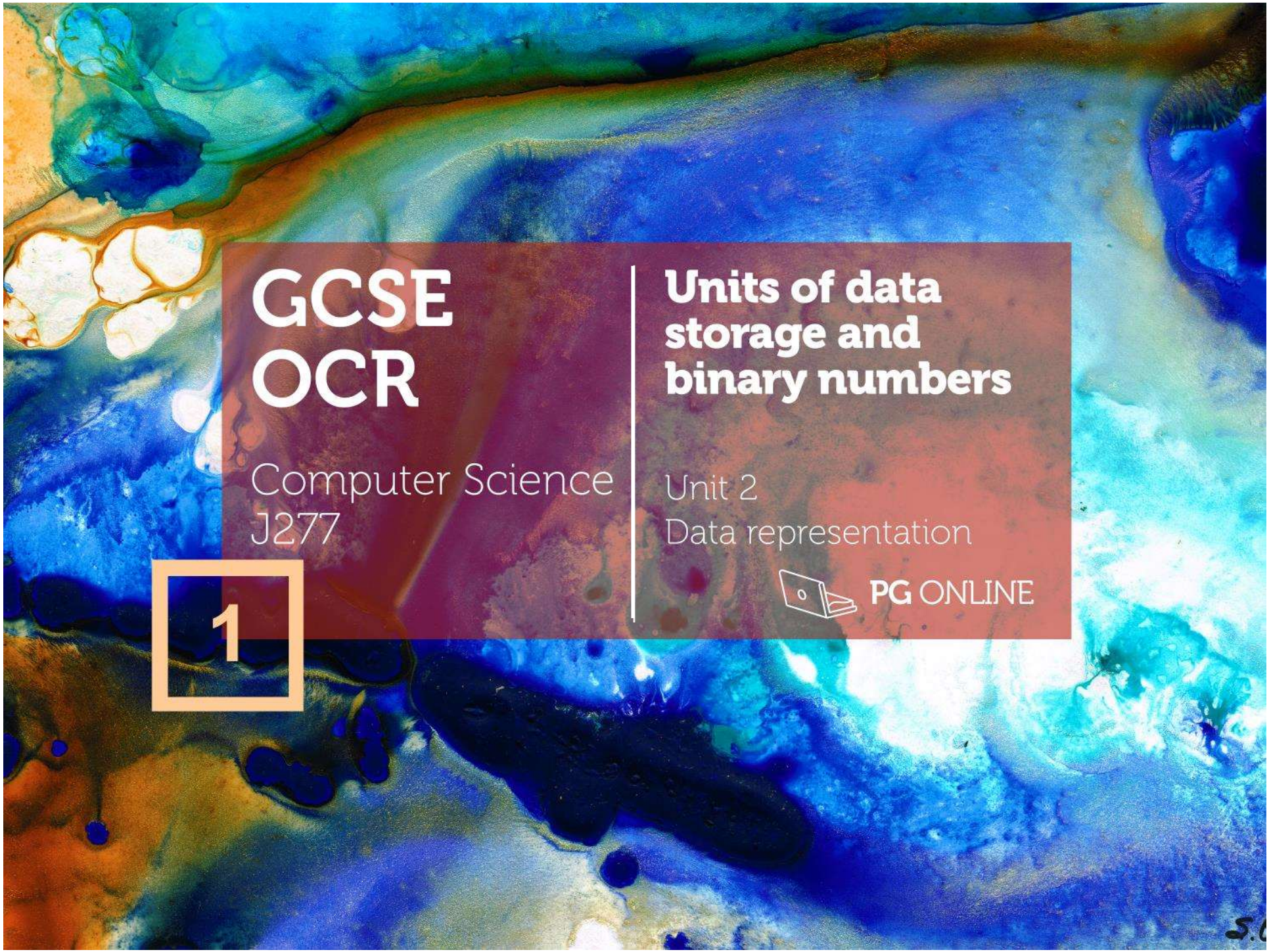

GCSE
OCR
Computer Science
J277
1
Units of data storage and binary numbers
Unit 2
Data representation
PG ONLINE

Objectives

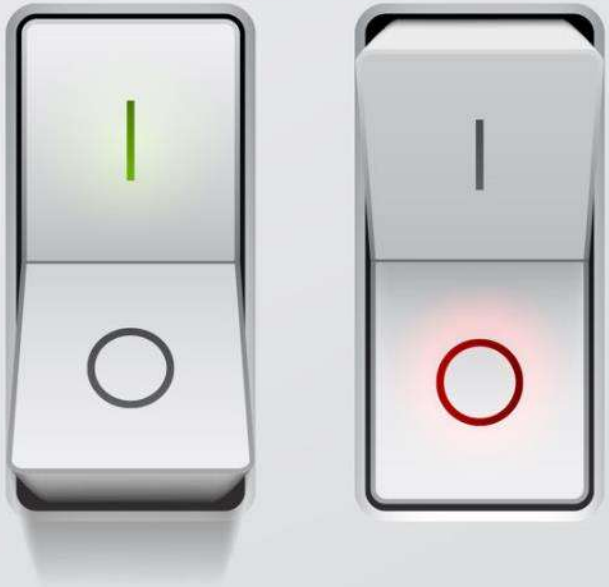
- Define the terms bit, nibble, byte, kilobyte, megabyte, gigabyte, terabyte and petabyte
- Understand that data needs to be converted into a binary format to be processed by a computer
- Convert positive denary whole numbers (0-255) into 8-bit binary numbers and vice versa

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

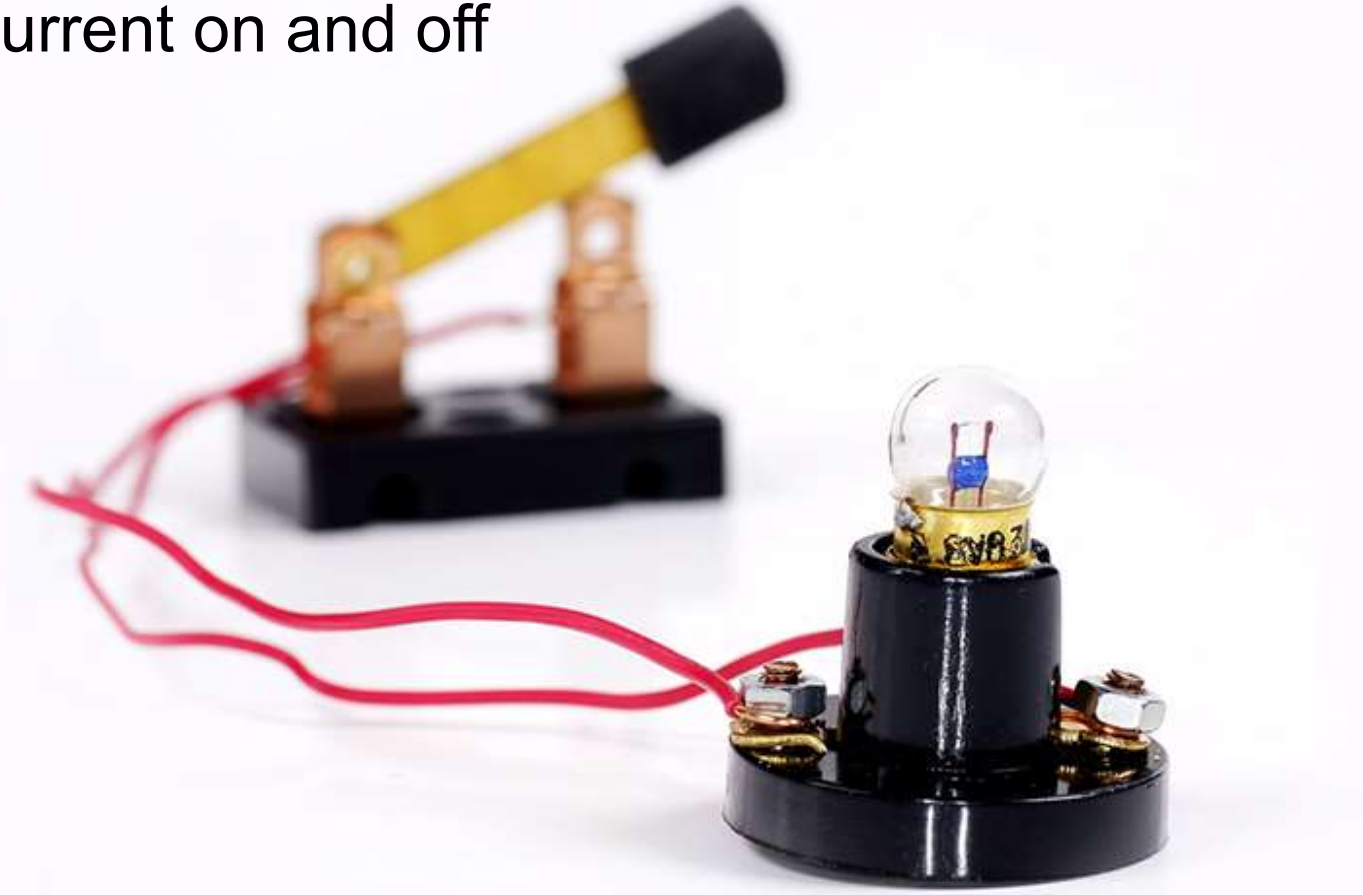


Binary number system

- 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

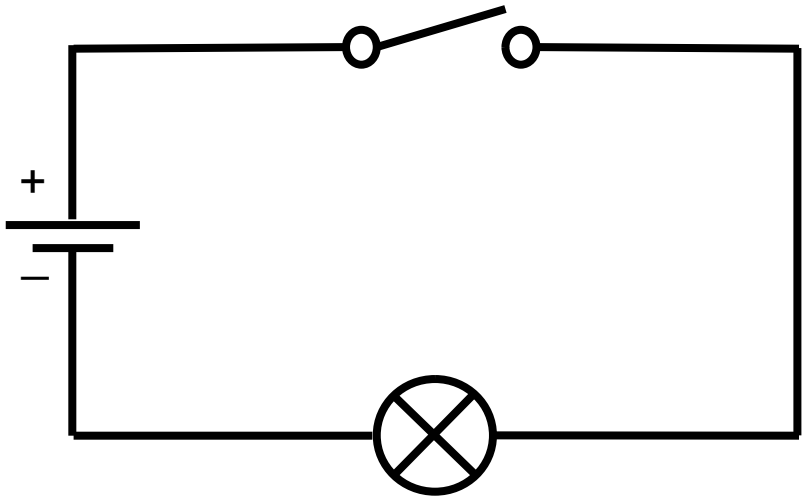
Creating a circuit

- 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
  - **K**ites – kilo
  - **M**ake - mega
  - **G**reat – giga
  - **T**oy – tera
  - **P**lanes - 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?

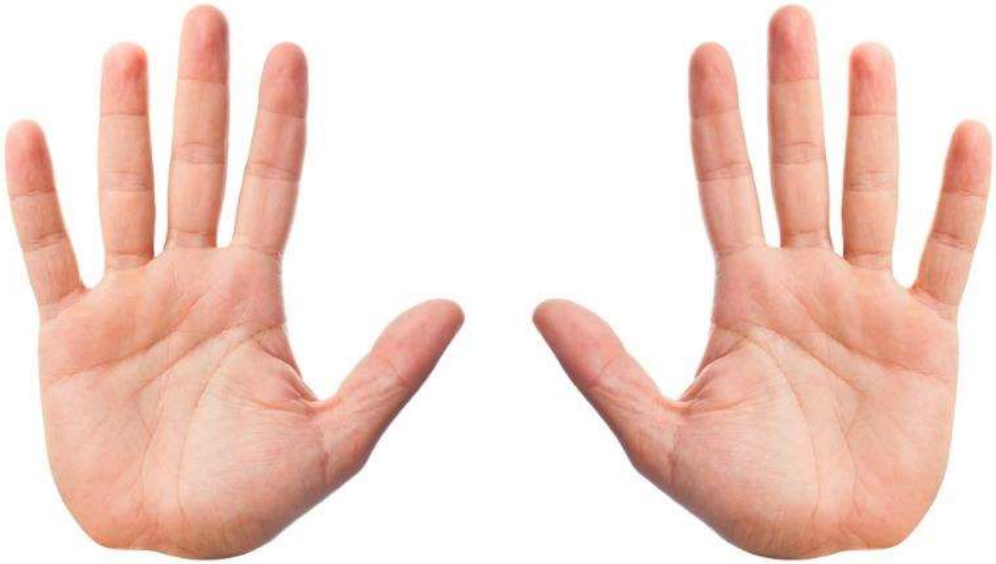
Number of Switches (Bits)	Possible combinations or states
1	2
2	4
3	
4	
5	
6	
7	
8	

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**

2x1000 + 7x100 + 0x10 + 3x1 = 2703

Binary works in exactly the same way

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

1x128 + 1x16 + 1x4 + 1x2 = ?

Binary to denary conversion

- What is:

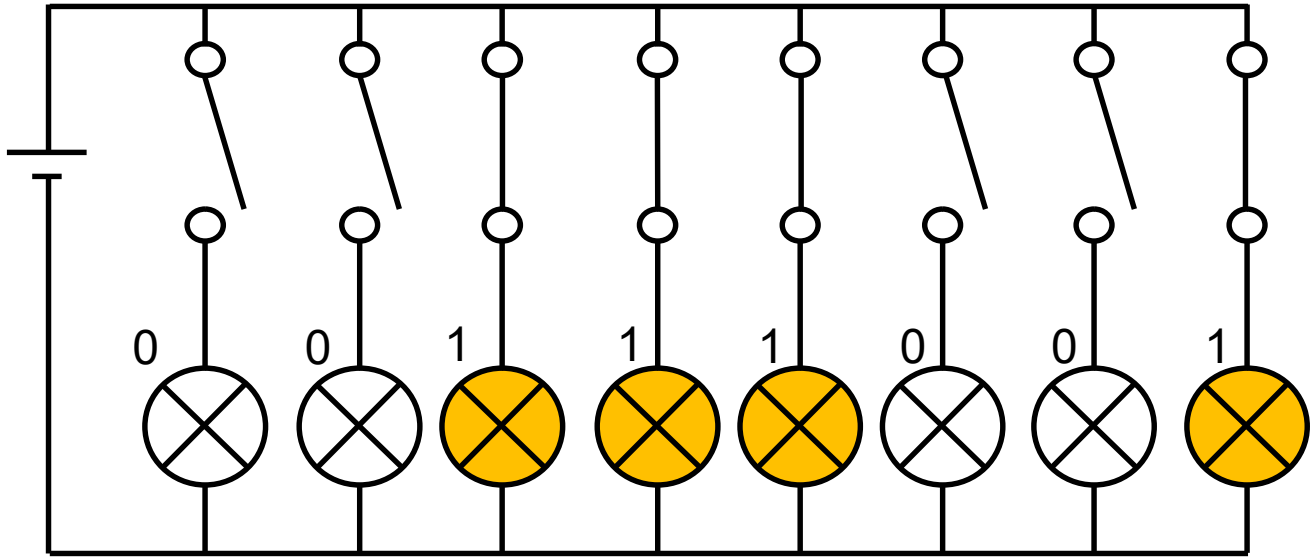
128	64	32	16	8	4	2	1
0	**0**	**1**	**1**	**1**	**0**	**0**	**1**

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

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 16 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

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