

Learning Launch



Binary is fundamental to all computing devices.

Use the chat to tell others why



Representation of number: binary conversion and binary addition

GCSE student booster

Key Information

- 1) Remember this booster is here to **help you**. Please consider your behaviour in the chat.
- 2) If you are in a room with a teacher/group, please login to the meeting. This is so we can mark your attendance. This information goes into a **prize draw**.
- 3) Make sure the name on the meeting is the **SAME** as the name on your Isaac account. We can't mark you present if they don't match.



Learning Outcomes

By the end of this session, you will be able to:

- State why computers use binary
- Identify number bases and units
- Convert between binary and denary
- Add 2 bytes and identify binary overflow errors



Representation of numbers in GCSE computer science

Topics covered in this session

- Why computers use binary
- Base 2 and Base 10 number systems
- Units used in computer science
- Binary number line
- Converting binary to denary
- Converting denary to binary
- Binary addition
- Overflow



Confidence Check-In

- Please take time to anonymously share your confidence in today's topics



Why binary?

- Computers are electronic systems
- Transistors process computer electronic signals
- Transistors have 2 states: **on** and **off**
- If a transistor is **on** the value is **1**
- If a transistor is **off** the value is **0**



Number Bases

We normally use the **Base 10** number system



Each column has a number range of 0-9:
increasing in multiples of 10 from right to left



Number Bases

To purchase a laptop costing 1409 pounds we would represent this as

1000	100	10	1
1	4	0	9



Number Bases

Computers use the **Base 2** number system



Each column has a number range of 0-1:
increasing in multiples of 2 from right to left

To purchase a music download costing 9
pounds, we would represent this as

8	4	2	1
1	0	0	1



Number Bases

A byte, 8 bits, in base 2 has a range of 0-255

Examination boards require you to be able to
work with a byte

How would you represent a gamer chair
costing 245 pounds in a byte?

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



You have
1 minute



Number Bases

Bit -> Nibble -> Byte

Bit – smallest value = 1/8 of a Byte

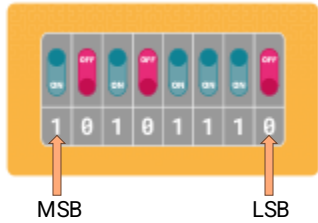
Nibble – equivalent to 4 bits = half a byte

Byte – equivalent to 8 bits



Number Bases

MSB → LSB



MSB → Most Significant Bit. Always the 1st left hand value
 LSB → Least Significant Bit. Always the 1st right hand value

Number Bases – over to you

Answer questions 1-4 on **handout 1**

Question 1

The table below uses base 2 place values. Insert the missing place values

	64				4		
--	----	--	--	--	---	--	--

Question 2

What is the number base for

10100011₂

1001₁₀

1421₁₀



You have
3 minutes

Number Bases – over to you

Answer questions 1-4 on **handout 1**

Question 3

What is the value of the MSB and LSB in a byte?

MSB

LSB

Question 4

What is the place value of the digit with the value 1 in the binary number 10000₂?

Number Bases – answers

Question 1

The table below uses base 2 place values.
Insert the missing place values

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

Question 2

What is the number base for

10100011₂ **Binary**

1001₁₀ **Denary**

1421₁₀ **Denary**



Number Bases – answers

Question 3

What is the value of the MSB and LSB in a byte?

MSB **128**

LSB **1**

Question 4

What is the place value of the digit with the value 1 in the binary number 10000₂?

16



Prefixes

In computer science, using prefixes make numbers easier to read and manage

Multiples of 1000 **Bytes** have specific terms

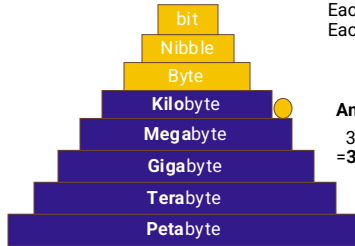
bit	1 or 0
Nibble	4 bits
Byte	8 bits
Kilobyte	1000 bytes
Megabyte	1000,000
Gigabyte	1000,000,000
Terabyte	1000,000,000,000
Petabyte	1000,000,000,000,000

Big Naughty Bears Keep Making Giant Tasty Pies



Prefixes – over to you

How many Megabytes is 3500 Kilobytes (KB) ?



Rules for converting:

Each step **up** = $\times 1000$
Each step **down** = $/ 1000$

Answer
 $3500/1000$
=3.5 MB

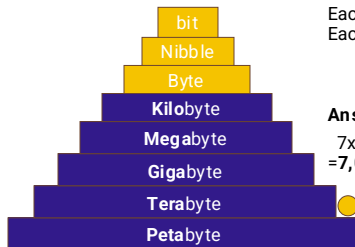


You have
1 minute



Prefixes – example 2

How many Megabytes is 7 Terabytes(TB) ?



Rules for converting:

Each step **up** = $\times 1000$
Each step **down** = $/ 1000$

Answer
 $7 \times 1,000,000$
=7,000,000 MB

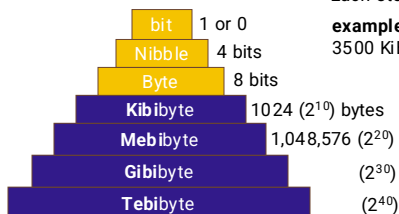


You have
1 minute



Prefixes – Edexcel

So far we have looked at decimal prefixes. This exam board cover **binary prefixes** and they are different.



Rules for converting:

Each step **up** = $\times 1024$
Each step **down** = $/ 1024$

example
 $3500 \text{ KiB} = 3.42 \text{ MiB}$



Prefixes – example question



How many?

Ananya has a 4GB SD card and wants to store short movies taken with her smart phone.

Each movie is 200 MB in size.

How many can I store?



Prefixes – example question



Working

Each movie is 200 MB
Storage available = 4GB

4 GB = 4000 MB
 $4000 / 200 = 20$ movies

Reduce to a common denominator



Prefixes – over to you



Answer questions 5-6 on **handout 1**

**You have
3 minutes**

Question 5

The following list of units of measurement are not in order. Rearrange them into the correct ascending order using the initials.

Out of Order

PB	MB	KB	Bit	Nibble	Byte	TB	GB
----	----	----	-----	--------	------	----	----

In Order

--	--	--	--	--	--	--	--



Prefixes – over to you

Answer questions 5-6 on **handout 1**

Question 6

Mr Jones is researching broadband suppliers. A supplier advertises as having a maximum speed equal to 0.75 TB per minute. How many MB is this?

.....



Prefixes – answers

Question 5

The following list of units of measurement are not in order. Rearrange them into the correct ascending order using the initials.

Out of Order

PB	MB	KB	Bit	Nibble	Byte	TB	GB
----	----	----	-----	--------	------	----	----

In Order

Bit	Nibble	Byte	KB	MB	GB	TB	PB
-----	--------	------	----	----	----	----	----



Prefixes – answers

Question 6

Mr Jones is researching broadband suppliers. A supplier advertises as having a maximum speed equal to 0.75 TB per minute. How many MB is this?

750,000MB

Working

We need to convert 0.75TB to MB

$$0.75 \times 1000 \times 1000 = 750,000 \text{ MB}$$



Converting Binary to Denary

Remember your number line

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

Each place value is either **on** (1) or **off** (0)


To convert a binary value to denary, add up all the place values with a 1 in them

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

$$128 + 32 + 16 + 4 + 1 = 181$$



Converting Binary to Denary

In your head 

- a. $1110 = 8 + 4 + 2 = 14$
- b. $0111 = 4 + 2 + 1 = 7$
- c. $11111110 = \text{All place values except } 1 = 254$



Use the chat to respond



Converting Binary to Denary

Tips

If a **1** is in place value 1(LSB) – number is **odd**

If a **0** is in place value 1(LSB) – number is **even**

Let's play odd or even

- a. 00010100 **Even**
- b. 00101001 **Odd**
- c. 00000100 **Even**
- d. 10111111 **Odd**



Use the chat to respond



Converting Binary to Denary

Tips

When all bits from the LSB are 1s and the rest 0, the denary is the next place value minus 1

Let's play 'what's the number' in the chat

	128	64	32	16	8	4	2	1	Denary
a.	0	0	0	0	0	0	1	1	3
b.	0	0	0	0	1	1	1	1	15
c.	0	0	0	1	1	1	1	1	31
d.	1	1	1	1	1	1	1	1	255



Converting Binary to Denary

Over to you

Answer questions 7-10 on **handout 1**



You have
5 minutes

Question 7

Use the number line to convert from binary to denary

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

Question 8

Convert the following binary number into denary.

01010101₂



Converting Binary to Denary

Question 10

Is the denary value of the binary number line below odd or even?

1	0	0	1	1	1	0	0
---	---	---	---	---	---	---	---

Question 9

All the place values in a byte have a value of 1 except for the LSB which has a value of 0.

What is the denary value of the binary number?



Converting Binary to Denary

Answers

Question 7

Use the number line to convert from binary to denary

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

$64+16+8+4+2+1=95$

Question 8

Convert the following binary number into denary.

01010101₂

$64+16+4+1=85$



Converting Binary to Denary

Answers

Question 9

Is the denary value of the binary number line below odd or even?

1	0	0	1	1	1	0	0
---	---	---	---	---	---	---	---

Even

Question 10

All the place values in a byte have a value of 1 except for the LSB which has a value of 0.

What is the denary value of the binary number? = 254

(remember 8 bits are 255, so 1 less)



Converting Denary to Binary

To convert 151 denary to binary.

Rules

- Start at the **MSB** and check each place
- If smaller put a 1 and move on with remainder
- If bigger put a 0 and move on with remainder

128	64	32	16	8	4	2	1
1	0	0	1	0	1	1	1
remainder	23	23	7	7	3	1	0



Converting Denary to Binary

Your go

A new games console handset costs £200
What is this in binary?



You have
2 minutes

128	64	32	16	8	4	2	1
1	1	0	0	1	0	0	0
remainder	72	8	8	0	0	0	0



Converting Denary to Binary

Over to you

Answer questions 11-13 on **handout 1**



You have
5 minutes

Question 11

Convert the denary value 73 into an 8-bit binary value

Question 12

Convert the denary value 92_{10} into a byte

Question 13

Convert 205_{10} into binary



Converting Denary to Binary

Answers

Question 11

Convert the denary value 73 into an 8 bit binary value
01001001

Question 12

Convert the denary value 92_{10} into a byte
01011100

Question 13: Convert 205_{10} into binary

128	64	32	16	8	4	2	1
1	1	0	0	1	1	0	1
remainder	77	13	13	5	1	1	0



Binary Addition

It's binary – addition is always a 0 or 1

$$\begin{array}{r} 0 \\ + 0 \\ \hline 0 \end{array} \quad \begin{array}{r} 0 \\ + 1 \\ \hline 1 \end{array} \quad \begin{array}{r} 1 \\ + 0 \\ \hline 1 \end{array} \quad \begin{array}{r} 1 \\ + 1 \\ \hline 2 \end{array}$$

When the sum is bigger than 1 we need to carry

	2	1
		1
+		1
result	1	0
carry	1	



Binary Addition

We also need to consider adding **three 1s**

This time we have
1 carry 1

Rules

- 0 + 0 = 0
- 1 + 0 = 1
- 0 + 1 = 1
- 1 + 1 = 0 carry 1
- 1 + 1 + 1 = 1 carry 1

	2	1
		1
		1
+		1
result	1	1
carry	1	



Binary Addition

At GCSE level, we need to add:-

- Using Bytes
- Up to 3 1s

Rules

- 0 + 0 = 0
- 1 + 0 = 1
- 0 + 1 = 1
- 1 + 1 = 0 carry 1
- 1 + 1 + 1 = 1 carry 1

Let's add 2 bytes together using the rules

	128	64	32	16	8	4	2	1
	0	1	0	1	1	0	0	1
+	1	0	0	1	1	1	1	1
result	1	1	1	1	1	0	0	0
carry			1	1	1	1	1	



Binary Addition – over to you

Answer questions 14 -15 on the handout

Question 14

Complete the binary addition



You have
5 minutes

	8	4	2	1
	0	0	1	1
	1	0	1	0
Result				
Carry				



Binary Addition – over to you

Question 15

Add the 2 denary values as binary numbers.
Complete the table

	128	64	32	16	8	4	2	1
123 ₁₀	0	1	1	1	1	0	1	1
94 ₁₀								
Result								
Carry								



Binary Addition – answers

Question 14

Complete the binary addition

	8	4	2	1
	0	0	1	1
	1	0	1	0
Result	1	1	0	1
Carry		1		



Binary Addition – answers

Question 15

Add the 2 denary values as binary numbers.
Complete the table

	128	64	32	16	8	4	2	1
123 ₁₀	0	1	1	1	1	0	1	1
94 ₁₀	0	1	0	1	1	1	1	0
Result	1	1	0	1	1	0	0	1
Carry	1	1	1	1	1	1		



Binary Overflow

Let's add these 2 numbers using the rules

	8	4	2	1
Result	1	1	1	1
Carry	1	0	1	1
	1	0	1	0
	1	1	1	

A binary overflow occurs when you do not have enough bits to hold your binary number



Overflow – over to you

Answer question 16 on the handout



You have
3 minutes

Question 16

Take the following two 8-bit binary numbers and add them together. Show your working by completing this table:
Would an overflow error occur?

	128	64	32	16	8	4	2	1
123 ₁₀	1	1	1	1	1	0	1	1
94 ₁₀	0	0	0	1	0	1	1	0
Result								
Carry								



Overflow – answers

Answer question 16 on the handout

Question 16

Take the following two 8-bit binary numbers and add them together. Show your working by completing this table:

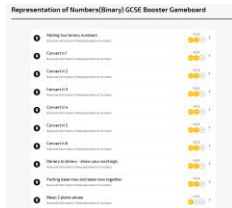
Would an overflow error occur? - Yes

		128	64	32	16	8	4	2	1
123 ₁₀		1	1	1	1	1	0	1	1
94 ₁₀		0	0	0	1	0	1	1	0
Result		0	0	0	1	0	0	1	0
Carry	1	1	1	1	1	1	1		



All together – Isaac Gameboard

This gameboard can be started now. You will need to complete this as additional practice after the session.



You have 5 minutes

ncce.io/isc-binary



Learning Outcomes

By the end of this session, you will be able to:

- State why computers use binary
- Identify number bases and units
- Convert between binary and denary
- Add 2 bytes and identify overflow errors



Thank You