

Recap

_____ is the maximum amount of data that can be transmitted over a connection per second. It is measured in bits per second (**bps**).

_____ is the time taken for a transmission to reach its destination.

File size units	Equivalent to
bit	1 bit
nibble	4 bits
byte	8 bits
Kibibyte(KiB)	1024 bytes
Mebibyte (MiB)	1024 kibibytes
Gibibyte (GiB)	1024 mebibytes
Tebibyte (TiB)	1024 gibibytes

Speed Units	Equivalent to
1 Kbps	1000 bps
1Mbps	1000^2 bps
1 Gbps	1000^3 bps

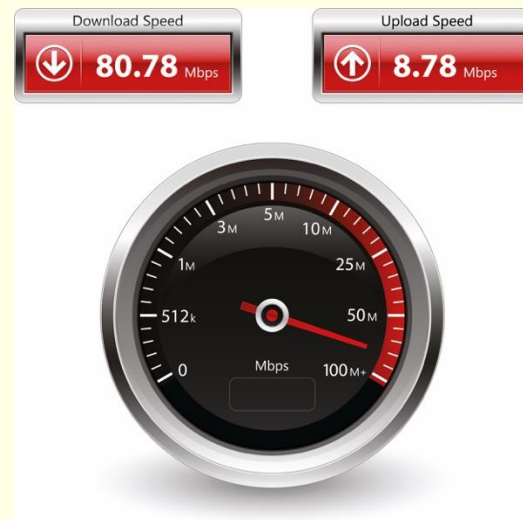
$$time = \frac{file\ size\ (in\ bits)}{network\ speed\ (in\ bps)}$$



Learning Aims

In this lesson you will learn to:

- Define the meanings of the terms '**bandwidth**' and '**latency**'
- Explain how bandwidth and latency affect the performance of a network
- Use bits per second (bps) to describe network speed
- Construct expressions involving file size, transmission rate and time.

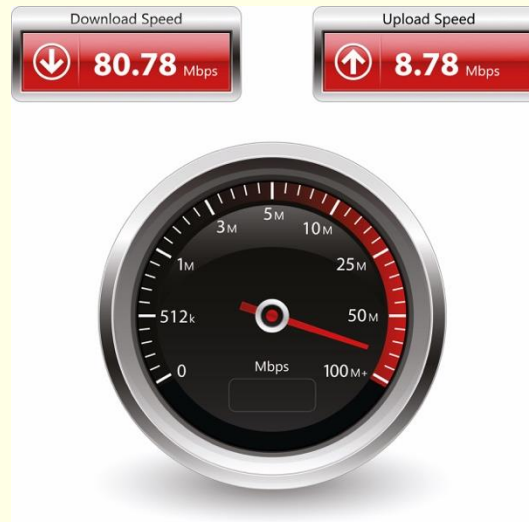


What does speed mean?

The term '**download speed**' refers to how much data can be downloaded **per second** over a connection.

There are a number of factors that can affect the speed of a connection.

The two most important are the **bandwidth** and **latency**.



Bandwidth and latency

Bandwidth is the maximum amount of data that can be transmitted over a connection per second. It is a measurement of capacity. It is measured in bits per second (**bps**).

Latency is the time taken for a transmission to reach its destination.

Gamers may be familiar with the term '**ping**'. This is a way of measuring latency. It times a single transmission as it travels to a server and back again.



Measuring speed

We measure network speed in bits per second (bps).

Modern networks have high bandwidths, measured in millions of bits per second.

The following units are used to measure network speeds.

Units	Abbreviation	bits per second
bits per second	bps	1
kilobits per second	Kbps	1 000 bps
megabits per second	Mbps	1 000 ² bps
gigabits per second	Gbps	1 000 ³ bps

Edexcel require you to measure file size using the following:

Unit	Abbreviation	Equivalent to
bit		1 bit
nibble		4 bits
byte		8 bits
kibibyte	KiB	1024 bytes
mebibyte	MiB	1024 kibibytes
gibibyte	GiB	1024 mebibytes
tebibyte	TiB	1024 gibibytes



Calculating transmission times

$$time = \frac{file\ size\ (in\ bits)}{network\ speed\ (in\ bps)}$$



Formulas for working out speed and size

$$\text{speed} = \text{size} / \text{time}$$

$$\text{size} = \text{time} * \text{speed}$$



Worked example

How long will it take to download a **20MiB file** over a **12 Mbps connection**?

1. Convert the file size to bits

$$20 \times 8 \times 1024 \times 1024$$

2. Convert the speed to bits per second

$$12 \times 1000 \times 1000$$

3. Arrange the size and speed

expressions

$$time = \frac{20 \times 8 \times 1024 \times 1024}{12 \times 1000 \times 1000}$$

$$time = \frac{20 \times 8 \times 1024^2}{12 \times 1000^2}$$

File size units	Equivalent to
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Speed Units	Equivalent to
1 Kbps	1000 bps
1 Mbps	1000 ² bps
1 Gbps	1000 ³ bps

$$time = \frac{\text{file size (in bits)}}{\text{network speed (in bps)}}$$



Must know for exam

In an exam, you could be asked to construct an expression involving file size, transmission rate and time. This could include an expression for:

- how long it takes to transfer a file of a given size
- how many mebibytes or kibibytes can be transmitted per second
- how many files of a given size can be transmitted per second



You will find the following expressions useful:

File Size

one byte (B) = 8 bits (b)

file size in bits (b) = file size in bytes (B) x 8

one kibibyte (KiB) = 1024 x 8 bits

one mebibyte (MiB) = 1024² x 8 bits

one gibibyte (GiB) = 1024³ x 8 bits

Speed

one kilobit per second (Kbps) = 1000 bits per second (bps)

one megabit per second (Mbps) = 1000 Kbps = 1000² (bps)

one gigabit per second (Gbps) = 1000 Mbps = 1000³ (bps)



- 1** Anke plays cricket. She has made a video to promote women's cricket. The file size of the video is 22 GiB.
Construct an expression to calculate how long it will take to transmit the video across a network that has a transmission speed of 54 Mbps.
- 2** Erik uses the network to send a file to his colleague Jens. It takes 35 seconds for Jens to receive the file. The network transmits data at a rate of 40 Mbps.
Construct an expression to calculate the size of the file in mebibytes.
- 3** Marty plays multi-user games online with other gamers. How might a high latency internet connection affect her user experience?



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- Use bits per second (bps) to describe network speed
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