Learning Aims

- Use the units bit, byte, kibibyte, mebibyte gibibyte, tebibyte in calculating file size
- Construct an expression to convert units
- Construct an expression to calculate the file size of an image (width x height x colour depth) and – given the file size and the values of any two of the variables – to calculate the value of the remaining one
- Construct an expression to calculate the file size of a sound (sample rate x bit depth x time)

Powers of 2

A binary is base 2 and uses binary multiples that are 2 to the power

- 1 **kibi**byte is 1,024 bytes = 2^{10} bytes 2 to power of 10
- Count in powers of 2:

  1, 2, 4, 8, 16, 32, 64, 128, 256, 512, **1024**

Unit	Abbreviation	Bytes	Equivalent to
bit			1 bit
nibble			4 bits
byte		2^0 bytes	8 bits or 2 nibbles
kibibyte	KiB	2^{10} bytes	1024 bytes
mebibyte	MiB	2^{20} bytes	1024 kibibytes
gibibyte	GiB	2^{30} bytes	1024 mebibytes
tebibyte	TiB	2^{40} bytes	1024 gibibytes

In the exam

- In the exam you **must** use **binary bytes** for calculating **file sizes** and **storage**
- You will not have access to a calculator and so questions will only ask you to create an expression.
- You should also be able to rank units of measurement in size order and convert from a larger unit to a smaller one and vice-versa.

Worked Example

A file uses 28 KiB of storage.

a) Construct an expression to calculate the number of bytes in the file.

$= \ file\ size\ in\ KiB \times 1024$

$= \ 28 \times 1024$ bytes

Worked Example

Construct an expression to calculate how many bytes there are in 3 MiB.

$$= file\ size\ in\ MiB \times 1024 \times 1024$$

$$= 3 \times 1024 \times 1024 \quad \text{bytes}$$

Worked Example

Construct an expression to calculate how many hexadecimal digits (nibbles) are needed to represent a binary bit pattern with a word length of 32 bits.

$$= \frac{number\ of\ bits}{4} = \frac{32}{4} \text{ hex digits}$$

$$= 32 / 4$$

Worked Example

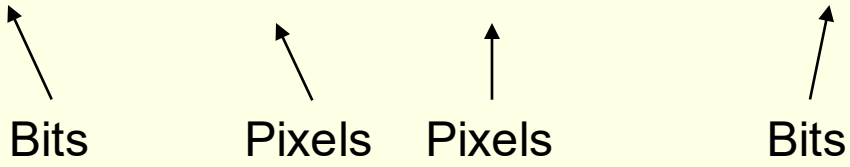
Construct an expression to show 23,354,273 MiB in TiB.

$$= \frac{file\ size\ in\ MiB}{1024\ x\ 1024} = \frac{23{,}354{,}273}{1024\ x\ 1024}\ \text{TiB}$$

Calculate the file size of an image

The file size of an image is calculated by:

File size = width × height × colour depth



$$\frac{\text{(file size in bits)}}{\text{((bits in a byte) × (bytes in a kibibyte) etc.)}}$$

Worked Example

An image is 500 pixels high and 400 pixels wide, with a colour depth of 16.

- Construct an expression to calculate the file size of the image in bits.

$= 500 \times 400 \times 16$

Worked Example

Construct an expression to calculate the file size in kibibytes of:

i. An 8-bit colour image with a width of 640 pixels and a height of 480 pixels.

$$\frac{(640 \times 480 \times 8)}{(8 \times 1024)}$$

Converting to kibibytes

Mix it up

- Now, the formula all together is:

$$\frac{(\text{width} \times \text{height} \times \text{colour depth})}{(\text{file size in units})}$$

- If you know three of the four values, you can calculate the missing one
- This is just rearranging the formula the same way you do in Maths and Science.

Worked Example

An image has a file size of 454 kibibytes, its height is 800 pixels and its width is 600 pixels.

- Construct an expression to calculate the colour depth of the image.

$$\frac{(800 \times 600 \times colour)}{(1024 \times 8)}$$

colour depth = file size / width × height

Rearranged:

$$\frac{(454 \times 8 \times 1024)}{(800 \times 600)}$$

Calculating file size of an audio file

- Just like image representation, we can calculate the size of an audio file based on its characteristics.

$$\text{file size} = \text{sample rate} \times \text{bit depth} \times \text{time}$$

- Just like image representation, we can also calculate any one unknown, if we know the other three

- Remember to use the correct units.

Worked Example

Construct an expression to show the size of a sound file, in KiB, with a sample rate of 44.1kHz, a bit depth of 16, and a duration of 90 seconds.

file size = sample rate × bit depth × time

$$\text{size} = \frac{(44100 \times 16 \times 90)}{(8 \times 1024)}$$

Worked Example

The sample rate of a file is 10 kHz. Its file size is 3 MiB and its bit depth is 16 bits.

Construct an expression to calculate how long the sound will play.

Time = file size / (sample rate × bit depth)

$$\text{Time} = \frac{(3 \times 8 \times 1024 \times 1024)}{10 \times 16}$$