IGCSE COMPUTER SCIENCE • EXERCISE SHEET

1.2 Text, sound and images

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS resolution 分辨率 • colour depth 颜色深度 • unicode 统一码 • sample resolution 采样分辨率 • sample rate 采样率

Objective

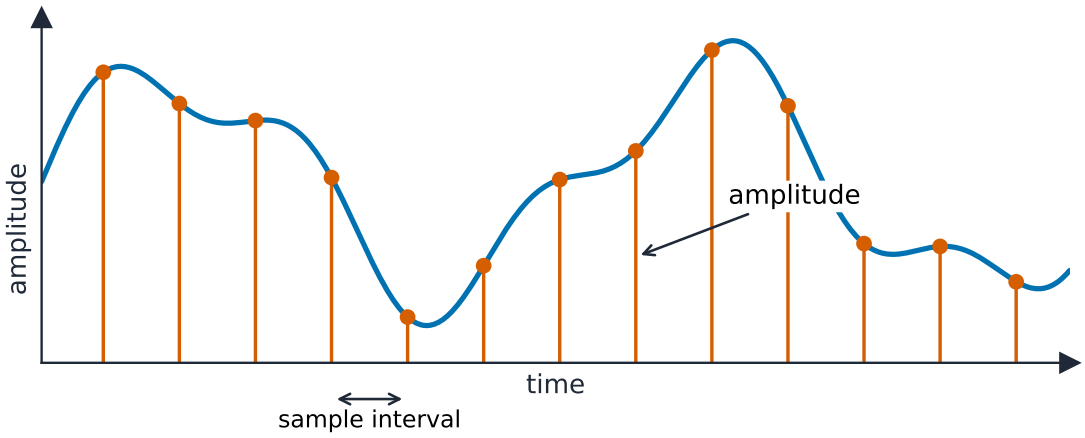
Build the skills to answer exam questions on **text, sound and images** 文本、声音与图像 — character sets, **sampling** 采样, pixels, and file-size calculations.

You must be able to:

- compare ASCII and Unicode
- define sample rate, sample resolution, resolution and colour depth
- calculate image and sound file sizes

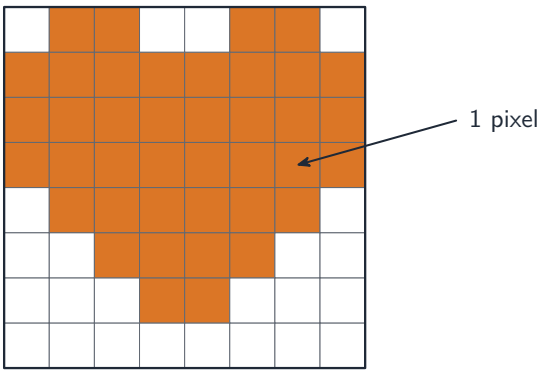
1 Worked examples

Sampling and pixels



sample rate = samples/s · Nyquist $\geq 2f_{max}$

Sampling records the wave's height (amplitude) at regular moments



An image is a grid of pixels; resolution = number of pixels, colour depth = bits per pixel

- **image bits** = width × height × colour depth. **sound bits** = sample rate × resolution × seconds.

Text, sound and images: the same three questions

For every kind of data the exam asks the same things: how is it represented, what makes the file bigger, and what is the trade-off?

Text. Each character has a code. **ASCII** uses 7 bits, giving 128 characters, which is enough for English but not for other alphabets. **Unicode** 统一码 uses more bits per character (16 or more), so it covers every writing system, emoji included, but the same text takes more storage.

Sound. The wave is **sampled**: its amplitude is measured at regular intervals.

- **Sampling rate** 采样率 is the number of samples each second (in Hz or kHz). A higher rate follows the wave more closely, giving better quality and a larger file.
- **Sample resolution** 采样分辨率 (bit depth) is the number of bits used per sample. More bits record the amplitude more accurately, again improving quality and increasing the file size.

$$\text{file size (bits)} = \text{sampling rate} \times \text{sample resolution} \times \text{seconds} \times \text{channels}$$

Worked example. A 30-second mono recording is sampled at 44 100 Hz with a resolution of 16 bits. Size = $44\,100 \times 16 \times 30 = 21\,168\,000$ bits = 2 646 000 bytes ≈ 2.6 MB. (Divide bits by 8 for bytes, then by 1024 for kibibytes, then by 1024 again for mebibytes.)

Images. A bitmap is a grid of **pixels** 像素.

- **Resolution** is the number of pixels, for example 1920 × 1080.
- **Colour depth** 颜色深度 is the number of bits per pixel; n bits give 2^n colours, so 8 bits give 256 colours and 24 bits give over 16 million.

$$\text{file size (bits)} = \text{width} \times \text{height} \times \text{colour depth}$$

Worked example. An image of 800×600 pixels with a colour depth of 24 bits: $800 \times 600 \times 24 = 11\,520\,000$ bits $= 1\,440\,000$ bytes ≈ 1.4 MB. Doubling the colour depth doubles the file size; doubling both width and height multiplies it by four.

2 Practice

2.1 State the difference between ASCII and Unicode. [2]

2.2 Define sample rate. [1]

2.3 Give one advantage and one disadvantage of Unicode compared with ASCII. [2]

2.4 Calculate the file size, in bytes, of a 10-second mono sound recording sampled at 8000 Hz with a resolution of 8 bits. [3]

2.5 State what happens to the file size of an image if its colour depth is increased from 8 bits to 16 bits. [1]

3 Exam-style questions

3.1 Increasing the colour depth of an image will: [1]

- **A** reduce the file size
- **B** increase the file size and quality
- **C** have no effect
- **D** reduce the resolution

3.2 An image is 200 × 100 pixels with a colour depth of 8 bits.

(a) Calculate the file size in bits. [2]

(b) Convert your answer to bytes. [1]

3.3 A sound is recorded for 20 seconds at a sample rate of 10 000 Hz with a sample resolution of 8 bits. Calculate the file size in bits. [2]

3.3 A student records a podcast and takes a photograph for its cover.

(a) Explain what is meant by sampling rate and by sample resolution. [2]

(b) The recording lasts 60 seconds, is mono, is sampled at 22 050 Hz and uses a resolution of 16 bits. Calculate the file size in mebibytes. [4]

(c) The student halves the sampling rate. State the effect on the file size and on the sound quality. [2]

(d) The cover photograph is 1200 × 900 pixels with a colour depth of 24 bits. Calculate its file size in mebibytes. [3]

(e) Explain why a colour depth of 24 bits allows over 16 million different colours. [2]

(f) The student's text file of show notes contains Chinese characters. Explain why it must use Unicode rather than ASCII. [2]

Solutions

2.1 ASCII uses fewer bits (7) and fewer characters; Unicode uses more bits and can represent many more characters/languages.

2.2 the number of samples taken each second.

3.1 B. A greater colour depth increases the file size (and quality).

3.2 (a) $200 \times 100 \times 8 = 160\,000$ bits.
(b) $160\,000 \div 8 = 20\,000$ bytes.

3.3 $10\,000 \times 8 \times 20 = 1\,600\,000$ bits.

2.3 Advantage: Unicode represents the characters of every writing system, not just English. Disadvantage: it uses more bits per character, so the same text takes more storage.

2.4 $8000 \times 8 \times 10 = 640\,000$ bits; $640\,000 \div 8 = 80\,000$ bytes.

2.5 It doubles.

3.3 (a) The sampling rate is the number of samples taken each second; the sample resolution is the number of bits used to store each sample.
(b) $22\,050 \times 16 \times 60 = 21\,168\,000$ bits; $\div 8 = 2\,646\,000$ bytes; $\div 1024 \div 1024 = 2.52$ MiB.
(c) The file size halves; the quality falls, because the samples follow the shape of the original wave less closely.
(d) $1200 \times 900 \times 24 = 25\,920\,000$ bits; $\div 8 = 3\,240\,000$ bytes; $\div 1024 \div 1024 = 3.09$ MiB.
(e) Each pixel has 24 bits, and each bit has two possible values; the number of combinations is $2^{24} = 16\,777\,216$.
(f) ASCII has only 128 codes, which cover the English alphabet, digits and punctuation but no Chinese characters; Unicode uses more bits per character, so it has enough codes for every writing system, including Chinese.