A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

1.2 Multimedia

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

Objective

Build the skills to answer exam questions on **multimedia** 多媒体—how bitmap images and sound are stored, how to calculate their **file size** 文件大小, and when to use a bitmap or a vector graphic.

You must be able to:

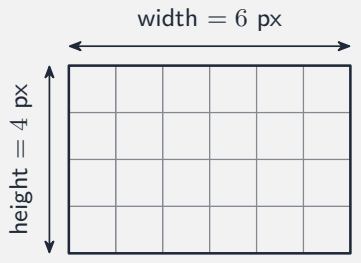
- describe how a **bitmap** 位图 image is encoded, and calculate its file size
- explain how **resolution** 分辨率 and **colour depth** 颜色深度 affect quality and size
- describe how a **vector graphic** 矢量图形 is encoded, and choose bitmap *or* vector for a task
- describe how sound is **sampled** 采样, and how the sampling rate and resolution affect quality and size

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ Bitmap images and file size

A **bitmap** image stores the colour of every **pixel** 像素 in a grid. Two numbers describe it: the **resolution** (width × height in pixels) and the **colour depth** (bits per pixel). Multiply all three to get the size in bits.



pixels = $6 \times 4 = 24$

size = $24 \times \mathbf{8} = \mathbf{192}$ bits

(**8** = colour depth, bits per pixel)

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

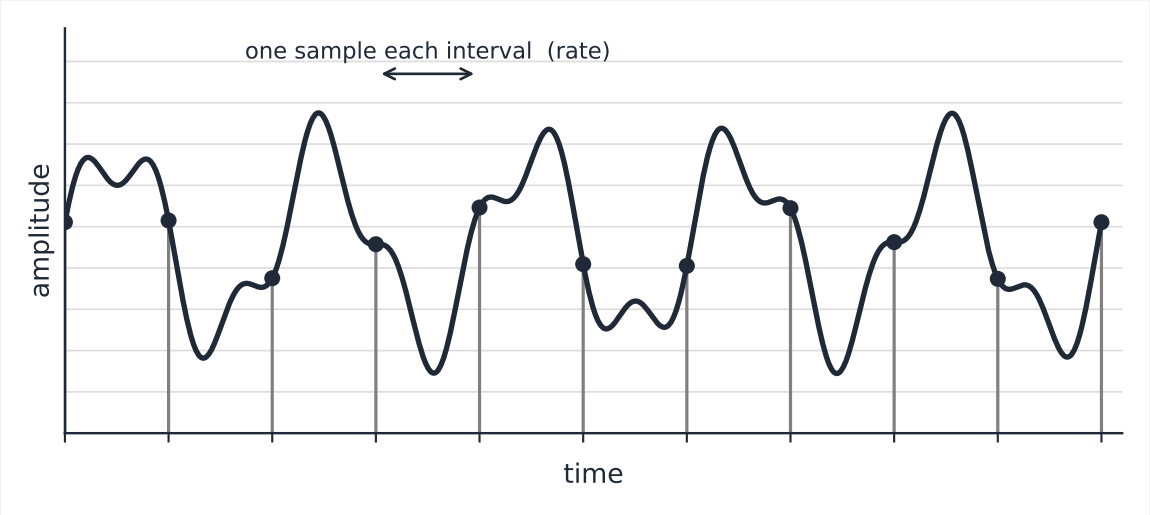
Then ÷ 8 for **bytes**, ÷ 1024 for **KiB**, ÷ 1024 again for **MiB**.

Example. A 200×150 image at 8 bits per pixel:

$$200 \times 150 \times 8 = 240\,000 \text{ bits} = 30\,000 \text{ bytes} = \frac{30\,000}{1024} \approx 29.3 \text{ KiB}.$$

Sound and file size

Sound is **sampled**: the wave's height (**amplitude** 振幅) is measured at regular time intervals. The **sampling rate** 采样率 is how many samples per second (Hz); the **resolution** is how many bits store each sample.



The faint horizontal lines are the amplitude levels —more bits of resolution means more levels and finer detail.

$$\text{size (bits)} = \text{sampling rate} \times \text{resolution} \times \text{duration} \times \text{channels}$$

Example. A 5-second **mono** (1 channel) clip at 8000 Hz, 16-bit resolution:

$$8000 \times 16 \times 5 \times 1 = 640\,000 \text{ bits} = 80\,000 \text{ bytes} \approx 78.1 \text{ KiB}.$$

Bitmap or vector?

A **vector graphic** stores the *instructions* to draw the image —geometric shapes (lines, curves, circles, polygons), each with attributes like position, size, colour and line width. The program draws ("renders") them at whatever size is needed, so a vector **scales without losing quality**. It cannot, however, capture the detail of a photograph.

Task	Better choice	Why
Photograph	**bitmap**	per-pixel detail can't be described as shapes
Logo, icon, road sign	**vector**	sharp at any size; small file
Engineering drawing	**vector**	exact geometry, scales precisely

2 Practice

Now apply the methods above.

2.1 State what **colour depth** means, and write the formula for a bitmap's file size. [2]

2.2 Calculate the file size of a 1024×768 bitmap at 8 bits per pixel. Give your answer in **KiB**, showing your working. [3]

2.3 A 30-second **mono** sound clip is sampled at 16 kHz (16 000 Hz) with 8-bit resolution. Calculate its file size in **KiB**. [3]

2.4 Give one reason a **vector** graphic is a good choice for a company logo. [1]

3 Exam-style questions

3.1 A photo is 1920×1080 pixels with a colour depth of 24 bits.

(a) Calculate the file size in **MiB**. Show your working. [3]

(b) State **one** change to the image that would reduce its file size, and explain its effect on quality. [2]

3.2 A 3-minute song is recorded in **stereo** (2 channels), sampled at 44.1 kHz with 16-bit resolution.

(a) Calculate the file size in **MiB**. Show your working. [3]

(b) Explain the effect on the recording of **halving** the sampling rate. [2]

3.3 (a) State **two** pieces of data a vector graphic would store to describe a single circle. [2]

(b) A museum scans old paintings to put online. Justify whether a bitmap or a vector format is the better choice. [2]

3.4 Explain why a bitmap logo looks blocky when it is enlarged, but a vector logo stays sharp. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **1.2 Multimedia** past-paper sheet in the Library, or try these in **Practice mode**:

- 9618/11 J24 —Q2 (bitmap and sound file-size calculations)
- 9618/12 J24 —Q2 (bitmap and sound file-size calculations)
- 9618/13 N24 —Q6 (image and sound representation)

- 9618/13 N24 —Q9 (file-size calculations)

Solutions

2.1 Colour depth = the number of **bits used per pixel**. Size = width × height × colour depth.

2.2 $1024 \times 768 \times 8 = 6\,291\,456$ bits; $\div 8 = 786\,432$ bytes, $\div 1024 =$ **768 KiB**.

2.3 $16\,000 \times 8 \times 30 \times 1 = 3\,840\,000$ bits; $\div 8 = 480\,000$ bytes, $\div 1024 =$ **468.75 KiB**.

2.4 e.g. it stays **sharp at any size** (a logo is used large and small) / the file is small.

3.1 (a) $1920 \times 1080 \times 24 = 49\,766\,400$ bits; $\div 8 \div 1024 \div 1024 \approx$ **5.93 MiB**.
(b) e.g. **lower the colour depth** (or resolution) → smaller file, but fewer colours / less detail.

3.2 (a) $44\,100 \times 16 \times 180 \times 2 = 254\,016\,000$ bits; $\div 8 \div 1024 \div 1024 \approx$ **30.28 MiB**.
(b) Fewer samples per second: the file is roughly **half the size**, but high-pitched sounds are lost / quality drops.

3.3 (a) Any two of: centre position (x, y); radius; line/fill colour; line width.
(b) **Bitmap** —a painting has continuous, per-pixel tonal detail that cannot be described as a few shapes.

3.4 A bitmap has a fixed number of pixels; enlarging it makes each pixel bigger, so the squares show. A vector stores shapes and is **re-drawn** at the new size, so edges stay smooth.