A-LEVEL COMPUTER SCIENCE • EXERCISE SHEET

1.3 Compression

Name: _____ Class: _____ Date: _____ **Total: 35 marks**

KEY WORDS compression 压缩 • lossy 有损 • lossless 无损 • run-length encoding 行程编码 • bitmap 位图

Objective

Build the skills to answer exam questions on **compression** 压缩 — why it is used, the difference between lossless and lossy, and how text, images and sound are compressed.

You must be able to:

- explain the **need** for compression (storage and **bandwidth** 带宽)
- explain the difference between **lossless** 无损 and **lossy** 有损 compression, and justify which to use
- describe how a text file, bitmap image, vector graphic and sound file can be compressed

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.

■ Lossless or lossy?

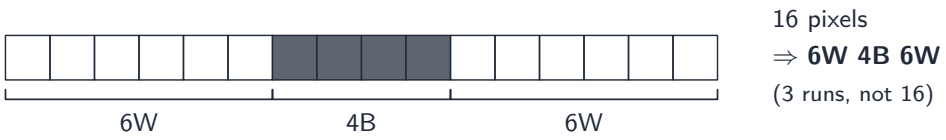
Compression makes a file smaller, so it needs less storage and less bandwidth to send. There are two kinds — the key question in the exam is *which one is suitable and why.*

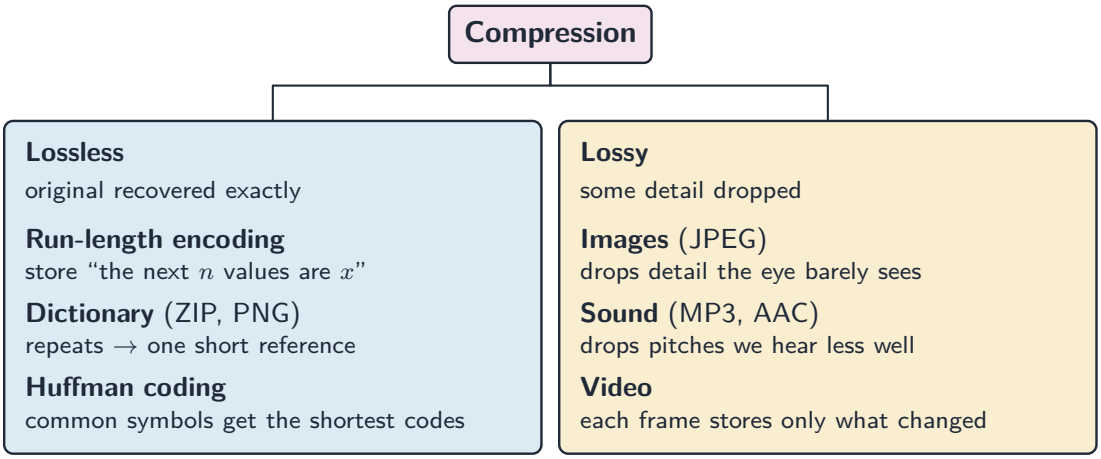
	keeps every bit?	smaller file?	use for	examples
lossless	yes — exact original back	smaller	text, code, data that must stay exact	ZIP, PNG
lossy	no — drops fine detail	much smaller	photos, music, video	JPEG, MP3

So: choose **lossless** when the data must be recovered exactly; choose **lossy** when a much smaller file matters more than perfect detail (e.g. streaming).

Run-length encoding (a lossless method)

Run-length encoding 行程编码 (RLE) stores each *run* of identical values as a (count, value) pair, instead of repeating the value. It shrinks large flat areas a lot, but does nothing for noisy data (where runs are length 1).





Lossless versus lossy compression methods

Compressing text and sound

- **Text (lossless):** a **dictionary** method (ZIP) replaces repeated sequences of characters with a short reference; **Huffman coding** gives the most frequent characters the shortest codes.
- **Sound (lossy, e.g. MP3):** drop pitches the ear barely hears, and quiet sounds masked by louder ones — much smaller, slight quality loss.
- **Video (lossy): spatial** compression shrinks each frame (like JPEG); **temporal** compression stores only what *changed* from the previous frame.

2 Practice

Now apply the methods above.

2.1 State the difference between **lossless** and **lossy** compression. [2]

2.2 Give one situation that needs **lossless** compression and one suited to **lossy** compression, with a reason for each. [2]

2.3 Write the run-length encoding of this pixel row: **W W W W W B B B W** (W = white, B = black). [2]

2.4 State why run-length encoding gives almost no saving on a detailed photograph. [1]

3 Exam-style questions

3.1 A website streams live video. Explain why **lossy** compression is used rather than lossless. [3]

3.2 (a) Describe how run-length encoding compresses a black-and-white bitmap image. [2]

(b) State one kind of image for which run-length encoding gives a large saving. [1]

3.3 Explain how a text file can be compressed **without losing any data**. [2]

3.4 A music app streams songs to phones.

(a) Justify the use of lossy compression for the songs. [2]

(b) State one drawback of using lossy compression here. [1]

3.5 Describe the difference between **spatial** and **temporal** compression in a video file. [3]

3.6 A messaging app compresses the media its users send, and checks every message for transmission errors.

(a) A sound clip is compressed by **reducing the sampling rate**. **Explain** the effect on the file size and on the quality, and **state** which type of compression this is. [3]

(b) A photograph is compressed with a **lossless** method instead. **Explain** why the app might choose lossless for a scanned document but lossy for a holiday photograph. [3]

(c) The system uses **even parity**. **Complete** each byte by writing the missing parity bit in the space provided. [2]

seven data bits	parity bit
1011010	_____
1110111	_____

(d) The app also uses a **parity block check** with even parity. **Complete** the missing row and column. [3]

	b1	b2	b3	b4	parity
byte 1	1	0	1	1	_____
byte 2	0	1	1	0	_____
byte 3	1	1	0	1	_____
parity byte	_____	_____	_____	_____	

(e) **Explain** why a parity **block** check can locate a single flipped bit, while a parity **byte** check can only detect that something is wrong. [3]