Tiverton High School Year 11
J277 GCSE Computer Science
Knowledge Organiser / Recap
Part 2: Number Bases and Data Representation

Unit 1-2-3 Number Bases

Binary means base-2 **Denary means base-10** **Hexadecimal means base-16**

Humans traditionally use **denary (base 10)** when dealing with numbers.
Computers always use **binary (base 2)** to store and process digital data.

Electronic computers contain millions of tiny **transistor** components. A transistor behaves like a **switch**, that can only be turned **on** or **off**.

Because binary only uses two possible digits, these closely match the on/off states of the transistors that computers are made of.
The **on** or **off states** of transistors can be used to represent the two different number symbols that binary uses:

off means **0**
on means **1**

Unit 1-2-4 Converting Binary to Denary

128	64	32	16	8	4	2	1
0	1	0	0	1	0	1	0

= (**1** x 64) + (**1** x 8) + (**1** x 2) = **74** in base ten

Unit 1-2-4 Converting Binary to Hexadecimal

Convert binary value **01011101** to hexadecimal

0101 **1101**

8	4	2	1
0	1	0	1

= (**1** x 4) + (**1** x 1)
= **5** in base ten
= **5** in hexadecimal

8	4	2	1
1	1	0	1

= (**1** x 8) + (**1** x 4) + (**1** x 1)
= **13** in base ten
= letter **D** in hexadecimal

So binary value **01011101** is **5D in hexadecimal**

Unit 1-2-4 Converting Hexadecimal to Denary

Hexadecimal is a more **compact** and **convenient** way to represent large numbers than binary.

Large numbers can be represented using **fewer** hexadecimal digits.

Hexadecimal numbers can only uses the symbols **0123456789ABCDEF**

A means **10**
B means **11**
C means **12**
D means **13**
E means **14**
F means **15**

16	1
2	**D**

2 groups of 16, plus **D** units.
(**2** x 16) + (**D** x 1)
(**2** x 16) + (**13** x 1)
32 + 13
45 in base 10.

Unit 1-2-4 How Computers Store Text

A **character** is a **symbol** that can be represented and stored by the computer system.
The full collection of ALL of the characters that a computer can represent/store is called a **character set**.
Each character symbol is represented using a **special number**: a **character code**.
All character codes are always stored inside the computer as patterns of **binary digits**.

ASCII is the **American Standard Code for Information Interchange**. It can be used for writing in the English language.
Plain **ASCII** text is often stored using **7 bits per character**.

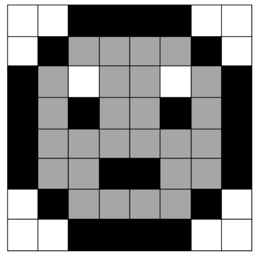
Unicode is a better character set. It can represent **any** language in the world, including Russian and Chinese, not just English.
Unicode uses **up to 32 bits (4 bytes)** to store each character code.

中文 р у с с к и й 日本語 ☺

Emoji pictures are character symbols from the Unicode character set. ASCII and Extended-ASCII do not contain any emojis.

The same English text can be stored more efficiently using ASCII rather than Unicode (because each character code only uses 7 bits).

Unit 1-2-4 How computers Store Images



Bitmap images are **pictures** that are made up of **pixels** (picture elements).

A **pixel** is a small coloured dot in a picture.

All of the pixels are arranged in a grid, a little bit like a mosaic.

The **colour** of each pixel is stored in the memory of the computer using binary digits... **1**s and **0**s.

The **bit-depth** of an image means **how many binary digits are used to store each pixel**.

A **1-bit image** uses exactly **1 bit to store each pixel** in the picture. This allows **2 possible colours**.
A **2-bit image** uses exactly **2 bits to store each pixel** in the picture. This allows **4 possible colours**.
An **8-bit image** uses exactly **8 bits to store each pixel** in the picture. This allows **256 possible colours**.

Photoshop uses **24-bit images**. It uses **24 bits to store each pixel**. This allows **16,777,216 possible colours** for **realistic** pictures.

The **resolution** of an image defines how large the individual pixels are drawn.

Resolution means the **density** of the pixels in an image: **how many pixels will fit into a certain area**.
The higher the resolution, the more life-like the image/better quality, but the more data will be included in the bitmap file.

Most computer **screens** use **72 dots per inch** - large pixels.
Many **printers** use **150 dots per inch** or **300 dots per inch** - the smaller pixels produce a more **detailed** picture on paper.

Many image files contain **extra data**, as well as the pixel data. The extra data is called **meta-data**.

Meta-data can be used by programs to **reconstruct** and display images from a file of binary data.
It includes the **width**, the **height**, the **resolution** and the **bit-depth** of the image.

Extra meta-data can also be included in an image file, such as the **file format**, the **date/time it was created or last changed**, **who owns the copyright** and the **GPS coordinates of where a photo was taken**.

Unit 1-2-4 How Computer Store Audio - Sounds and Music

To represent audio/sound inside a computer, soundwaves are converted to **digital data**.

First of all, a sound wave must be captured by a microphone as **analogue electrical signals**.

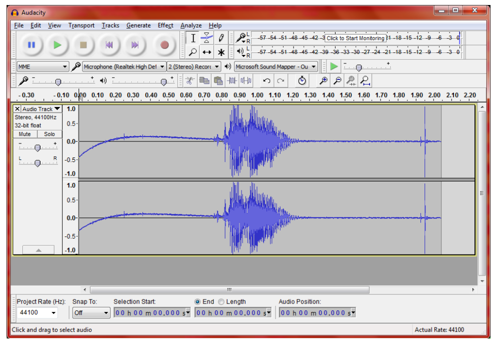
The **height of the sound wave** can then be **measured** at **regular intervals**. We call each measurement a **sample**.

The **number of sample measurements that are generated each second** is called the **sample-rate**. This is specified in **Hertz (Hz)**.

Each sample/measurement is stored in the computer using a binary number.
The **number of binary digits used in each sample** is called the **sample-size**.

A realistic audio file will need to use thousands of samples a second. Common sample rates include **22050 Hz** or **44100 Hz**.
A **higher sample rate** leads to a **larger audio-file**, but a **better-quality recording**.
A **larger sample size** allows more higher frequencies and lower frequencies to be captured, not just mid-frequencies.

To reconstruct a sound from binary data, an audio file needs to contain extra **meta-data** that describes how the binary data is structured and how to play it back:



Duration of the sound (how many **seconds** the recording lasts).

Sample-Rate (**how many samples were used each second** e.g. **8000 Hz**).

Sample-Size (**how many bits each sample contains** e.g. **32 bits**).

Channels (**how many speakers are needed** e.g. **1 for mono**, **2 for stereo**).

Date & time that the audio file was **created or last changed**.

Author, **genre** or **copyright information** about **who** created the recording.