**Topic: Binary represents data**

Reading Time: 20 mins

**·        Note\* Highlight important/core points while reading**

·        Read the content and write the answers given in the document in your words, to get the solid grip on topic.

**How Binary Represents Data in a Computer**

Computers use the **binary number system** to represent and process data. Binary is a base-2 numbering system that consists of only two digits: **0 and 1**. These two values correspond to the basic electrical states of a computer’s hardware:

* **0 represents OFF (low voltage)**
* **1 represents ON (high voltage)**

Since computers are made up of billions of tiny electronic switches (transistors), they can only understand and process data in binary form. All types of data—including numbers, text, images, and sound—must be converted into binary before a computer can process them.

**How Binary Works in Different Data Types**

1. **Binary Representation of Numbers**
   * Computers use **place values** based on powers of **2** to store numbers.
   * Example: The decimal number **13** is represented in binary as **1101**
     + (1 × 2³) + (1 × 2²) + (0 × 2¹) + (1 × 2⁰)
     + (8 + 4 + 0 + 1) = 13
2. **Binary Representation of Text (ASCII & Unicode)**
   * Each letter or character is assigned a unique binary code using **ASCII** (American Standard Code for Information Interchange) or **Unicode**.
   * Example: The letter **A** in ASCII is represented as **01000001** (Binary for 65 in Decimal).
3. **Binary Representation of Images**
   * Images are made up of small squares called **pixels**. Each pixel is assigned a binary value representing its **color**.
   * In **black & white images**, 1 bit is used per pixel:
     + **0** = Black
     + **1** = White
   * In **color images**, more bits are used to represent different colors using formats like **RGB (Red, Green, Blue)**.
4. **Binary Representation of Sound**
   * Sound waves are converted into digital signals using **sampling**.
   * The sound is recorded at intervals (samples), and each sample is stored as a binary number.
   * Higher **sampling rates** and **bit depth** improve sound quality.

**A-Rated Questions/Answers By Examiner**

**Q1: Why do computers use the binary number system instead of decimal?**  
**Answer:** Computers use the binary system because their hardware consists of electronic circuits that have two states: ON (1) and OFF (0). These two states can easily represent binary digits.

**Q2: Convert the decimal number 25 into an 8-bit binary number.**  
**Answer:**

* 25 in decimal = **11001** in binary
* In 8-bit format: **00011001**

**Q3: How is text represented in binary?**  
**Answer:** Text is represented using character encoding systems such as **ASCII** and **Unicode**. Each character is assigned a unique binary code. For example, in ASCII, the letter **C** is represented as **01000011**.

**Q4: What is the difference between an analogue and a digital signal?**  
**Answer:**

* **Analogue signals** are continuous and vary smoothly over time (e.g., sound waves).
* **Digital signals** are discrete and represented using binary numbers (0s and 1s).

**Q5: How does increasing the bit depth in sound representation affect quality?**  
**Answer:** Increasing the **bit depth** allows more precise storage of sound amplitude, reducing distortion and improving audio quality. For example, **16-bit sound** is clearer than **8-bit sound** because it captures more levels of volume.

### Write your Answers on your Notebook and Verify it on Next Screen

**Q6: What is a pixel, and how is it represented in binary?**

**Q7: Convert the binary number 101011 into decimal.**

**Q8: How is sound represented in binary inside a computer?**

**Q9: What is Unicode, and why is it important?**

**Q10: Why do computers need to convert decimal numbers into binary?**

**6. Answer:**

* A **pixel** is the smallest unit of a digital image.
* Each pixel is represented using **binary numbers**.
* In **black & white images**, 1 bit per pixel is used (0 = Black, 1 = White).
* In **color images**, multiple bits are used to represent different colors (e.g., 24-bit RGB uses 8 bits for Red, Green, and Blue).

**7. Answer: Binary: 101011**

* **Calculation:**

(1 × 2^5) + (0 × 2^4) + (1 × 2^3) + (0 × 2^2) + (1 × 2^1) + (1 × 2^0)

(32+0+8+0+2+1)=43

* **Decimal Equivalent: 43**

**8. Answer:**

* Sound is recorded in digital form using **sampling**.
* The sound wave is measured at regular intervals (**sampling rate**).
* Each sample is converted into a **binary number** that represents its amplitude.
* Higher **bit depth** and **sampling rate** result in higher sound quality.

**9. Answer:**

* **Unicode** is a character encoding system that assigns a **unique binary code** to every character, including symbols and letters from different languages.
* It is important because:
  + It supports **multiple languages** worldwide.
  + It allows **special characters** (e.g., emojis 😊, mathematical symbols √).
  + It extends ASCII (which only supports English characters).

**10. Answer:**

* Computers **only understand binary (0s and 1s)** because their hardware consists of transistors that can be **ON (1) or OFF (0)**.
* Decimal numbers must be converted into binary for **processing, calculations, and storage**.
* Example: The decimal number **12** is represented in binary as **1100**.