

4.2 Convert positional numbers and calculate in binary

Name: _____ Class: _____ Date: _____ Total: 24 marks

KEY WORDS number base 进制 • binary 二进制 • hexadecimal 十六进制

Objective

Convert positional numbers and calculate in binary. Original GAC004-aligned practice, not an official assessment. Show the method as well as the result. All applied scenarios are invented classroom problems.

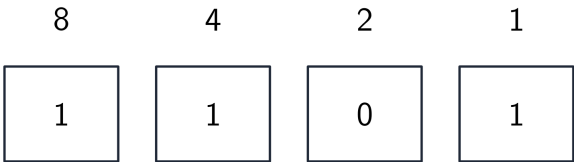
1 Key knowledge and worked examples

■ Key knowledge: a numeral must be read in its stated base

A positional **number base** 进制 b uses digits from zero to b minus one and place weights b^0, b^1, b^2 and so on. **Binary** 二进制 uses digits 0 and 1; **hexadecimal** 十六进制 uses 0 to 9 and A to F. Four bits correspond to one hexadecimal digit, including leading zeros where width matters.

Binary addition carries at 2. State whether a result is an unrestricted mathematical numeral or must fit a fixed-width representation. An unsigned n -bit pattern represents values from zero to $2^n - 1$. A carry beyond a fixed width may indicate overflow; it must not be silently retained or discarded without stating the convention.

■ Worked example: place weights determine the decimal value



place weights above binary digits

Known numeral 1101₂. Use weights from right to left: 1, 2, 4 and 8.

$$V = \sum d_i 2^i$$

$$V = 1(8) + 1(4) + 0(2) + 1(1) = 13$$

The same value is D in hexadecimal. Leading zeros would not change this nonnegative value but can record an intended width.

2 Practice

2.1 Convert 10110₂ to decimal. [2]

2.2 Write decimal 13 as an unsigned four-bit binary pattern. [2]

2.3 Convert 2F₁₆ to decimal and to an eight-bit binary pattern. [3]

2.4 Calculate $1011_2 + 0110_2$ as an unrestricted binary numeral. Then state whether it fits in four unsigned bits. [3]

3 Exam-style questions

3.1 (a) Write decimal 45 as an unsigned eight-bit pattern and hexadecimal numeral. (b) Subtract 00101101_2 from 01000000_2 as nonnegative integers. Give the result as eight bits and decimal. [6]

3.2 An unsigned eight-bit counter starts at 11111010_2 . A calculation adds decimal 10. (a) Find the initial decimal value and the unrestricted sum. (b) Write the unrestricted sum in binary. (c) Decide whether it fits the counter. (d) Under a separately specified wraparound rule that keeps only the lowest eight bits, find the stored pattern and decimal value. Explain why the stored value differs from the mathematical sum. [8]