

Bits & data

C Reference

Bits, binary & bitwise operators

A bit 位 is a single 0 or 1; numbers are stored in binary 二进制. Bitwise 按位 operators work on the bits directly: & AND, | OR, ^ XOR, << shift left ($\times 2$ each step), >> shift right ($\div 2$).

```
#include <stdio.h>

int main(void) {
    int a = 12;           // 1100
    int b = 10;           // 1010
    printf("%d\n", a & b); // 8   AND   -> 1000
    printf("%d\n", a | b); // 14  OR    -> 1110
    printf("%d\n", a ^ b); // 6   XOR   -> 0110
    printf("%d\n", a << 1); // 24  left  shift
    printf("%d\n", a >> 1); // 6   right shift
    return 0;
}
```

Hexadecimal 十六进制 (base 16) writes binary compactly: one hex digit is exactly four bits. Write hex literals with 0x; print with %x:

```
#include <stdio.h>

int main(void) {
    printf("%d\n", 0xFF); // 255  (0x marks a hex literal)
    printf("%x\n", 255);  // ff
    printf("%x\n", 12);   // c
    return 0;
}
```



Exam tip: bitwise ops work on bits of integers; << multiplies by 2, >> divides by 2

Bitwise operators work on the bits of integers

Run-length encoding

Run-length encoding (RLE) is a simple compression 压缩 method: replace each run 游程 of repeated characters with a count and the character. It is lossless 无损 — the original is fully recoverable.

```
#include <stdio.h>
#include <string.h>

int main(void) {
    char *s = "aaabbc";
    int n = strlen(s);
    for (int i = 0; i < n; ) {
        char c = s[i];
        int run = 0;
        while (i < n && s[i] == c) { run++; i++; }
        printf("%d%c", run, c);    // 3a2b1c
    }
    printf("\n");
    return 0;
}
```

Common mistakes

- & is bitwise AND and && is logical AND — do not confuse them.
- A left shift << 1 doubles a value; a right shift >> 1 halves it.
- Bit n has value 1 << n (C has no ** power operator); check a bit with (x >> n) & 1.