

1.4 Write the number 45.0 in the following forms (in part (c), follow the IEEE-754 standard):
 (a) Binary form. (b) Base 2 floating point representation. (c) 32-bit single-precision string.

Solution

(a) To convert 45 to binary form, first find the largest power of 2 that can be divided into 45. This is $2^5 = 32$. Note that $2^6 = 64$, which is larger than 45. Next, subtract $45 - 2^5 = 13$. Now, find the largest power of 2 that will divide into 13, without exceeding it. This would be $2^3 = 8$. Subtract $13 - 2^3 = 5$, and so on. Thus,

$$\begin{aligned} 45 &= 32 + 8 + 4 + 1 = 1 \times 2^5 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^0 \\ &= 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 101101 \end{aligned}$$

Thus, the number 45 in binary form is 101101.

(b) From part (a), the largest power of two that divides into 45 is 2^5 . The binary floating point representation is obtained as follows:

$$\frac{45}{2^5} \times 2^5 = \frac{45}{32} \times 2^5 = 1.40625 \times 2^5$$

(c) According to the IEEE-754 standard, 81 in single precision form is as follows:

- Since the number is positive, the first bit is 0.
- From part (b), the exponent is 5. Adding a bias of 127, the value of the exponent that must be stored is $5 + 127 = 132$. The number 132 in binary form is $132 = 1 \times 2^7 + 1 \times 2^2 = 128 + 4$. Thus the number 132 in binary form is 10000110. In single precision, 8 bits can be used to store the exponent so that 132 is stored as 10000101 without the need for rounding or chopping.
- Next, the mantissa 0.40625 is converted to binary form: $1 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-5}$ or 0.01101
- Since 23 bits are allocated for the mantissa, the binary number stored is 01101000000000000000000.

Thus, the number 45 in single precision is stored as: **|0|10000110|01101000000000000000000|**

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