

Converting Between Binary and Decimal Number Systems

Try to complete these four conversions on your own. Solutions are presented below.

1. Given 25_{10} (base 10 or decimal), what is the equivalent binary (base two) number?
2. Given 37_{10} (base 10 or decimal), what is the equivalent binary (base two) number?
3. Given 110011_2 (base 2 or binary), what is the equivalent decimal (base ten) number?
4. Given 010110_2 (base 2 or binary), what is the equivalent decimal (base ten) number?

Solutions

1. The easiest way to convert from decimal to binary is to write out the value for each position and use subtraction to solve the problem.
 - a. 32 is greater than 25; therefore, we cannot use that slot – enter a zero
 - b. 16 is less than 25; therefore, we need that number – enter a one and subtract: $25-16=9$
 - c. 8 is less than 9; therefore, we need that number – enter a one and subtract: $9-8=1$
 - d. 4 is greater than 1; therefore, we cannot use that slot. If we entered a 1 in the slot under 4, we would have $16+8+4 = 28$. 28 does not equal 25; enter a zero
 - e. 2 is greater than 1; enter a zero
 - f. $1 = 1$; enter a one
 - g. To verify our solution $(0*32) + (1*16) + (1*8) + (0*4) + (0*2) + (1*1) = 16+8+1 = 25$
 - h. The solution is 011001

32	16	8	4	2	1
0	1	1	0	0	1

2. Again, write out the value for each position, and then do simple subtraction to solve the problem.
 - a. 32 is less than 37; enter a one and subtract: $37-32=5$
 - b. 16 is greater than 5; enter a zero
 - c. 8 is greater than 5; enter a zero
 - d. 4 is less than 5; enter a one and subtract: $5-4=1$
 - e. 2 is greater than 1; enter a zero
 - f. $1 = 1$; enter a one
 - g. To verify our solution $(1*32)+(0*16)+(0*8)+(1*4)+(0*2)+(1*1) = 32+4+1 = 37$
 - h. The solution is 100101

32	16	8	4	2	1
1	0	0	1	0	1

3. To convert from binary to decimal, write out the value for each position, and perform multiplication and addition.
 - a. We were given 110011

- b. Multiply: $(1 \cdot 32) + (1 \cdot 16) + (0 \cdot 8) + (0 \cdot 4) + (1 \cdot 2) + (1 \cdot 1) = 32 + 16 + 2 + 1$
- c. Add: $32 + 16 + 2 + 1 = 51$
- d. To verify our answer, subtract: $51 - 32 = 19 - 16 = 3 - 2 = 1 - 1 = 0$
- e. The solution is 51

32	16	8	4	2	1
1	1	0	0	1	1

4. Again, to convert from binary to decimal, write out the value for each position, and perform multiplication and addition.
- a. We were given 010110
 - b. Multiply: $(0 \cdot 32) + (1 \cdot 16) + (0 \cdot 8) + (1 \cdot 4) + (1 \cdot 2) + (0 \cdot 1) = 16 + 4 + 2$
 - c. Add: $16 + 4 + 2 = 22$
 - d. To verify our answer, subtract: $22 - 16 = 6 - 4 = 2 - 2 = 0$
 - e. The solution is 22

32	16	8	4	2	1
0	1	0	1	1	0