Number Systems

Answer the following problems related to number systems used in digital circuits.

1. How many different numbers can be represented with 16 bits?

2. What is the largest unsigned 32-bit binary number?

3. What is the largest 16-bit and 32-bit binary numbers that can be represented with
    a. Unsigned numbers

    b. Two's complement numbers

    c. Sign/Magnitude Numbers

4. What is the smallest (most negative) 16-bit and 32-bit binary numbers that can be represented with
    a. Unsigned numbers

    b. Two's complement numbers

    c. Sign/Magnitude Numbers

5. Convert the following unsigned binary numbers to decimal and hexadecimal.
    a. 1010

    b. 110110

    c. 111100000

    d. 0001000101001111

6. Convert the following two's complement numbers to decimal and hexadecimal.
    a. 1110

    b. 100011

    c. 01001110

    d. 10110101

7. Convert the following decimal numbers to unsigned binary and two's complement binary.
    a. 42

    b. 63

    c. 229

    d. 845

8. How many 7-bit two's complement numbers are greater than 0? How many are less than 0? How does your answer differ for sign/magnitude numbers?

9. How many 5-bit two's complement numbers are greater than 0? How many are less than 0? How does your answer differ for sign/magnitude numbers?

10. What is the range of numbers that can be represented by the following number systems?
    a. U12.12 format (24-bit unsigned fixed-point numbers with 12 integer bits and 12 fraction bits)

    b. 24-bit sign/magnitude fixed point numbers with 12 integer bits and 12 fraction bits

    c. Q12.12 (24-bit two's complement fixed-point numbers with 12 integer bits and 12 fraction bits

11. Express the following base 10 numbers in 16-bit fixed-point sign/magnitude format with eight integer bits and eight fraction bits. Express your answer in hexadecimal.
    a. -13.5625

    b. 42.3125

    c. -17.15625

12. Express the following base 10 numbers in 12-bit fixed-point sign/magnitude format with six integer bits and six fraction bits. Express your answer in hexadecimal.
    a. -30.5

    b. 16.25

    c. -8.078125

13. Express the numbers in (3) using Q6.6 format (12-bit fixed-point two's complement format with 6 integer bit and 6 fractional bits).
    a. 30.5

    b. 16.25

    c. -8.078125

14. Convert the following Q4.4 (two's complement binary fixed-point numbers) to base 10. The binary point is shown for clarity.
    a. 0101.1000

    b. 1111.1111

    c. 1000.0000