- To convert a hexadecimal number to a binary number, simply replace each hexadecimal digit with its four-digit binary equivalent.
- Because we are accustomed to working in decimal, it is convenient to convert a binary, octal or hexadecimal number to decimal to get a sense of the number's "real" worth.
- To convert a number to decimal from another base, multiply the decimal equivalent of each digit by its positional value, and sum these products.
- Computers represent negative numbers using two's complement notation.
- To form the negative of a value in binary, first form its one's complement by applying Java's bitwise complement operator (~). This reverses the bits of the value. To form the two's complement of a value, simply add one to the value's one's complement.

TERMINOLOGY

base
base 2 number system
base 8 number system
base 10 number system
base 16 number system
binary number system
bitwise complement operator (~)
conversions
decimal number system
digit
hexadecimal number system
negative value
octal number system
one's complement notation
positional notation
positional value
symbol value
two's complement notation

SELF-REVIEW EXERCISES

E.1 The bases of the decimal, binary, octal, and hexadecimal number systems are __________, __________, __________ and __________ respectively.

E.2 In general, the decimal, octal, and hexadecimal representations of a given binary number contain (more/fewer) digits than the binary number contains.

E.3 (True/False) A popular reason for using the decimal number system is that it forms a convenient notation for abbreviating binary numbers simply by substituting one decimal digit per group of four binary bits.

E.4 The (octal / hexadecimal / decimal) representation of a large binary value is the most concise (of the given alternatives).

E.5 (True/False) The highest digit in any base is one more than the base.

E.6 (True/False) The lowest digit in any base is one less than the base.

E.7 The positional value of the rightmost digit of any number in either binary, octal, decimal, or hexadecimal is always __________.

E.8 The positional value of the digit to the left of the rightmost digit of any number in binary, octal, decimal, or hexadecimal is always equal to __________.

E.9 Fill in the missing values in this chart of positional values for the rightmost four positions in each of the indicated number systems:

decimal	`1000`	`100`	`10`	`1`
hexadecimal	`...`	`256`	`...`	`...`
binary	`...`	`...`	`...`	`...`
octal	`512`	`...`	`8`	`...`

E.10 Convert binary 110101011000 to octal and to hexadecimal.

E.11 Convert hexadecimal FACE to binary.

E.12 Convert octal 7316 to binary.

E.13 Convert hexadecimal 4FEC to octal. (Hint: First convert 4FEC to binary then convert that binary number to octal.)

E.14 Convert binary 1101110 to decimal.

E.15 Convert octal 317 to decimal.

E.16 Convert hexadecimal EFD4 to decimal.

E.17 Convert decimal 177 to binary, to octal, and to hexadecimal.

E.18 Show the binary representation of decimal 417. Then show the one's complement of 417, and the two's complement of 417.

E.19 What is the result when the one's complement of a number is added to itself?

EXERCISES

E.20 Some people argue that many of our calculations would be easier in the base 12 number system because 12 is divisible by so many more numbers than 10 (for base 10). What is the lowest digit in base 12? What might the highest symbol for the digit in base 12 be? What are the positional values of the rightmost four positions of any number in the base 12 number system?

E.21 How is the highest symbol value in the number systems we discussed related to the positional value of the first digit to the left of the rightmost digit of any number in these number systems?

E.22 Complete the following chart of positional values for the rightmost four positions in each of the indicated number systems:

```
decimal1000100 10  1
base 6 ......   6...
base 13 ... 169... ...
base 3  27........
```

E.23 Convert binary 100101111010 to octal and to hexadecimal.

E.24 Convert hexadecimal 3A7D to binary.

E.25 Convert hexadecimal 765F to octal. (Hint: First convert 765F to binary, then convert that binary number to octal.)

E.26 Convert binary 1011110 to decimal.

E.27 Convert octal 426 to decimal.

E.28 Convert hexadecimal FFFF to decimal.

E.29 Convert decimal 299 to binary, to octal, and to hexadecimal.

E.30 Show the binary representation of decimal 779. Then show the one's complement of 779, and the two's complement of 779.

E.31 What is the result when the two's complement of a number is added to itself?

E.32 Show the two's complement of integer value -1 on a machine with 32-bit integers.

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Binary to Decimal Conversion Worksheet

Name:

10101001	=	
00110010	=	
00111000	=	
01100010	=	
11101110	=	
11100001	=	
00101101	=	
00011000	=	
11010110	=	
01110010	=	

Decimal to Binary Conversion Worksheet

Name:

55	=	
147	=	
227	=	
235	=	
217	=	
252	=	
122	=	
105	=	
215	=	
41	=	

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Hexadecimal to Decimal Conversion Worksheet

Name:

11E =	197 =
1B0 =	150 =
198 =	191 =
146 =	1D2 =
73 =	1A2 =
86 =	18D =
71 =	83 =
47 =	1DA =

Number Systems Homework

1. Convert binary 110101011000 to octal and to hexadecimal.

2. Convert hexadecimal FACE to binary.

3. Convert 7316_{10} to binary.

4. Convert hexadecimal 4FEC to octal.

5. Convert binary 1101110 to decimal.

6. Convert octal 317 to decimal.

7. Convert hexadecimal EFD4 to decimal.

8. Convert decimal 177 to binary, octal and hexadecimal.