COS126 Number Systems Activity — Booksite 5.1

Instead of "ones, tens, hundreds, ..." places, binary has "ones, twos, fours, eights, ..." places.

Base	**Digits**	**#digits**	"1000" in this base converted to decimal	"205" in this base converted to decimal
decimal		10	$10^3 = 1000$	$2 \times 10^2 + 0 \times 10^1 + 5 \times 10^0 = 205$
binary			$2^3 = 8$	n/a
hexadecimal	$0, \ldots, 9, A, \ldots, F$	16	$= 4096$	$= 517$ dec.
octal	$0, 1, 2, 3, 4, 5, 6, 7$		$8^3 = 512$	$2 \times 8^2 + 0 \times 8^1 + 5 \times 8^0$ $= 2 \times 64 + 0 \times 8 + 5 \times 1 = 133$ dec.

1. What is the binary integer 101, represented in decimal?

2. What is the binary integer 1010, represented in decimal?
   (How is this related to the previous answer?)

3. What is the binary integer 10100, represented in decimal?
   (What is the pattern?)

4. What is the binary integer 101001, represented in decimal?
   (Could you write a program to use this approach?)

5. What is the decimal integer 126, represented in binary? Use either of two common approaches:

   - Work right to left; start by determining the rightmost bit.

   - Work left to right; start by determining how many bits this binary number will have.

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6. What are the hexadecimal numbers C, D, and E, expressed in binary?

7. Express the hexadecimal number C0DE as a sum of 4 terms corresponding to the 4 digits. What is the value of this expression when converted to binary?

8. What is the binary number 100100110, represented in hexadecimal? (Avoid using decimal.)

9. Optional: what is the value of DEE+24 in hexadecimal? (Avoid using decimal.)

Bitwise Operators (In Q10 thru Q14, all numbers are in binary)

10. What is the binary value of 1010 `|` 110?

11. What is the binary value of 1010 `&` 110?

12. What is the binary value of 1010 << 10?

13. What is the binary value of 1010 >> 10?

14. What is the binary value of 1010 $\wedge$ 110?

15. What is the value, expressed in hexadecimal, of C05126 $\wedge$ CBE245 $\wedge$ C05126? (What is the trick?)

16-bit Two's-Complement Representations

16. What is the complement of 0101 0000 1100 1111?

17. Give the **16-bit two's-complement** binary representation of the decimal integer 126 (Use question 5)

18. Give the 16-bit two's-complement binary representation of the decimal integer -126

19. What is the 16-bit two's-complement **hexadecimal** representation of the decimal integer -126?

20. What is the decimal representation of the 16-bit two's-complement hexadecimal number FFFE?

Challenges (Read Booksite §5.1)

21. What should the binary numbers 0.1 and 0.01 represent?
22. What are the powers of nine in octal? What are the powers of seventeen in hexadecimal?
23. Booksite exercises 5.1.18, 5.1.23, 5.1.25, Booksite creative exercises 5.1.6, 5.1.29