

Exercise 5

Suppose that **A = 45** and **B = -13**, **C = 0** and **D** is a given number.

Notice: The placeholder for A, B, C and D is one byte (8 bits).

D is **unknown** and can be any number in the range of **0** and **255**.

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

1. Convert A, B and C to **binary** and **hexadecimal**

- a. $A = 0b00101101 = 0x2D$
- b. $B = \sim 13 + 1 = \sim 0b00001101 + 0b00000001 = 0b11110011 = 0xF3$
- c. $C = 0b00000000 = 0x00$

2. Calculate A + B, A - B, C - A and B - A.

- a. $A + B = 0b00101101 + 0b11110011 = 0b00100000$
- b. $A - B = 0b00101101 - 0b11110011 = 0b00111010$
- c. $C - A = 0b00000000 - 0b00101101 = 0b11010011$
- d. $B - A = 0b11110011 - 0b00101101 = 0b11000110$

3. Perform the following operations.

- a. $A | B = 0b00101101 | 0b11110011 = 0b11111111$
- b. $A \& B = 0b00101101 \& 0b11110011 = 0b00100001$
- c. $A \wedge B = 0b00101101 \wedge 0b11110011 = 0b11011110$
- d. $A \ll 3 = 0b00101101 \ll 3 = 0b01101000$
- e. $B \gg 2 = 0b11110011 \gg 2 = 0b11111100$
- f. $C \gg 5 = 0b00000000 \gg 5 = 0b00000000$
- g. $(A \ll 3) \gg 3 = (0b00101101 \ll 3) \gg 3 = 0b01101000 \gg 3 = 0b00001101$
- h. $(\sim A \& B) \wedge (\sim C | A) =$
 - i. $(\sim 0b00101101 \& 0b11110011) \wedge (\sim 0b00000000 | 0b00101101) =$
 - ii. $(0b11010010 \& 0b11110011) \wedge (0b11111111 | 0b00101101) =$
 - iii. $0b11010010 \wedge 0b11111111 = 0b00101101$

4. Using bitwise operators and masks

- a. Set the first and last bits of A: $A | 0b10000001 = A | (1 | (1 \ll 7)) = A | 129$
- b. Toggle (Flip) the third bit of B: $B \wedge 0b00000100 = B \wedge (1 \ll 2) = B \wedge 4$

c. Read the value of 3rd and 4th bits of D (D2 and D3)

i. $(0bD_7D_6D_5D_4D_3D_2D_1D_0 \gg 2) \& 0b00000011 =$

ii. $0b00D_7D_6D_5D_4D_3D_2 \& 0b00000011 = 0b000000D_3D_2 = (D \gg 2) \& 3$

d. Change the 3rd and 4th bits of D to 10 (D3 to 1 and D2 to 0)

i. $(D \& 0b11110011) | 0b00001000 = (D \& 243) | 8$

ii. $0b11110011 = \sim 0b00001100 = \sim(0b00000011 \ll 2) = \sim(3 \ll 2) = 243$