Name _____ Date _____

Addition and Overflow

Remember

In two's complement, subtracting means adding the opposite: $6 - 2 = 6 + (-2)$. Add as usual and **throw away the carry out of the first bit**.

Example

$$\begin{array}{cccccc} & 1 & 1 & 1 & & \\ & & 0 & 1 & 1 & 0 \\ + & & 1 & 1 & 1 & 0 \\ \hline & \not{1} & 0 & 1 & 0 & 0 \end{array}$$

$6 = 0110,\ -2 = 1110$

Throw away the crossed-out carry: $0100 = 4$.

$6 + (-2) = 4$ ✓

1 ON YOUR OWN Add (4 bits, two's complement) and check in decimal.

$$\begin{array}{cccc} & 0 & 0 & 1 & 1 \\ + & 0 & 0 & 1 & 0 \\ \hline & \square & \square & \square & \square & \square \end{array}$$

$3 + 2 =$ ☐

result: ☐

$$\begin{array}{cccc} & 1 & 1 & 1 & 0 \\ + & 1 & 1 & 0 & 1 \\ \hline & \square & \square & \square & \square & \square \end{array}$$

$-2 + (-3) =$ ☐

result: ☐

$$\begin{array}{cccc} & 0 & 1 & 0 & 1 \\ + & 1 & 1 & 0 & 0 \\ \hline & \square & \square & \square & \square & \square \end{array}$$

$5 + (-4) =$ ☐

result: ☐

2 ON YOUR OWN **Subtracting by adding.** Write the opposite number and add.

$7 - 3 = 7 + (-3)$

$$\begin{array}{cccc} & 0 & 1 & 1 & 1 \\ + & 1 & 1 & 0 & 1 \\ \hline & \square & \square & \square & \square & \square \end{array}$$

result: ☐

$2 - 5 = 2 + (-5)$

$$\begin{array}{cccc} & 0 & 0 & 1 & 0 \\ + & 1 & 0 & 1 & 1 \\ \hline & \square & \square & \square & \square & \square \end{array}$$

result: ☐

Names (pair) _____ Date _____

Remember

With 4 bits we can only write numbers from -8 to 7. If the real sum is outside this range, there is an **overflow** and the result is wrong. You can spot it when two positive numbers give a negative sum, or two negative numbers give a positive sum.

3 IN PAIRS Complete the table (4 bits). Is there an overflow?

Sum	Decimal	Result (4 bits)	Result in decimal	Overflow?
$0101 + 0100$	$5 + 4$			yes / no
$1100 + 1011$	$-4 + (-5)$			yes / no
$0111 + 0001$	$7 + 1$			yes / no
$1111 + 1111$	$-1 + (-1)$			yes / no

4 IN PAIRS Can there be an overflow when we add a positive and a negative number? Explain.

5 ON YOUR OWN Add $100 + 50$ with 8 bits: $01100100 + 00110010$. Which number do we get? Why?

[ ] = [ ] because [ ]

The Two's Complement app · otooly.com/twos-complement

Addition mode: add two numbers and notice when the overflow warning appears.

★ ON YOUR OWN **Exit card.** $0110 + 0011 =$ [ ] Overflow? **yes** / **no**