

# Warm-Up: Adders

Prepared by Mark on January 24, 2025

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**Problem 1:**

Fill the following binary addition table.

*Hint:*  $s$  is “sum,”  $c$  is “carry”

$a$	$b$	$s$	$c$
0	0	?	?
0	1	?	?
1	0	?	?
1	1	?	?

**Problem 2:**

Draw a logic circuit that satisfies the above table.

This is called a *half adder*.

*Hint:* You should need exactly two gates.

**Definition 3:**

A *full adder* is similar to a half adder, but it has an extra input:

a full adder takes  $a$ ,  $b$ , and  $c_{\text{in}}$ , and produces  $s$  and  $c_{\text{out}}$ .

*Hint:*  $c_{\text{in}}$  is “carry in”

**Problem 4:**

Use two half adders to construct a full adder.

**Problem 5:**

How can we add two four-bit binary numbers using the full adder?

We want a four-bit output sum and a one-bit  $c_{\text{out}}$ .

**Problem 6:**

Say that all basic logic gates need  $1u$  of time to fully switch states.

*Note:* This is called *gate delay*

How much time does a full adder need to fully switch states?

How about your circuit from ???

**Problem 7: Bonus**

Design a faster solution to ??.