4 3 2 1 0

$1\,1\,0\,0\,1_2$

Binary to Decimal

$2^4 \times 1 + 2^3 \times 1 + 2^2 \times 0 + 2^1 \times 0 + 2^0 \times 1$

$= 16 + 8 + 0 + 0 + 1$

$= 25$

Decimal to binary conversion

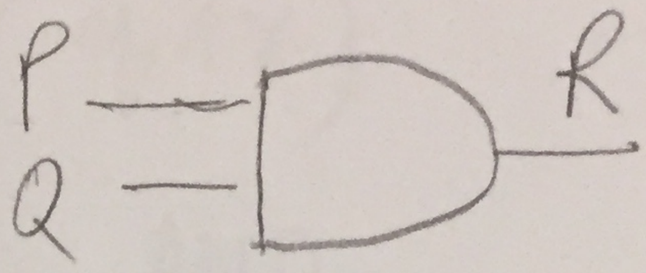
$2 \overline{)25}$	$2 \overline{)12}$	$2 \overline{)6}$	$2 \overline{)3}$
12	6	3	1
24	12	6	2
1	0	0	1

Most Significant bit

$1\,1\,0\,0\,1$

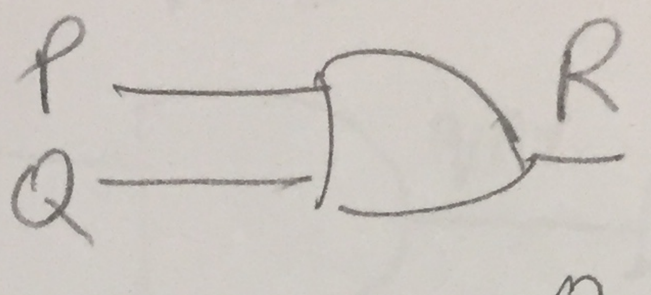
Least Significant bit

AND

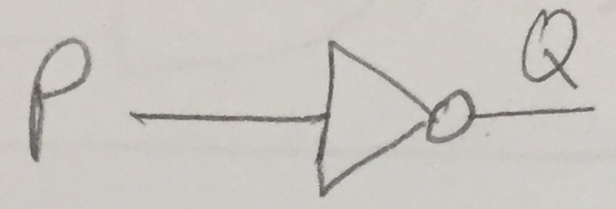


P	Q	R
1	1	1
1	0	0
0	1	0
0	0	0

OR

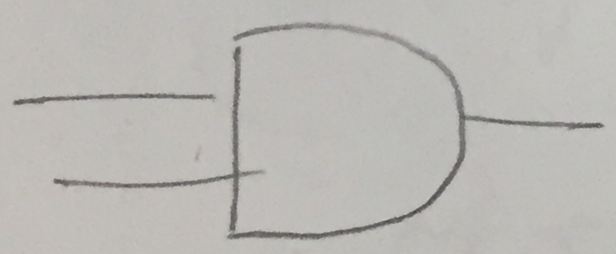


NOT

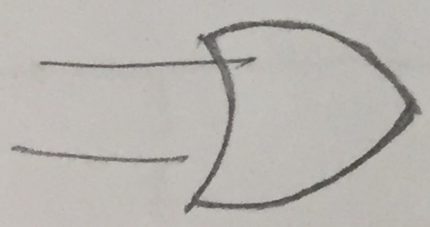


P	Q
1	0
0	1

AND



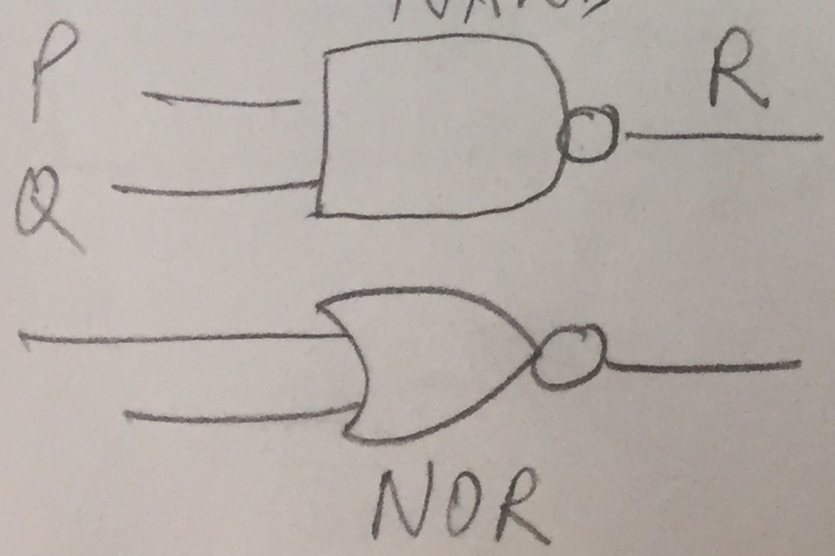
NOR



OR

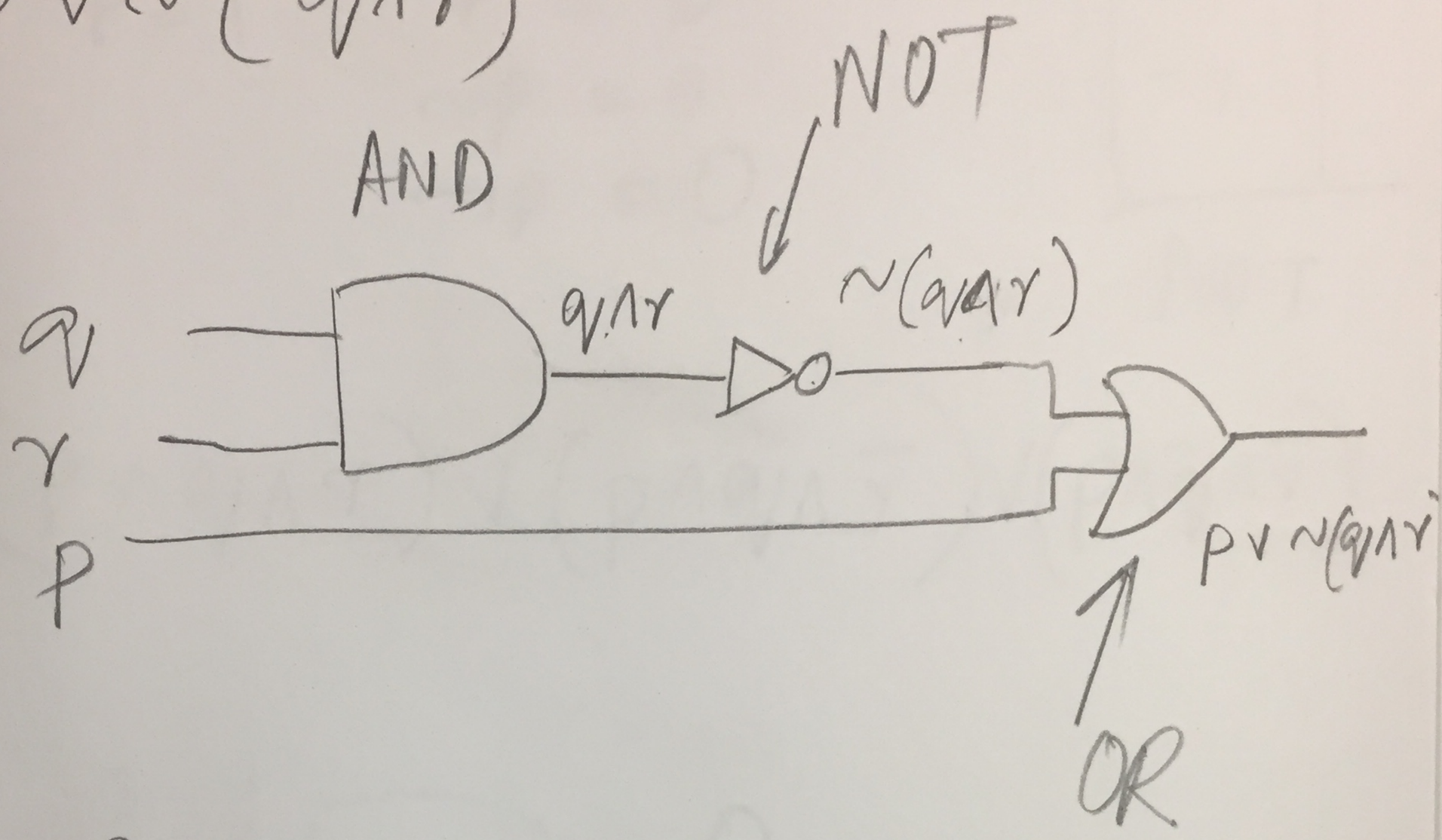
P	Q	R
1	1	1
1	0	1
0	1	1
0	0	0

NAND



P	Q	R
1	1	0
1	0	1
0	1	1
0	0	1

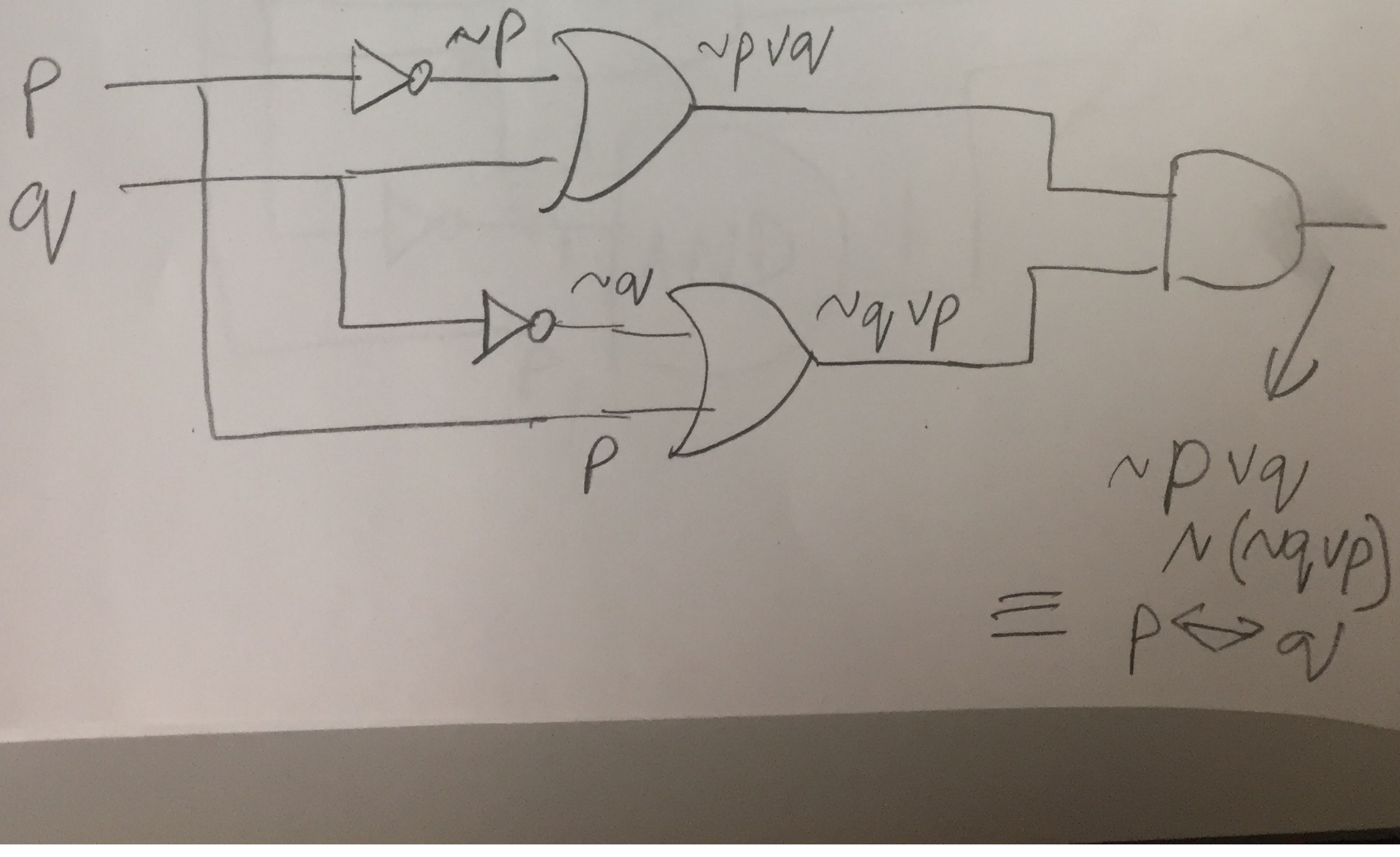
$p \vee \sim(q \wedge r)$



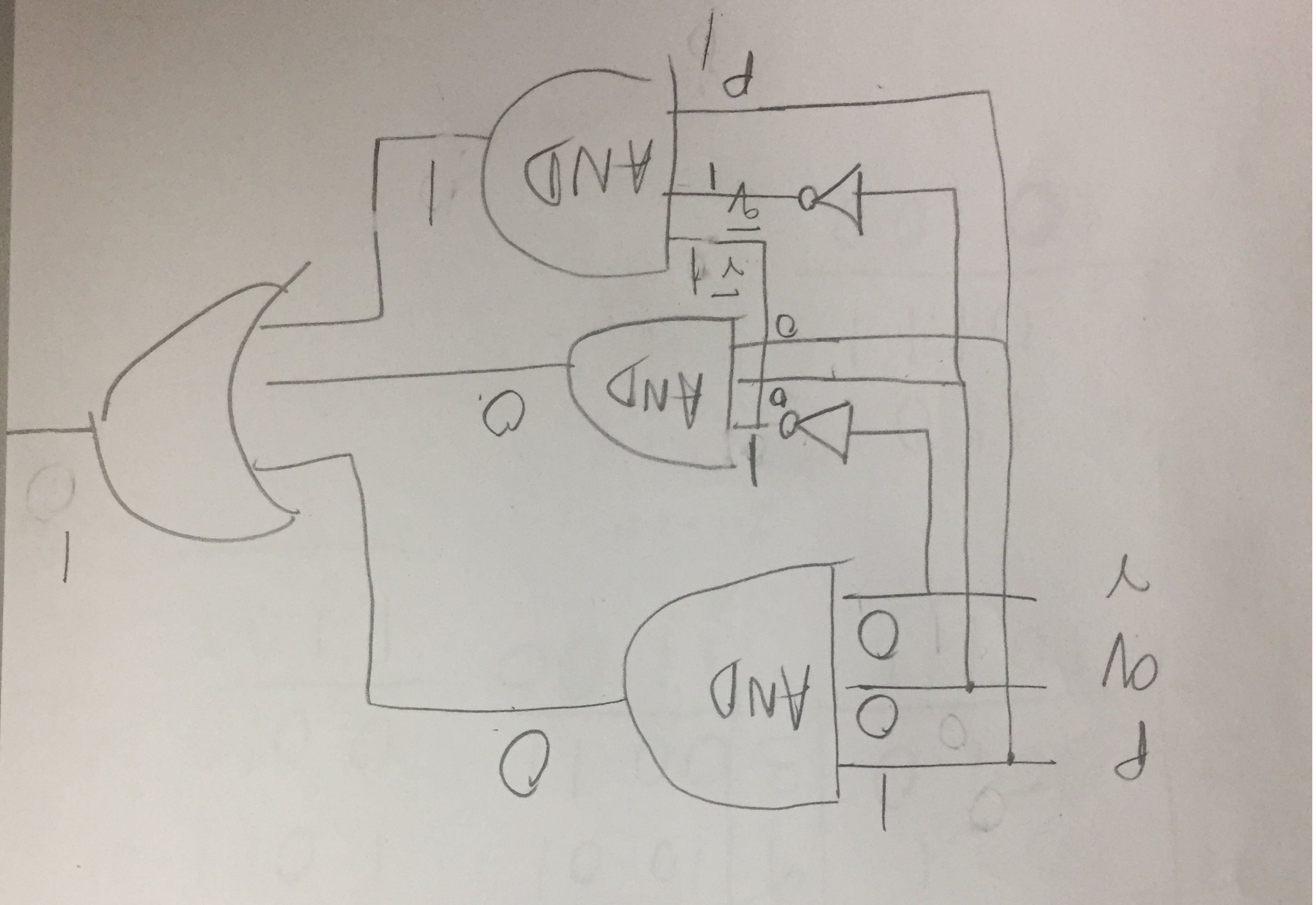
$p \leftrightarrow q$

$\equiv (p \rightarrow q) \wedge (q \rightarrow p)$

$\equiv (\sim p \vee q) \wedge (\sim q \vee p)$



$\equiv p \leftrightarrow q$



$$(P \wedge Q \wedge \overline{r}) \vee (P \wedge Q \wedge r) \vee (P \wedge \overline{Q} \wedge \overline{r})$$

NOT

1	
0	

$$0 = \overline{1}$$
$$0 = \overline{0}$$
$$a = \overline{a} \qquad 1 = \overline{0}$$

$1_2 + 1_2 = 10_2$

$10_2 + 01_2$

$= 11_2$

9	1001
2	0010
	1011

9	1001
3	0011
	1100

1_2

$2^3 \times 1 + 2 \times 1$

1011
0010
1101

11
2
13

1101
0111
10100

b_1 —— 0, 1

b_2 —— 0, 1

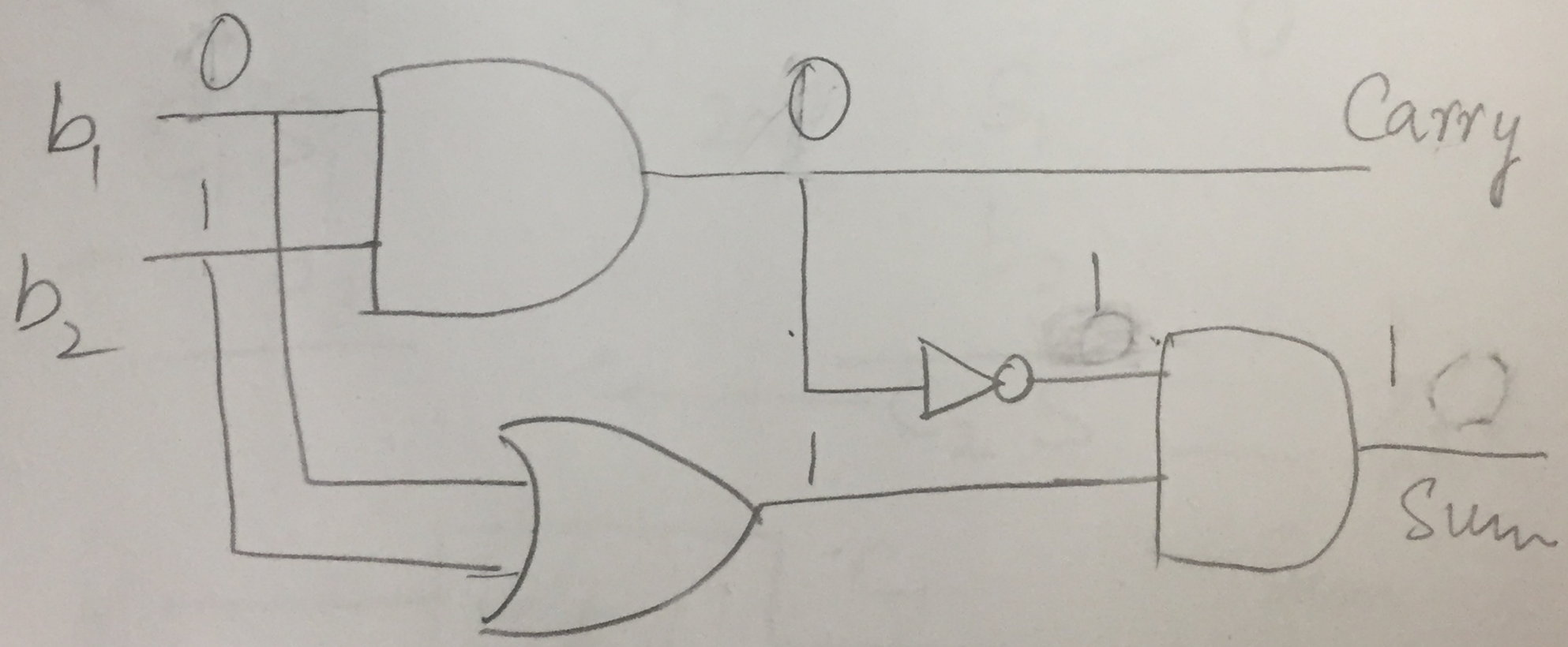
Carry Sum

$1_2 + 1_2 = 10_2$

$0_2 + 1_2 = 01_2$

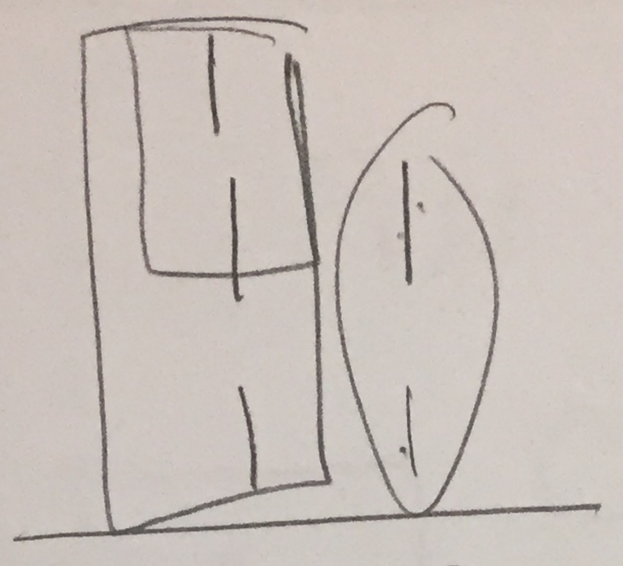
$1_2 + 0_2 = 01_2$

$0_2 + 0_2 = 0_2$



$$(b_1 \vee b_2) \wedge \sim(b_1 \wedge b_2)$$

Half- Adder



$$1_2 + 1_2 = 10_2$$

$$0_2 + 1_2 = 01$$

$$\begin{array}{r} 1\ 1\ 0 \\ \hline \end{array}$$

$$\begin{array}{r} b_1 \\ + \quad b_2 \\ \quad b_3 \\ \hline \end{array}$$

Step 1

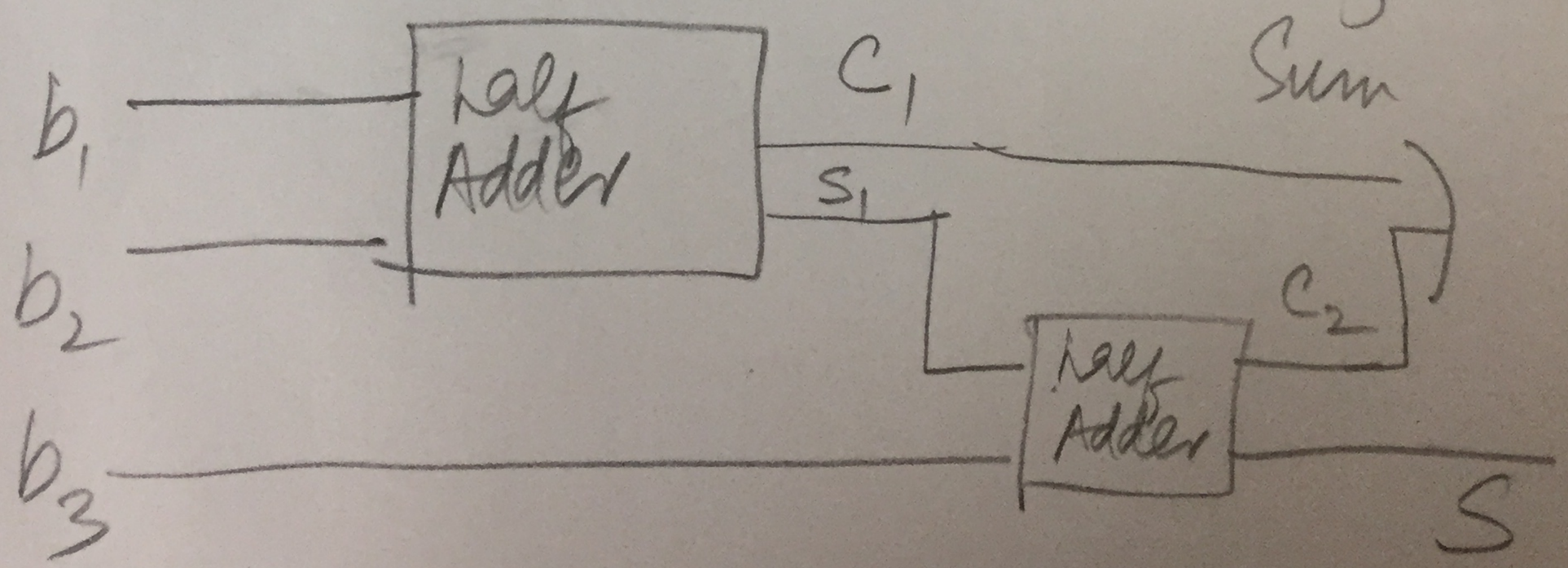
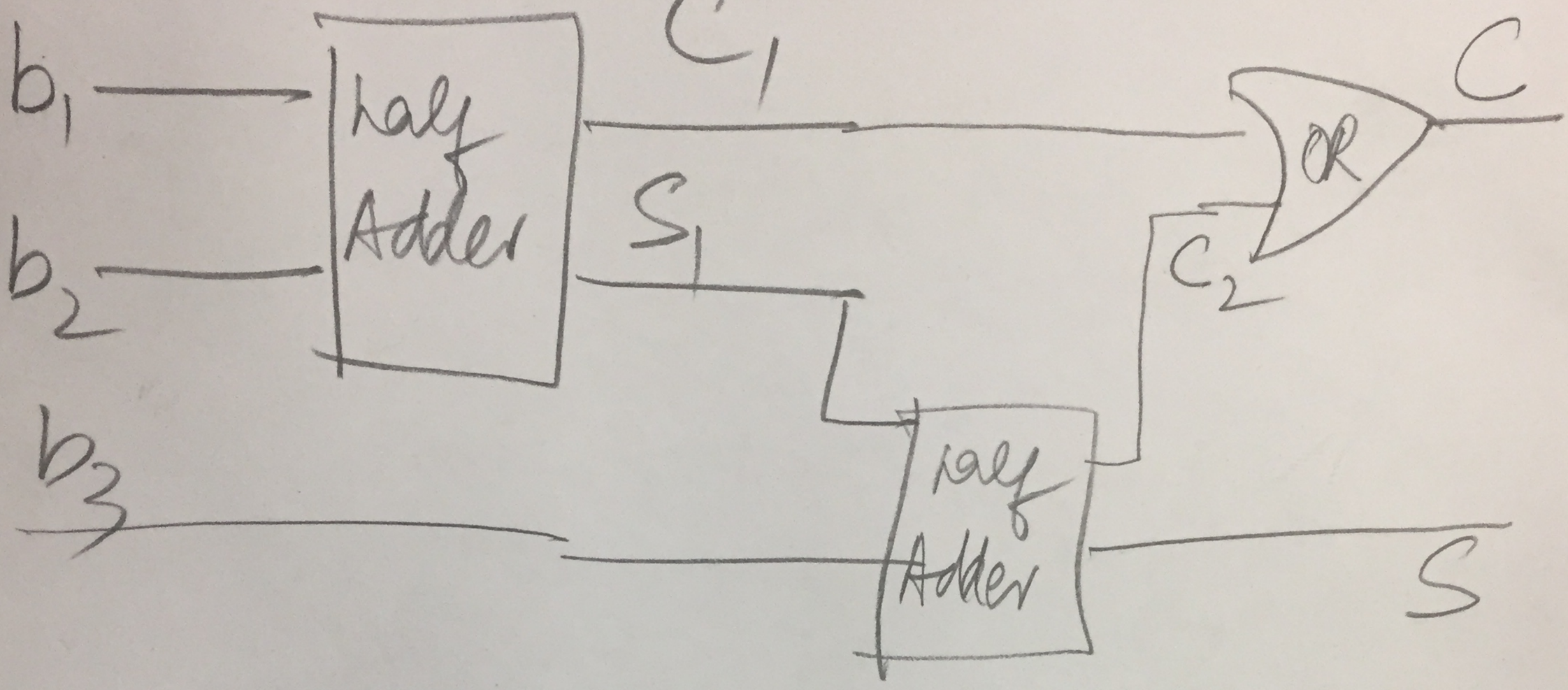
$$\begin{array}{r} b_i \text{ —— } 1 \\ b_2 \text{ —— } 1 \\ \hline C_1\ S_1 \end{array}$$

$$\begin{array}{r} S_1 \text{ —— } 0 \\ b_3 \\ \hline C_2\ S \end{array} \text{ —— final Sum}$$

Step 2

$$\begin{array}{r} C_1\ S_1 \\ + \quad b_3 \\ \hline \end{array}$$

(2a)



Full Adder