One Qubit :

H - Gate

$$|0\rangle \mapsto \frac{|0\rangle + |1\rangle}{\sqrt{2}}$$

$$|1\rangle \mapsto \frac{|0\rangle - |1\rangle}{\sqrt{2}}$$

$$|0\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$|1\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

$$H = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$$

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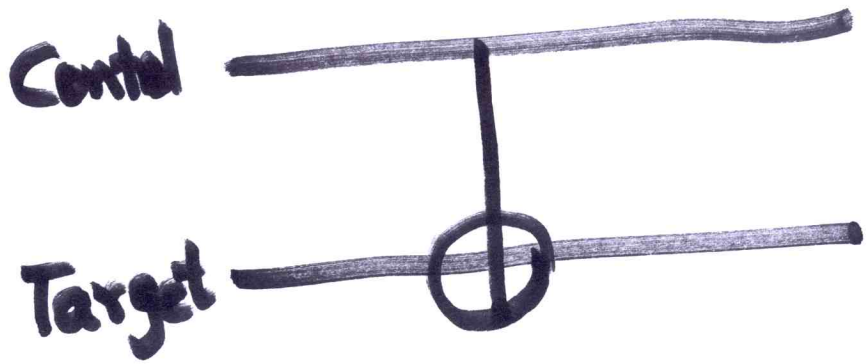
X - Gate $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ $|0\rangle \longleftrightarrow |1\rangle$

Y - Gate $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ $\sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$

Z - Gate $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

2. Qubit Gates.

CNOT Gate

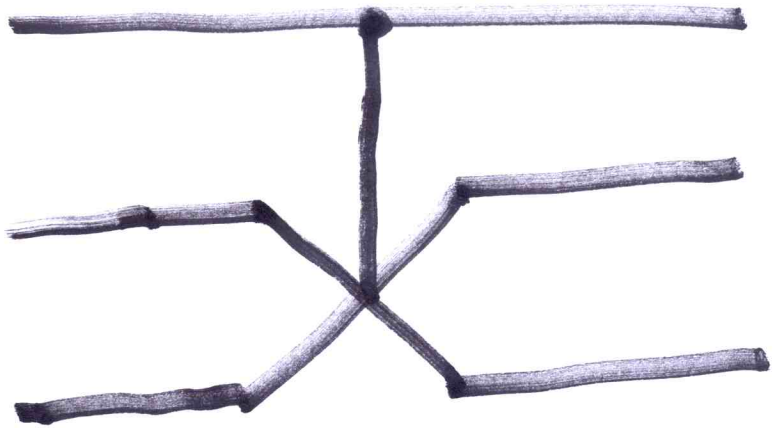


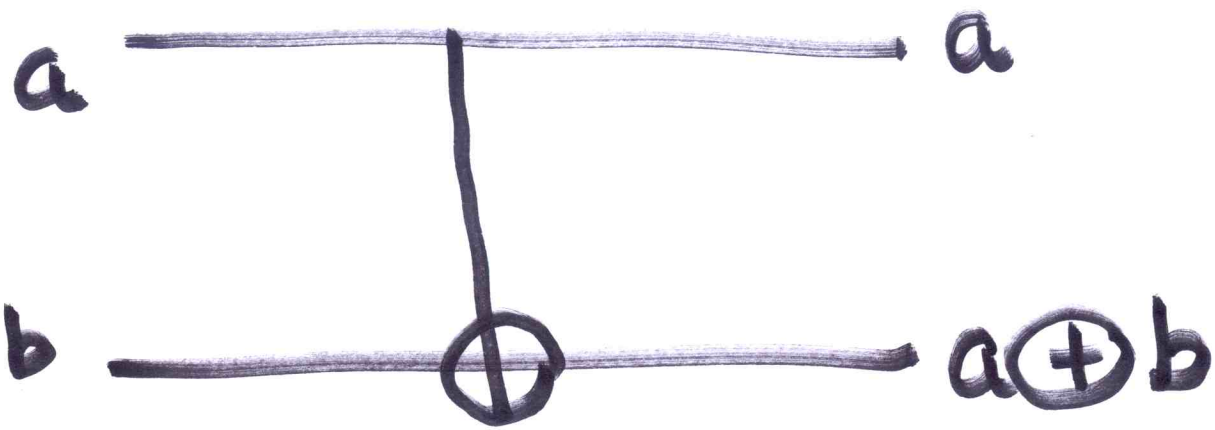
If C = 0 No change

C = 1
Target is
flipped

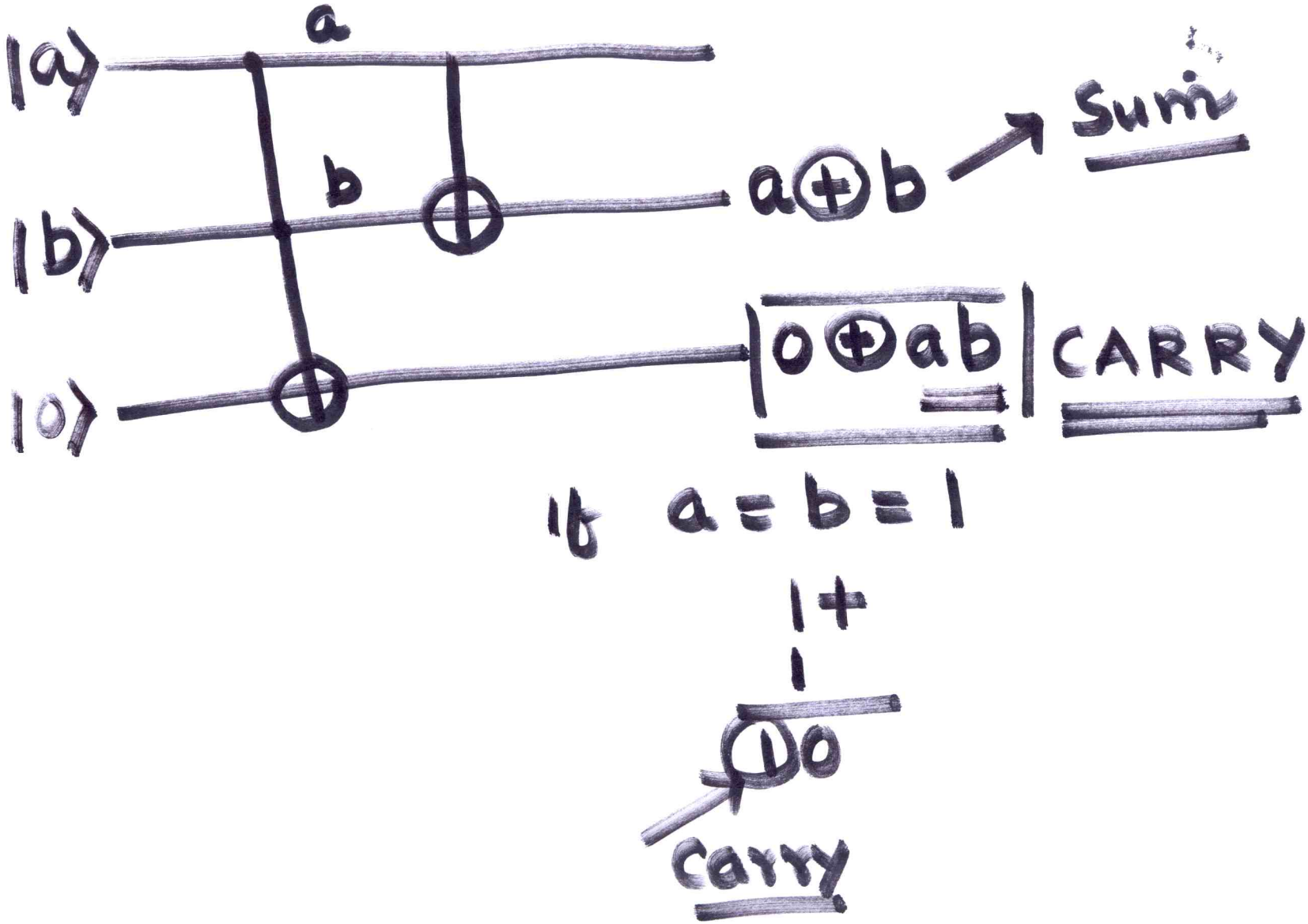
3. Qubit Gates : Toffoli (CCNOT)

CSWAP (Fredkin)

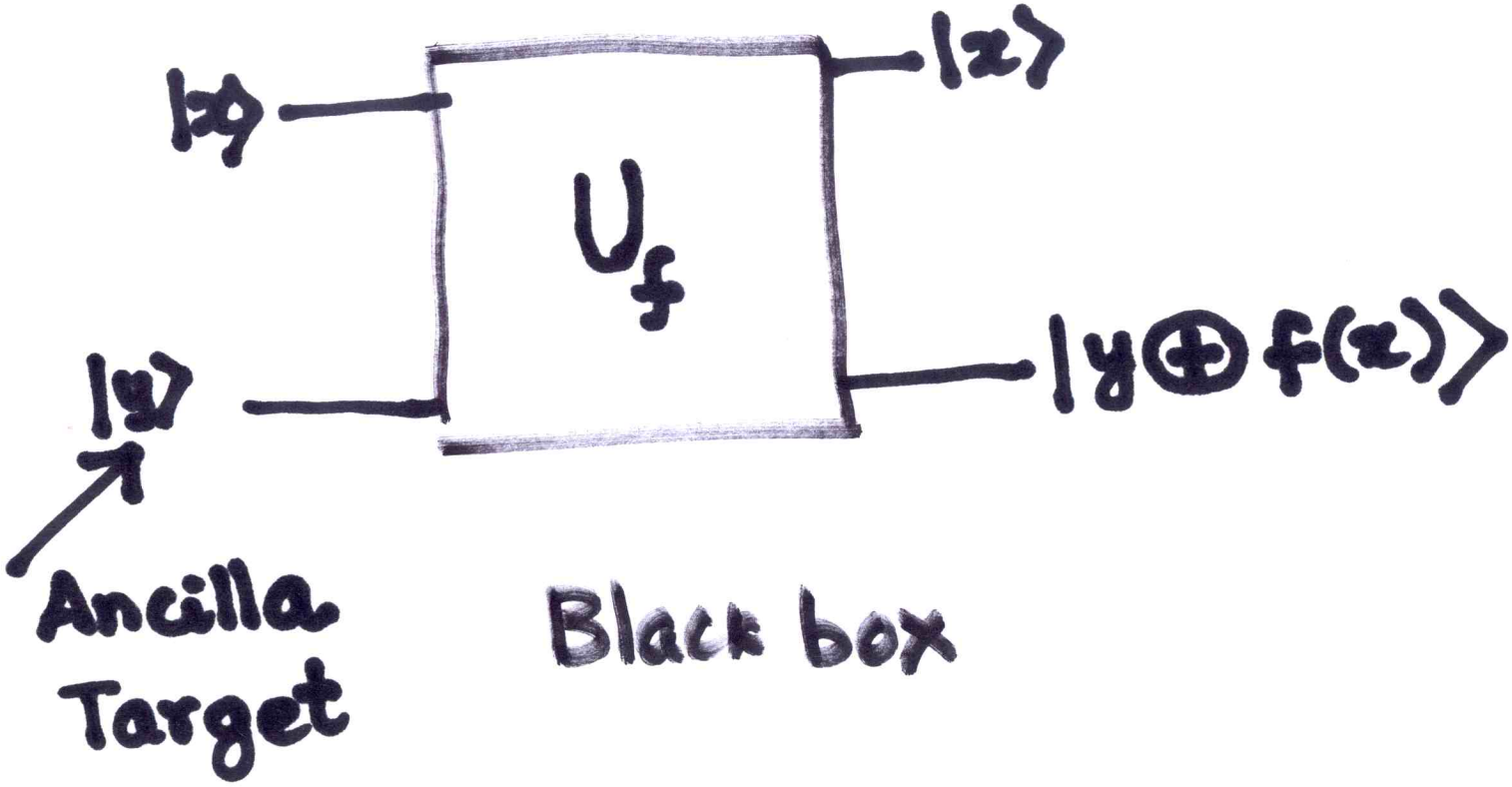


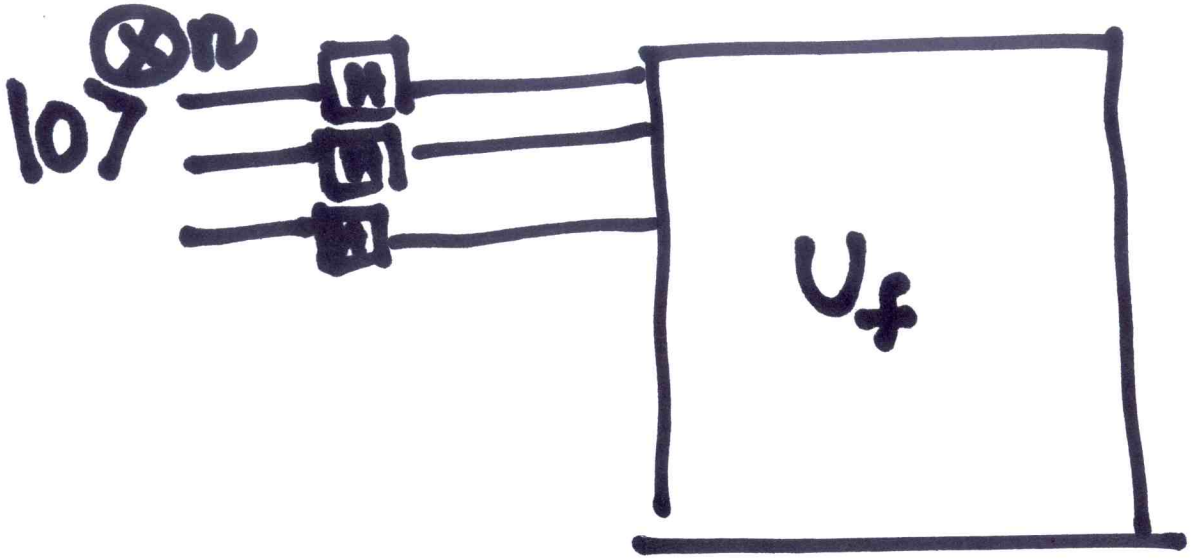

a
b
a
a ⊕ b

Half Adder :



Oracle





$$|0\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$$

$$|0\rangle \otimes |0\rangle \xrightarrow{H^2} \left(\frac{1}{\sqrt{2}}\right)^2 (|0\rangle + |1\rangle)(|0\rangle + |1\rangle)$$

$$= \frac{1}{2}[|00\rangle + |01\rangle + |10\rangle + |11\rangle]$$

Uniform superposition of 2 qubit basis

$$|0\rangle^{\otimes n} \xrightarrow{H^{\otimes n}} \frac{1}{\sqrt{2^n}} \sum_x |x\rangle$$

Uniform superposition of n-qubit basis