
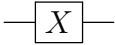
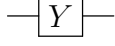
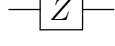


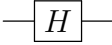
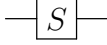
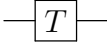

# Quantum Computing Cheat Sheet

## 1 States

$$\begin{aligned}
 |0\rangle &= \begin{bmatrix} 1 \\ 0 \end{bmatrix} & |1\rangle &= \begin{bmatrix} 0 \\ 1 \end{bmatrix} \\
 |+\rangle &= \frac{|0\rangle + |1\rangle}{\sqrt{2}} = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix} & |-\rangle &= \frac{|0\rangle - |1\rangle}{\sqrt{2}} = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{bmatrix} \\
 |\psi\rangle &= \alpha|0\rangle + \beta|1\rangle = \begin{bmatrix} \alpha \\ \beta \end{bmatrix}, & |\alpha|^2 + |\beta|^2 &= 1
 \end{aligned}$$

## 2 Unitary Operators

$I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$	$I 0\rangle =  0\rangle$ $I 1\rangle =  1\rangle$	
$X = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$	$X 0\rangle =  1\rangle$ $X 1\rangle =  0\rangle$	
$Y = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$	$Y 0\rangle = i 1\rangle$ $Y 1\rangle = -i 0\rangle$	
$Z = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$	$Z 0\rangle =  0\rangle$ $Z 1\rangle = - 1\rangle$	

$H = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$	$\begin{aligned} H 0\rangle &=  +\rangle \\ H 1\rangle &=  -\rangle \end{aligned}$	
$S = \begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$	$\begin{aligned} S 0\rangle &=  0\rangle \\ S 1\rangle &= i 1\rangle \end{aligned}$	
$T = \begin{bmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{bmatrix}$	$\begin{aligned} T 0\rangle &=  0\rangle \\ T 1\rangle &= e^{i\pi/4} 1\rangle \end{aligned}$	
$\text{CNOT} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$	$\begin{aligned} \text{CNOT} 00\rangle &=  00\rangle \\ \text{CNOT} 01\rangle &=  01\rangle \\ \text{CNOT} 10\rangle &=  11\rangle \\ \text{CNOT} 11\rangle &=  10\rangle \end{aligned}$	

### 3 Operator identities

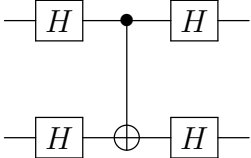
$$X^2 = Y^2 = Z^2 = H^2 = I$$

$$T^2 = S \quad S^2 = Z$$

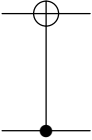
$$XY = iZ \quad YX = -iZ \quad XZ = -iY \quad ZX = iY \quad YZ = -iX \quad ZY = iX$$

$$\begin{aligned} HX &= ZH & HZ &= XH \\ SX &= XZS & SZ &= ZS \end{aligned}$$

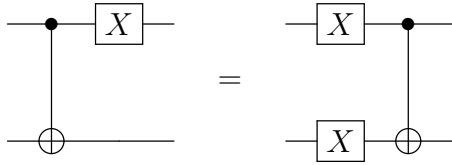
$$\begin{aligned} HXH &= Z & HYH &= -Y & HZH \\ SXS &= Y & SYS &= X & SZS &= Z \end{aligned}$$



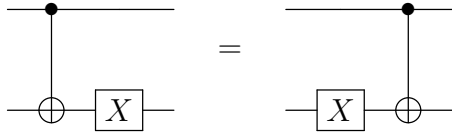
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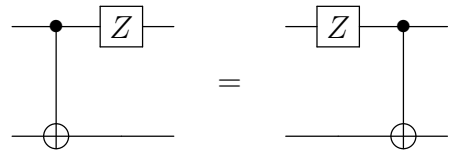
$(H \otimes H)\text{CNOT}_{0,1}(H \otimes H) = \text{CNOT}_{1,0}$



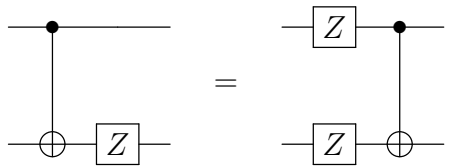
$$\text{CNOT}_{0,1}(X \otimes I) = (X \otimes X)\text{CNOT}_{0,1}$$



$$\text{CNOT}_{0,1}(I \otimes X) = (I \otimes X)\text{CNOT}_{0,1}$$



$$\text{CNOT}_{0,1}(Z \otimes I) = (Z \otimes I)\text{CNOT}_{0,1}$$



$$\text{CNOT}_{0,1}(I \otimes Z) = (Z \otimes Z)\text{CNOT}_{0,1}$$