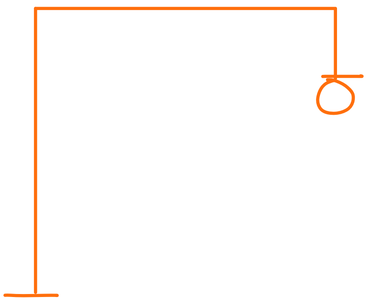
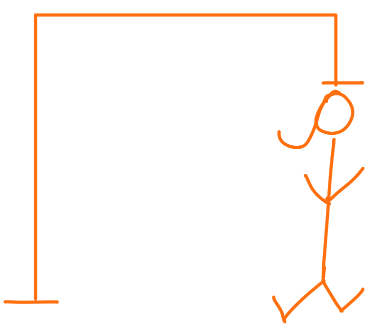
s w i m m i n g

e



s u n g l a s s e s

h



f l o w e r s

a c t i p d

h g

$$|00\rangle \rightarrow \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)\,|0\rangle = \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|10\rangle$$

$$|01\rangle \rightarrow \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)\,|1\rangle = \frac{1}{\sqrt{2}}|01\rangle + \frac{1}{\sqrt{2}}|11\rangle$$

$$|10\rangle \rightarrow \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)\,|0\rangle = \frac{1}{\sqrt{2}}|00\rangle - \frac{1}{\sqrt{2}}|10\rangle$$

$$|01\rangle \rightarrow \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)\,|1\rangle = \frac{1}{\sqrt{2}}|01\rangle - \frac{1}{\sqrt{2}}|11\rangle$$

$$HH|10\rangle = \left(H|1\rangle\right)\left(H|0\rangle\right)$$

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

$$= \frac{1}{2}\left(|00\rangle + |01\rangle - |10\rangle - |11\rangle\right)$$

NOT SAME

Let's analyze what this circuit does. The state of the two qubits starts off as $|00\rangle$. After the application of the Hadamard gate, the state of the two qubits is

$$HI|00\rangle = \frac{(|1\rangle + |0\rangle)}{\sqrt{2}}|0\rangle \qquad \boxed{\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)\,|0\rangle} = \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|10\rangle$$

Applying the CNOT gate (i.e. flip the second qubit if the first is in state '1', and do nothing otherwise) maps this to

$$\frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|11\rangle,$$

which is the desired Bell pair.

A & B always reply 0. (wins if $a \oplus b = x \cdot y$)

$a \oplus b = 0$

x	y	xy
0	0	0
0	1	0
1	0	0
1	1	1

To win with probability 1 we need:

$\boxed{a \oplus b = x \cdot y}$

- $a_0 = b_0$
- $a_0 = b_1$
- $a_1 = b_0$
- $a_1 \neq b_1$.

x, y	$x \cdot y$
0,0	0
0,1	0
1,0	0
1,1	1

$a_0 = b_0 \neq a_1 = b_1$

$a_0 = b_1$

$a_1 = b_0$

At least one of the four conditions is not satisfied.