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HW - 7.

1) $|01\rangle \to H \to |0\rangle \oplus |0\rangle = \frac{|0\rangle \pm |1\rangle}{\sqrt{2}} \oplus |1\rangle$

$= \frac{1}{\sqrt{2}}(|01\rangle + |11\rangle) \to CNOT \to$

$= \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle)$

2) $|10\rangle \quad H \to |1\rangle \otimes |0\rangle = \frac{|0\rangle \pm |1\rangle}{\sqrt{2}} \otimes |0\rangle$

$= \frac{1}{\sqrt{2}}(|100\rangle - |110\rangle) \to CNOT$

$= \frac{1}{\sqrt{2}}(|100\rangle - |11\rangle)$

3) $|11\rangle \to H \to |1\rangle \otimes |1\rangle = \frac{|0 - |1\rangle}{\sqrt{2}} \otimes |1\rangle$

$= \frac{1}{\sqrt{2}}(|01\rangle - |11\rangle) \to CNOT.$

$= \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle).$

✱ Q2 → submitted on canvas.

3) Q6) →

a) $|00\rangle$ CNOT $|00\rangle$ d) $\frac{1}{\sqrt{2}}|01\rangle + \frac{1}{\sqrt{2}}|10\rangle \Rightarrow$

b) $|01\rangle$ $|01\rangle$

c) $|11\rangle$ $|10\rangle$ $\frac{1}{\sqrt{2}}|01\rangle + \frac{1}{\sqrt{2}}|11\rangle$

d) ~~|1⟩~~

e) $\frac{1}{\sqrt{2}}|00\rangle + \frac{1}{2}|10\rangle - \frac{1}{2}|11\rangle \xrightarrow{\text{CNOT}} \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{2}|11\rangle - \frac{1}{2}|10\rangle$

7) The inputs to the CNOT gate were $|01\rangle$.

8) a). As control is $|0\rangle$ there is no change, only Pauli's gate inverts values.

$|00\rangle \rightarrow |01\rangle$

b). As ~~eol~~ control is $|0\rangle$ so no change for CNOT

$\rightarrow |10\rangle$.

c). As input to CNOT control is $|1\rangle$ target changes.

$\rightarrow |11\rangle$

d). As control bit is $|1\rangle$ the target changes

$\rightarrow |01\rangle$

9) a). $\frac{|0\rangle + |1\rangle}{\sqrt{2}} \otimes |0\rangle \rightarrow \frac{|00\rangle + |10\rangle}{\sqrt{2}} \xrightarrow{\text{CNOT}}$

$\rightarrow \frac{|00\rangle + |10\rangle}{\sqrt{2}}$

b) $|0\rangle \otimes \frac{|0\rangle + |1\rangle}{\sqrt{2}} \rightarrow \frac{|00\rangle + |01\rangle}{\sqrt{2}} \xrightarrow{\text{CNOT}}$

$\rightarrow \frac{|00\rangle + |10\rangle}{\sqrt{2}}$

c) $\frac{|0\rangle + |1\rangle}{\sqrt{2}} \otimes |0\rangle \rightarrow \frac{|00\rangle + |10\rangle}{\sqrt{2}}$

a) d) $|0\rangle \otimes \dfrac{|0\rangle + |1\rangle}{\sqrt{2}} \rightarrow \dfrac{|00\rangle + |01\rangle}{\sqrt{2}}$

10) a) After X gate we get $|01\rangle$ which we provid to CNOT. then we get $|11\rangle$. This is then Fed to second CNOT and we get $|110\rangle$

b) First after applying H we get
$$|0\rangle \otimes \dfrac{|0\rangle + |1\rangle}{\sqrt{2}} \longrightarrow \dfrac{|00\rangle + |01\rangle}{\sqrt{2}}$$

After applying CNOT to this we get.
$$\dfrac{|00\rangle + |11\rangle}{\sqrt{2}} \quad \text{As there is an}$$

H gate on qubit 2 we get.
$$\dfrac{|0\rangle}{\sqrt{2}}\dfrac{(|0\rangle + |1\rangle)}{\sqrt{2}} + \dfrac{|1\rangle}{\sqrt{2}}\dfrac{(|0\rangle - |1\rangle)}{\sqrt{2}}$$
$$= \dfrac{|00\rangle + |01\rangle + |10\rangle - |11\rangle}{2}$$

11) Submitted as code.

12) They cannot transmit information faster than speed of light., because once Alice measures the qubit at her end there is no quantum means to corroborate the what Bob has measured and need classical passage of information as well.