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## 解答

1.

$$\begin{aligned} X|+\rangle &= \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ 1 \end{pmatrix} \\ &= |+\rangle, \end{aligned} \tag{1}$$

$$\begin{aligned} X|-\rangle &= \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -1 \end{pmatrix} \\ &= -|-\rangle \end{aligned} \tag{2}$$

2.

$$\begin{aligned} Y|i\rangle &= \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ i \end{pmatrix} \\ &= |i\rangle, \end{aligned} \tag{3}$$

$$\begin{aligned} Y|-i\rangle &= \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -i \end{pmatrix} \\ &= -|-i\rangle \end{aligned} \tag{4}$$

3.

$$\begin{aligned} Z|0\rangle &= \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} \\ &= |0\rangle, \end{aligned} \tag{5}$$

$$\begin{aligned} Z|1\rangle &= \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ &= -|1\rangle \end{aligned} \tag{6}$$

4.

$$\langle 0|+\rangle = \frac{1}{\sqrt{2}}, \quad \langle 1|+\rangle = \frac{1}{\sqrt{2}}, \tag{7}$$

$$\langle 0|-\rangle = \frac{1}{\sqrt{2}}, \quad \langle 1|-\rangle = -\frac{1}{\sqrt{2}}, \tag{8}$$

$$\langle 0|i\rangle = \frac{1}{\sqrt{2}}, \quad \langle 1|i\rangle = \frac{i}{\sqrt{2}}, \tag{9}$$

$$\langle 0|-i\rangle = \frac{1}{\sqrt{2}}, \quad \langle 1|-i\rangle = -\frac{i}{\sqrt{2}}, \tag{10}$$

$$\langle +|i\rangle = \frac{1}{2}(1+i), \quad \langle -|i\rangle = \frac{1}{2}(1-i), \tag{11}$$

$$\langle +|-i\rangle = \frac{1}{2}(1-i), \quad \langle -|-i\rangle = \frac{1}{2}(1+i) \tag{12}$$