Quiz 2;

1) $|\varphi\rangle = \frac{1}{\sqrt{2}}\left(|00\rangle + |11\rangle\right)$

We assume that $|\varphi\rangle = (a_1|0\rangle + b_1|1\rangle) \otimes (a_2|0\rangle + b_2|1\rangle)$

$= a_1 a_2 |00\rangle + a_1 b_2 |01\rangle + a_2 b_1 |10\rangle + b_1 b_2 |11\rangle$

Then $\begin{cases} a_1 a_2 = 1/\sqrt{2} & (1) \\ b_1 b_2 = 1/\sqrt{2} & (2) \\ a_1 b_2 = a_2 b_1 = 0 \rightarrow \text{at least 1 component} = 0 \end{cases}$

$\rightarrow$ cannot satisfy (1) & (2)

2) We can choose $|\varphi\rangle = \underbrace{\frac{1}{\sqrt{2}}\left(|0\rangle + |1\rangle\right)}_{|+\rangle} \otimes \underbrace{\frac{1}{\sqrt{2}}\left(|0\rangle - |1\rangle\right)}_{|-\rangle}$

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

$= \frac{1}{2}\left[\begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix} - \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} - \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}\right]$

$= \frac{1}{2}\begin{pmatrix} 1 \\ 1 \\ -1 \\ -1 \end{pmatrix}$. $|\varphi\rangle$ is separable since $|\varphi\rangle = |+\rangle \otimes |-\rangle \leftarrow$ pure tensors