Which of the below states are valid quantum states?

A) $|0\rangle$

B) $|0\rangle + |90\rangle$

C) $(|0\rangle - |90\rangle)/\sqrt{2}$

D) B and C

E) A and C

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B is not properly normalized
(the coefficients squared do not add to 1,
so the probabilities are not adding to 1)

A single photon hits a polarizer oriented vertically. It is transmitted. What can you conclude about the state of the photon **before** it hit the polarizer?

A) nothing

B) it was vertically polarized

C) it had vertical polarization with probability $\cos^2\theta$

D) it's quantum state could have been anything at all

E) it's quantum state could have been anything except $|90\rangle$

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All you know is that the quantum state has at least a small component in the |0> direction, so it can't be |90>

A stream of photons hits a polarizer at 0 degrees.
On average half of them are transmitted.
Which of the following are consistent explanations of this:

A) the photons are all in a state $(|0\rangle + |90\rangle)/\sqrt{2}$

B) half the photons are vertically polarized and half are horizontally polarized

C) A and B are both ok

D) A and B are **the same thing** and both ok

E) none of the above

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In case A, you have $\cos\theta = 1/\sqrt{2}$, or $\theta = 45$,
so there is prob=1/2 of **each photon** getting through
In case B, the vertically polarized photons go through and the horizontal ones do not.

A and B are not the same, since photons in A would all go through a 45 degree polarizer and only half of the photons in B would.

A stream of photons hits a polarizer at 0 degrees
and on average half of them are transmitted.
Does there exist an experiment which
can determine whether the photons are a half-and-half mixture of $|0\rangle$ and $|90\rangle$, or whether they are in a quantum state such as $(|0\rangle+|90\rangle)/\sqrt{2}$

A) no

B) yes (be prepared to propose such an experiment)

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B) yes (be prepared to propose such an experiment)

Use a polarizer at 45 degrees:
All of $(|0\rangle+|90\rangle)/\sqrt{2}$ go through, but only half of the mixture does.