HOMEWORK 11

QUANTUM MECHANICS 2

1. Which of the following properties of an electron is measured in the Stern-Gerlach experiment?

   a) Charge
   b) Kinetic Energy
   c) Mass
   d) Spin

2. After passing through a Stern-Gerlach apparatus, how many possible values for electron spin can be measured?

   a) 1
   b) 2
   c) 4
   d) A continuous range of values can be measured

3. The orientation of the Stern-Gerlach apparatus corresponds to which of the following?

   a) The **basis** of measurement of electron spin.
   b) The **energy range** of measurement of electron spin
   c) The possible values for **magnitude** of electron spin that can be measured.
   d) Orientation of the Stern-Gerlach apparatus does not matter.

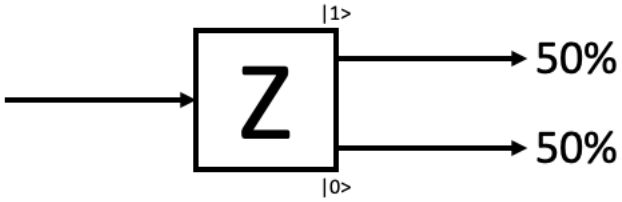
For **Questions 4-6**, state whether the following statements are **True** or **False**

4. A quantum state is changed when it is measured. TRUE

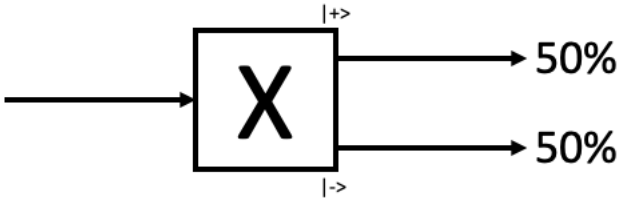
5. The probability of measuring a given quantum state does **not** depend on the **basis of measurement** FALSE

6. Electron spin is an example of a **single level system** FALSE

Questions 7-12 will use a sketch of the results of Stern-Gerlach experiments. A Stern-Gerlach apparatus oriented in the **z**-direction is represented by a box and the output of the apparatus corresponds to electrons which have been measured in the $|0\rangle$ state and $|1\rangle$ state. For example, an initial electron beam going through a Stern-Gerlach apparatus oriented in the z-direction, which results in 50% of electrons being measured as $|0\rangle$ and 50% being measured as $|1\rangle$ would be illustrated as follows.

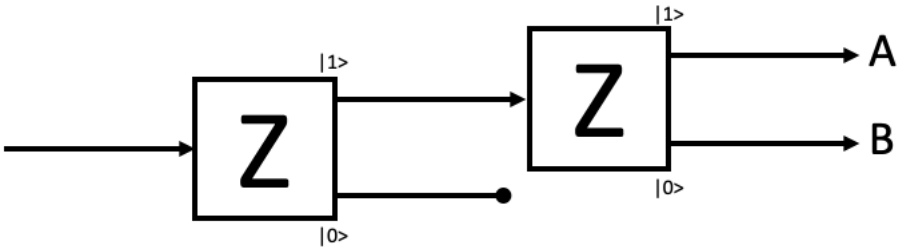


Similarly, an initial electron beam passing through a Stern-Gerlach apparatus oriented in the **x**-direction with outputs of $|+\rangle$ and $|-\rangle$ would be illustrated as:



In **Questions 7-12** we will analyze how various combinations of Stern-Gerlach measurements affect an initial electron beam. Answers to these questions should be given as a **percent of the initial number of electrons** that will travel down the given branch in the experiment.

Use the following Stern-Gerlach configuration to answer **Questions 7 & 8**.



Again, the answer should be 100% of the 50%, so 50% of the initial electrons

7. What percent of the initial number of electrons will travel down branch **A**?

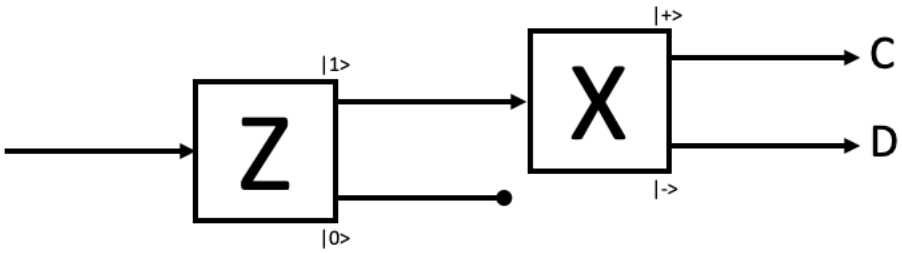
   a) 0%
   b) 25%
   c) 50%
   d) 100%

This is pertaining to the fact that the first branch of my apparatus 1 corresponds to only the |1> state and measuring again in the SAME BASIS means that the state was not disturbed and thus is exactly the same as the given input

8. What percent of the initial number of electrons will travel down branch **B**?

   a) 0%
   b) 25%
   c) 50%
   d) 100%

Use the following Stern-Gerlach configuration to answer **Questions 9 & 10**.



But since it is written initial, it should be 50% of the 50% which is 25%

9. What percent of the initial number of electrons will travel down branch **C**?

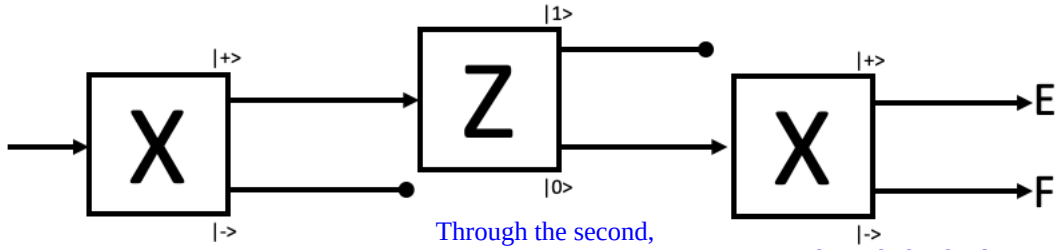
   a) 0%
   b) 25%
   c) 50%
   d) 100%

Again, the answer to this question lies in the fact that the state |1> is an equal superposition of the x-basis states |+> and |->.
The prepared state |1> gives us no idea about the orientation of the spin along the x basis and thus it is totally random.

10. What percent of the initial number of electrons will travel down branch **D**?

    a) 0%
    b) 25%
    c) 50%
    d) 100%

Use the following Stern-Gerlach configuration to answer **Questions 11 & 12**.



Through the first, |+> is passed

Through the second, only |0> passed

Through the third, the outcomes are completely random

11. What percent of the initial number of electrons will travel down branch **E**?

    a) 0%
    b) 12.5%
    c) 25%
    d) 50%

But again it should be, 50% of the 50% of the 50% which is actually 12.5% for both

WHY? Because the |0> state preparation destroyed any kind of information we had for the x basis through the first apparatus.

12. What percent of the initial number of electrons will travel down branch **F**?

    a) 0%
    b) 12.5%
    c) 25%
    d) 50%