PHYS 313: Quantum Mechanics I

Problem set # 1 *(due September 13)*

All problems are mandatory, unless marked otherwise. Each problem is 10 points.

Townsend, Ch. 1: 1.3(a,b), 1.6, 1.7, 1.13, 1.14
Hint for 1.7: There are two ways to approach the problem of calculating the probability of a particle passing through the second apparatus. One is mathematical: you can express the incoming state ($|+z\rangle$) in terms of output states ($|\pm\vec{n}\rangle$). This one is straightforward, but may involve a bit of trig calculations. The second way is simpler, but require good grasp on the background physics: you may also argue that physical outcome must depend only on the relative angle between the first two SG apparati, and you can mentally "tilt" your z-axis for the second SG. In this case you should be able to write the probability right away, using expression from 1.3. If you have time, you can try both approaches, and check that the answers match!

Q1 Your classmate claims that the expression below is a correct representation of an electron spin state:

$$|\psi\rangle = 4|+z\rangle - 3i|-z\rangle.$$

where $\hat{1}$ is an identity operator.
(a) Point out what is wrong with this expression. What factor you need to multiply it to in order to obtain a proper wave function?
(b) Using the corrected (properly normalize) expression for $|\psi\rangle$, find the expectation value $\langle S_x\rangle$ and its uncertainty ΔS_x in this state.