Question 1

What is the Euclidean principle of relativity and what does it imply on the structure of quantum mechanics?

The Euclidean principle says that physical laws should be the same independently of the location in space or orientation of space. Space is homogeneous and isotropic. Translations and rotations are symmetry operations and the absolute values of inner products are unaffected by symmetry operations. As a result of Wigner’s theorem this actually limits the transformations to unitary and anti-unitary operators.

Question 2

What is a ”superselection” rule? Give one example with a consequence of its existence.

Superpositions of states behaving differently under symmetries are not allowed. Example are superpositions of particles with different spin, charge, or other internal quantum numbers.

Question 3

Section 17.3 introduces the concepts of groups (finite and continuous), symmetry groups, group representations (equivalent or not, reducible or not). Read these definition and the implications on quantum mechanics as illustrated by the derivation of Eq. (17.23). Does the symmetry need to be perfect to be useful?

No, it does not. An approximate symmetry is still useful as a starting point.

Question G

What remarkable (surprising, insightful, powerful, dubious) statement(s) did you find in your reading of Merzbacher’s Chapter 15? What exactly do you find remarkable about the statement(s)?

Question H

Which exercise and which problem from Merzbacher’s Chapter 15 would you like to be in charge of solving? Why?