Problem #1. Devise a synthesis of compound 3 from allene (1) and compound 2 (15 points).

![Chemical structures](image)

1: allene

Problem #2. From compounds 1 and 2, propose an enantioselective synthesis of compound 3 (15 points).

![Chemical structures](image)

Problem #3. When compound 1 is treated with a catalytic amount of Pd\(^0\) (formed in situ by reduction of Pd\(^{+2}\)), it is transformed to a tricyclic substance 2 having the molecular formula C\(_{15}\)H\(_{20}\)O\(_4\). What is the structure of 2 and how is it formed (15 points)?

![Chemical structures](image)

[see Tetrahedron Lett. 1991, 32, 3855]
Problem #4 (This problem has two parts). Why is Sharpless catalytic asymmetric epoxidation of 1 less diastereoselective when (+)-diethyl tartrate is used as the chiral ligand?

SAE = Sharpless asymmetric epoxidation
DET = diethyl tartrate

The virtue of the reagent-control strategy for managing acyclic stereorelationships is expressed in these examples. What must an asymmetric chemical process be capable of in order to be effective in the reagent-control strategy (15 points)?

Problem #5. Provide a retrosynthetic analysis for compound 1 and a plan for synthesis (including reagents) based on your analysis (15 points).

Problem #6. Use your knowledge of chemical reactions and synthesis strategy and propose a diastereoselective synthesis for one of the compounds shown below. Give me an opportunity to give you points (25 points).