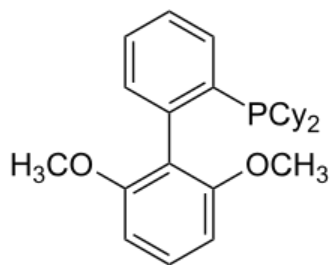
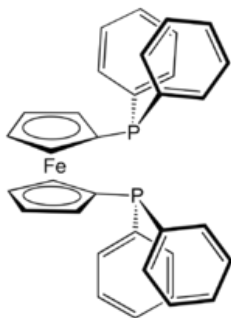


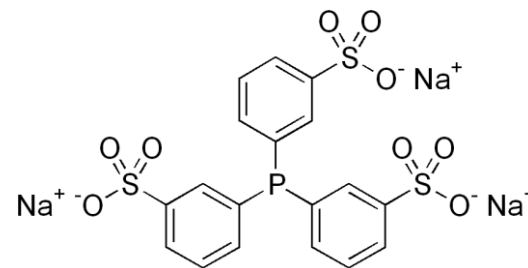
1. (a) Associate the most suitable phosphine ligands below for the following Pd-catalyzed cross-coupling reaction. (b) Give a brief explanation for each of your choice.



A, S-Phos



B, DPPF



C, TPPTS

Reactions:

- (i) Suzuki coupling of sterically hindered aryl chlorides; why?
- (ii) Suzuki coupling in water medium; why?
- (iii) Kumada and Suzuki coupling of alkyl nucleophiles; why?

(i) Suzuki coupling of sterically hindered aryl chlorides; why?

A: S-Phos. Because this ligand can stabilize one-coordinate Pd(0) species (along this line)

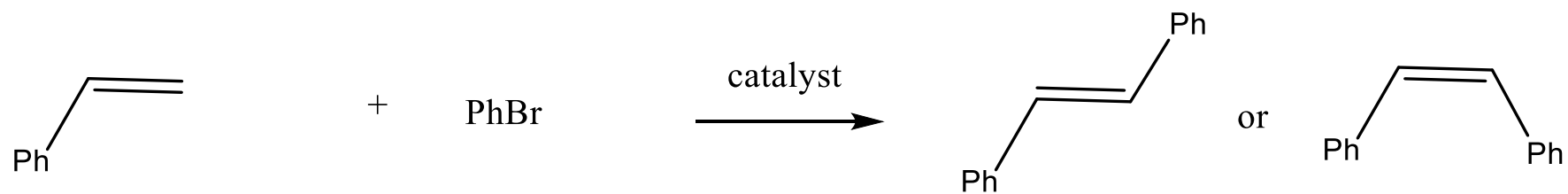
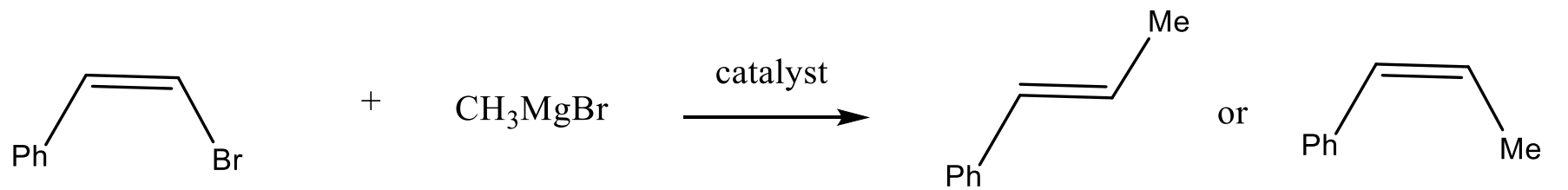
(ii) Suzuki coupling in water medium; why?

C: TPPTS. Because this ligand is water soluble (charged).

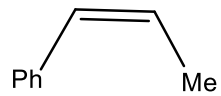
(iii) Kumada and Suzuki coupling of alkyl nucleophiles; why?

B: DPPF. Because this ligand is bidentate and suppress β -elimination. (second answer, promote reductive elimination)

Choose the correct major product in the following cross-coupling reactions. Explain why.

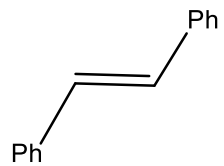


1:



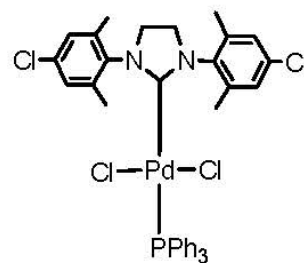
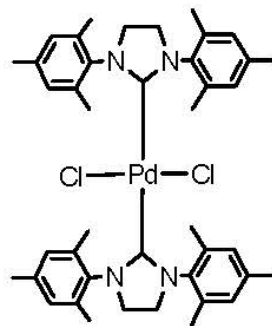
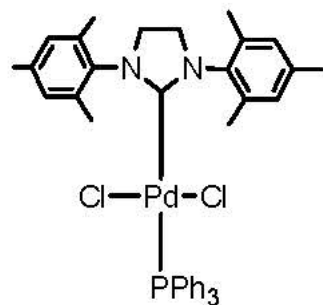
. Because cross coupling is stereospecific, or because the cis/trans configuration is conserved.

2:



. Because heck reaction gives the trans isomer as the major product (due to the syn-elimination).

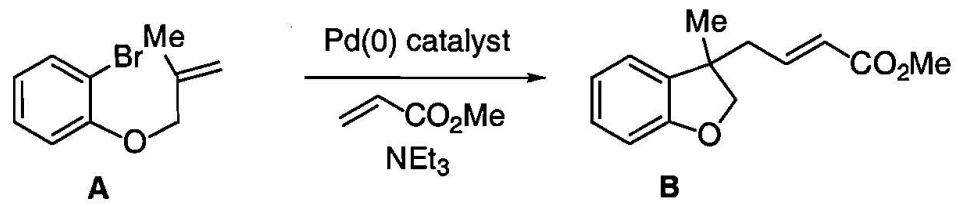
The following Pd-NHC complexes have been found to be useful in Suzuki coupling reactions. (a) Arrange them in the order of increasing reactivity for activation of alkyl halides. (b) Provide justification. Hint: A NHC ligand is more electron rich and less labile than a phosphine ligand.

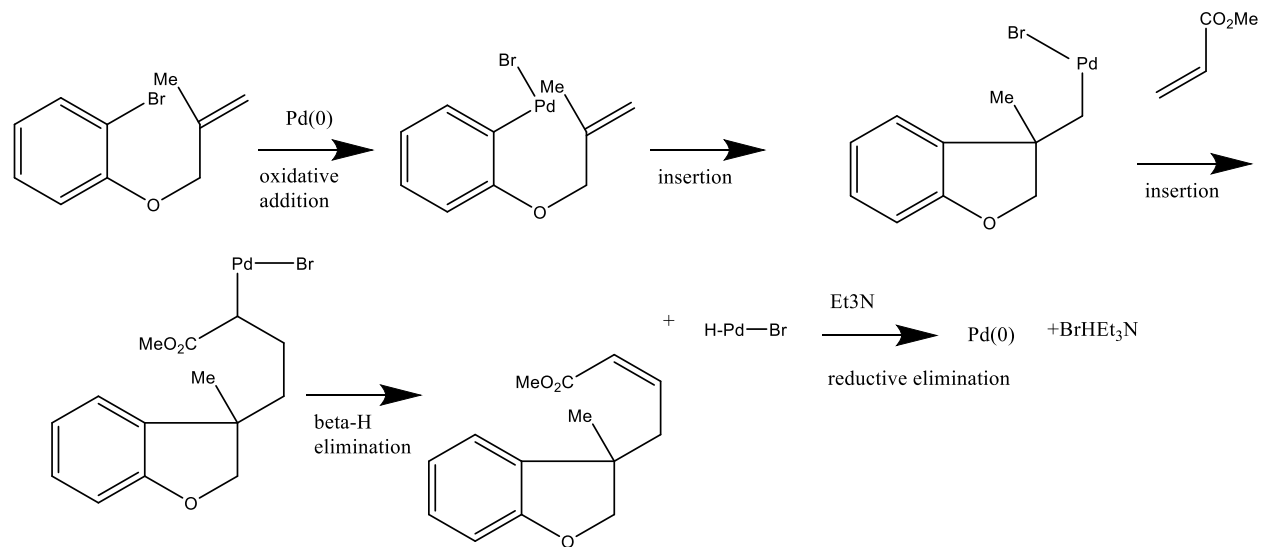


Answers: $A > C > B$

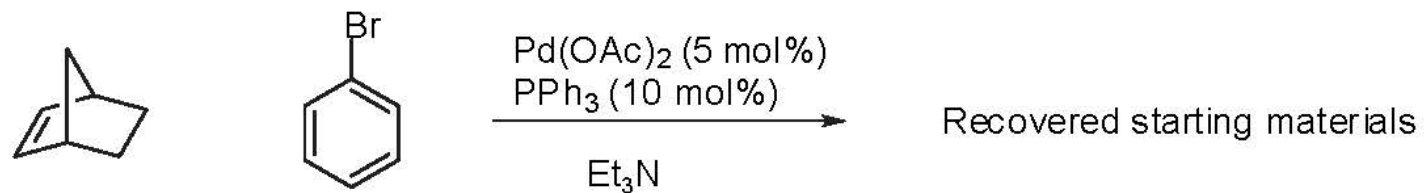
Explanation: (1) B is least active because NHC is hard to dissociate; in the Pd(0) complex there will be two NHC ligands, which is less active for oxidative addition than for A and C, where there will be just one NHC ligand. (2) The NHC ligand in C is less electron rich than in A, so oxidative addition is slower.

Provide a catalytic cycle for the following reaction.



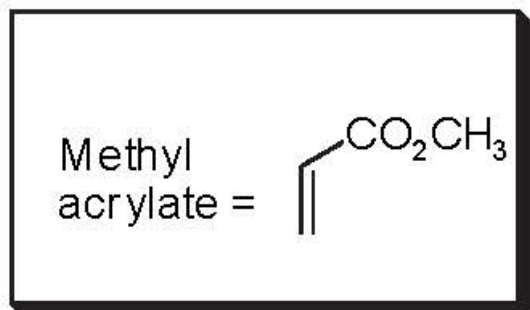


The following Heck coupling was attempted:



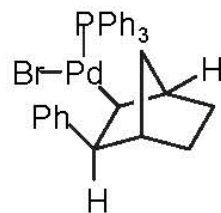
i) Provide a mechanistic explanation for the failure of this reaction.

ii) When methyl acrylate was added to the reaction mixture above, a new product was formed, in which the three organic components had been coupled. Draw the structure of this product and provide a mechanism for its formation.

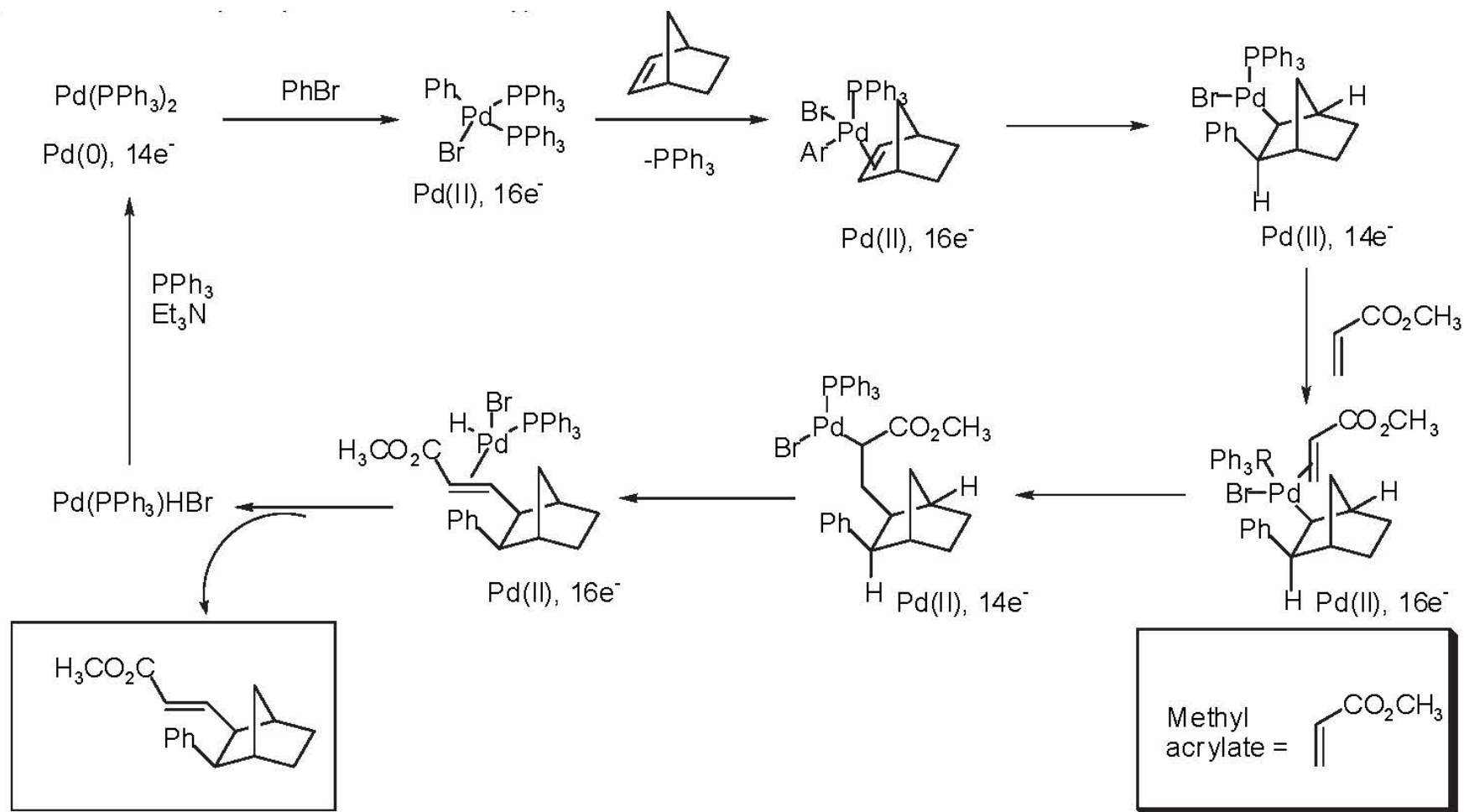


i) Provide a mechanistic explanation for the failure of this reaction.

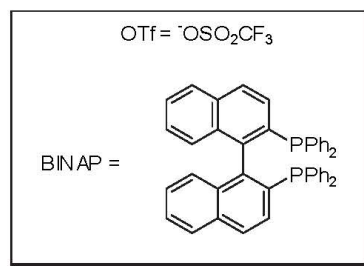
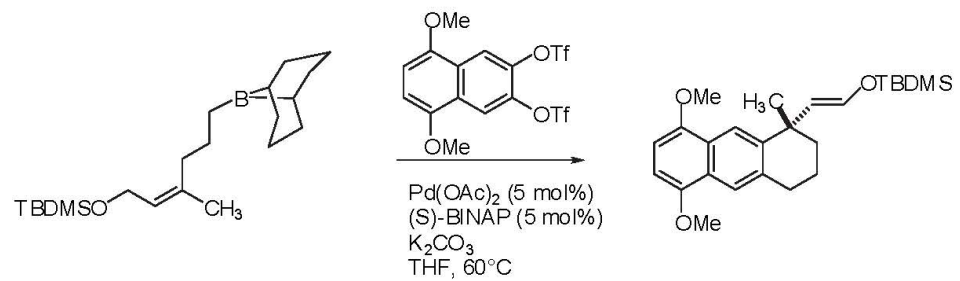
After oxidative addition of the aryl bromide and carbopalladation across the least hindered exo face of the olefin, the conformationally rigid bicyclic [2.2.1] structure prevents the bond rotation necessary to dispose a β -C-H bond in the syn-periplanar arrangement required for reductive elimination:



Thus, a productive reaction is not possible, and catalysis cannot be achieved.



. For the following reaction:



a. The reaction involves two types of cross-coupling reactions. What are they?

b. Please propose a mechanism for the reaction. You don't need to indicate oxidation state of Pd, nor rationalize the absolute stereochemistry obtained.

