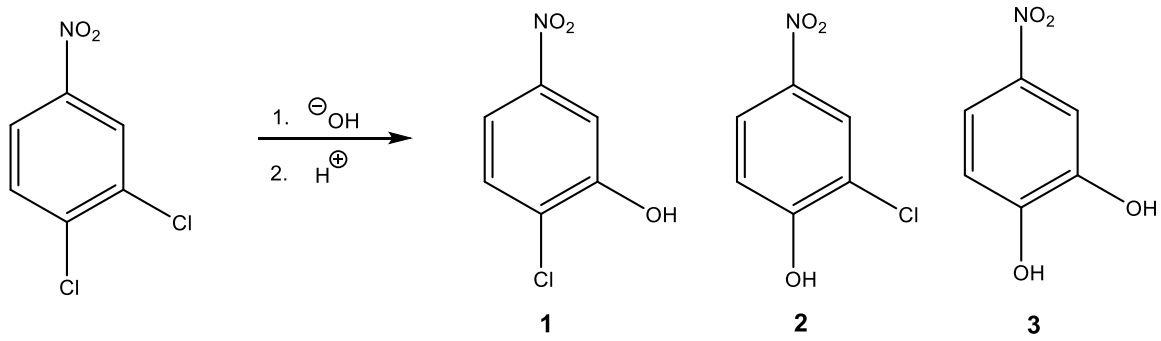
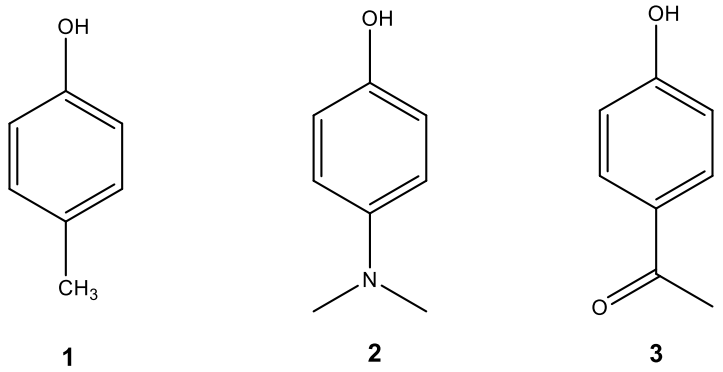
1. Select the major product(s) expected from the following nucleophilic aromatic substitution by an addition/elimination reaction.



1 **2** **3**

(A) 1 only (B) 2 only (C) 3 only (D) 1 and 2 (E) 1 and 3 (F) 2 and 3

2. Select the order that has the following phenols correctly arranged with respect to increasing acidity.



1 **2** **3**

(A) 1 2 3 increasing acidity

(B) 1 3 2 increasing acidity

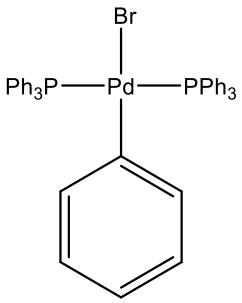
(C) 2 1 3 increasing acidity

(D) 2 3 1 increasing acidity

(E) 3 2 1 increasing acidity

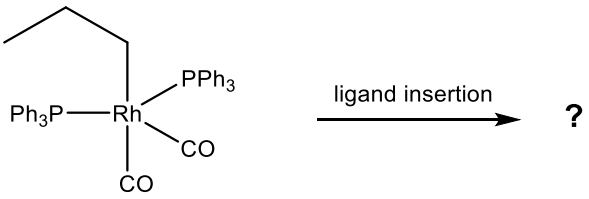
(F) 3 1 2 increasing acidity

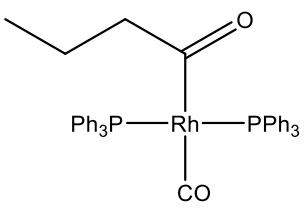
3. Select the correct number of valence electrons for the following metal complex.



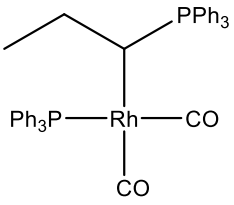
(A) 14 (B) 15 (C) 16 (D) 17 (E) 18 (F) 20

4. Choose the correct intermediate formed by a ligand insertion step from the intermediate shown.

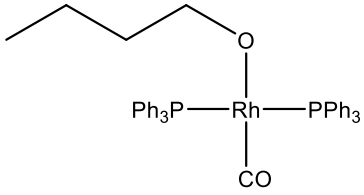




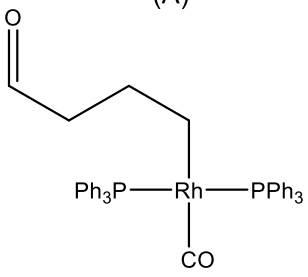
(A)



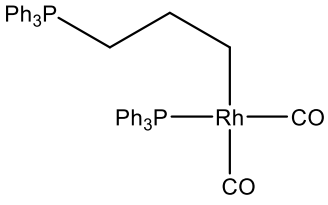
(B)



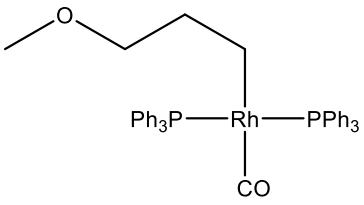
(C)



(D)

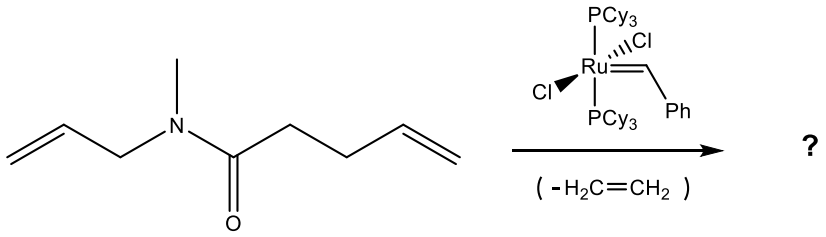


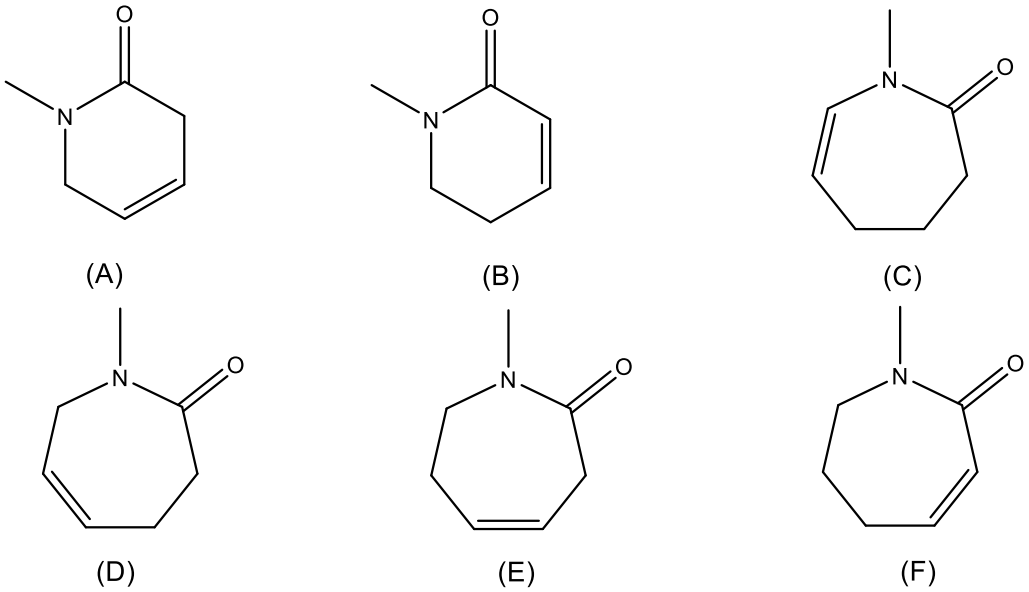
(E)



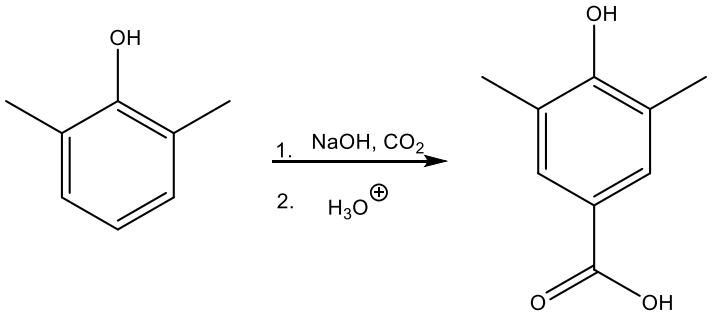
(F)

5. Select the major product of the following ring-closing metathesis reaction.

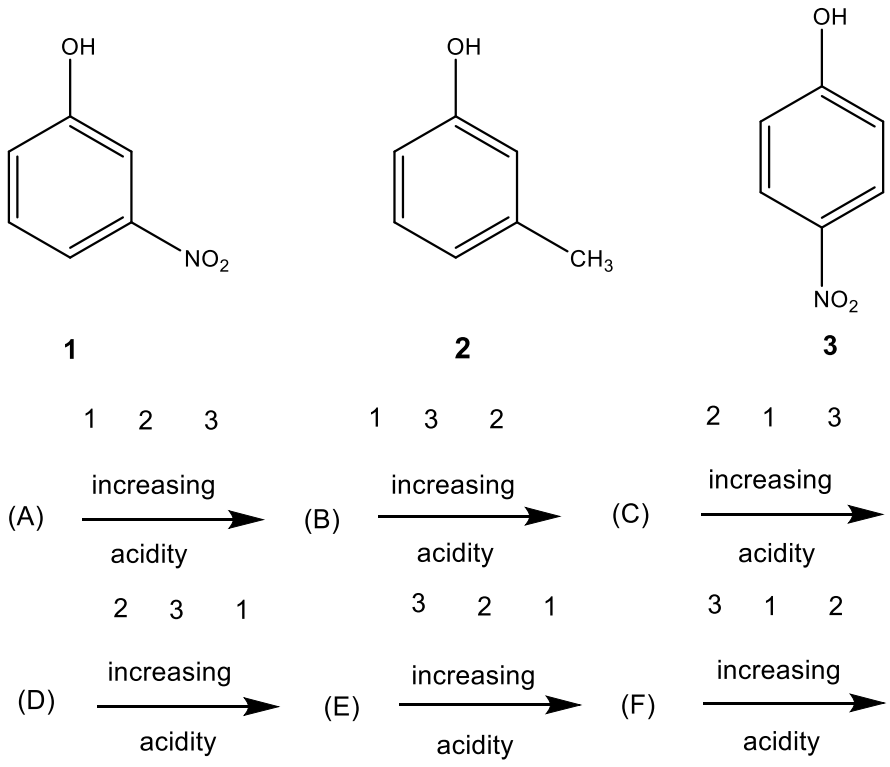




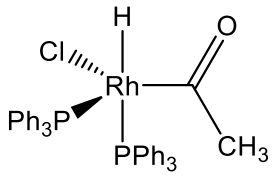
6. Using the curved arrow formalism, show all the bond making and bond breaking steps of the following reaction sequence. For full credit, draw out all important intermediates.



7. Select the order that has the following phenols correctly arranged with respect to increasing acidity.

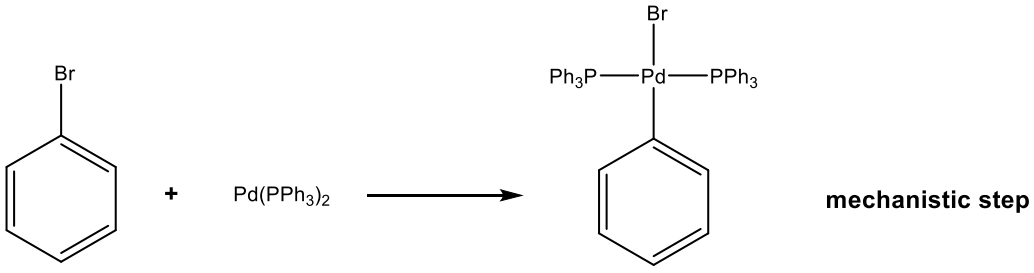


8. Choose the correct oxidation state of rhodium in the following compound.



(A) -2 (B) -1 (C) 0 (D) +1 (E) +2 (F) +3

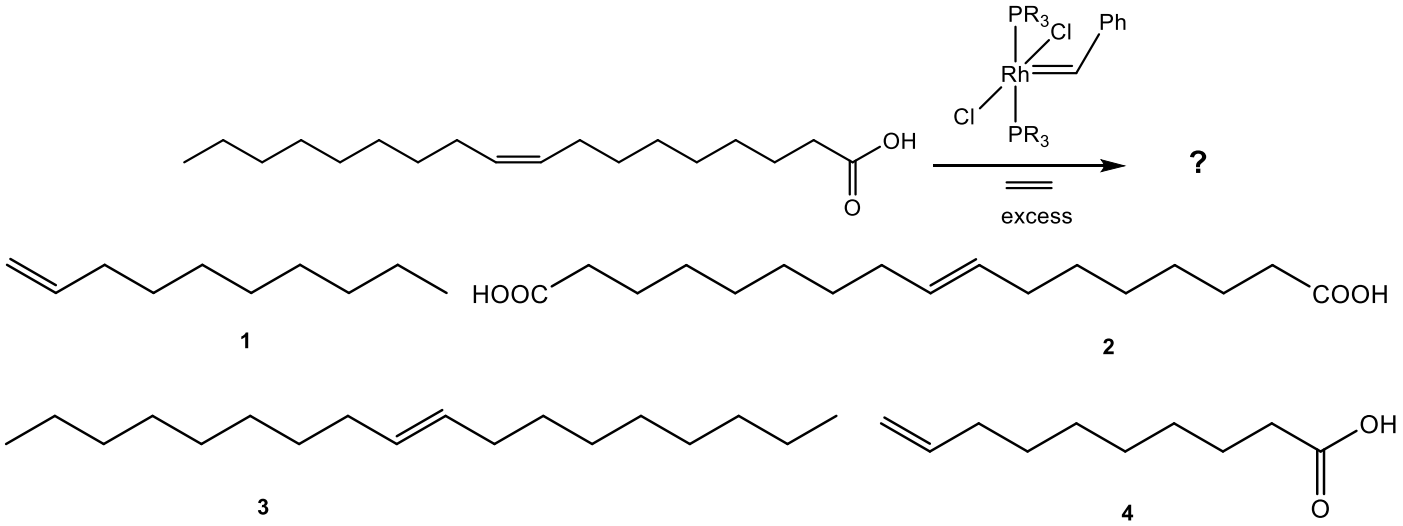
9. Choose the term that best describes the following mechanistic step in the Heck reaction.



mechanistic step

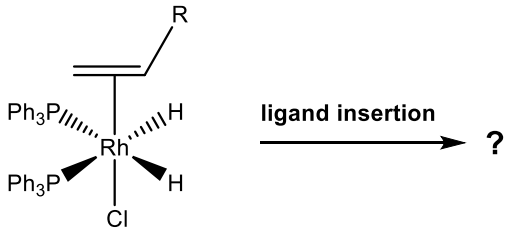
(A) Oxidative addition (C) Ligand association (E) Ligand insertion
(B) Reductive elimination (D) Ligand dissociation (F) Ligand deinsertion

10. Select the major product(s) of the following metathesis reaction.

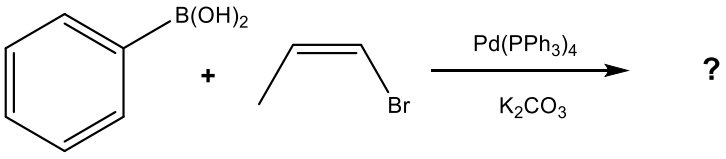


(A) 1 only (B) 2 only (C) 4 only (D) 1 and 4 (E) 2 and 3 (F) all of them

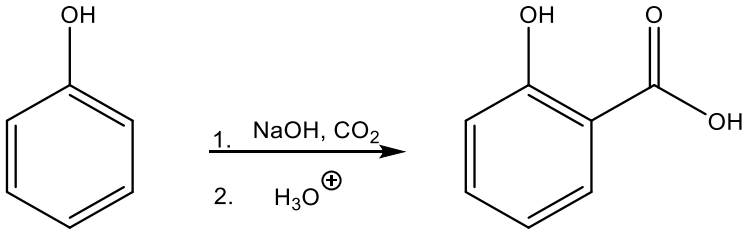
11. Draw the intermediate that results from the following ligand insertion step.



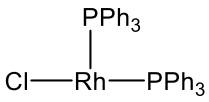
12. Predict and draw the major product of the following Suzuki reaction.



13. Using the curved arrow formalism, show all the bond making and bond breaking steps of the following reaction sequence. For full credit, draw out all important intermediates.

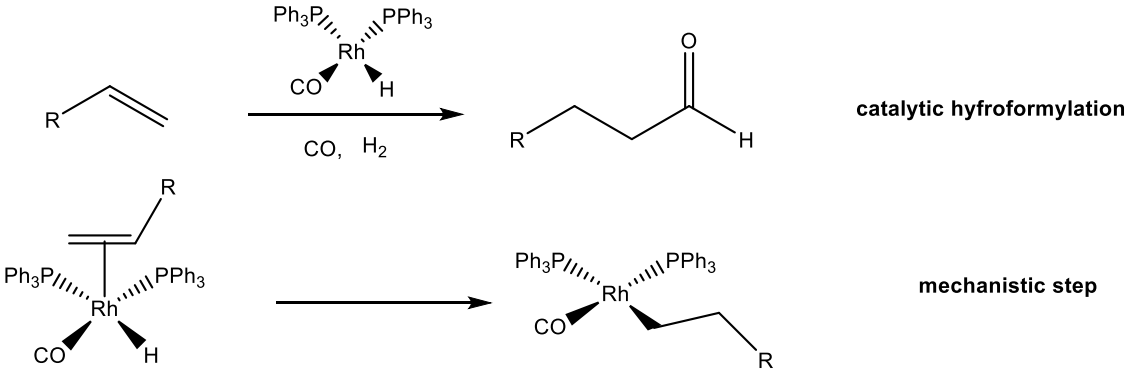


14. Choose the correct number of valence electrons rhodium has in the following compound.



(A) 14 (B) 15 (C) 16 (D) 17 (E) 18 (F) 19

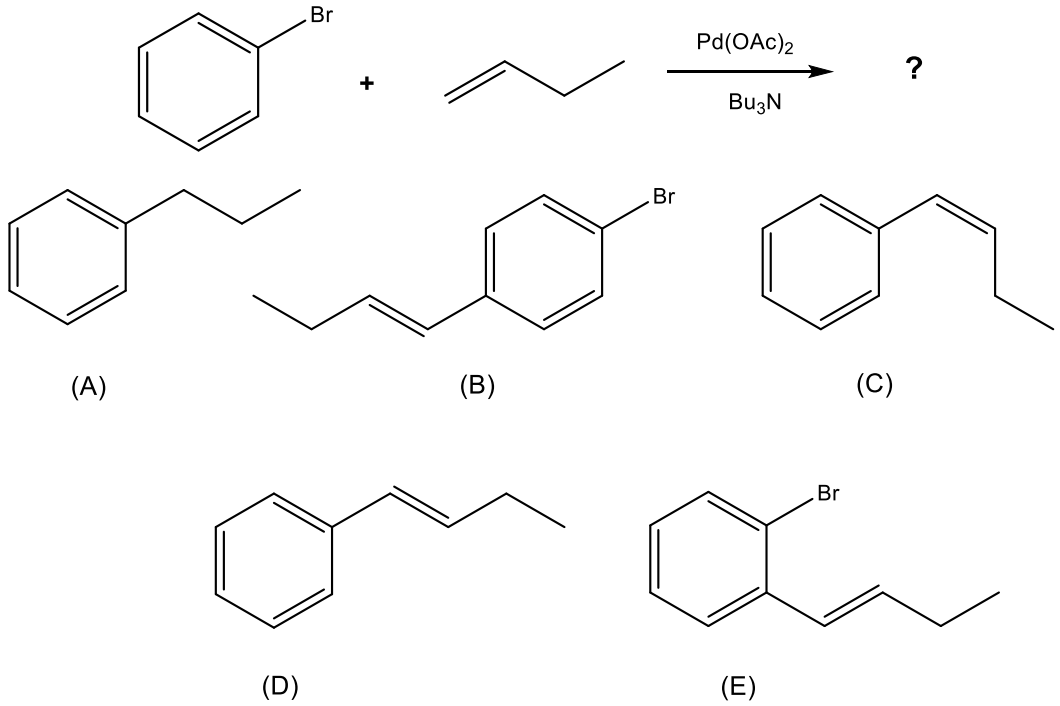
15. Choose the term that best describes the following mechanistic step in a process known as catalytic hydroformylation shown below.



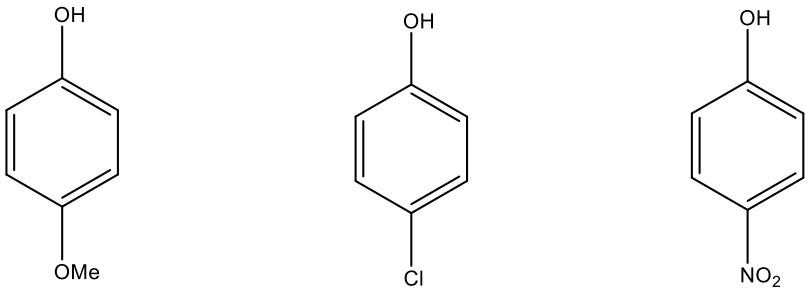
(A) Oxidative addition (C) Ligand association (E) Ligand insertion

(B) Reductive elimination (D) Ligand dissociation (F) Ligand deinsertion

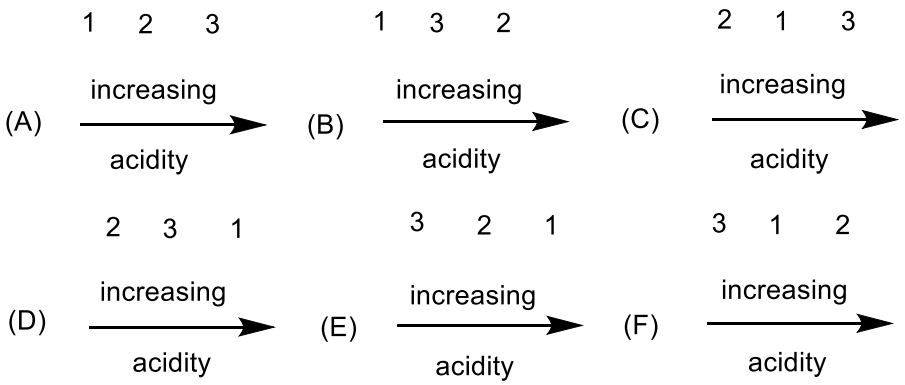
16. Select the major product of the following Heck reaction.



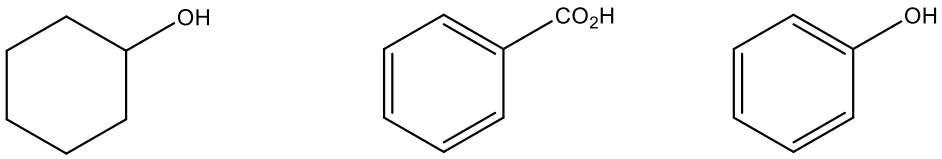
17. Choose the order that has the following phenols correctly arranged with respect to increasing acidity.



(see next page for answer choices)

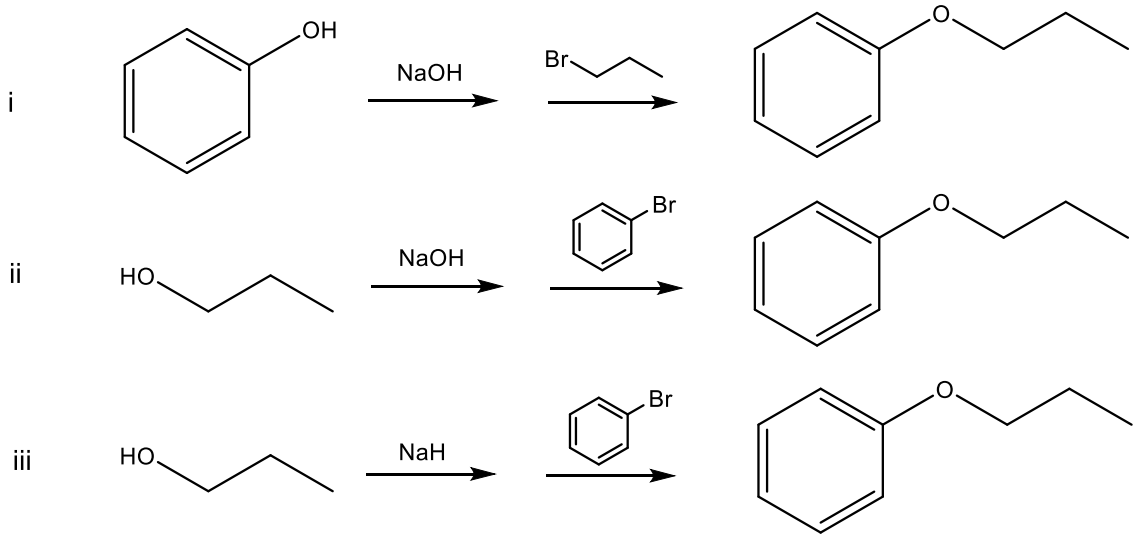


18. Which of the three compounds is the most acidic?



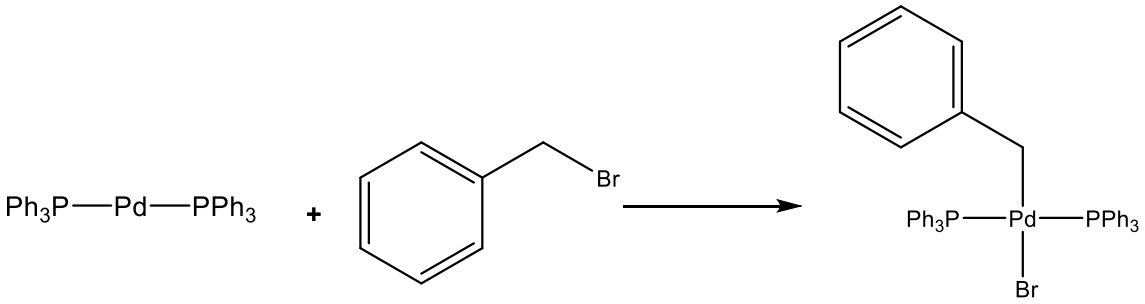
(A) (B) (C)

19. Here are three possible syntheses of phenylpropylether. Which ones would work?



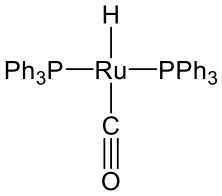
(A) i only (B) iii only (C) ii or iii (D) i or iii (E) i or ii or iii

20. Organometallic reactions can be classified into fundamental reaction types. Classify the following reaction.



(A) Ligand association
(B) Ligand insertion
(C) Ligand dissociation
(D) Reductive elimination
(E) Oxidative addition

21. What is the electron count for the following transition metal complex?



(A) 14 (B) 15 (C) 16 (D) 17 (E) 18

22. Use your knowledge of organometallic chemistry to propose a synthesis of the compound shown below. Your carbon starting materials may include 1, 2-dibromobenzene and any other carbon containing compounds of four carbons or less.