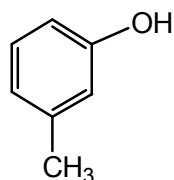




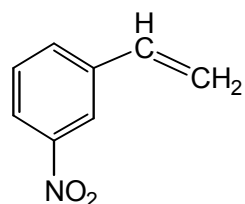
I. Multiple choice questions. (3 points each). Please put your answers on Scantron sheet. Your score will be graded based only on your answers from Scantron sheet.

1. What is the name for the following compound?



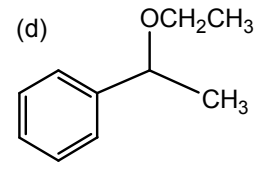
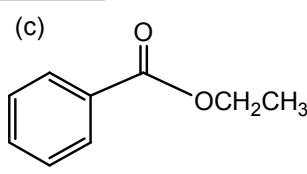
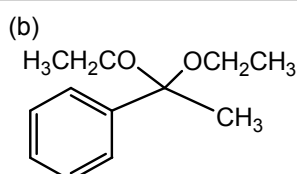
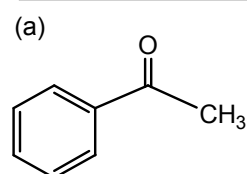
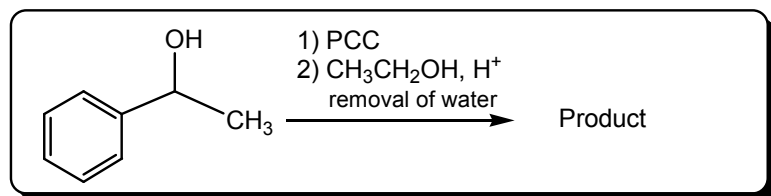
- (a) *p*-methylphenol
- (b) *m*-methylphenol
- (c) *o*-methylanisole
- (d) 3-methylanisole
- (e) None of the above

2. What is the name for the following compound?



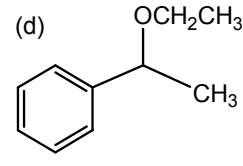
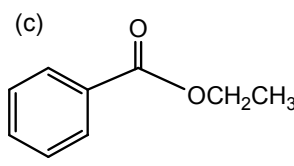
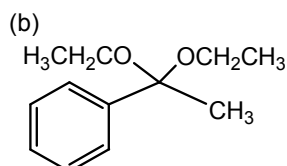
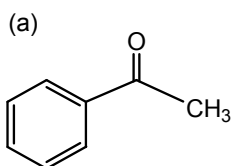
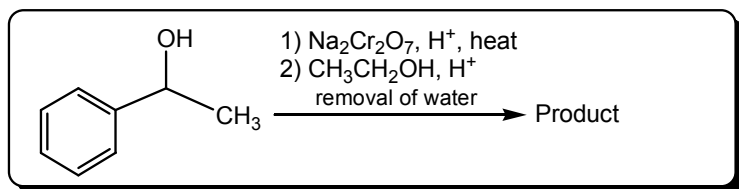
- (a) *p*-aminotoluene
- (b) *m*-nitrotoluene
- (c) *m*-nitrostyrene
- (d) 3-aminostyrene
- (e) None of the above

3. What could be the product for the following reaction?



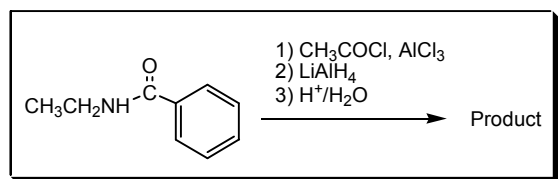
(e) none of the above

4. What could be the product for the following reaction?



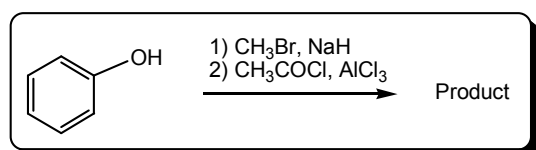
(e) none of the above

5. What could be the product for the following reaction?



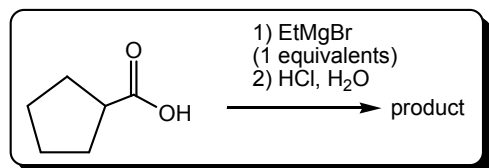
- (a) CCNC(=O)c1ccc(O)cc1 (b) CCNC(=O)c1ccc(O)cc1
- (c) CCNC(=O)c1ccc(O)cc1 (d) CCNC(=O)c1ccc(O)cc1
- (e) none of the above

6. What could be the product for the following reaction?



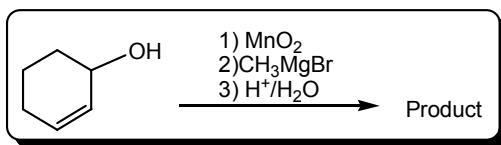
- (a) CC(=O)c1ccccc1O (b) CC(=O)c1ccc(OC)cc1
- (c) OC(=O)c1ccc(O)cc1 (d) OC(=O)c1ccc(OC)cc1
- (e) none of the above

7. What could be the product for the following reaction?



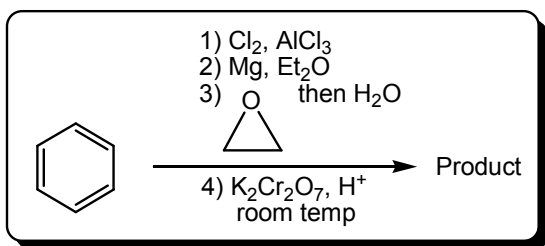
- (a) OC(=O)C1CCCC1 (b) OC(O)C1CCCC1 (c) OC(O)C1CCCC1 (d) OC(O)C1CCCC1
- (e) none of the above

8. What could be the product for the following reaction?



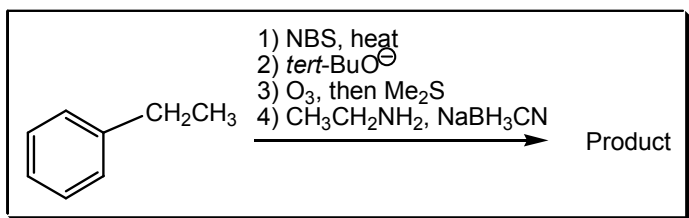
- (a) OC1=CCCCC1 (b) OC1=CCCCC1 (c) O=C1C=CCCC1 (d) O=C1C=CCCC1
- (e) none of the above

9. What could be the product for the following reaction?



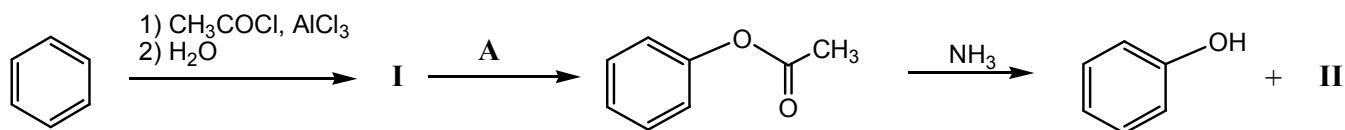
- (a) c1ccccc1CC=O (b) c1ccccc1CCO  
 (c) c1ccccc1CC(=O)O (d) c1ccccc1C(=O)O  
 (e) none of the above

10. What could be the product for the following reaction?



- (a) c1ccccc1C(C)Br (b) c1ccccc1CN (c) c1ccccc1C=O (d) c1ccccc1C(=O)NCC  
 (e) none of the above

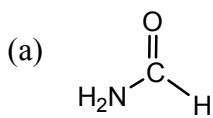
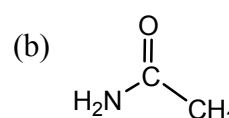
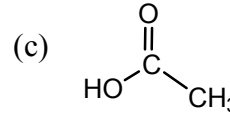
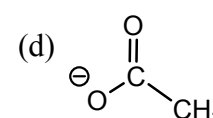
Answer Q.11 to Q.13 according to the following synthetic scheme:



11. What could be the structure of compound **I**?

- (a) c1ccccc1C=O (b) c1ccccc1C(=O)C (c) c1ccccc1C(=O)O (d) c1ccccc1O  
 (e) None of the above

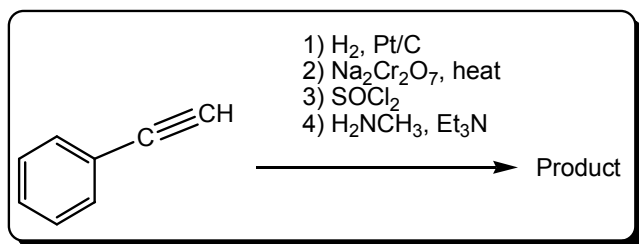
12. What could be the structure of compound **II**?

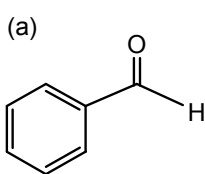
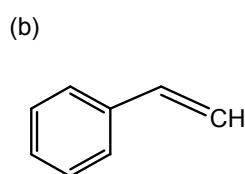
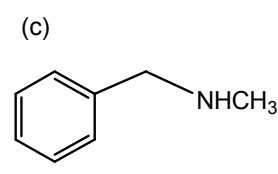
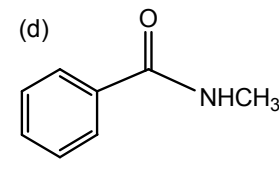
- (a)  (b)  (c)  (d) 
- (e) None of the above

13. What could be the structure of reagent **A**?

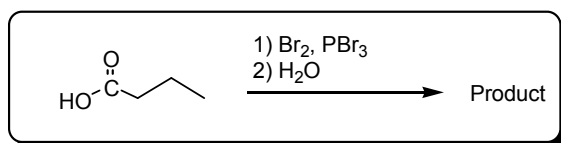
- (a)  $\text{KMnO}_4$ , heat  
(b)  $\text{O}_3$  then  $\text{H}_2\text{O}_2$   
(c)  $\text{OsO}_4$ ,  $\text{KIO}_4$   
(d)  $\text{PhCO}_3\text{H}$   
(e) None of the above

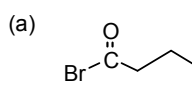
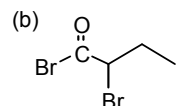
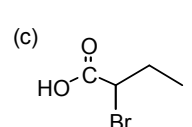
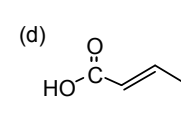
14. What could be the product for the following reaction?



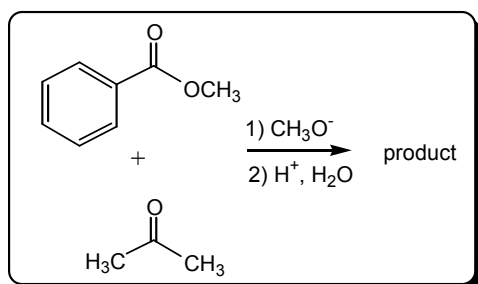
- (a)  (b)  (c)  (d) 
- (e) none of the above

15. What could be the product for the following reaction?



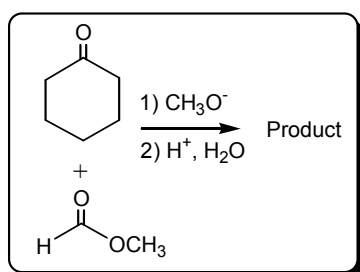
- (a)  (b) 
- (c)  (d) 
- (e) none of the above

16. What could be the product for the following reaction?



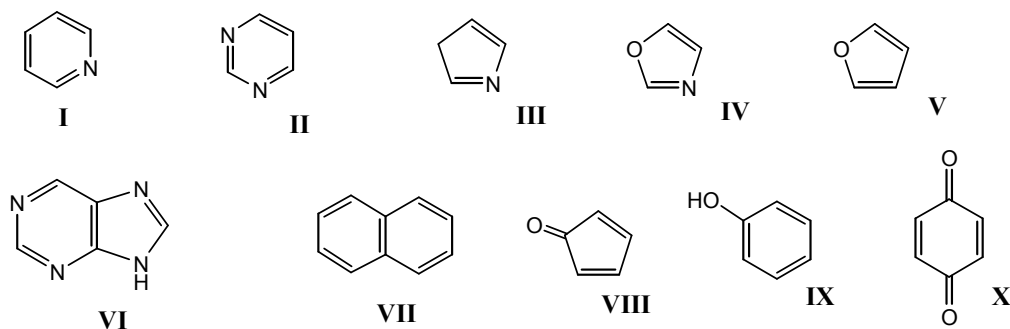
- (a)
- (b)
- (c)
- (d)
- (e) None of the above

17. What could be the product for the following reaction?



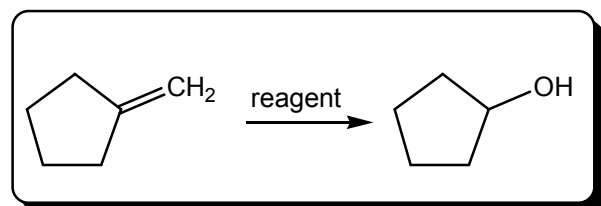
- (a)
- (b)
- (c)
- (d)
- (e) none of the above

18. Which of the following compounds are aromatic?



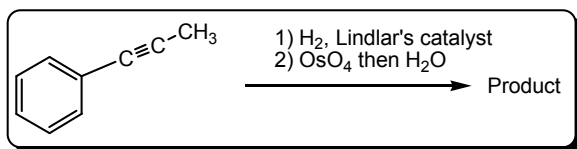
- (a) I, II, III, IV, V, VI, VIII, IX, X
- (b) I, II, IV, V, VI, VII, IX
- (c) I, II, III, IV, V, VI, VII, X
- (d) I, II, IV, V, VI, VII, VIII
- (e) None of the above

19. Which one of the reagents could be used for the following transformation?



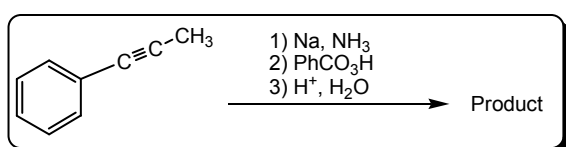
- (a)  $\text{O}_3$  then  $\text{NaBH}_4$
- (b)  $\text{O}_3$  then  $\text{H}_2\text{O}_2$
- (c)  $\text{OsO}_4$  then  $\text{HIO}_4$
- (d)  $\text{KMnO}_4$ , heating
- (e) none of the above

20. What could be the product for the following reaction?



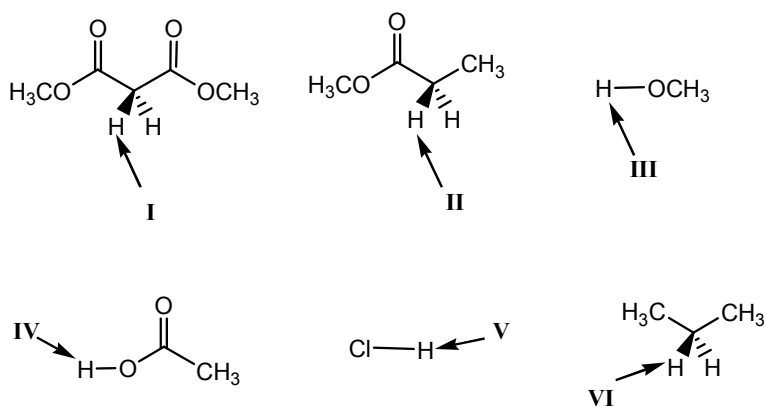
- (a)
- (b)
- (c)
- (d)
- (e) none of the above

21. What could be the product for the following reaction?



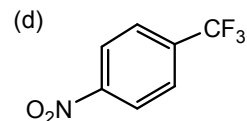
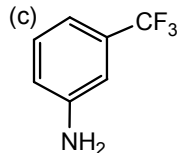
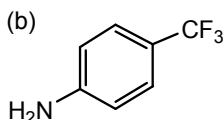
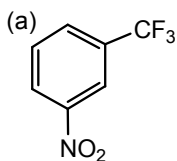
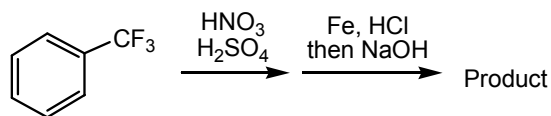
- (a)
- (b)
- (c)
- (d)
- (e) none of the above

22. What is the correct order of decreasing acidity (strongest to weakest) for the protons indicated by arrow in the following compounds?



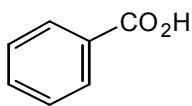
- (a)  $\text{V} > \text{IV} > \text{III} > \text{II} > \text{I} > \text{VI}$
- (b)  $\text{V} > \text{II} > \text{III} > \text{IV} > \text{I} > \text{VI}$
- (c)  $\text{V} > \text{IV} > \text{I} > \text{III} > \text{II} > \text{VI}$
- (d)  $\text{V} > \text{III} > \text{I} > \text{IV} > \text{II} > \text{VI}$
- (e) None of the above

23. What could be the major product for the following reaction?

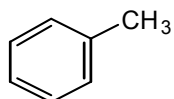


(e) none of the above

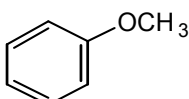
24. What is the correct order of decreasing reactivity (fastest to slowest) toward the electrophilic aromatic substitution for the following compounds?



I



II



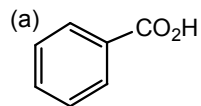
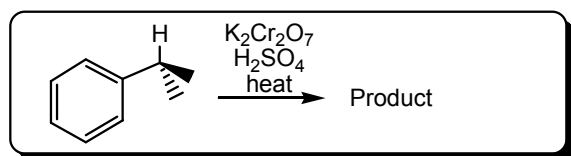
III



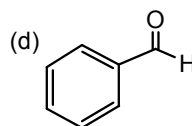
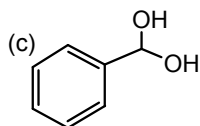
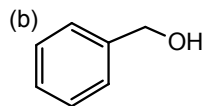
IV

- (a) I>II>III>IV  
 (b) II>I>IV>III  
 (c) III>II>IV>I  
 (d) IV>III>II>I  
 (e) None of the above

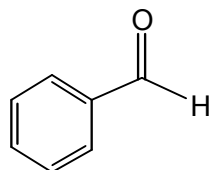
25. What could be the product for the following reaction?



(e) none of the above

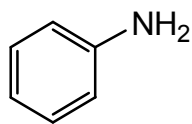


26. What is the name for the following compound?



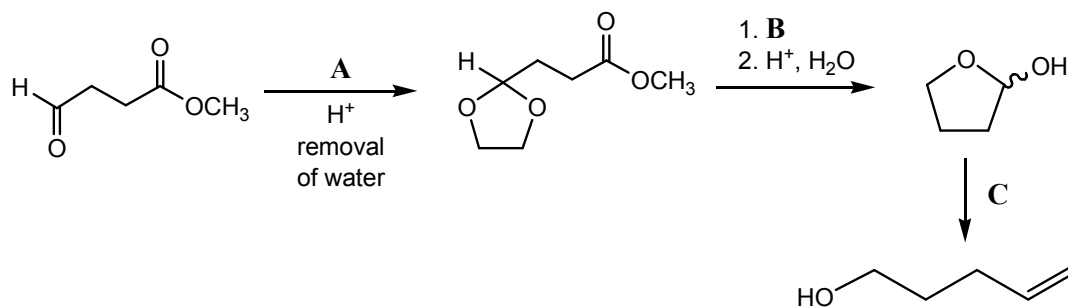
- (a) benzaldehyde  
 (b) benzylcarbonyl  
 (c) phenylaldehyde  
 (d) phenylketone  
 (e) None of the above

27. What's the name for the following compound?



- (a) Toluene
- (b) Styrene
- (c) Aniline
- (d) Anisole
- (e) None of the above

Answer Q.28 to Q.30 according to the following synthetic scheme:



28. What could be reagent **A**?

- (a)  $\text{CH}_3\text{OH}$
- (b)  $\text{CH}_3\text{CH}_2\text{OH}$
- (c)  $\text{HOCH}_2\text{CH}_2\text{OH}$
- (d)  $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH}$
- (e) None of the above

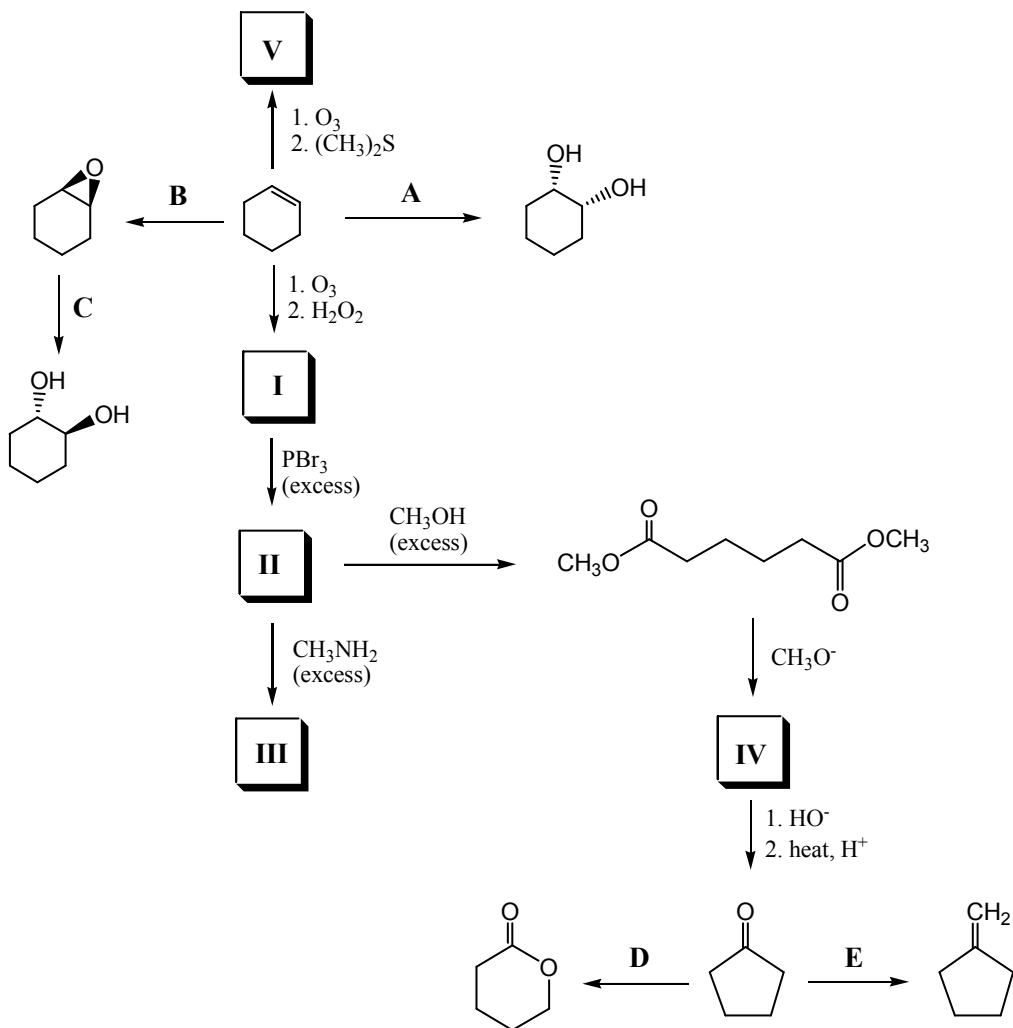
29. What could be reagent **B**?

- (a)  $\text{H}_2$ , Pt/C
- (b)  $\text{LiAlH}_4$  then  $\text{H}^+$ ,  $\text{H}_2\text{O}$
- (c)  $\text{CH}_3\text{MgBr}$  (2 equivalents)
- (d)  $\text{RCO}_3\text{H}$
- (e) None of the above

30. What could be reagent **C**?

- (a)  $\text{Ph}_3\text{PCH}_2$
- (b)  $\text{OsO}_4$ ,  $\text{KIO}_4$
- (c)  $\text{O}_3$  then Zn
- (d)  $\text{HSCH}_2\text{CH}_2\text{SH}$  then Raney Nickel
- (e) None of the above

II. Use the provided table (next page) and fill in compound structures and reagents for the following synthesis. Make sure your answer is correctly put in the designated box of the given table. **No partial point will be given for the misplaced answer.** (20 points)

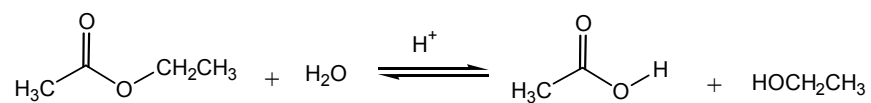


|           |           |           |
|-----------|-----------|-----------|
| <b>A:</b> | <b>B:</b> | <b>C:</b> |
| <b>D:</b> | <b>E:</b> | <b>F:</b> |
| <b>G:</b> | <b>H:</b> | <b>I:</b> |
| <b>J:</b> |           |           |

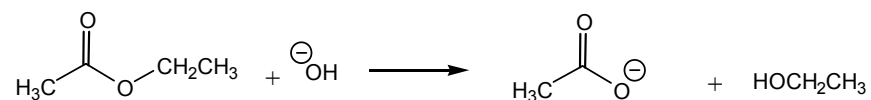
**Continue to the next page**

III. Propose an electron-pushing mechanism for each of the following reactions. Briefly explain why the hydrolysis of ester in acidic condition is reversible (reaction a) while in basic condition (reaction b) is irreversible. (10 points)

(a)

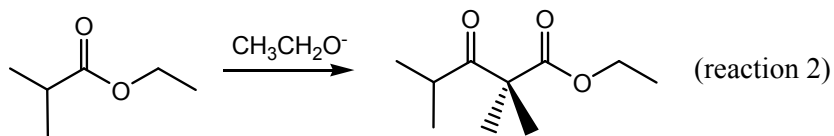
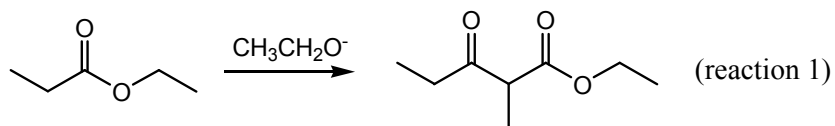


(b)



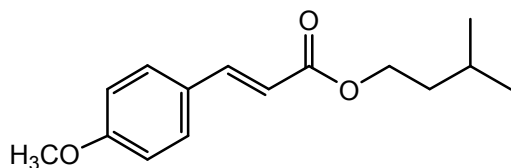
**Continue to the next page**

IV. Propose an electron pushing mechanism for **reaction 1 only**. For the following two Claisen condensations, briefly explain why the yield for reaction 1 could be much better than that of reaction 2 (10 points)



**Continue to the next page**

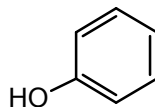
V. Propose a synthesis for the following compound (Isoamyl methoxycinnamate) from the provided starting materials. You can use any reagents, acids, or bases you have learned but you can **only** use the provided starting materials. (10 points)



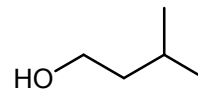
**Isoamyl methoxycinnamate**

(new sunscreen waiting for FDA approval)

From



CH<sub>3</sub>Br



CO<sub>2</sub>

CH<sub>3</sub>CO<sub>2</sub>H

**Continue to the next page**

VI. **Bonus Points:** propose a correct structure based on the following spectroscopic information (next two pages). Put all your analysis and answer on this page (page 15). The grading will base only on your analysis and answer of this page. (10 points)