Chemistry 337/400 Summer 2021
Final Exam Study Guide

Exam Logistics

- The exam will be available in the **Final Exam Items** module between 2 pm Pacific Time Thursday July 15 and 2 pm Pacific Time Friday July 16.
- You will take the exam within the context of OSU's Code of Student Conduct.
- The exam is closed book and un-proctored that you will take in the location of your choice.
- The exam is 80 minutes in duration (120 minutes for students with a DAS approved 1.5X extra time factor).
- The exam is timed and must be completed in a single seating.
- You may start the exam at any time between 2 pm Pacific Time Thursday July 15 and 12:40 pm Pacific Time Friday July 16 and still have the full 80 minutes to complete and submit the exam. If you start the exam after 12:40 pm Pacific Time Friday July 16 the exam will still terminate at 2 pm Pacific Time Friday July 16.
- Regarding students with a DAS approved 1.5X extra time factor. You may start the exam at any time between 2 pm Pacific Time Thursday July 15 and 12 pm Pacific Time Friday July 16 and still have the full 120 minutes to complete and submit the exam. If you start the exam after 12 pm Pacific Time Friday July 16 the exam will still terminate at 2 pm Pacific Time Friday July 16.
- Permitted items are limited to (a) scratch papers (b) a calculator (scientific, graphing or basic) (c) a molecular model set. No other items are permitted.
- Relevant molecular weights will be provided within the exam in lieu of a periodic table.
- Structures of relevant amino acids, along with their names, name abbreviations, and respective pKa values, will be provided within the exam.
- The exam consists of a multiple-choice/fill-in-the-blank Part A and a draw/take a photo/upload Part B, both combined into a single Canvas portal.
- If you experience a momentary loss of internet connectivity during the exam, please refresh your browser. This should allow you to resume the exam where you left off.

Details of Exam Questions

The 20-question exam covers Units 6, 8, 9, 10, 13 and 14. It consists of a multiple-choice/fill-in-the-blank Part A and a draw/take a photo/upload Part B. Part A is worth 16 pts and Part B is worth 9 pts, for a grand total of 25 pts.

Other Items to Review in Preparation for the Final Exam

The "Solved questions" for Units 6, 8, 9/10, 13 and 14 found on Canvas. The solutions to Lab reports 6, 8 and 9/10.

Part A of the Final Exam / Allocation of questions

Three of the eleven "General questions" (found on page 2 of this document) will appear on the final exam. Each question is worth 0.9 pts.

Two of the eleven items in "Table 1" (found on page 3 of this document) will appear on the final exam. You will be asked to identify them. Each question is worth 0.8 pts.

Four questions (drawn from questions A1 through A7 of this document) will be selected and modified using different structural formulas, numerical values, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.3 pts.

Two questions (drawn from questions A8 through A16 of this document) will be selected and modified using different structural formulas, solvent systems, numerical values, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.3 pts.

One question (drawn from questions A17 through A21 of this document) will be selected and modified using different structural formulas, numerical values, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.3 pts.

Two questions (drawn from questions A22 through A31 of this document) will be selected and modified using different structural formulas, numerical values, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.3 pts.

Part B of the Final Exam / Allocation of questions

Two questions (drawn from B through B4 of this document) will be selected and modified using different structural formulas, reaction conditions, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.5 pts.

Two questions (drawn from B5 through B14 of this document) will be selected and modified using different structural formulas, reaction conditions, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.5 pts.

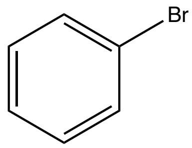
Two questions (drawn from B15 through B17 of this document) will be selected and modified using different structural formulas, reaction conditions, etc for placement on the final exam. The theme of each selected question will be retained. Each question is worth 1.5 pts.

"Practice exam questions" for Part A of the Final Exam

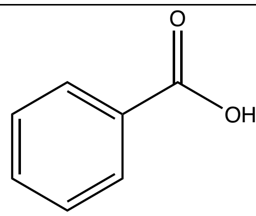
General questions

1. In liquid-liquid extraction what governs the distribution of the solutes between the aqueous phase and the organic phase?
2. In liquid-liquid extraction which layer is always the lower layer?
3. Why must extraction mixtures be vented?
4. What three advantages are associated with the TLC technique?
5. What types of compounds are bound weakly to TLC adsorbents?
6. What types of compounds are bound strongly to TLC adsorbents?
7. What two limitations are associated with gas-liquid chromatography?
8. What three pieces of information are provided in the data table of a gas chromatogram?
9. What must be available in order for GC analysis to permit compound identification?
10. What conditions are employed to "completely" hydrolyze a peptide?
11. An enzyme that catalyzes the hydrolysis of a peptide bond at the end of the peptide chain is called?

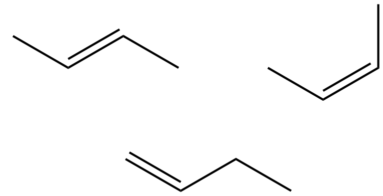
Table 1



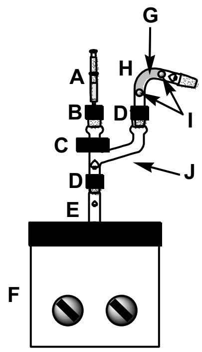
bromobenzene



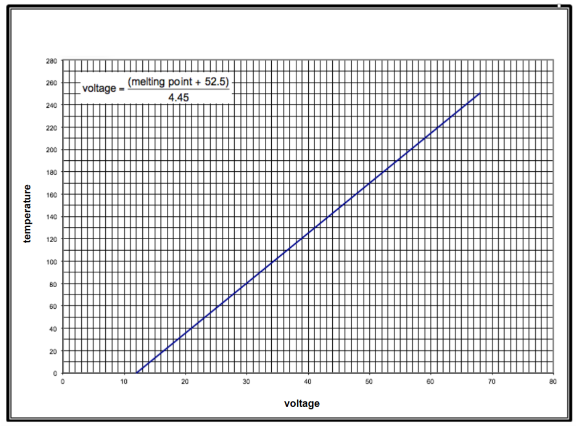
benzoic acid



isomeric butenes

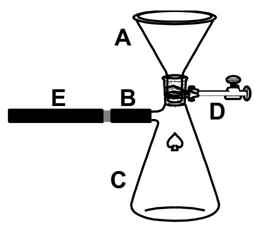


Unit 6 rection apparatus

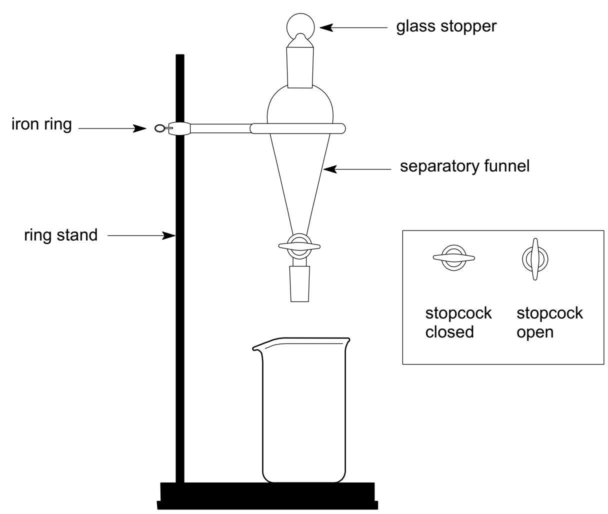


graph for calculating MelTemp voltage settings

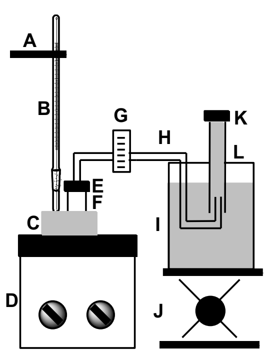
MelTemp device



vacuum filtration apparatus



liquid-liquid extraction apparatus

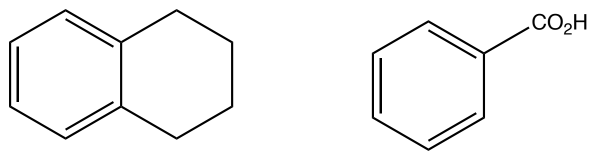


Units 9/10 reaction apparatus

A1. The value of K (aka K_p) @ 25ºC for compound **A** when partitioned between water and cyclohexane is 13.4. Starting with a solution of 15.2 g of compound **A** in 75 mL of water what mass of compound **A** would remain in the water layer after **two** successive extractions with cyclohexane each using 90 mL of cyclohexane?

A2. Calculate K (aka K_P) given that the solubilities of compound **B** are 11.3 g in 100 mL of water and 33.7 g in 100 mL of methylene chloride (CH_2Cl_2).

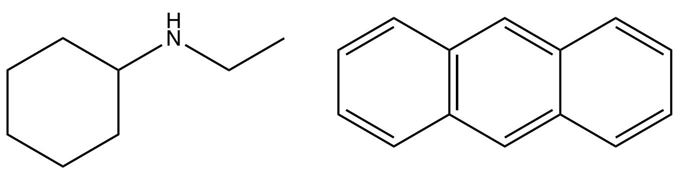
A3. Assemble a flowchart that outlines, with appropriate reagents and structures, how compound **C** can be separated from compound **D**. The end goal is to have two separate solutions, one of compound **C** in diethyl ether and the other of compound **D** in diethyl ether.



C **D**

in diethyl ether

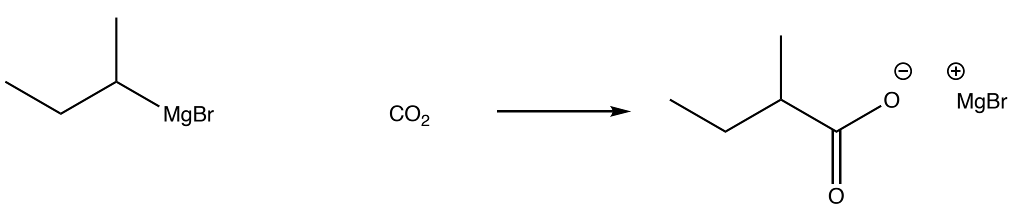
A4. Assemble a flowchart that outlines, with appropriate reagents and structures, how compound **E** can be separated from compound **F**. The end goal is to have two separate solutions, one of compound **E** in chloroform ($CHCl_3$) and the other of compound **F** in chloroform.



E **F**

in chloroform

A5. What quantity of carbon dioxide **H** (in grams) would be required to convert 18.6 g of *sec*-butylmagnesium bromide **G** to carboxylate **I**?



sec-butylmagnesium bromide **G**

carbon dioxide **H**

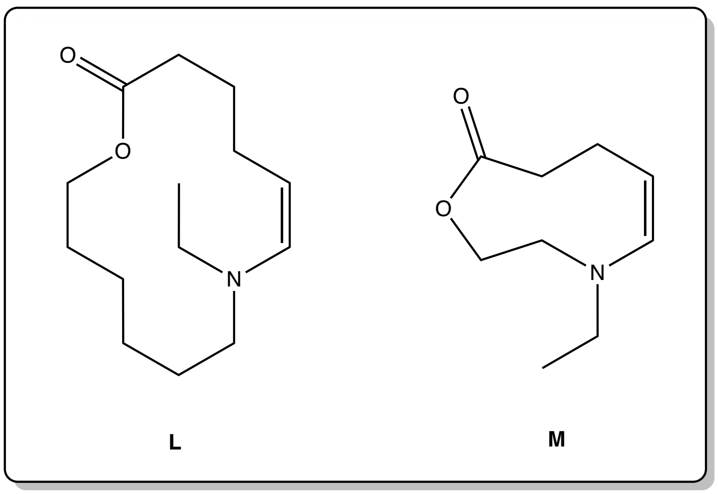
I

A6. The value of K (aka K_P) @ 25 °C for compound **J** when partitioned between water and dichloromethane (CH_2Cl_2) is 17.2. Starting with a solution of 2.15 g of compound **J** in 70.0 mL of water what mass of compound **J** would be extracted from the water after ***two*** successive extractions with dichloromethane (each using 35.0 mL of dichloromethane)?

A7. The value of K (aka K_p) 25°C for compound **K** when partitioned between water and benzene is 11.3. Starting with a solution of 215 g of compound **K** in 745 mL water what volume of benzene (in mL) would be required (in the context of a single extraction protocol) to extract 75.5 g of compound **K** from the original aqueous solution?

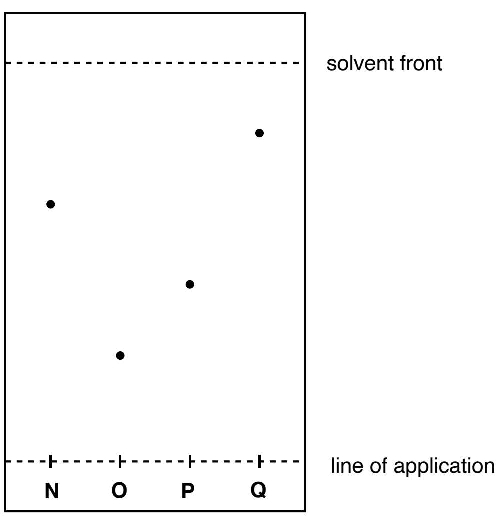
A8. A recent article from the scientific literature reports that the R_f values of compounds **L** and **M** are 0.41* and 0.46*, respectively. What can one conclude about the relative polarities of these compounds?

*solvent system was 33 % ethyl acetate in hexanes

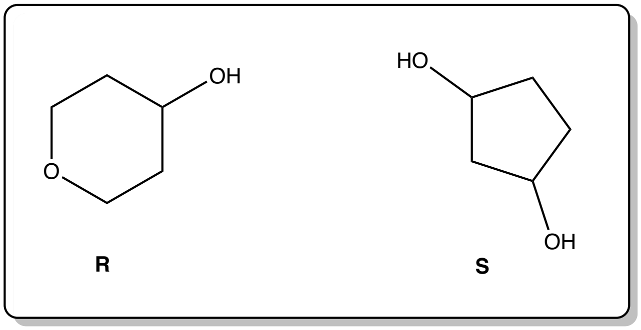


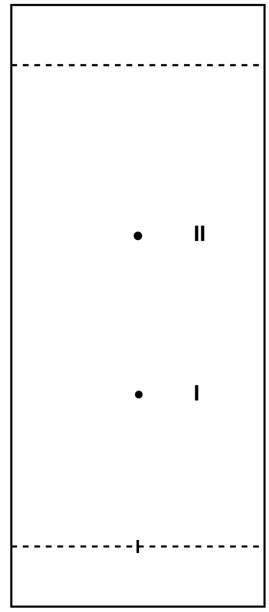
A9. Consider the developed TLC plate depicted below.

a) What is the R_f value of compound **P**?
b) Which compound is the most polar?



A10. A mixture of compounds **R** and **S** were analyzed by TLC (the developed chromatogram is provided below).





a) Which compound is responsible for spot **I**?
b) Which compound is responsible for spot **II**?

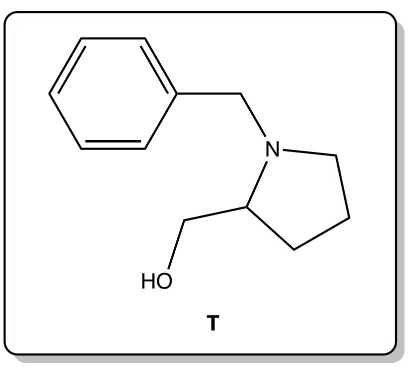
A11. What is the stationary phase in TLC?

A12. What is the mobile phase in TLC?

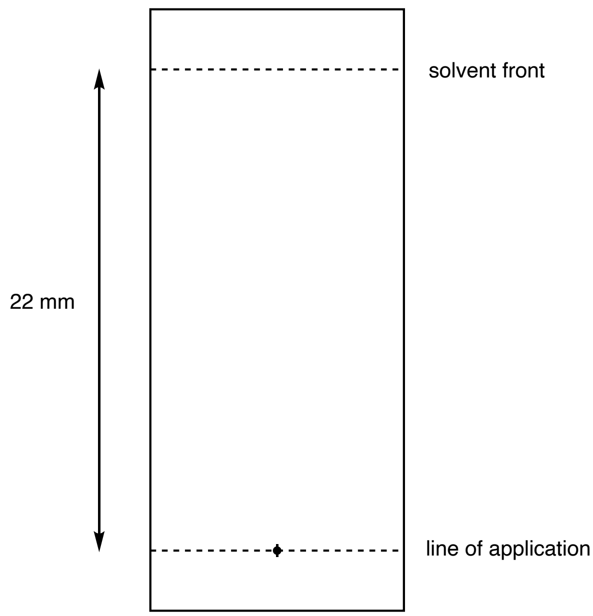
A13. What types of compounds move up the TLC plate at the slowest rate?

A14. The R_f value of a certain compound was found to be 0.361. Assuming the compound traveled up the TLC plate a distance of 29.8 mm during development what was the solvent front (in mm)? Please show your work.

A15. TLC analysis of compound **T**, using diethyl ether as solvent, resulted in no migration of the compound from its original point of application. What solvent would one try next? Briefly explain your reasoning.



A16. A small quantity of compound **U** was applied to the mid-point of the following TLC plate's line of application (drawing is not to scale). After development of this plate by a suitable solvent, compound **U** was determined to have an R_f value of 0.20. Once the solvent had evaporated from the TLC plate it was ***re-developed*** using the same solvent as before. What distance (in mm) did compound **U** travel during the second development? Please show your work.

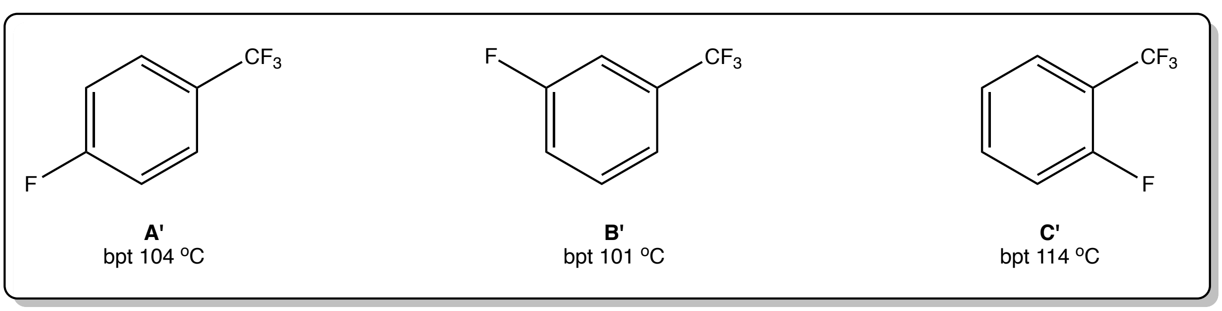


drawing is not to scale

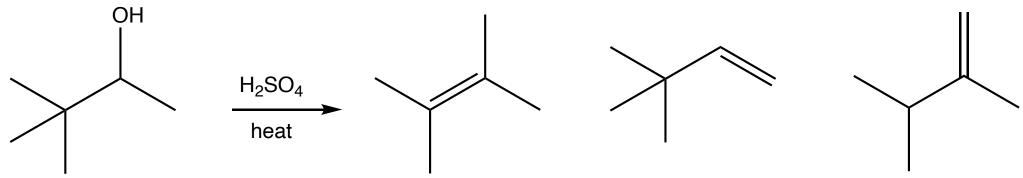
A17. Which would you expect to have the shorter retention time, hexane (boiling point 69°C) or toluene (boiling point 111°C)?

A18. What mobile phase was used during our GC analysis of the butene products from Units 9 and 10?

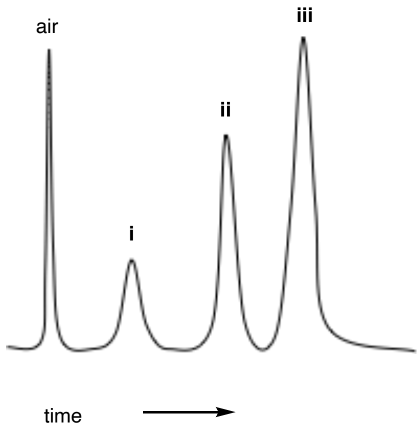
A19. Rank the following compounds in order of relative GC retention times (largest retention time first).



A20. A student used gas chromatography to analyze the mixture of alkenes collected after heating a sample of compound **V** in the presence of sulfuric acid. The student's GC tracing is shown below.



V (bpt = 120 ^oC) **W** (bpt = 73 ^oC) **X** (bpt = 41 ^oC) **Y** (bpt = 56 ^oC)



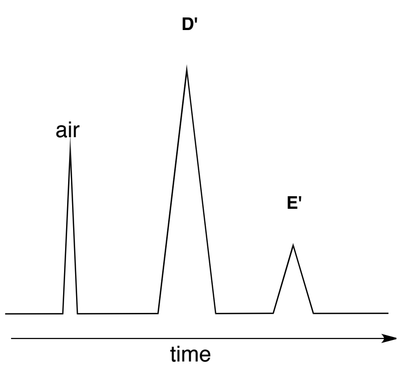
a) Identify each one of the following statements as being either true (T) or false (F).

The compound responsible for peak **ii** is more polar than the compound responsible for peak **iii**
The compound responsible for peak **i** is less polar than the compound responsible for peak **ii**

b) The student has proposed that the three GC peaks are due to the compounds shown above but is unsure as to which compound corresponds to which peak.

Which one of the three alkenes shown above is most likely responsible for peak **i**?
Which one of the three alkenes shown above is most likely responsible for peak **ii**?
Which one of the three alkenes shown above is most likely responsible for peak **iii**?

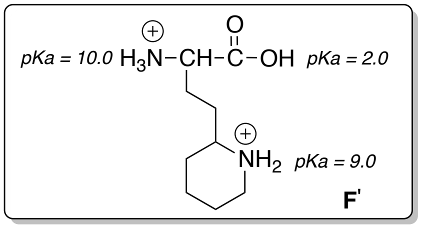
A21. Consider the following GC chromatogram and calculate the relative percentages for compounds **D'** and **E'**.



Which compound is more polar, compound **D'** or compound **E'**?
Relative percentage of compound **D'** ______%
Relative percentage of compound **E'** ______%

A22. Which amino acid is expected to have the smaller TLC R_f value, phenylalanine or tyrosine? Briefly outline your reasoning.

A23. What is the isoelectric point (pI) of fictitious amino acid **F'**?



A24. What is the isoelectric point (pI) of leucine?

A25. A 1:1 mixture of leucine and glutamic acid was analyzed by electrophoresis at pH 8. Which one of the following statements is true?

- ❑ Both leucine and glutamic acid move towards the positive electrode
- ❑ Leucine moves towards the negative electrode while glutamic acid moves towards the positive electrode
- ❑ Leucine moves towards the positive electrode while glutamic acid moves towards the negative electrode

A26. A 1:1 mixture of leucine and glutamic acid was analyzed by electrophoresis at pH 8. Which one of the following statements is true?

- ❑ Both leucine and glutamic acid move towards the positive electrode
- ❑ Leucine moves towards the negative electrode while glutamic acid moves towards the positive electrode
- ❑ Leucine moves towards the positive electrode while glutamic acid moves towards the negative electrode

A27. The eleven peptide bonds of the following polypeptide are labeled 1 through 11. Which of these peptide bonds would be cleaved when the polypeptide is treated with trypsin?

arg —1— cys —2— val —3— thr —4— ala —5— ile —6— val —7— gly —8— lys —9— phe —10— trp —11— his

A28. The eleven peptide bonds of the following polypeptide are labeled 1 through 11. Which of these peptide bonds would be cleaved when the polypeptide is treated with chymotrypsin?

arg —1— cys —2— val —3— thr —4— ala —5— ile —6— val —7— gly —8— lys —9— phe —10— trp —11— his

A29. The eleven peptide bonds of the following polypeptide are labeled 1 through 11. Which of these peptide bonds would be cleaved when the polypeptide is treated with elastase?

arg —1— cys —2— val —3— thr —4— ala —5— ile —6— val —7— gly —8— lys —9— phe —10— trp —11— his

A30. What is the C-terminal amino acid of the polypeptide gly–leu–tyr–glu–val–ser–phe–met–val–ala?

A31. What is the N-terminal amino acid of the polypeptide gly–leu–tyr–glu–val–ser–phe–met–val–ala?

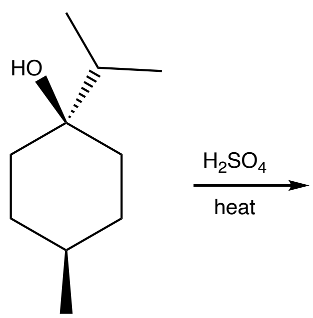
A32. A nonapeptide has the composition: ala, glu, his, leu, met. phe, ser, tyr, val. Partial hydrolysis gives the peptides listed below. Deduce the sequence of amino acids in this nonapeptide. Enter the actual sequence of amino acids in the spaces provided below.

val-his									
leu-met									
phe-ala-glu									
his-tyr-leu									
ala-glu-ser									

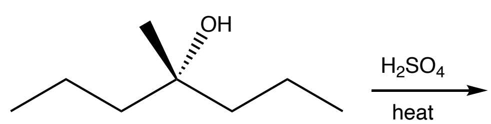
Final answer →									

"Practice exam questions" for Part B of the Final Exam

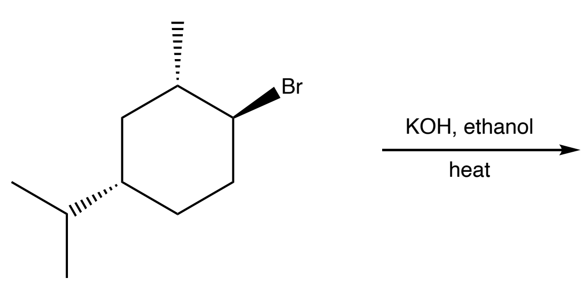
B1. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



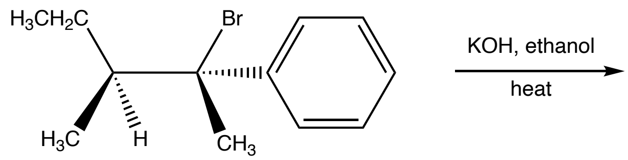
B2. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



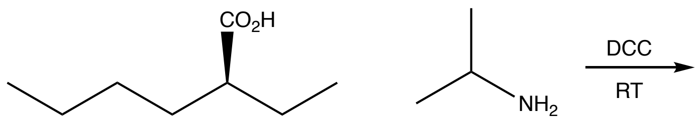
B3. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



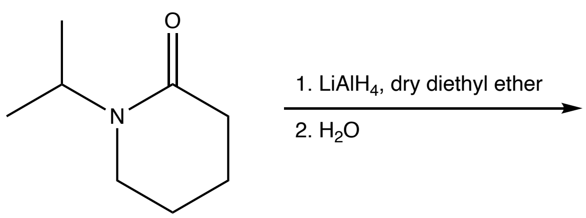
B4. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



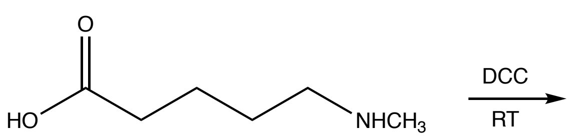
B5. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



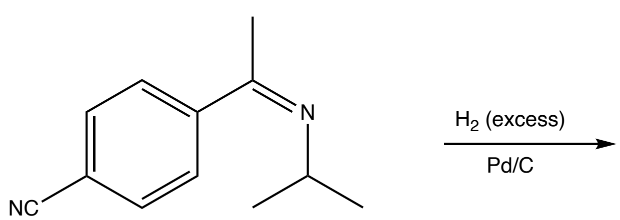
B6. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



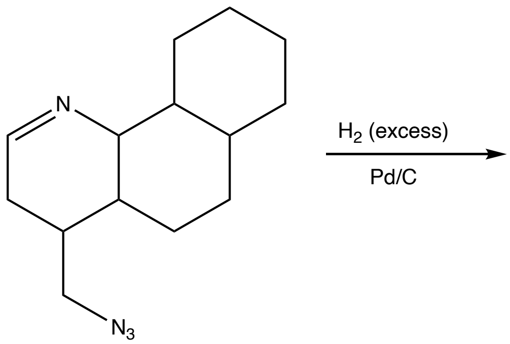
B7. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



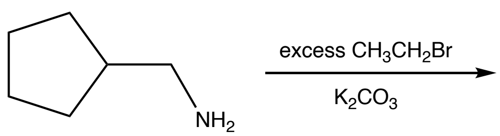
B8. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



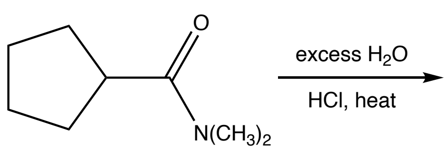
B9. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



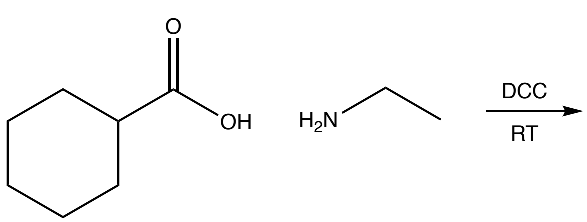
B10. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



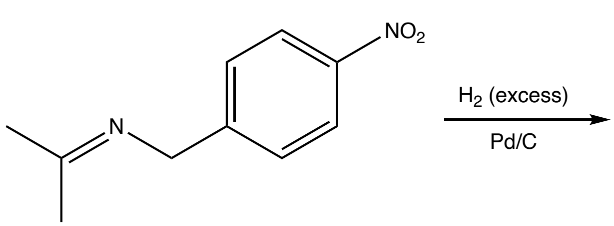
B11. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



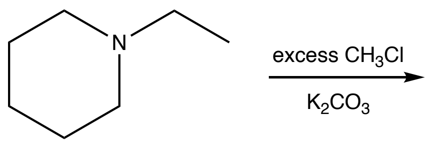
B12. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



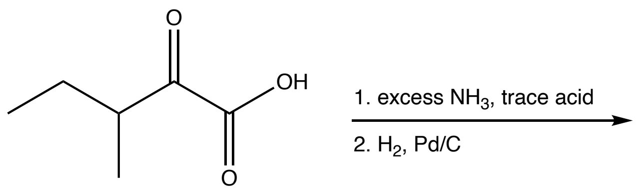
B13. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



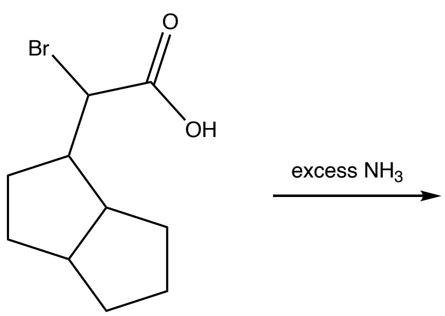
B14. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



B15. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



B16. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.



B17. Draw the major organic product(s) of the following reaction. Don't forget to use wedge/dash notation where appropriate.