Chemistry 4321/8321	**Midterm Examination II** 6:00 – 8:00 PM	November 29, 2023
Organic Synthesis		T. R. Hoye

Name: ANSWERS

Clearly **print** your name above.

There are 103 points and four questions on the exam.

Answer all questions directly in the space provided on the five exam pages.

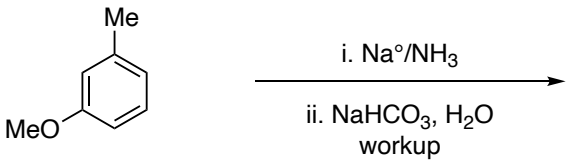
You may not use books, notes, phones, computers, etc.

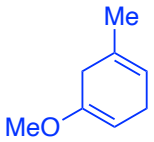
Our diamond lattice is attached as a final page for your use, should you like.

Part I	12 / 12
Part II	16 / 16
Part III	24 / 24
Part IV	47 / 47
Bonus	4 / 4
Total	103 /103

I. **(12 points)** Provide the structure of the major product in each of the reactions **a**)-**c**).

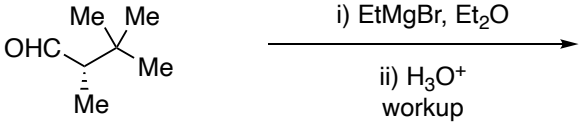
a)

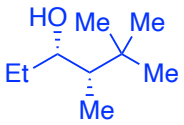




$C_8H_{12}O$

b)

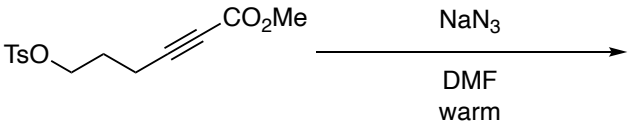


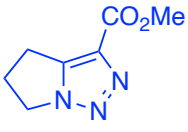


provide the relative configuration

$C_9H_{20}O$

c)





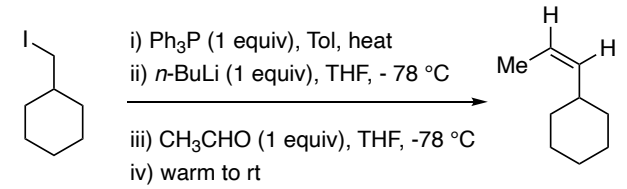
+ NaOTs

a bicyclic compound having a pair of fused, 5-membered rings

$C_7H_9N_3O_2$

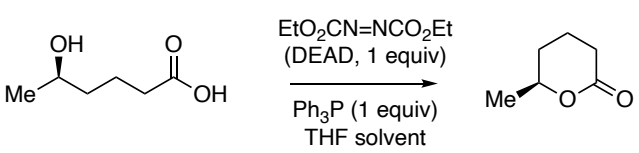
II. (16 points) In each box, add the byproducts that, together with the main product (whose structure is provided), constitute a stoichiometrically and fully balanced reaction equation for each of the following four [**a**-**d**)] transformations. Note: in every reaction there is more than one byproduct. Ignore any substoichiometric, catalyst-derived materials that might also be formed.

a)



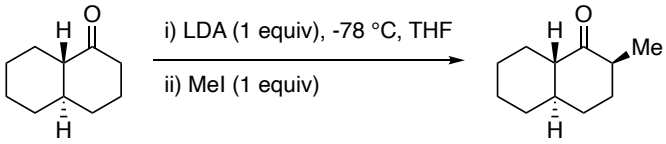
+ ***n*-BuH + LiI + O=PPh$_3$**

b)



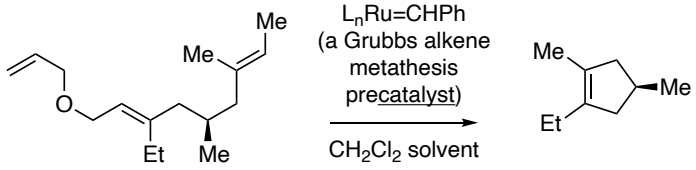
+ **Ph$_3$P=O + EtO$_2$CNHNHCO$_2$Et**

c)



+ ***i*Pr$_2$NH + LiI**

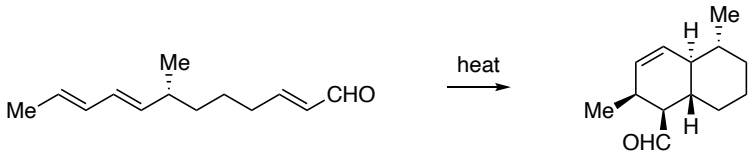
d)

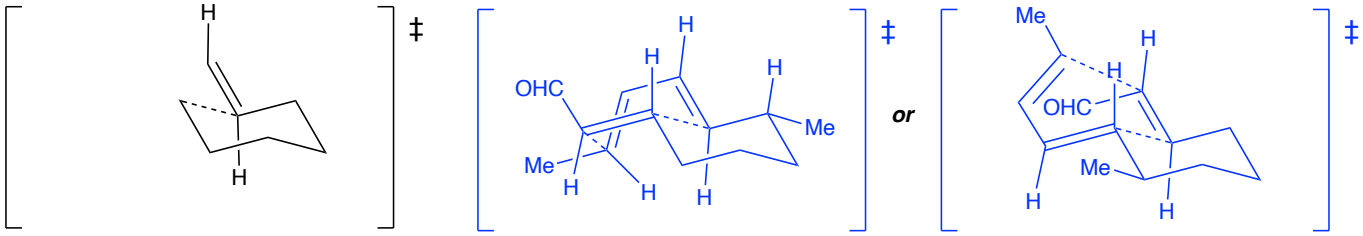


+ 

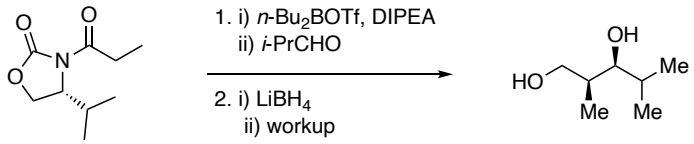
III. (24 points) Provide a *carefully drawn* transition structure (TS) for <u>the step that establishes all of the new stereocenters</u> in each of the following three transformations. Use the provided partial template and add all of the missing structural elements.

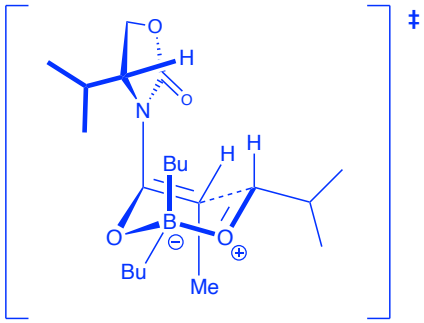
a) (8 points) An intramolecular Diels-Alder reaction. (*hint: recall that the Diels-Alder reaction is a concerted cycloaddition process that proceeds through a boat-like TS geometry)*



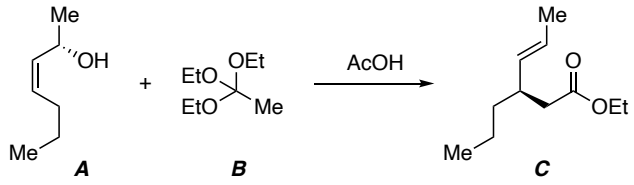


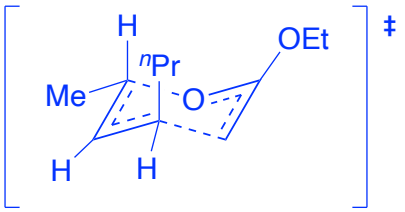
b) (8 points) Show the TS for the Evans aldol addition reaction that occurs in reaction 1 (and <u>not</u> for the $LiBH_4$ reduction in reaction 2).





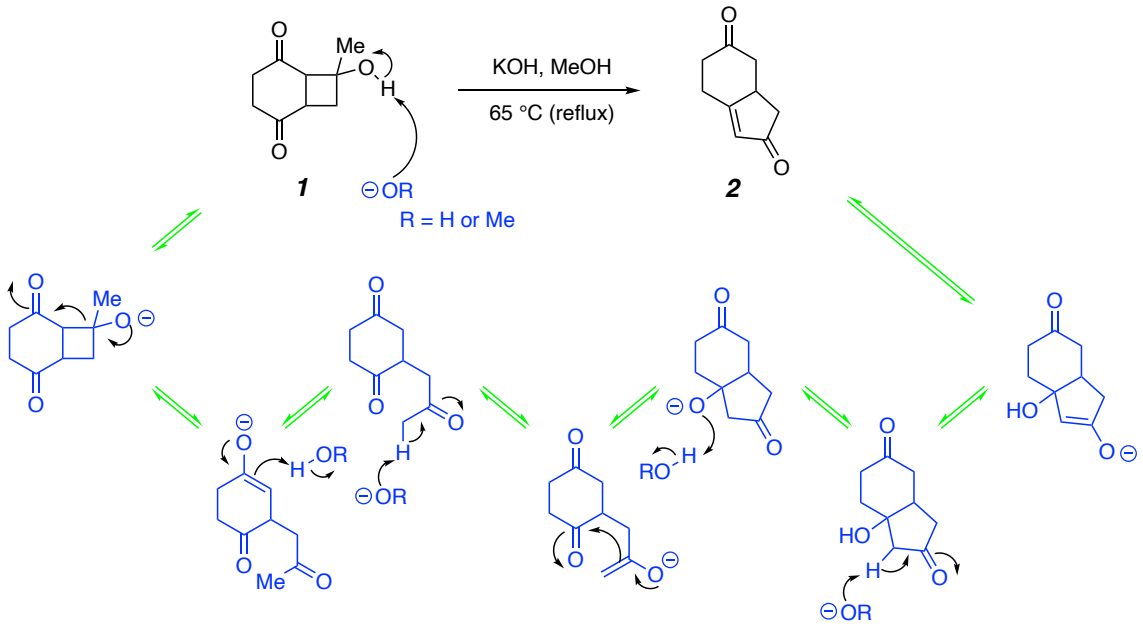
d) (8 points) The Johnson-Claisen rearrangement *of* the allylic alcohol **A** and triethyl orthoacetate (**B**) to form the alkenyl ester **C**. You worked through the detailed mechanism for this Johnson-Claisen rearrangement on a recent problem set. Now provide a careful 3D representation of the TS geometry for the key step that accounts for the stereochemical outcome of the reaction.



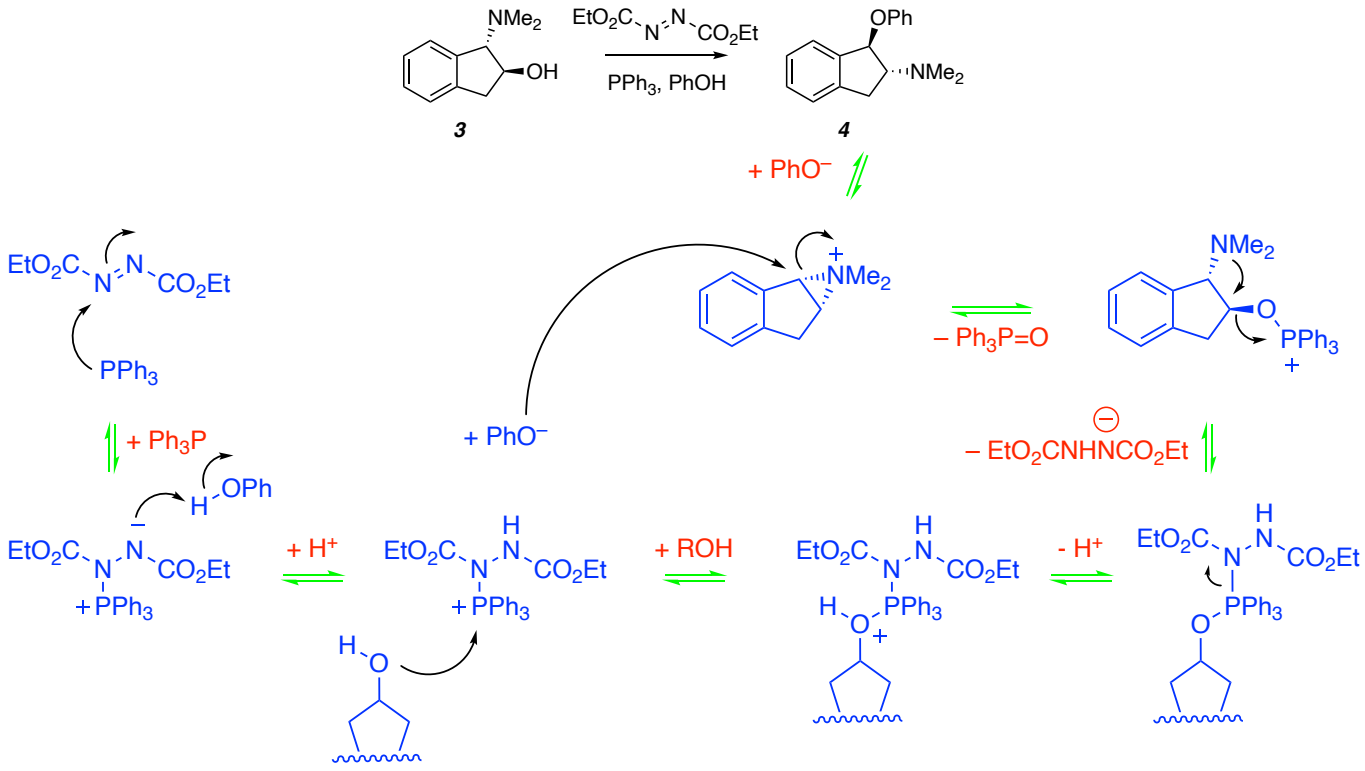


IV. **(47 points)** Provide a detailed mechanism to account for each of the following four reactions. Show *ALL* intermediates, equilibria, and bond-making and -breaking steps. For any species that have more than one significant resonance contributor, you only need to show one of them.

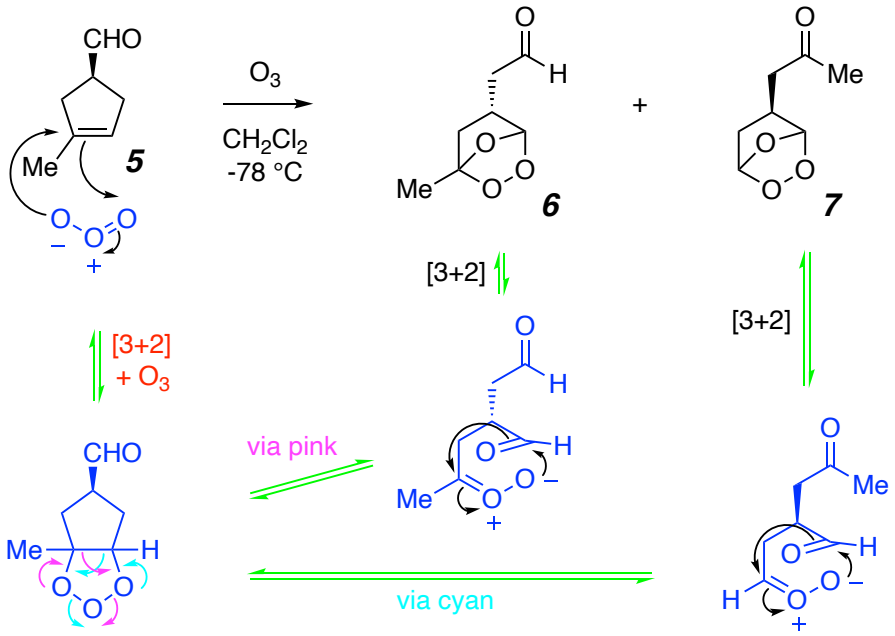
a) **(14 points)** Conversion of the bicyclo[4.2.0]octanedione **1** to the bicyclo[4.3.0]octanedione **2**. (*hint: a retro-aldol addition reaction is involved)*



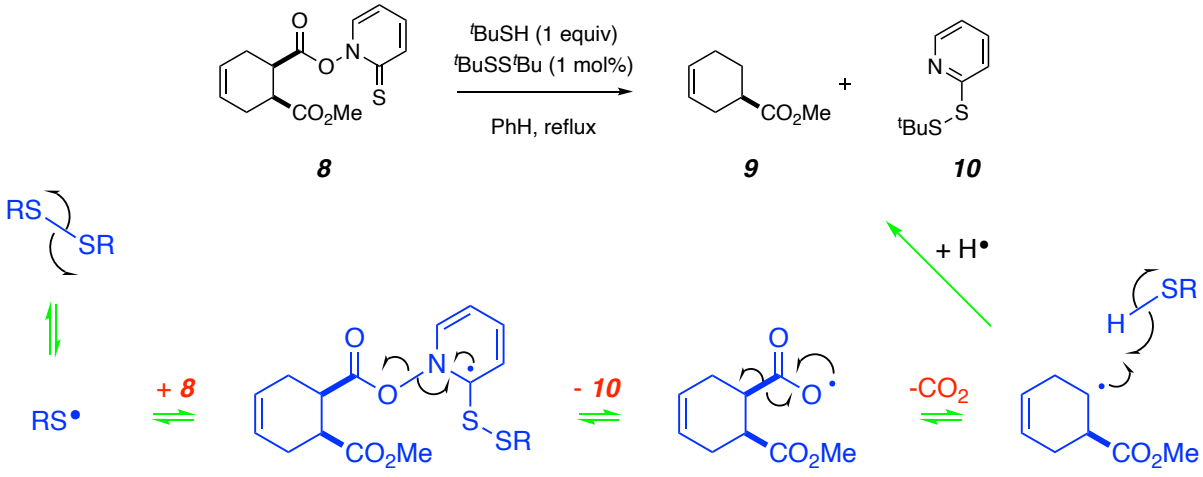
b) **(12 points)** A Mitsunobu reaction that involves an intervening rearrangement reaction in the conversion of **3** to **4**.



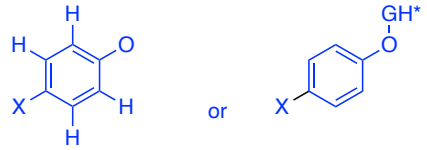
c) **(9 points)** The formation of the isomeric, bicyclic trioxolanes **6** and **7** upon treatment of the cyclopentene derivative **5** with ozone in methylene chloride (note: no methanol is used).



d) **(12 points)** The reductive decarboxylation of **8** to give **9** and **10**. Note the amounts of each of the di-*t*-butyldisulfide and *t*-butanethiol that are used. [*hint: the bond dissociation energy of disulfides is ca. 60 kcal mol^{-1}; the reaction, via a radical chain mechanism, is initiated by (a very slow) homolysis of the S–S bond in di-t-butyldisulfide*]



Reaxys Bonus (4 points) Provide a single Reaxys substance search query you would use to identify all disubstituted* 4-halogenated phenols or phenol derivatives.
* that is, carbons 2, 3, 5, and 6 bear only a hydrogen atom.



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