

Please read and sign the Honor Code statement below:

I pledge that on my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this exam.

Signature

General Instructions: There are 25 questions. Be sure you have them all. Read each question carefully so that you know exactly what is being asked.

Each multiple choice question (1-25) is worth **4 points and has only one correct answer**. Bubble in your answers to these questions on the Scantron provided. Only the Scantron will be graded.

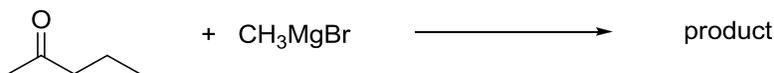
At the end of the exam, turn in your Scantron and this signed cover sheet. You may keep the rest of the exam to check your answers against the key later.

Good luck!

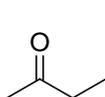
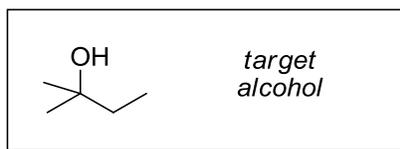
PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES		
1 H 1.00797														1 H 1.00797	2 He 4.0026		
3 Li 6.939	4 Be 9.0122										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183	
11 Na 22.9898	12 Mg 24.312										13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948	
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	+89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

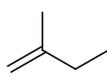
1. Which of the following solvents could you not use to run the reaction shown? (Assume any appropriate aqueous workup also occurs.)



- THF
 - Et_2O
 - EtOH
 - Any of these could be used
 - None of these could be used
2. Which of the following is a possible precursor to this alcohol? (Another way to think of this question is, From which of these compounds can the alcohol be made in one step, including workup?) You can use any reagents you like.



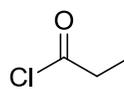
A



B



C

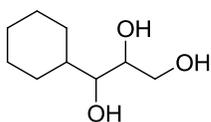
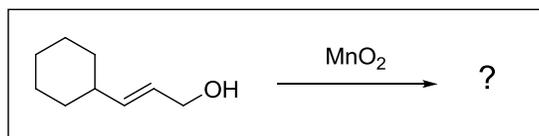


D

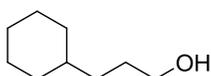
All of these are possible precursors to the alcohol

E

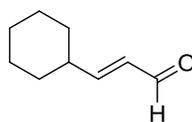
3. Select the correct product of the following reaction.



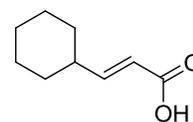
A



B



C

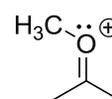
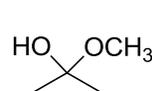
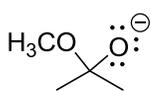
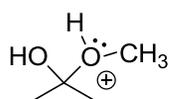
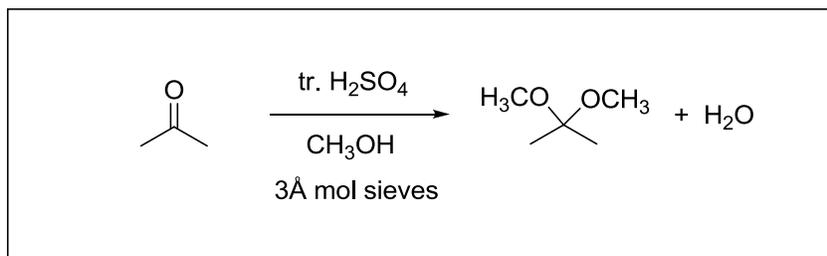


D

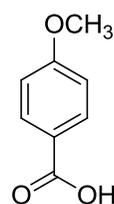
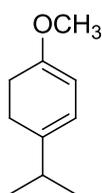
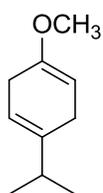
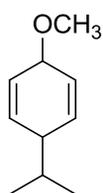
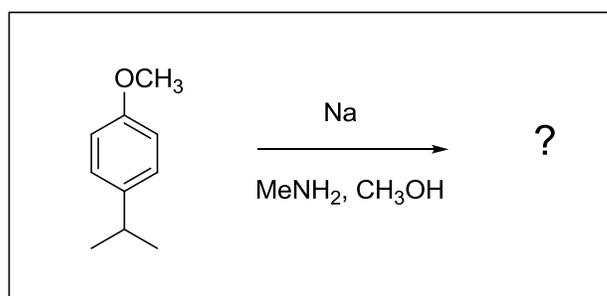
None of these is the product

E

4. Which of these structures is not a mechanistic intermediate in acetal formation? (The overall reaction is shown in the box.)

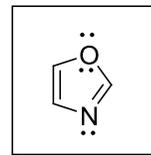


5. What is the product of this reaction?

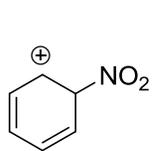
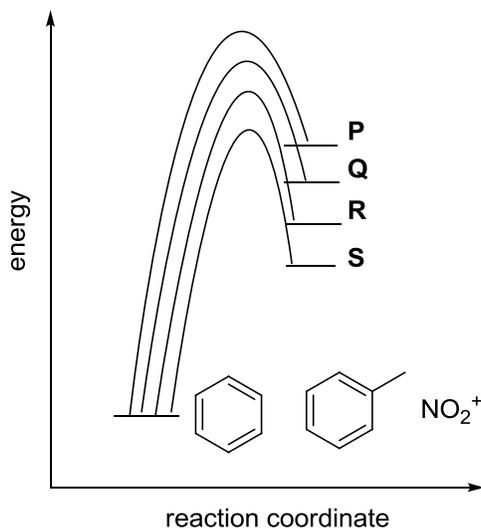


E None of these is the product of the reaction

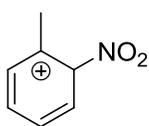
6. This compound is called oxazole. What type of orbital contains the nitrogen lone pair in oxazole?



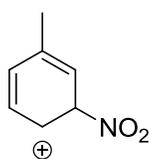
- sp
 - sp^2
 - sp^3
 - p
 - None of these
7. Equal amounts of benzene and toluene are mixed and allowed to react with the nitronium ion, NO_2^+ , in an electrophilic aromatic substitution (nitration). An energy vs. reaction coordinate diagram for the rate-limiting step of the reaction is shown. Which structure corresponds to the intermediate marked "Q" on this diagram? (Notice that each of your answer choices also has several resonance structures that are not shown.)



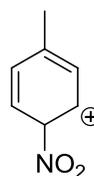
A



B



C



D

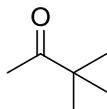
None of these structures is Q

E

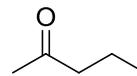
8. Place these compounds in *increasing* order of $K_{\text{hydration}}$ (smallest K to largest K).



P

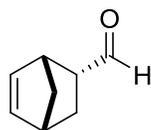


Q

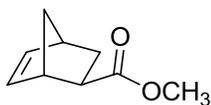


R

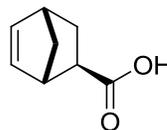
- a. P, Q, R
b. P, R, Q
c. R, Q, P
d. Q, R, P
e. Q, P, R
9. Which of these is an *endo* Diels Alder product?



A



B

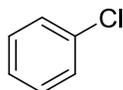


C

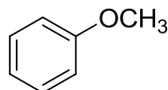
None of these
are *endo*
products

D

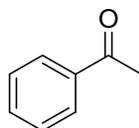
10. Which of these compounds contains an ortho, para director?



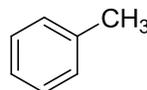
W



X



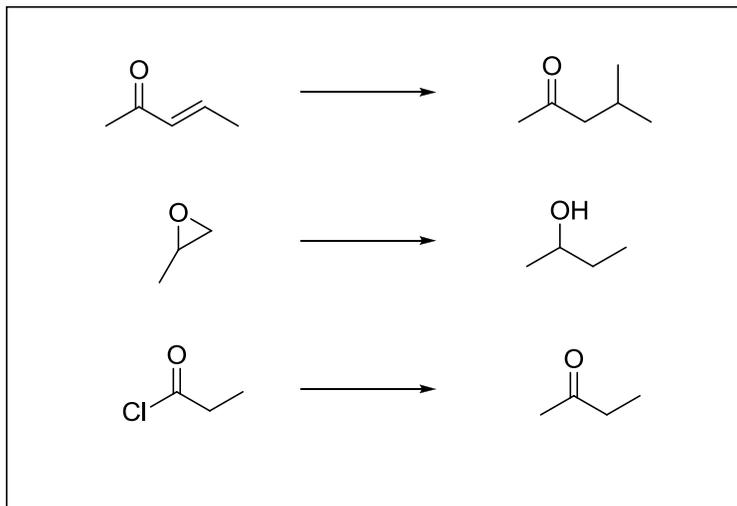
Y



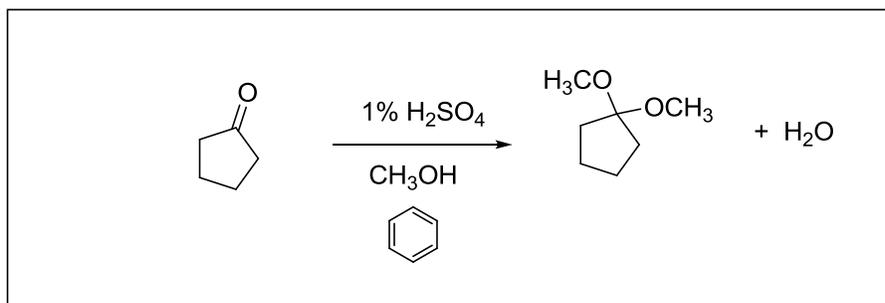
Z

- a. W, X
b. X, Z
c. W, X, Z
d. W, X, Y, Z
e. X, Z

11. Which of the reagents listed (followed by aqueous workup) will accomplish each of the transformations shown?



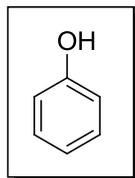
- CH₃Li
 - CH₃MgBr
 - (CH₃)₂CuLi
 - either "a" or "b"
 - "a", "b" or "c" would all work
12. A dimethyl acetal can be formed in the following conditions:



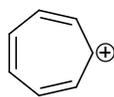
What is the purpose of the benzene in this reaction?

- It is a catalyst
- To allow the water formed in the reaction to be removed through an azeotropic distillation
- To facilitate the reaction by lowering the energies of the transition states for several of the steps
- To prevent a Friedel Crafts reaction from happening
- There was a little left in the bottle and we wanted to use it up

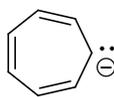
13. Which of the following statements about phenol and electrophilic aromatic substitution is true?



- a. Donation of electron density to the ring is a more important factor than inductive withdrawal of electron density.
- b. Donation of electron density to the ring is a less important factor than inductive withdrawal of electron density.
- c. Both donation and withdrawal of electron density are equally important.
- d. The rate of electrophilic aromatic substitution is not affected by whether or not electron density is donated to the ring or withdrawn from it.
- e. The ring in phenol is deactivated.
14. Which of the following compounds is anti-aromatic? For this question, assume that all compounds are planar. All lone pairs are shown.



A



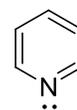
B



C

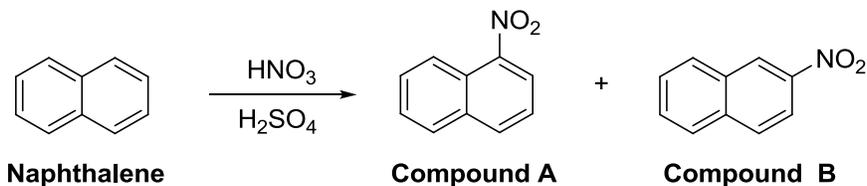


D



E

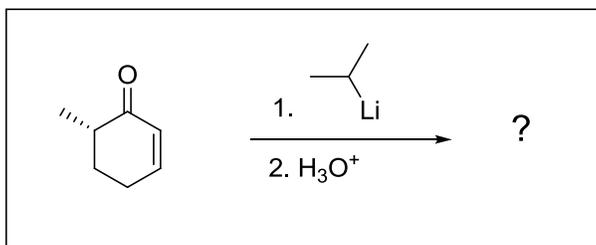
15. Naphthalene can undergo a nitration reaction:



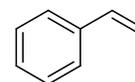
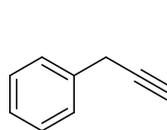
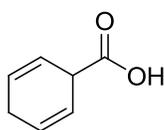
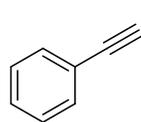
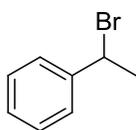
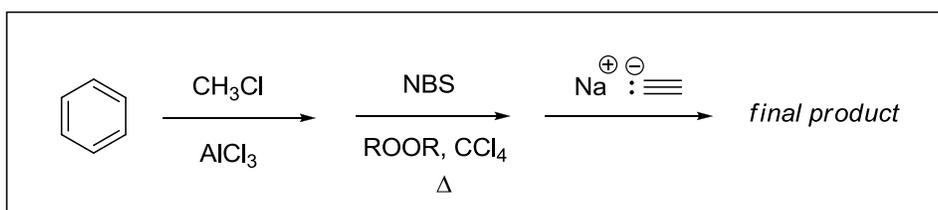
One of the two possible products forms in significant preference to the other. Which of the two compounds is the *major* product?

- a. Compound A
- b. Compound B

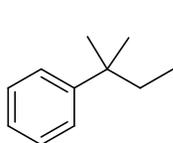
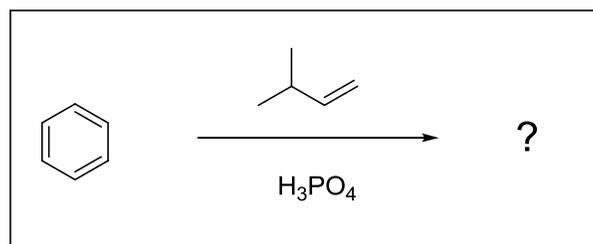
16. Which of the following statements is the best description of the product(s) of this reaction?



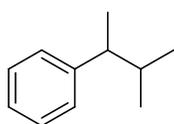
- A racemic mixture of alcohols
 - A racemic mixture of ketones
 - A single achiral alcohol
 - A mixture of ketones that are diastereomers
 - A mixture of alcohols that are diastereomers
17. Predict the final product of this sequence of reactions.



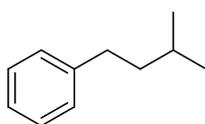
18. What is the final product of these conditions?



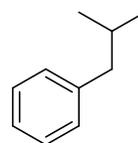
A



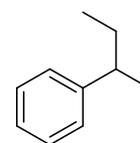
B



C

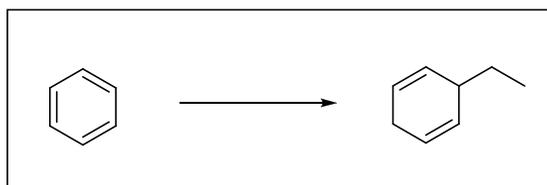


D



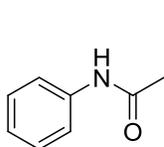
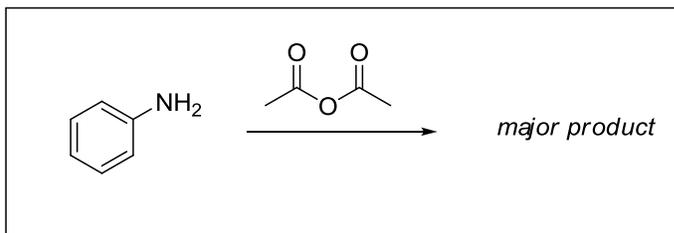
E

19. In this multistep synthesis, what reagent(s) would you use in the *last* step of the sequence?

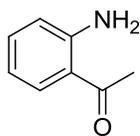


- a. Na, NH_3
- b. $\text{H}_2, \text{Pd/C}$
- c. H_2 , Lindlar catalyst
- d. $\text{HCl(aq)}, \text{Hg/Zn}$
- e. $\text{H}_2\text{NNH}_2, \text{KOH}, \text{heat}$

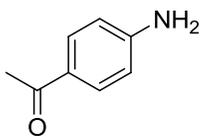
20. What is the major product of this reaction?



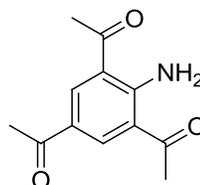
A



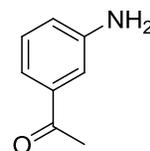
B



C

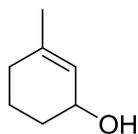
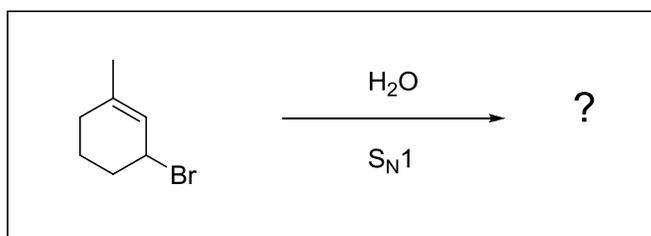


D

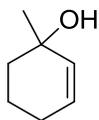


E

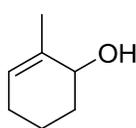
21. What is the outcome of these conditions?



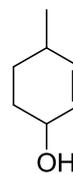
A



B



C

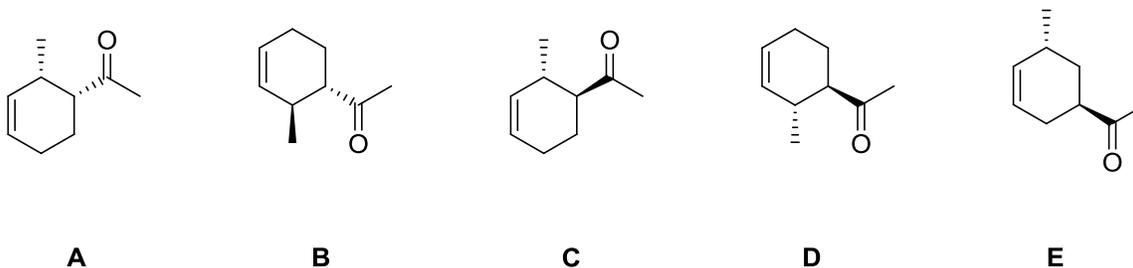
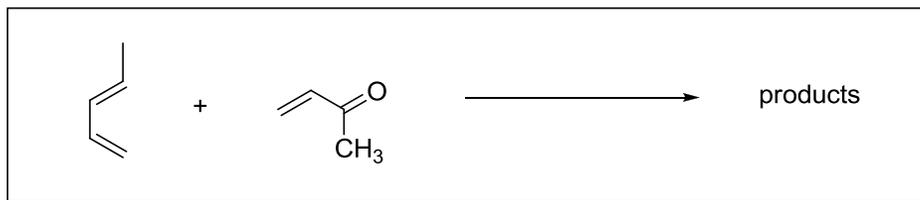


D

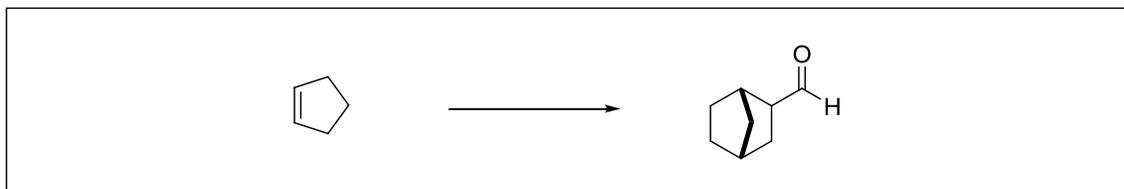
A mixture
of A and B

E

22. Which structure is the least likely product of this reaction?



23. You wish to accomplish the following multistep synthesis. The reagents available to you are listed below. Can you successfully complete this synthesis? (All necessary solvents and solutions for aqueous workups are also available, though not necessarily listed.)

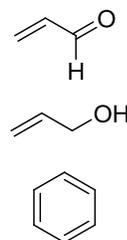


Available reagents:

LAH
OsO₄
H₂O₂
O₃
DMS
NBS

Sia₂BH
Aqueous acid (H₃O⁺)
Aqueous base (HO⁻)
LDA
Na metal
NH₃

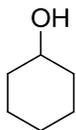
AlCl₃
KMnO₄
NaBH₄
Jones reagent
SOCl₂



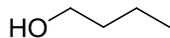
CH₃Li
(CH₃)₂CuLi
CO
HCl
CuCl
PCC
MCPBA

- Yes, I can complete the synthesis with the reagents provided.
- No, I cannot complete the synthesis because at least one reagent is missing.

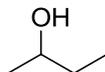
24. Which of these alcohols could not be made in one step (including workup) from an epoxide?



A



B



C

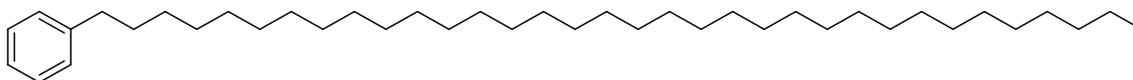
All could be made from epoxides

D

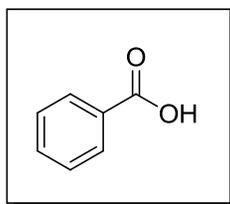
None could be made from epoxides

E

25. Kim Kardashian somehow managed to synthesize this molecule, which cures cancer, reverses the aging process, improves personality, and increases the IQ of whoever ingests it by at least 50 points.



Unfortunately, as Kim was rushing to the phone to call Khloe, she accidentally dropped the only sample of the molecule into a large beaker of boiling purple liquid. After this unfortunate accident, Kim recovered the following compound from the beaker:



What was in the beaker of boiling purple liquid?

- Kim's third husband (aq)
- HIO_4
- H_3O^+
- O_3
- KMnO_4