

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 10 pages and 19 questions, including this cover sheet. Be sure you have them all. Read each question carefully so that you know exactly what is being asked and what you need to write or draw. Your work on scratch pages will not be graded, so be sure everything you want graded is written on the exam itself and that your answers to the multiple choice questions are correctly bubbled in on the Scantron.

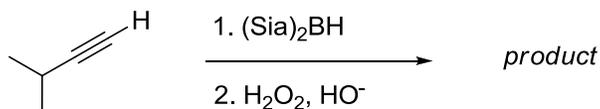
Each multiple choice question (1-15) is worth **4 points** and has **only one correct answer**. Good luck!

PERIODIC CHART OF THE ELEMENTS

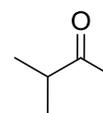
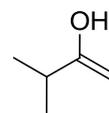
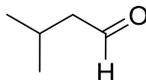
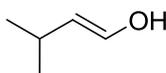
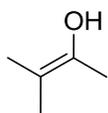
IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES		
1 H 1.00797														1 H 1.00797	2 He 4.0026		
3 Li 6.939	4 Be 9.0122										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183	
11 Na 22.9898	12 Mg 24.312										13 Al 26.9815	14 Si 28.086	15 P 30.9738	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)						

Circle the single best answer to each multiple choice question (1-15). (4 pts each)

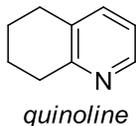
1. A terminal alkyne is treated with $(\text{Sia})_2\text{BH}$, then with hydrogen peroxide and sodium hydroxide:



Which of the following is an intermediate that would be generated in this reaction?



2. The Lindlar catalyst is composed of a number of reagents used in combination. Which of the following chemicals is not part of the reaction mixture containing the Lindlar catalyst?

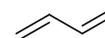


C A metal catalyst such as Pd

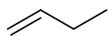
D BaSO_4 or CaCO_3



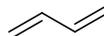
3. Which of these compounds will not react in a Diels Alder reaction?



4. The heat of hydrogenation of 1-butene is approximately 30 kcal/mol. What do you expect will be the heat of hydrogenation of 1,3-butadiene? (Recall that hydrogenation is an exothermic reaction, and that the heat of hydrogenation is often reported as the absolute value of the heat released in the reaction.)



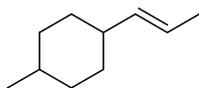
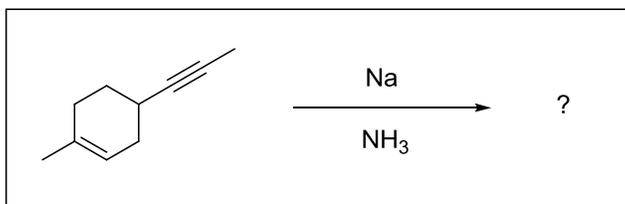
1-butene



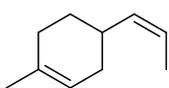
1,3-butadiene

- 30 kcal/mol
- 60 kcal/mol
- More than 60 kcal/mol
- Less than 60 kcal/mol
- There is not enough information provided to answer the question.

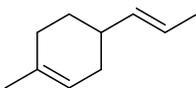
5. Which of these compounds is the major product of the reaction conditions shown?



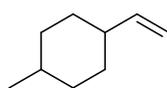
A



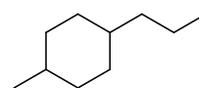
B



C



D



E

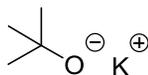
6. Which of the following bases can deprotonate acetylene?

LDA

P

NaNH_2

Q



R

$\text{Li-CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

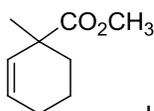
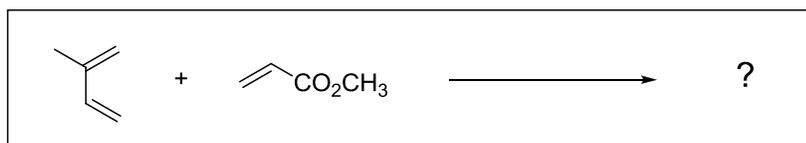
S

NaOH

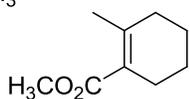
T

- All of these bases can deprotonate acetylene
- None of these bases can deprotonate acetylene
- P, Q, R
- P, Q, S
- P, Q, R, S

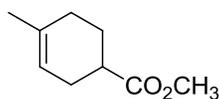
7. What is the major product of this reaction?



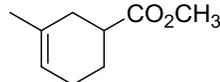
A



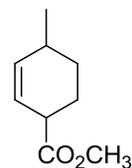
B



C

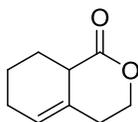
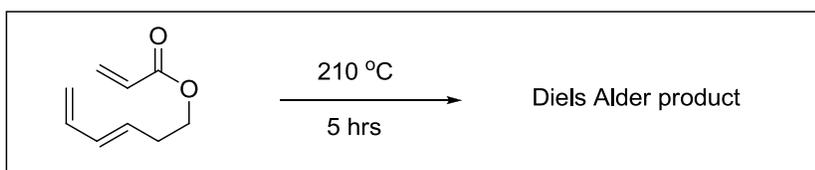


D

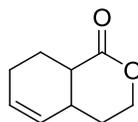


E

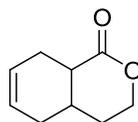
8. There are many examples of intramolecular Diels Alder reactions, including the one shown here. What is the product of this reaction?



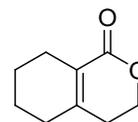
A



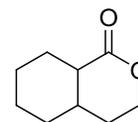
B



C



D

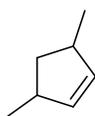


E

9. Which of the following molecules, when treated with NBS and dimethyl peroxide in carbon tetrachloride solvent (NBS, CH_3OOCH_3 in CCl_4) and heated, would generate more than one product?



A



B



C

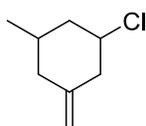
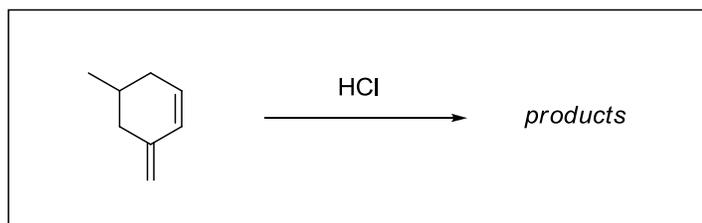


D

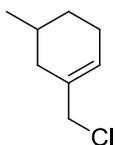


E

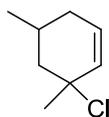
10. Which of these structures is the thermodynamic product of the reaction?



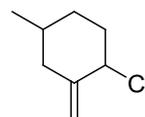
A



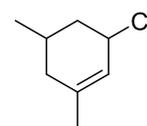
B



C

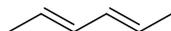


D



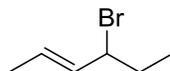
E

11. Consider this molecule:

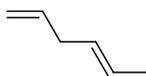


Which of these statements is false?

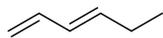
- a. This molecule is drawn in its most stable conformation.
- b. This molecule contains conjugated double bonds.
- c. This molecule would not react in a Diels Alder reaction.
- d. When this molecule is reacted with HBr, at least two products can form.
- e. This molecule could have been synthesized in one step from this compound:



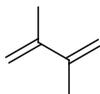
12. Which of the following C₆H₁₀ isomers is *least* stable?



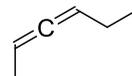
A



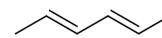
B



C

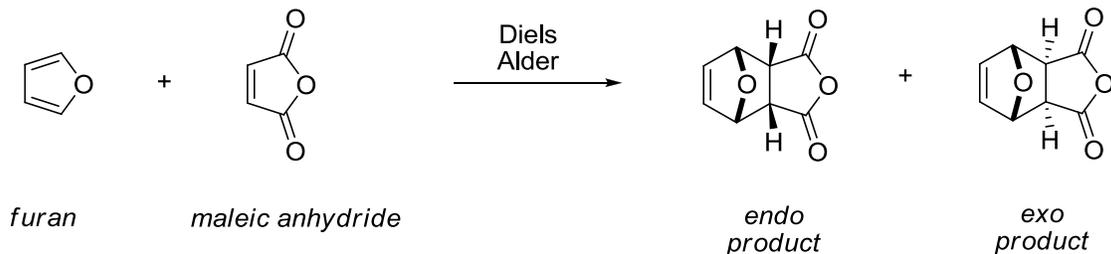


D



E

13. Consider the Diels Alder reaction between furan and maleic anhydride:

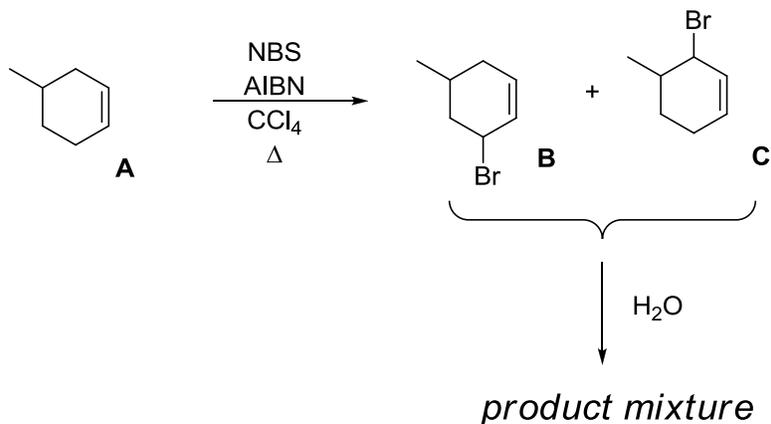


In this reaction, the endo product is the kinetic product. The Diels Alder is reversible; i.e., the endo product can revert to starting materials.

What conditions would you use to produce the maximum possible yield of the exo product?

- Long reaction time, low temperature
- Long reaction time, high temperature
- Short reaction time, low temperature
- Short reaction time, high temperature
- It is not possible to make the exo product.

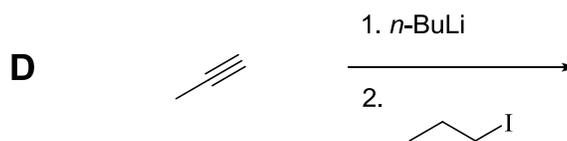
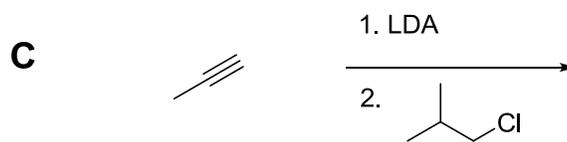
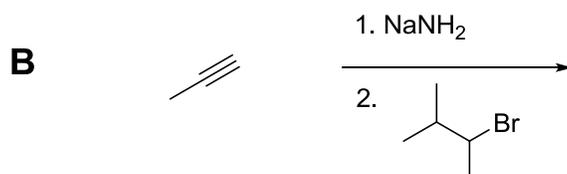
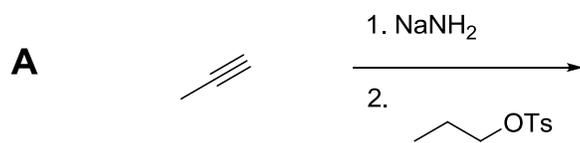
14. Compound **A** was treated with NBS and AIBN in carbon tetrachloride solvent and heated, producing two compounds, **B** and **C**. The mixture of compounds **B** and **C** was then placed in water (solvolysis conditions) and generated a mixture of products.



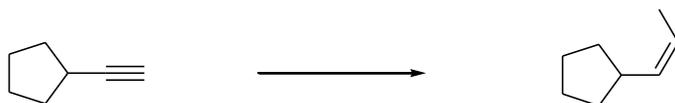
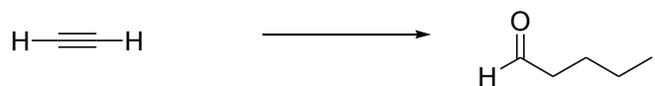
How many S_N1 products could form under these conditions?

- 1
- 2
- 3
- 4
- None of these numbers

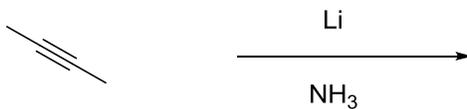
15. Which of the following syntheses is unlikely to give good yields of the final alkylated product?



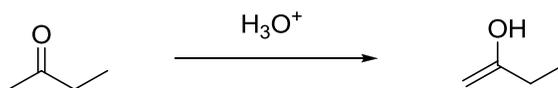
16. Propose a multi-step synthesis for each target molecule from the indicated starting material. Show the reagents needed for each step and the product of each step. Do not show any mechanisms. Do not simply give a list of reagents, or you will not receive full credit. (10 pts)



17. Predict the product of the following reaction conditions and draw a mechanism to illustrate its formation. Include all necessary electrons, curved arrows, and nonzero formal charges. (10 pts)



18. Draw a mechanism to illustrate the following transformation. Include all necessary electrons, curved arrows and nonzero formal charges. (10 pts)



19. Design a multistep synthesis to synthesize the target molecule, 2,7-dimethyl-4-octanone, from any necessary organic or inorganic reagents. **Your organic reagents may only contain 4 carbons or less.** Show the reagents needed for each step and the product of each step. Do not just give a list of reagents between starting material and target, or you will not receive full credit. (*Hint:* Because you are not given any starting materials, you will need to approach the problem retrosynthetically and work backwards to reagents containing 4 carbons or less. Then show the synthesis in the forward direction.) (10 pts)

