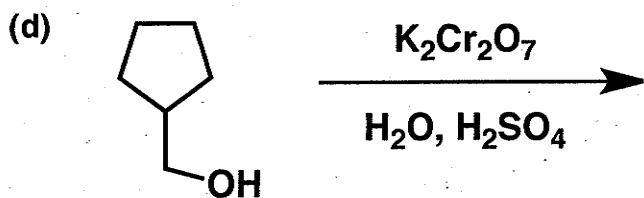
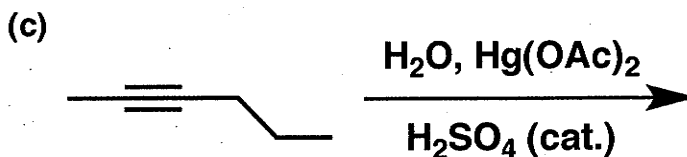
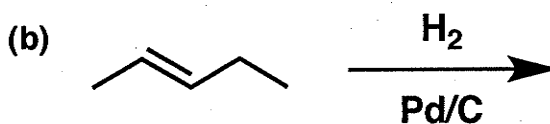
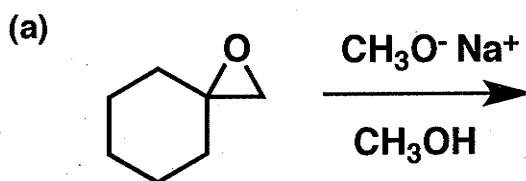


**General Instructions:**

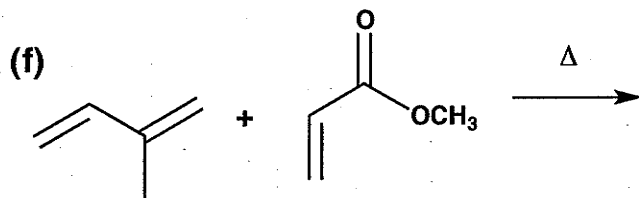
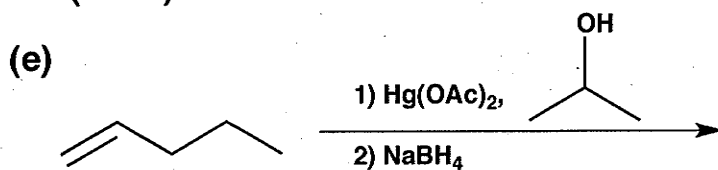
- (i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit. Models are allowed.
- (ii) Print your name on each page.
- (iii) Please keep your paper covered and your eyes on your own work. Misconduct will lead to failure in the course.

1. (32 points) Show the major product or products expected from each reaction.

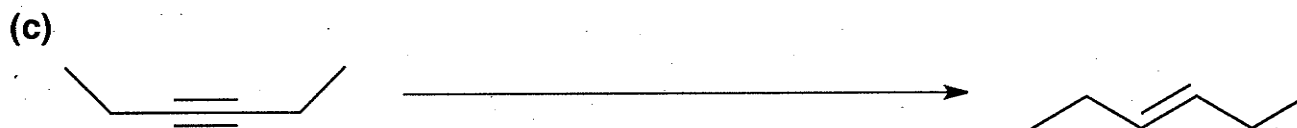
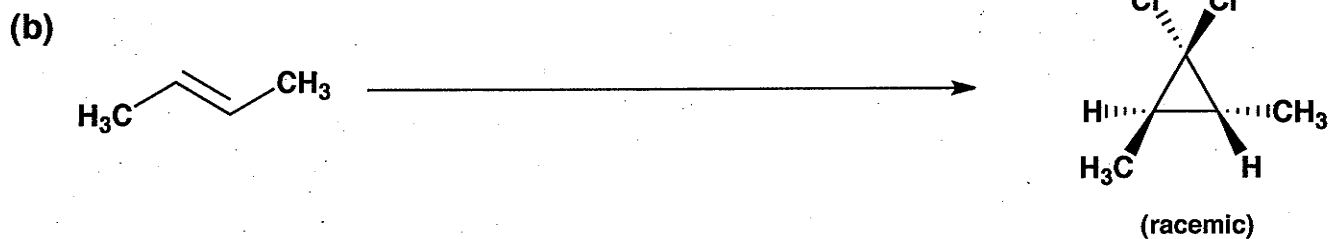
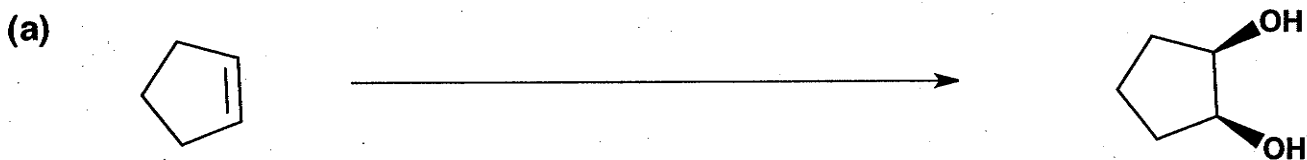


(continued on next page)

1. (cont.)



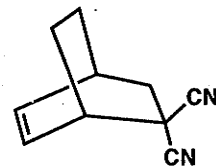
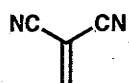
2. (41 points) Show the reagents required to convert the starting molecule to the indicated product. If necessary, be sure to differentiate clearly between distinct steps, by using "1)," "2)," etc. over the arrow.



(continued on next page)

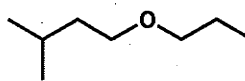
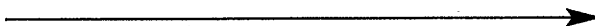
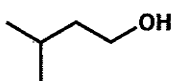
## 2. (cont.)

(d)

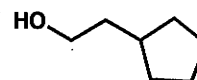
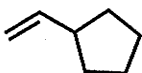


(racemic)

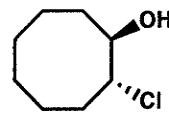
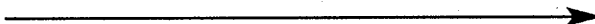
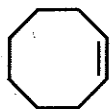
(e)



(f)

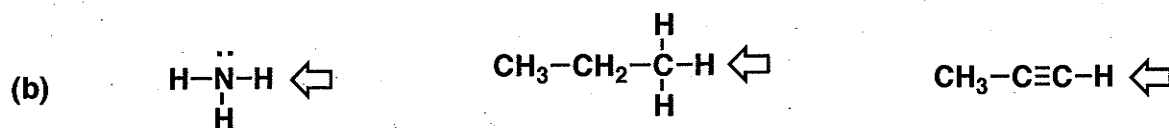
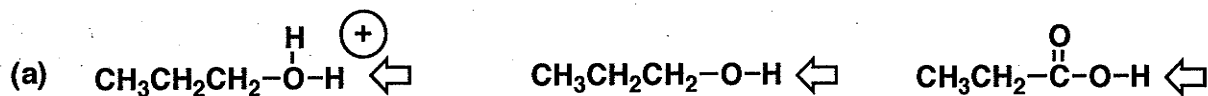


(g)



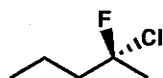
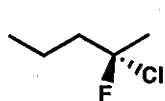
(racemic)

3. (8 points) For each set of three compounds listed below, *redraw them in the order that indicates the highest  $pK_a$  on the left and the lowest  $pK_a$  on the right.* (The arrow indicates the proton to be considered in each case.)

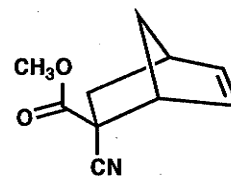
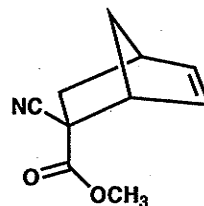


4. (20 points) For each pair of structures below, indicate (on the line below the pair) the relationship between the molecules (at room temperature), choosing from the following possibilities.

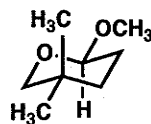
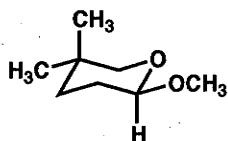
Identical  
Enantiomers  
Diastereomers  
Constitutional Isomers  
Non-isomeric



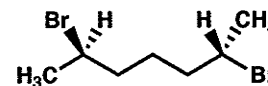
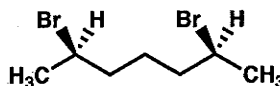
\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_

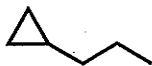


\_\_\_\_\_

5. (21 points) The "heat of combustion" ( $\Delta H_c$ ) for a hydrocarbon is the heat associated with complete reaction of the hydrocarbon with  $O_2$ , so that every carbon ends up in  $CO_2$  and every hydrogen in  $H_2O$ . These reactions are always favorable, which is to say that heat is always released (i.e.,  $\Delta H_c < 0$ ).

For each of the three pairs of isomeric hydrocarbons below, CIRCLE the one you expect to release MORE heat upon combustion (i.e., more negative  $\Delta H_c$ ). BRIEFLY explain your choice.

(a)



vs.



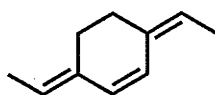
(b)



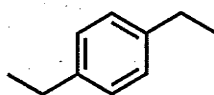
vs.



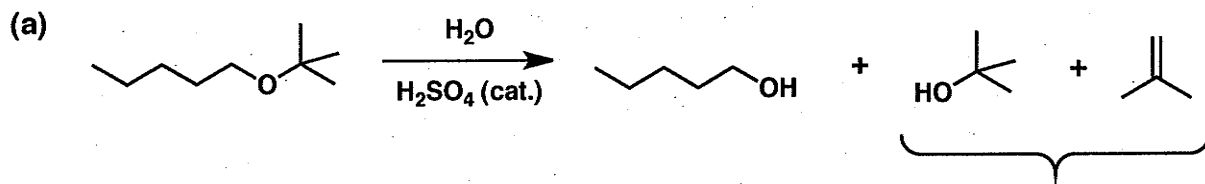
(c)



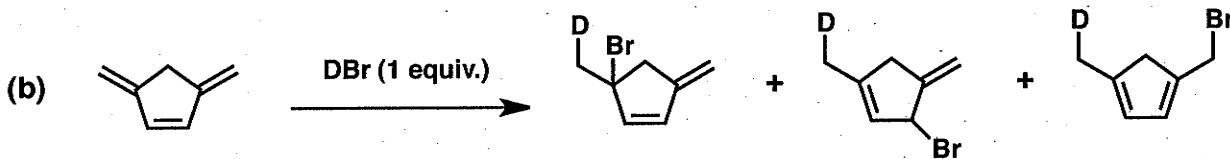
vs.



6. (30 points) Provide a mechanism (curved arrows) for the reaction shown below. Be sure to show intermediates and all important resonance structures.

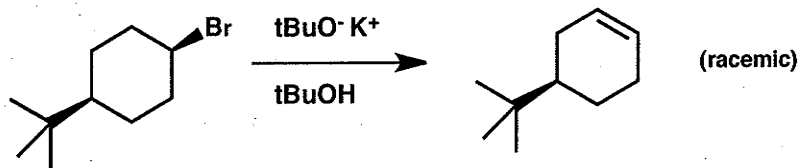


Note: The combined amount of these two products is equal to the amount of the other product.

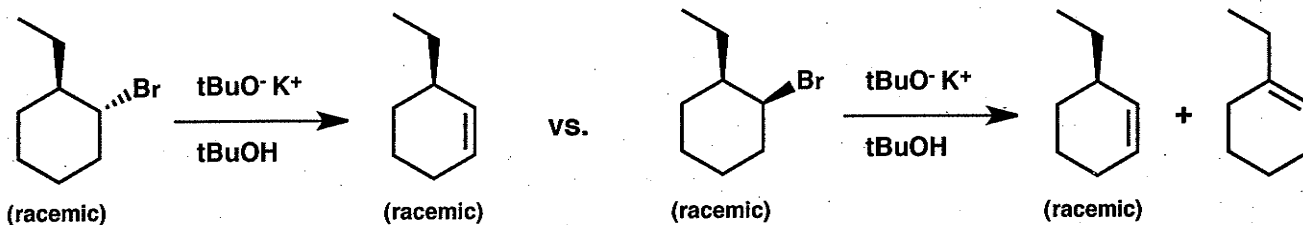


## 7. (18 points)

(a) Show the mechanism of the reaction shown below (curved arrows), using a conformationally informative drawing for the starting material.



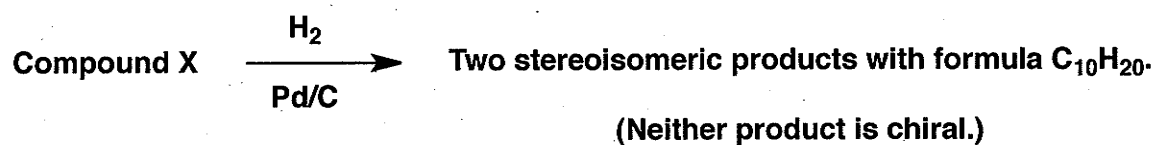
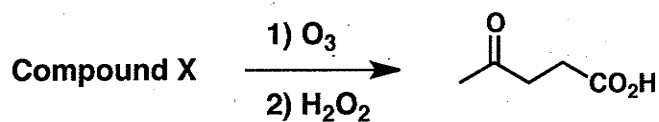
(b) Provide conformationally informative drawings for the two stereoisomeric bromides shown below, and use these drawings to explain why the one on the left gives only one product while the one on the right gives two products.



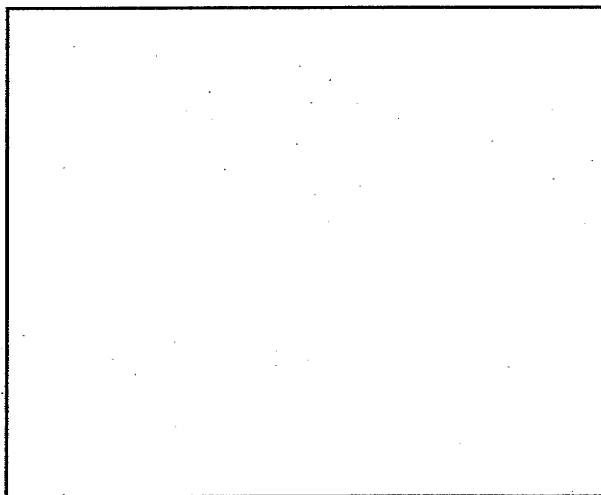
8. (10 points) Compound X has the molecular formula  $C_{10}H_{16}$ .

What is the degree of unsaturation (U) of compound X? \_\_\_\_\_

Under the two sets of reaction conditions summarized below, the indicated results are obtained. Based on these results, deduce the molecular structure of compound X.



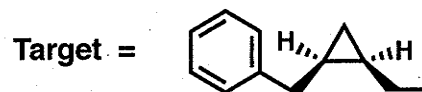
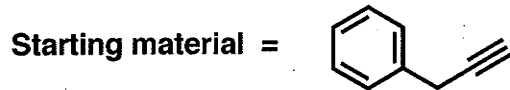
Compound X =





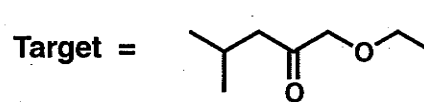
9. (30 points) Devise a synthetic route from the indicated starting material to the indicated target in each of the two cases below. Each route should be as short and as selective as possible. You may use any other organic molecules and any inorganic reagents in your synthetic plans. Show the expected product after each step in each synthetic route.

(a)



-- cont. on next page --

9. (cont.)



<u>Problem #</u>	<u>Score</u>
1	/ 32
2	/ 41
3	/ 8
4	/ 20
5	/ 21
6	/ 30
7	/ 18
8	/ 10
9	/ 30

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**Total:** / 200

Periodic Table of the Elements

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1 H 1.008																																	
2 He 4.003																																	
3 Li 6.94	4 Be 9.01																			5 B 10.81	6 C 12.011	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18								
11 Na 22.99	12 Mg 24.31																			13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95								
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80																
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30																
55 Cs 132.91	56 Ba 137.34	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97																	
87 Fr (223)	88 Ra 226.03	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (249)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)																	
		104 Unq* (261)	105 Unp* (262)	106 Unh* (263)	107 Uns* (262)	108 Uno* (265)	109 Una* (266)																										

Lanthanides

Actinides

\*Symbol (and name) provisional.

Numbers in parentheses: available radioactive isotope of longest half-life.