

# ANSWERS

CHM 2120  
Midterm #1  
September 29, 2010  
ANSWERS

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

Seat number: \_\_\_\_\_

**Approximate total number of marks: 72**

The marks are given as a guide and are subject to change.

You can write in pen or in pencil.

The use of molecular models is permitted but they cannot be shared.

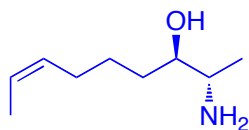
The use of calculators or other electronic devices is not permitted.

1a	2a	3b	4b	5b	6b	7b	8	1b	2b	3a	4a	5a	6a	7a	0		
1 H															2 He		
3 Li	4 Be									5 B	6 C	7 N	8 O	9 F	10 Ne		
11 Na	12 Mg									13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Ha	106 106												

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Final mark

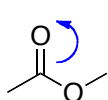
1. Draw the structure of (2*S*,3*R*,*Z*)-2-aminonon-7-en-3-ol. (3 points)



Correct skeleton : 1  
Configurations of stereocentres : 1  
Alkene Z : 1

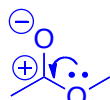
2.

- Draw all of the resonance structures of the following compound using arrows to show the movement of electrons. (4 points)
- Rank the resonance structures. (2 points)
- Justify your ranking. (5 points)
- Draw the resonance hybrid structure. (2 points)

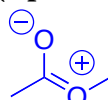


Major  
- All atoms have full octets

- No charges



Minor  
- The C<sup>+</sup> lacks an octet



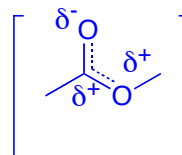
Intermediate  
- All atoms have full octets

- Two charges

a.

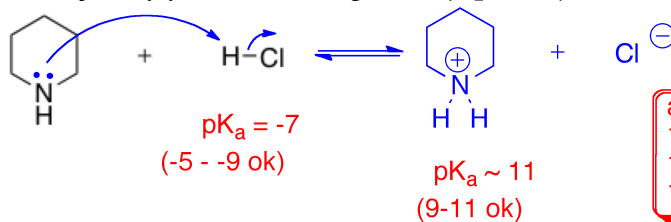
1 pt per resonance structure drawn  
1-curved arrows  
1-resonance arrow between structures  
b. -1 per error  
c. 1 point per correct statement  
d. -1 per error  
General: -1 per incorrect structure or statement

Hybrid:



3.

- Draw the mechanism and products for the following reaction. (5 points)
- Will the reaction favour the starting materials or the products? (1 point)
- Justify your choice in part b. (3 points)



a.  
1 pt per curved arrow (2)  
1 pt equilibrium arrow  
1 pt per final structure (2)

The equilibrium favours the side with the weakest acid, i.e. the side with the protonated amine on the right (products).

1 point

1 point per pK<sub>a</sub>, total 2  
1 point for the explanation, which must make a clear comparison of the acids and demonstrate the understanding that the equilibrium favours the side with the weakest acid

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4. Circle the most basic nitrogen atom in the following compound and justify your choice. (3 points)

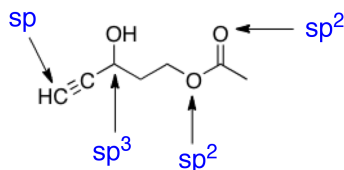


1 point: the circled N

1 point: the electrons in the right hand nitrogen are involved in resonance, they are more stabilized (they are delocalized). Aromaticity would be destroyed if this N was protonated (this would be destabilizing)

1 point: the electrons in the left hand nitrogen are not involved in resonance (they are in an  $sp^2$  orbital). Aromaticity is not destroyed if these electrons are protonated.

5. Identify the hybridization state for each of the atoms indicated with an arrow. (4 points)



1 point each

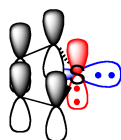
6. Decide whether each of the following compounds is aromatic, anti-aromatic, or non-aromatic and justify your choice (please support your answer with a drawing if you are discussing the position of electrons or orbitals in space). (11 points)

a.



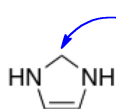
The ring is planar  
All the atoms are  $sp^2$  hybridized  
There are 6  $\pi$  electrons,  $n=1$  according to the  $4n+2$  rule  
  
Aromatic

1 point each



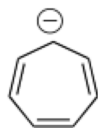
1 point

b.



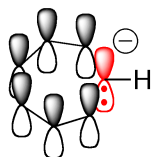
$sp^3$  carbon (1 point).  
This compound is non-aromatic (1 point)

c.



All the atoms are  $sp^2$  hybridized  
There are 8  $\pi$  electrons,  $n=2$  according to the  $4n$  rule  
  
Anti-aromatic

1 point each

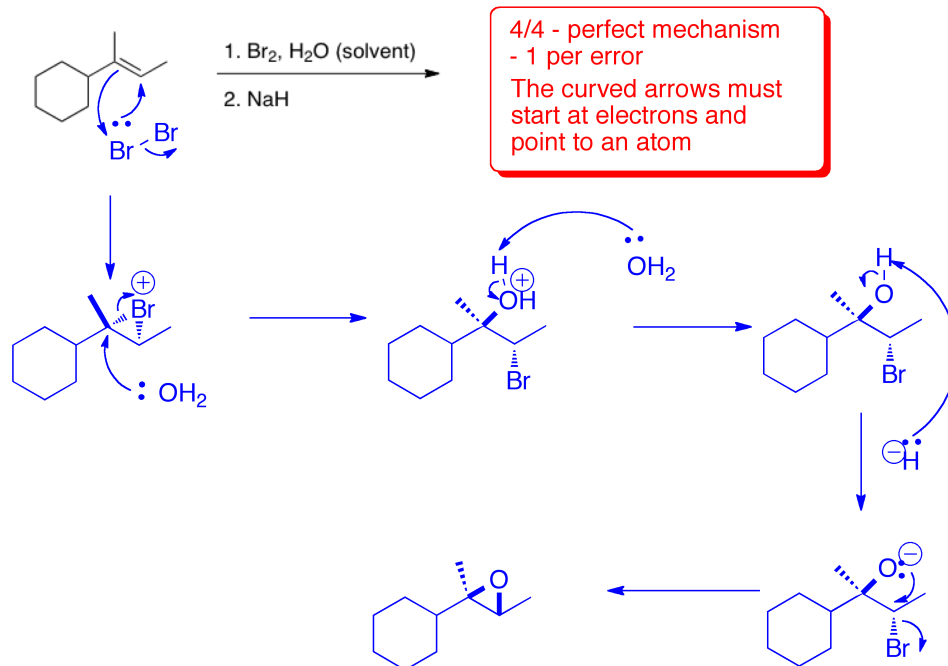


(1 point)

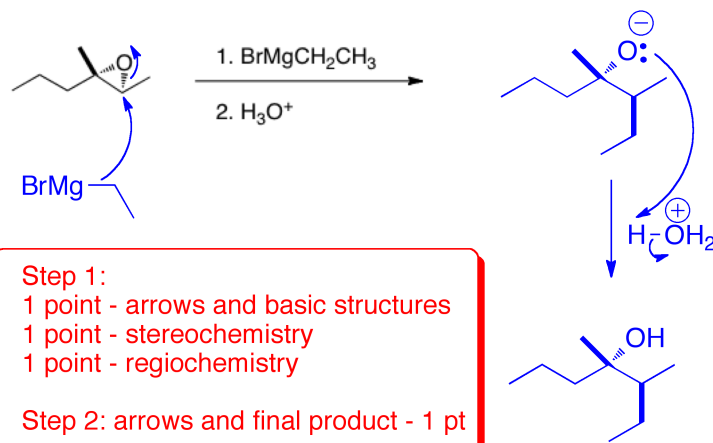
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7. Provide a mechanism and the major organic product of each of the following reactions. (4 points each = 12 points)

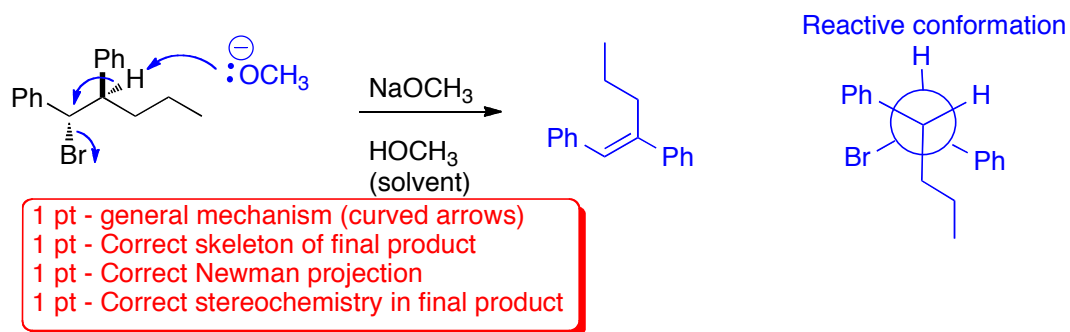
a.



b.



- c. Please include a Newman projection of the reactive conformation.

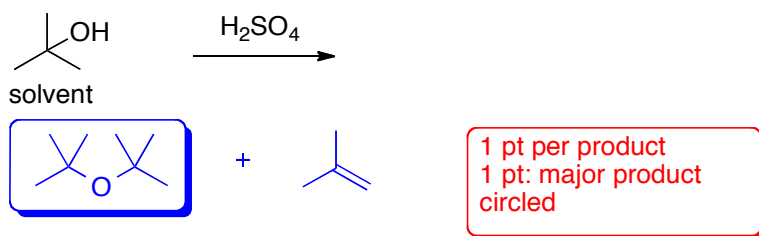


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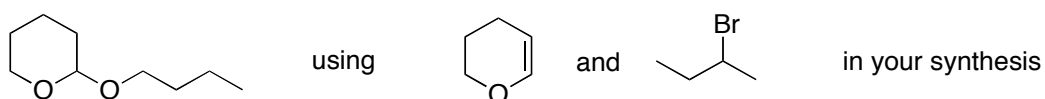
8.

a. Draw the two products of the following reaction. **(2 points)**

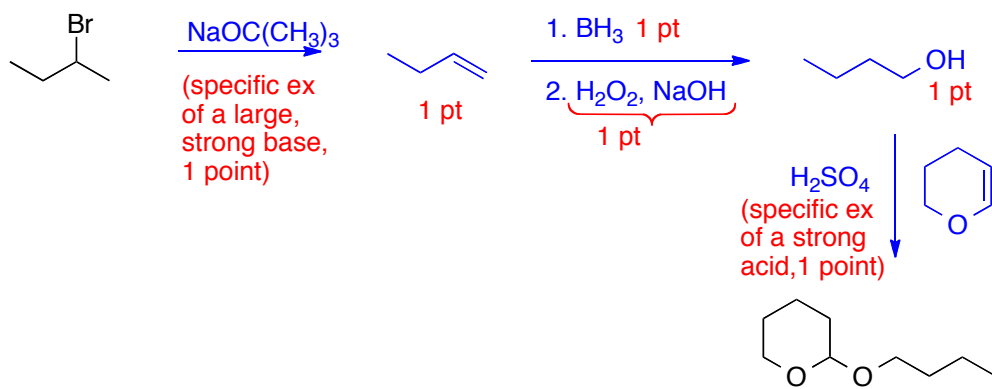
b. Circle the major product. **(1 point)**



9. Propose a synthesis of:

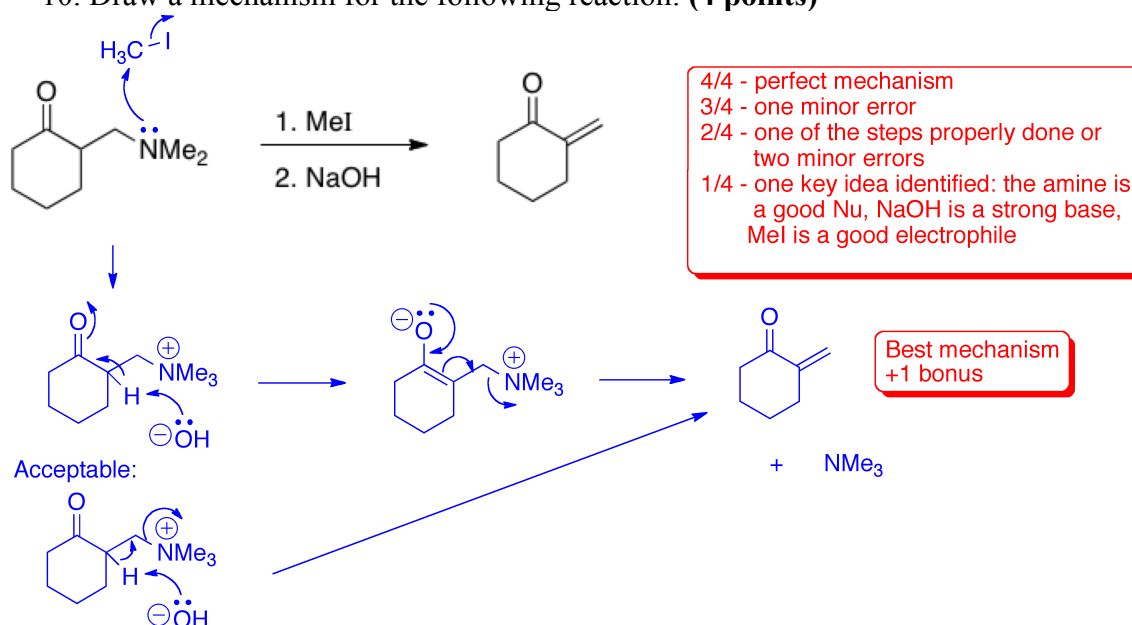


You can add in any other reagents that you require. You do not have to provide a retrosynthesis. **(6 points)**



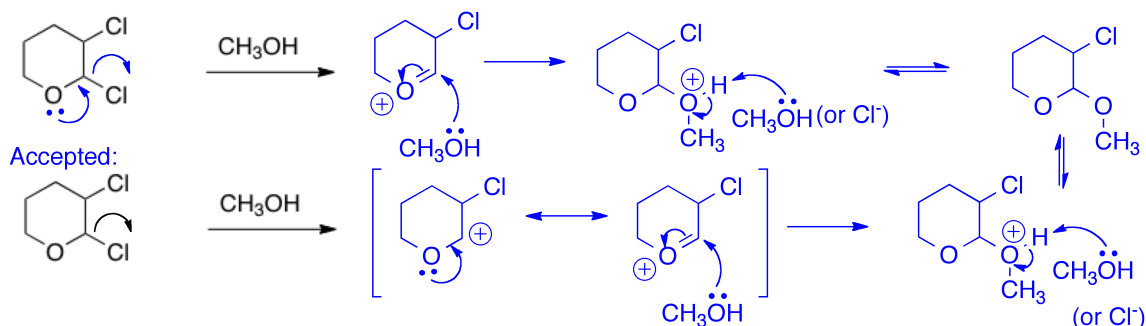
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10. Draw a mechanism for the following reaction: **(4 points)**



11. Draw a mechanism showing the formation of the major product of the following reaction: **(4 points)**

Best mechanism:



2 points -  $S_N1$  mechanism well-drawn (1 point - E1)  
1 point - regiochemistry (0 pts E1)  
1 point - implication of oxygen lone pair shown

**Bonus! (3 points)**

Explain the following results. Please draw a mechanism in 3D as part of your answer.

