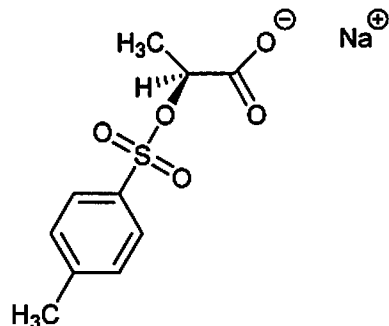


NAME: _____

1) (8pts) For the following compound, calculate the number of ...



- carbon atoms
 - hydrogen atoms
 - π bonds
 - sp^2 hybridized atoms
 - sp^3 hybridized carbons
 - chiral centers
 - lone pairs (non bonding pairs) of electrons
 - Group 1 (1A) alkali metal cations.
- 2) (4pts)
- Does the above compound have an IONIC bond?
 - Does it contain an *aromatic* ring?
 - Circle the “tosylate” group.
 - State one common property (or behavior) of the *tosylate* functional group.

3) (2pts) a) What are *resonance structures*?

b) (2pts) Provide an example of two species that are *tautomers*.

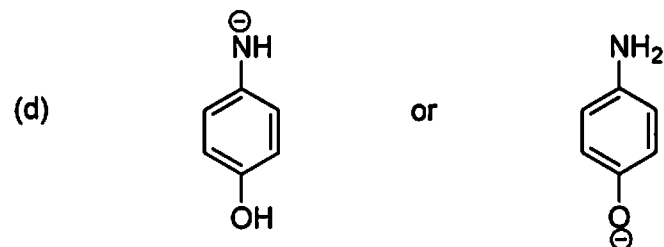
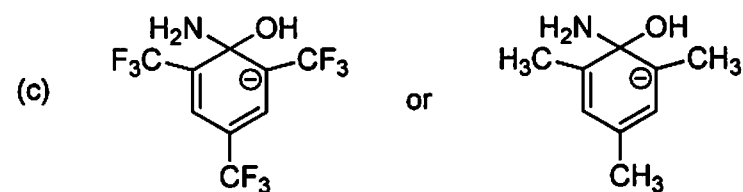
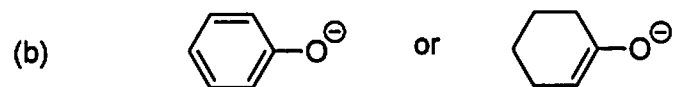
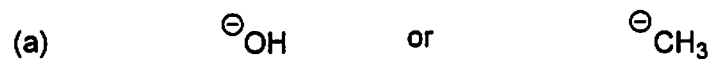
c) (2pts) Provide an example of two compounds that are two *stereoisomers*.

d) (2pts) What does this arrow
a mechanism?



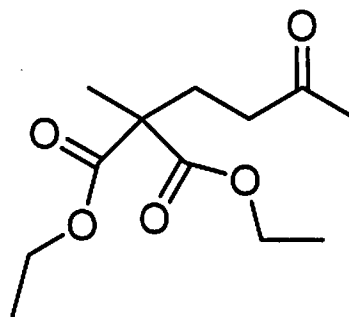
formally mean when writing

4) (8pts) Circle the **more stable species** in each pair.



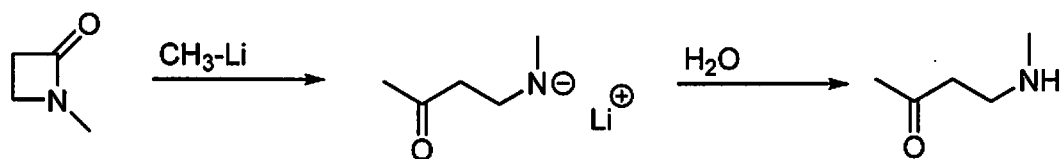
5) (4pts) State two facts about an $\text{S}_{\text{N}}2$ reaction mechanism.

6) (3+7=10pts) For the molecule below:



- How many oxygens are there?
- How many *ester* functional groups are present?
- What is the other oxygen containing functional group called?
- Deprotonation of the above molecule can lead to two different resonance stabilized anions – draw them both, and their resonance structures, and show mechanistically how each anion converts into its resonance structure, and back.

7) (4+6=10pts) For the following reaction:

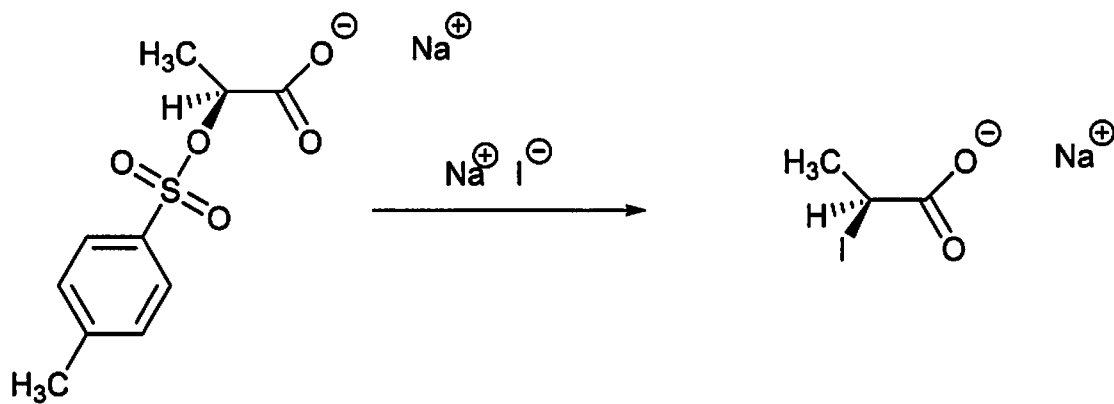


- How many carbons are in the starting cyclic amide (lactam)?
- Which is the most electrophilic carbon in the starting lactam?
- Which is the weakest covalent bond in the lactam?
- Is the methyl lithium acting as a *nucleophile* or a *base*?
- Write the mechanism for this *nucleophilic acyl substitution* reaction.

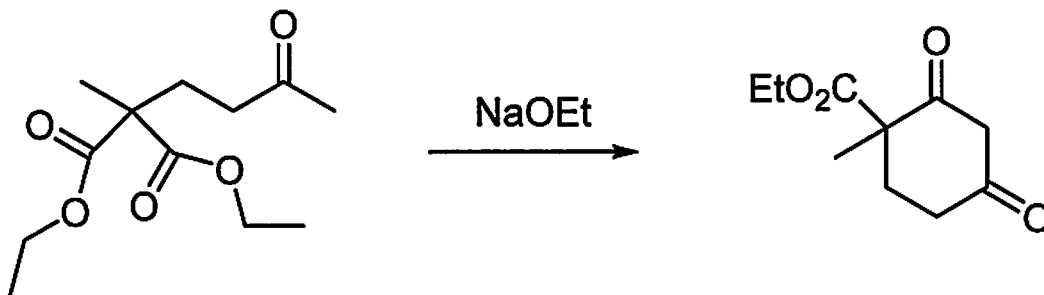
**In this section there are FOUR questions,
(A) – (D),
you must answer only 3.**

**Each is worth 16 points
(48pts)**

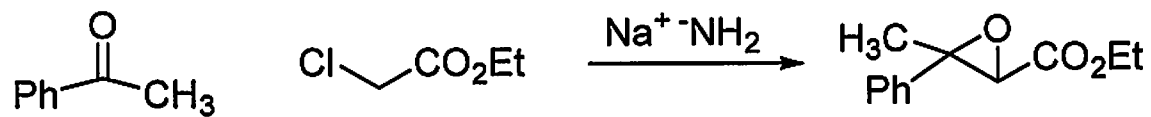
A) (16pts) Bearing in mind that this reaction seems to have proceeded with retention of stereochemistry, write a mechanism for the following transformation.



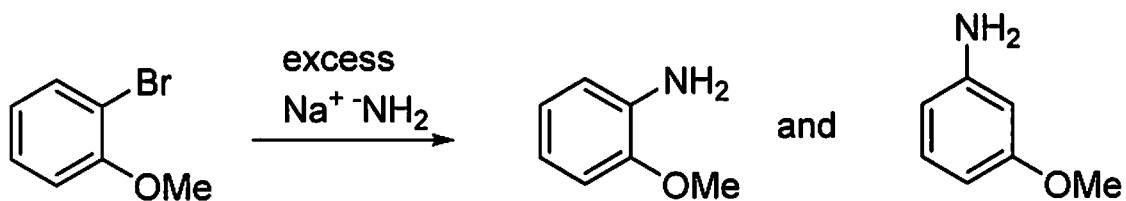
B) (16pts) Write a mechanism for the following transformation.



C) (16pts) Write a mechanism for the following reaction.



D) (16pts) Write a mechanism that explains the formation of both products for the following reaction.



BONUS POINTS (3 points)

I) What special type of lactam is the starting material in Question (7)?

II) What is the chirality of the product in Mechanism Question (A)?

III) What is the common name of the Nucleophilic Aromatic Substitution mechanism in Mechanism Question (D)?

hydrogen 1 H	beryllium 4 Be										helium 2 He									
lithium 3 Li	sodium 11 Na	potassium 19 K	calcium 20 Ca	scandium 21 Sc	titanium 22 Ti	vanadium 23 V	chromium 24 Cr	manganese 25 Mn	iron 26 Fe	cobalt 27 Co	nickel 28 Ni	cupper 29 Cu	zinc 30 Zn	gallium 31 Ga	germanium 32 Ge	arsenic 33 As	seleburn 34 Se	bromine 35 Br	krypton 36 Kr	
10079	90122	22990	24305	44856	47867	50942	51996	54938	55845	58933	58693	63546	6539	69723	7261	74922	7896	79904	8380	
berilium 4 Be	magnesium 12 Mg	calcium 20 Ca	strontium 38 Sr	yttrium 39 Y	zirconium 40 Zr	niobium 41 Nb	molybdenum 42 Mo	technetium 43 Tc	ruthenium 44 Ru	rhodium 45 Rh	paladium 46 Pd	silver 47 Ag	cadmium 48 Cd	indium 49 In	tin 50 Sn	antimony 51 Sb	tellurium 52 Te	iodine 53 I	xenon 54 Xe	
6941	24305	40078	8762	88906	91224	92906	9594	98	10107	10291	10642	10787	11241	11482	11871	12176	12760	12690	13129	
lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	
1391	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012
lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	
1391	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012
lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	
1391	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012
lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne	lithium 3 Li	beryllium 4 Be	boron 5 B	carbon 6 C	
1391	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012	14012

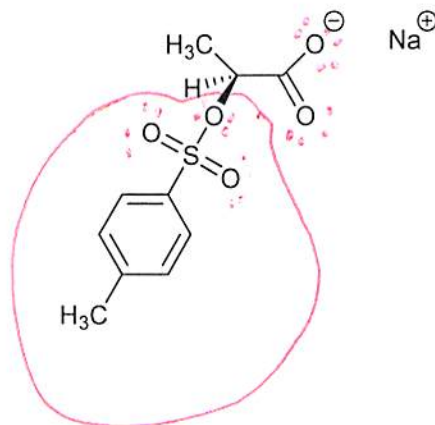
* Lanthanide series

** Actinide series

lanthanum 57 La	cerium 58 Ce	praseodymium 59 Pr	neodymium 60 Nd	promethium 61 Pm	samarium 62 Sm	europium 63 Eu	gadolinium 64 Gd	terbium 65 Tb	dyprosium 66 Dy	holmium 67 Ho	erbium 68 Er	thulium 69 Tm	ytterbium 70 Yb	actinium 89 Ac	thorium 90 Th	protactinium 91 Pa	uranium 92 U	neptunium 93 Np	plutonium 94 Pu	americium 95 Am	curium 96 Cm	berkelium 97 Bk	californium 98 Cf	einsteinium 99 Es	fermium 100 Fm	mendelevium 101 Md	nobelium 102 No		
13891	14012	14091	14424	149	15036	15196	15725	15893	16250	16493	16726	16893	17304	2271	23204	23104	23803	237	244	243	247	247	251	257	259	22304	23204	23104	2271
lanthanum 57 La	cerium 58 Ce	praseodymium 59 Pr	neodymium 60 Nd	promethium 61 Pm	samarium 62 Sm	europium 63 Eu	gadolinium 64 Gd	terbium 65 Tb	dyprosium 66 Dy	holmium 67 Ho	erbium 68 Er	thulium 69 Tm	ytterbium 70 Yb	actinium 89 Ac	thorium 90 Th	protactinium 91 Pa	uranium 92 U	neptunium 93 Np	plutonium 94 Pu	americium 95 Am	curium 96 Cm	berkelium 97 Bk	californium 98 Cf	einsteinium 99 Es	fermium 100 Fm	mendelevium 101 Md	nobelium 102 No		
13891	14012	14091	14424	149	15036	15196	15725	15893	16250	16493	16726	16893	17304	2271	23204	23104	23803	237	244	243	247	247	251	257	259	22304	23204	23104	2271

NAME: ANSWERS

1) (8pts) For the following compound, calculate the number of ...



a) carbon atoms 10

b) hydrogen atoms 11

c) π bonds 6d) sp^2 hybridized atoms 10e) sp^3 hybridized carbons 3

f) chiral centers 1

g) lone pairs (non bonding pairs) of electrons 11

h) Group 1 (1A) alkali metal cations. 1

2) (4pts) a) Does the above compound have an IONIC bond? Yes

b) Does it contain an *aromatic* ring? Yes

c) Circle the "tosylate" group. ✓

d) State one common property (or behavior) of the *tosylate* functional group

A good leaving group.

3) (2pts) a) What are *resonance structures*?

Species that differ only in their placement of electron density.

b) (2pts) Provide an example of two species that are *tautomers*.



c) (2pts) Provide an example of two compounds that are two *stereoisomers*.



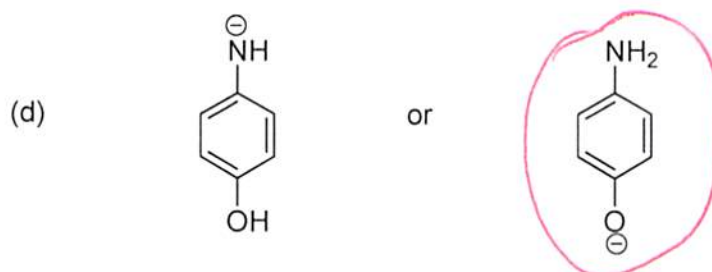
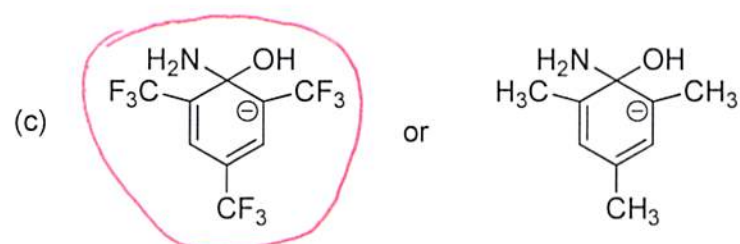
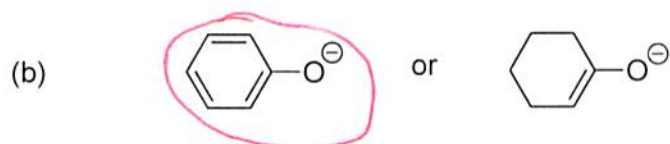
d) (2pts) What does this arrow



formally mean when writing a mechanism?

The movement of TWO electrons.

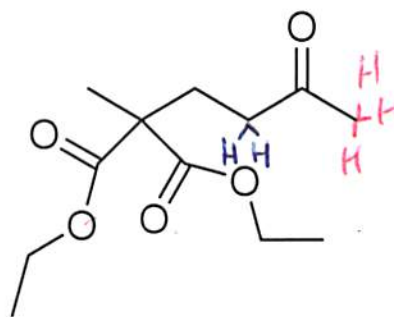
4) (8pts) Circle the **more stable species** in each pair.



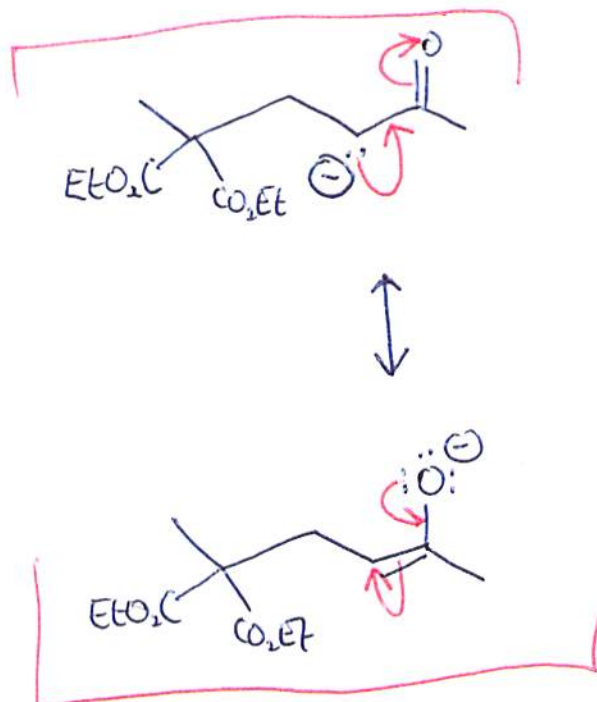
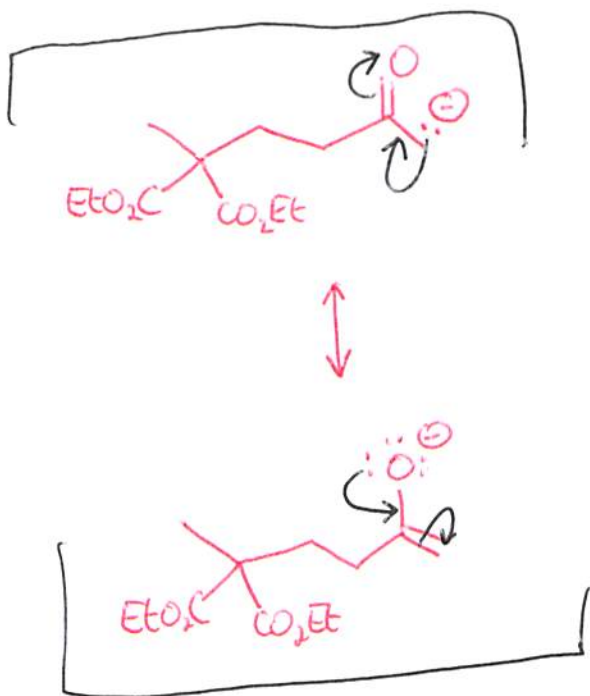
5) (4pts) State two facts about an $\text{S}_{\text{N}}2$ reaction mechanism.

- Bond breaking and bond formation are concerted.
- Back side attack of nucleophile (directly behind the C-LG bond).
- 100% inversion of stereochemistry.
- Strong nucleophile helps.
- Good leaving group helps ---- etc.

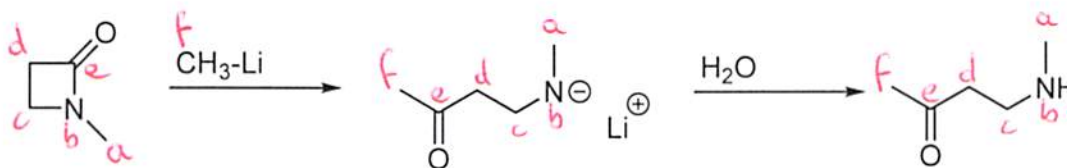
6) (3+7=10pts) For the molecule below:



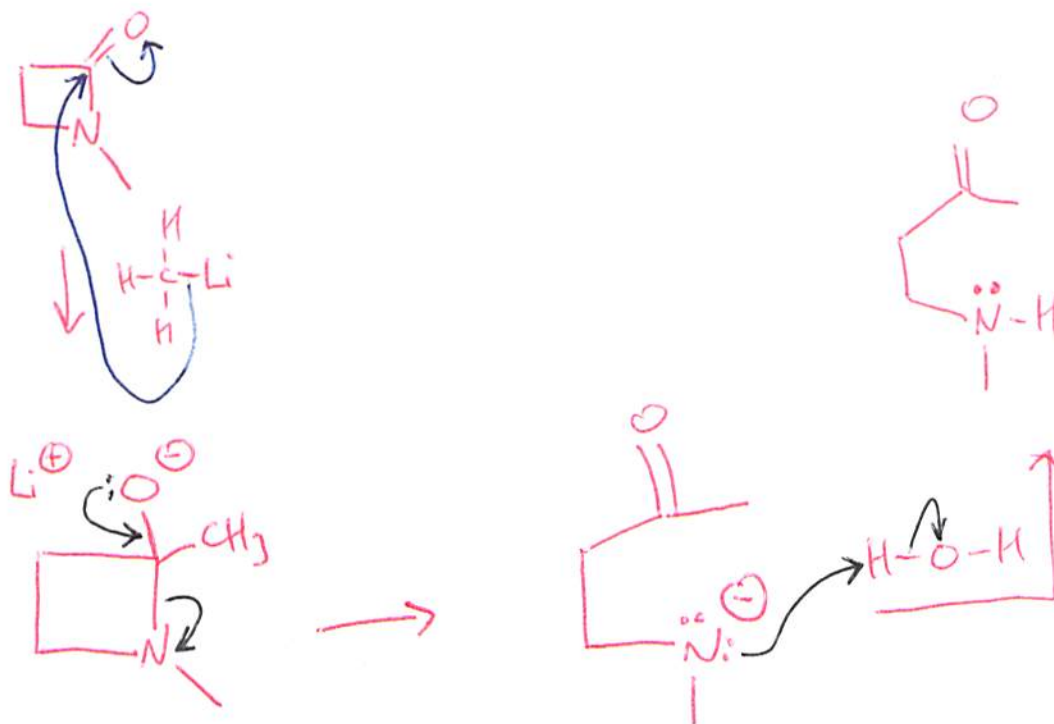
- a) How many oxygens are there? **5**
- b) How many *ester* functional groups are present? **2**
- c) What is the other oxygen containing functional group called? **Ketone**
- d) Deprotonation of the above molecule can lead to two different resonance stabilized anions – draw them both, and their resonance structures, and show mechanistically how each anion converts into its resonance structure, and back.



7) (4+6=10pts) For the following reaction:



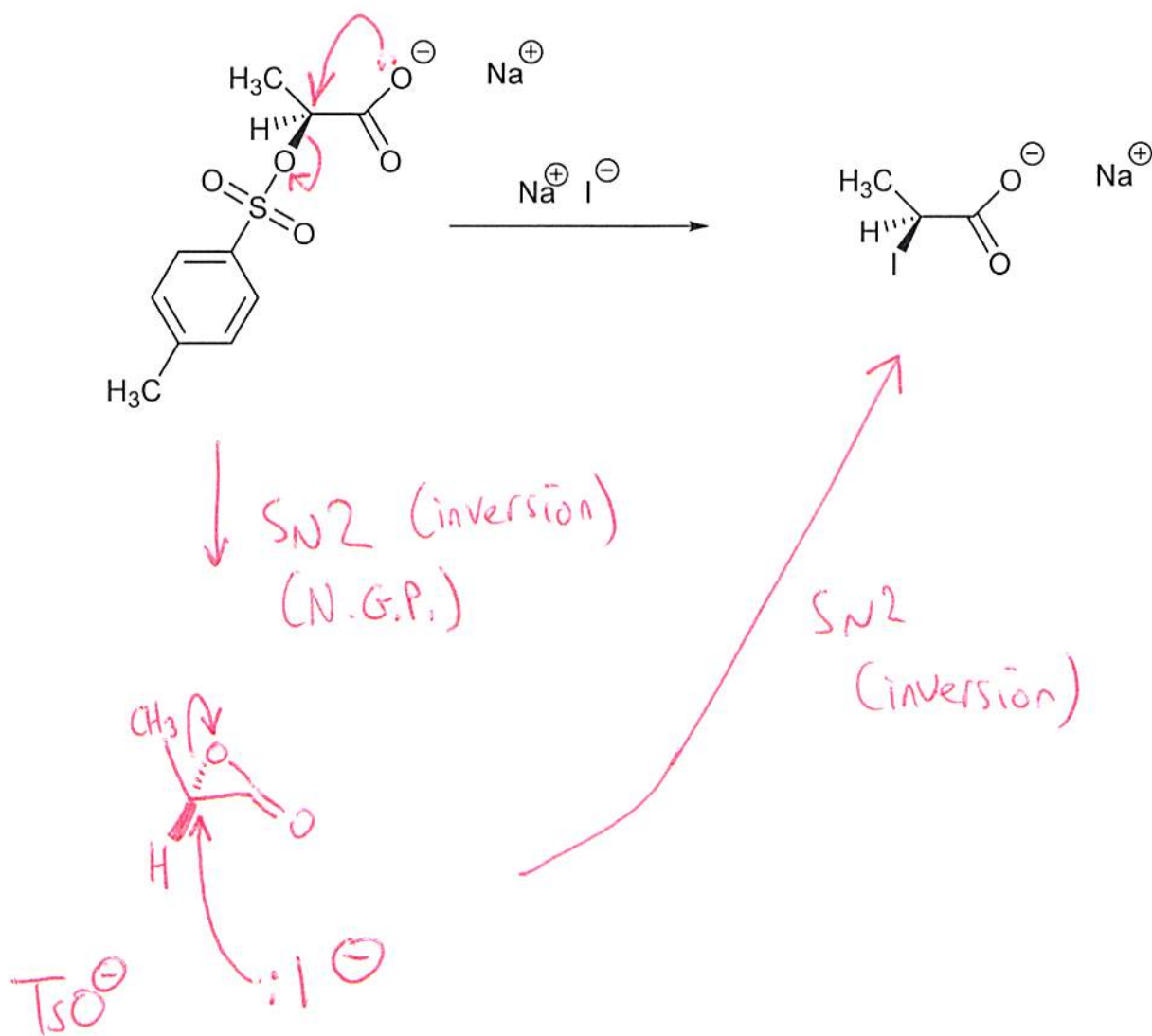
- a) How many carbons are in the starting cyclic amide (lactam)? **4**
- b) Which is the most electrophilic carbon in the starting lactam? **C=O**
- c) Which is the weakest covalent bond in the lactam? **π bond**
- d) Is the methyl lithium acting as a *nucleophile* or a *base*? **Nucleophile**
- e) Write the mechanism for this *nucleophilic acyl substitution* reaction.



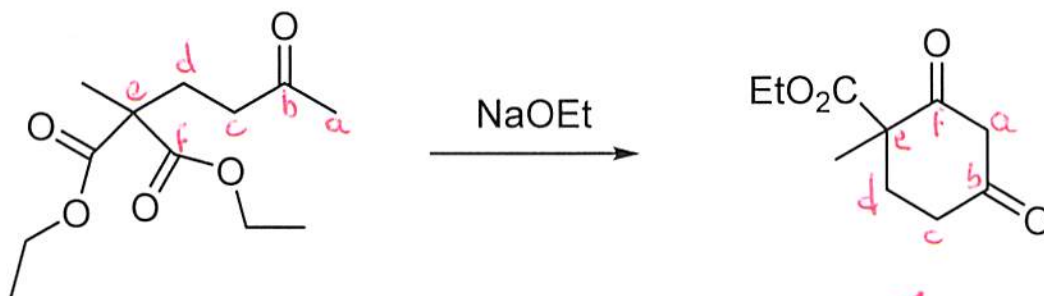
**In this section there are FOUR questions,
(A) – (D),
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**Each is worth 16 points
(48pts)**

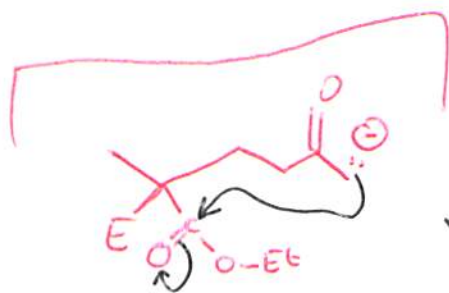
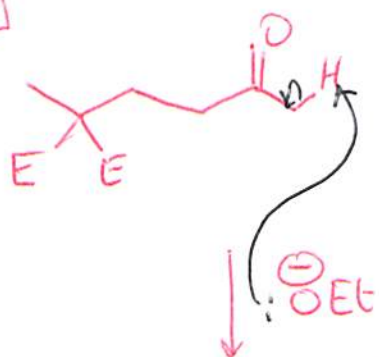
A) (16pts) Bearing in mind that this reaction seems to have proceeded with retention of stereochemistry, write a mechanism for the following transformation.



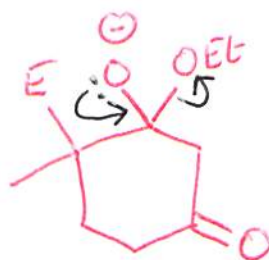
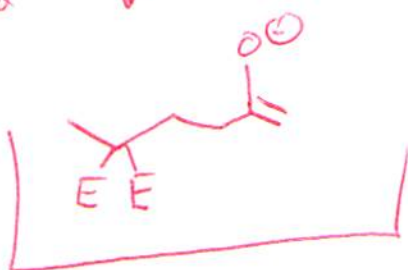
B) (16pts) Write a mechanism for the following transformation.



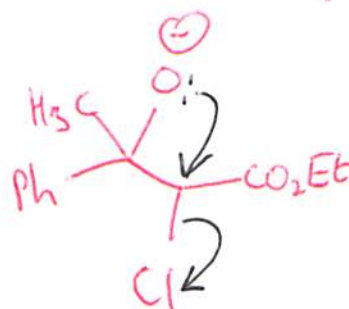
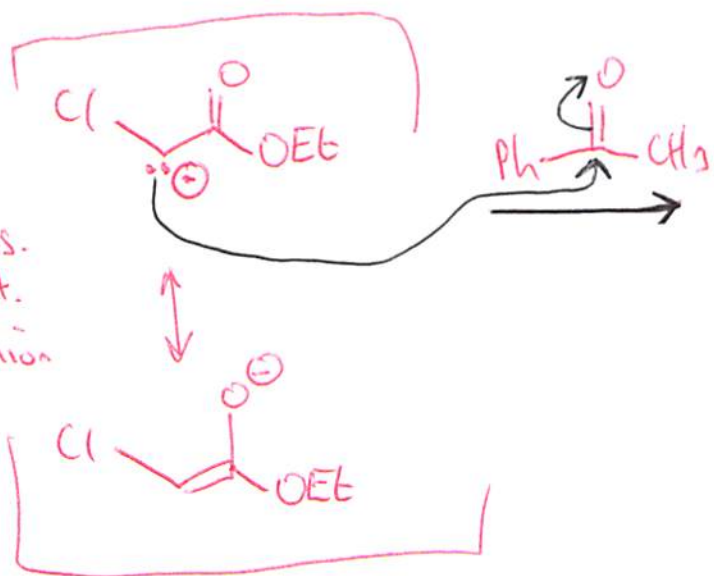
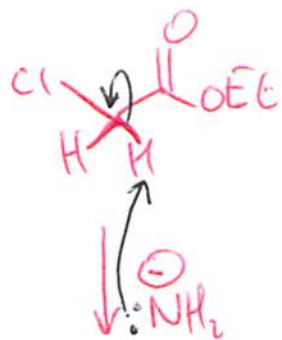
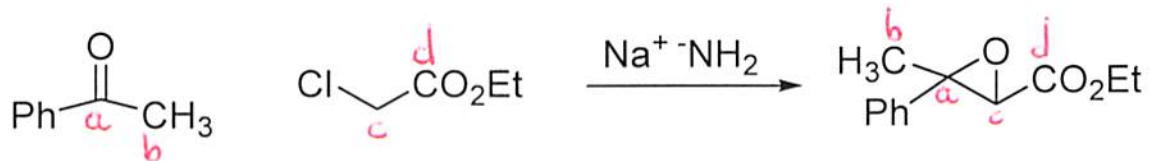
E = Ester



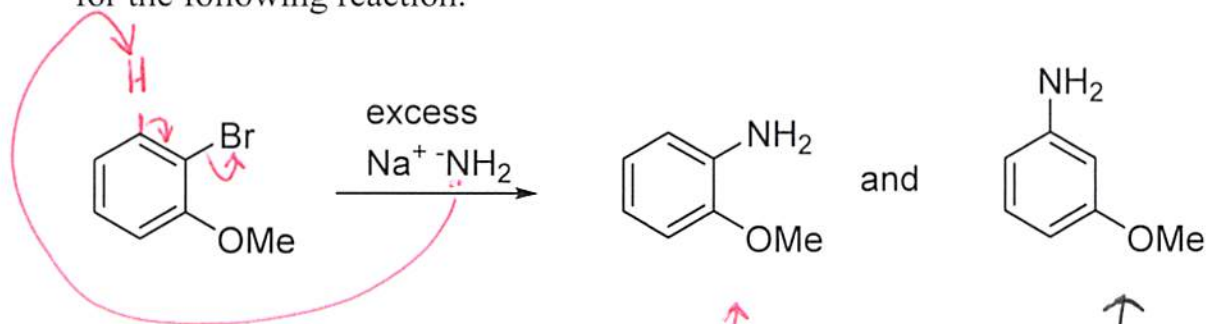
Resonance
Stabilized
Anion



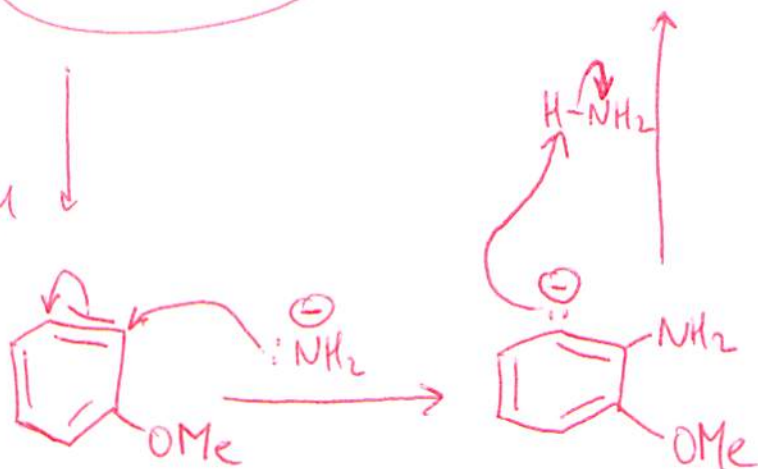
C) (16pts) Write a mechanism for the following reaction.



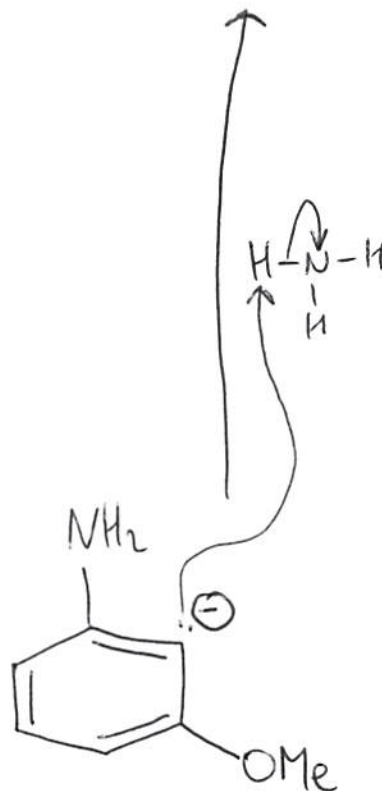
D) (16pts) Write a mechanism that explains the formation of both products for the following reaction.



BENZYNE
MECHANISM



but also

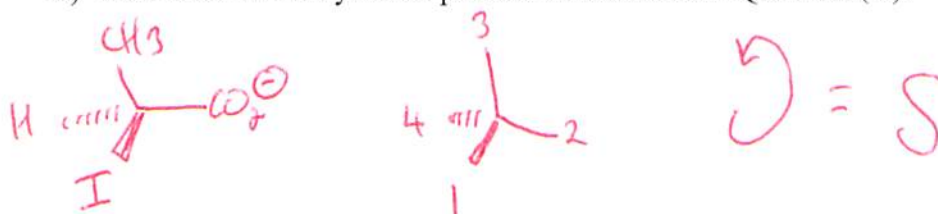


BONUS POINTS (3 points)

I) What special type of lactam is the starting material in Question (7)?



II) What is the chirality of the product in Mechanism Question (A)?



III) What is the common name of the Nucleophilic Aromatic Substitution mechanism in Mechanism Question (D)?

Benzyne mechanism.