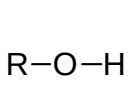
Sp2002 Final Organic II **200pts (Weighted as 300)**

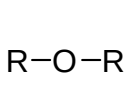
NAME: _____

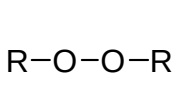
To **not** have your graded script placed outside my office please check this box ☐

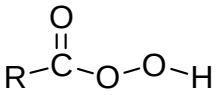
Good luck ("I believe in you, you can do it", etc.) and please read the questions!

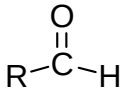
1) Identify the class of compounds each of the following molecules belongs to (22.5pts).

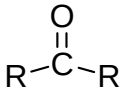


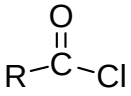


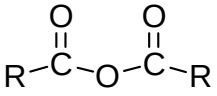


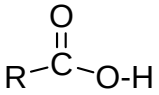


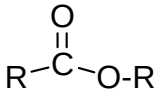


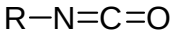


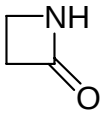


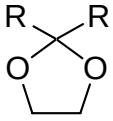


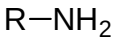












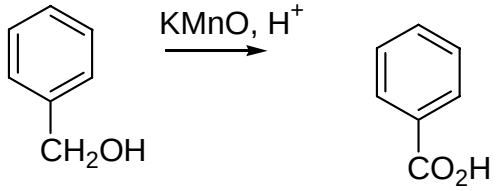
2) Circle the molecule which is most acidic (1.5pts)

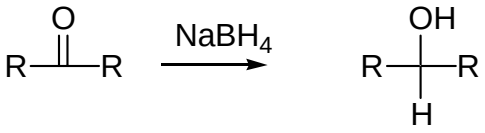
3) Double circle the molecule which contains aromatic rings (1.5pts)

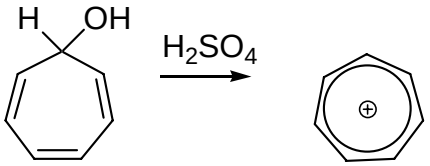
4) Underline the molecule which has the most ring strain (1.5pts)

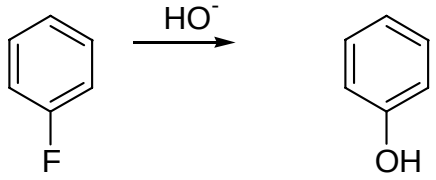
5) Put a cross through the molecule that contains the shortest carbon-nitrogen bond (1.5pts)

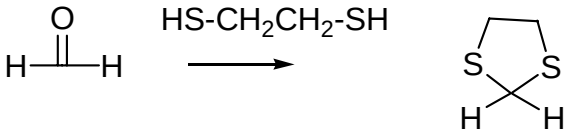
6) Provide one term for each reaction which describes each transformation (e.g. oxidation, electrophilic addition, elimination, etc) (16pts)

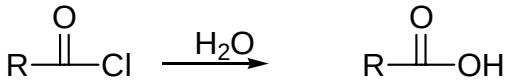
(a) 

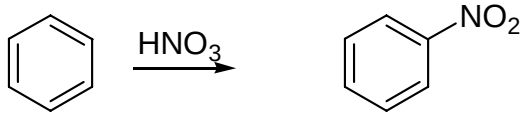
(b) 

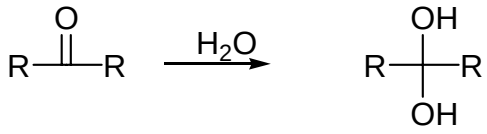
(c) 

(d) 

(e) 

(f) 

(g) 

(h) 

7) The following reactions are named after their inventors – provide a product that could be formed by each of these reactions (9pts).

(a) Friedel Crafts Alkylation

(b) Birch Reduction

(c) Wittig Reaction

(d) Sandmeyer Reaction

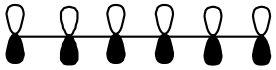
(e) Hoffman Elimination

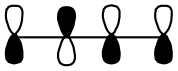
(f) Hoffman Rearrangement

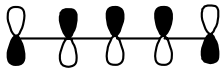
8) Choose one example of an electrophilic aromatic substitution of benzene, and show mechanistically (i.e. curly arrows) how the use of a **Lewis acid** helps promote the reaction (7pts).

9) Give two characteristic properties of aromatic compounds (4pts).

10) State whether each of the following Molecular orbitals are overall bonding, antibonding or non-bonding (4.5pts).

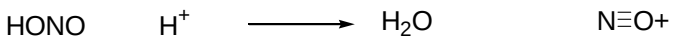
(a) 

(b) 

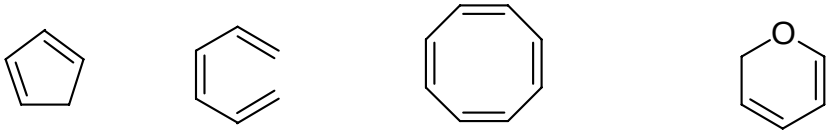
(c) 

11) Aniline (Ph-NH_2) reacts with nitrous acid (HONO) to form a diazonium salt. Draw a Lewis structure (with lone pairs) for nitrous acid.

During the reaction, Nitrous acid undergoes <u>acid catalyzed dehydration</u> to produce the nitrosonium cation (NO^+). Draw the **mechanism** for this transformation, and show that the nitrosonium cation is **resonance stabilized**. (2+4pts)

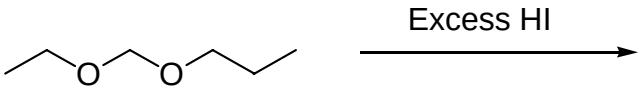


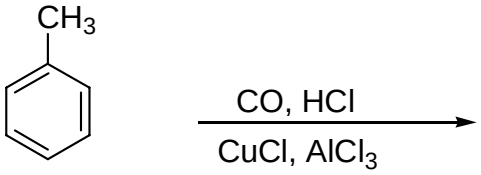
12) Indicate which of the following molecules are aromatic, non-aromatic or anti-aromatic. (<u>Assume all the molecules are planar</u>). (12pts)

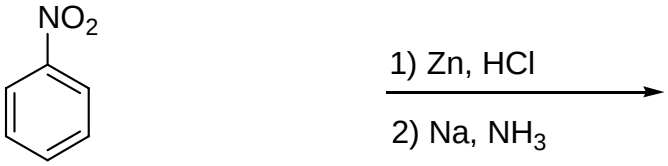


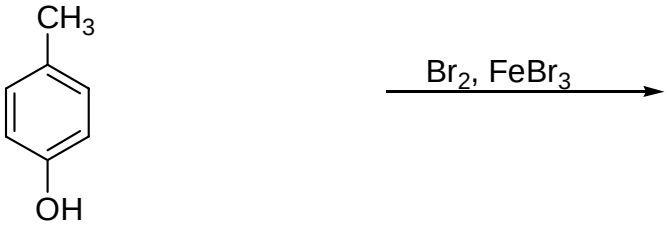
13) Pick one of the above **<u>aromatic</u>** molecules, and use the polygon rule to demonstrate its **aromaticity**. (8pts)

14) Give the products in **six** of the following reactions, paying attention to regio/stereochemistry where applicable. (18pts)

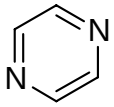








15) The below heterocycle is 6π Hückel aromatic.



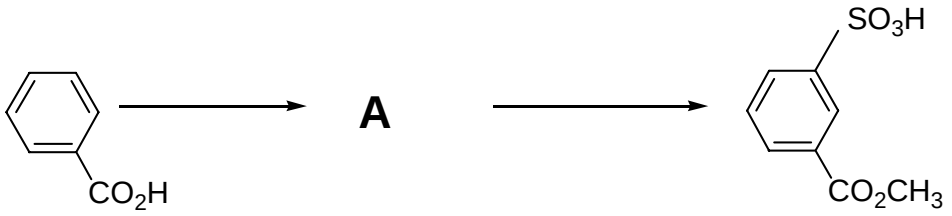
What is a heterocycle? (1pt)

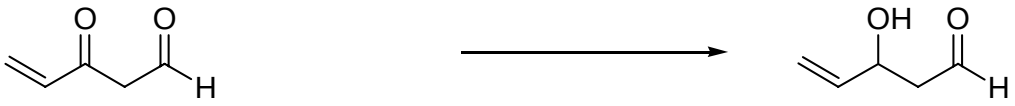
Explain why there are 6 π electrons (3.5pts).

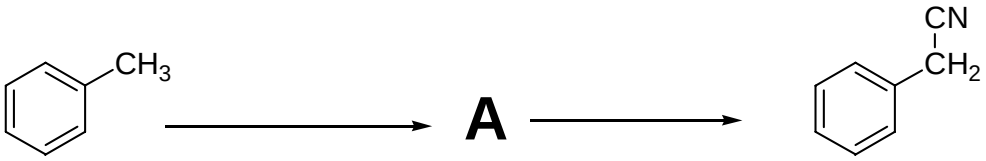
Would you expect this compound to **more** or **less** activated than benzene towards electrophilic aromatic substitution reactions? (1.5pts)

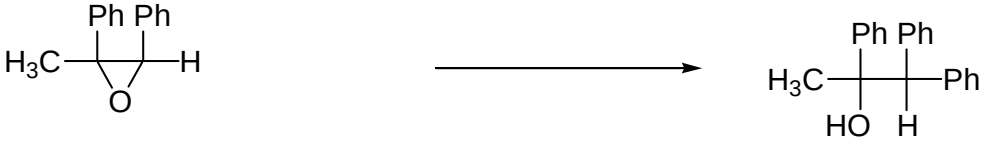
When nitration of the above heterocycle is attempted using a mixture of nitric and sulfuric acids, the reaction is much slower and more difficult than might be initially expected. What is the problem with this reaction? (4pts).

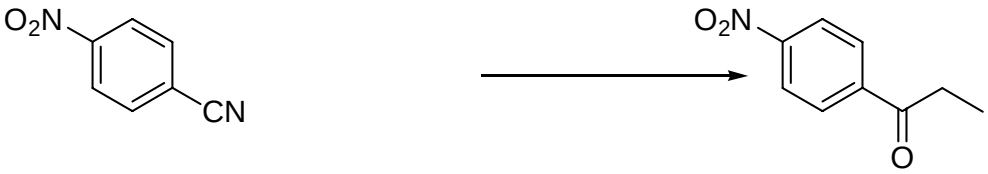
16) Give reagents and conditions to accomplish **five** of the following transformations. (15pts)

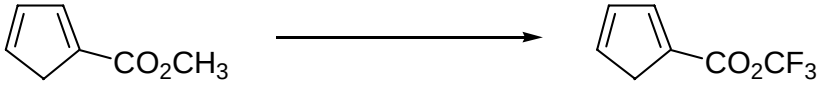




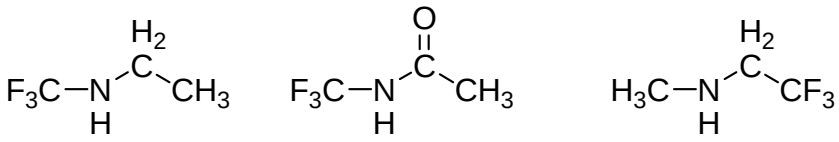


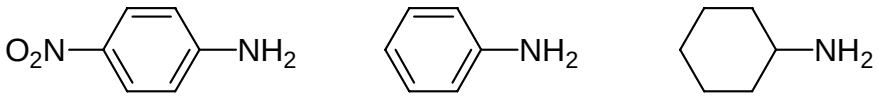


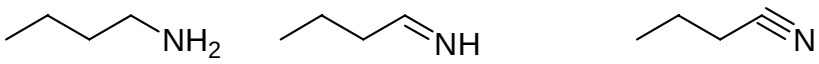




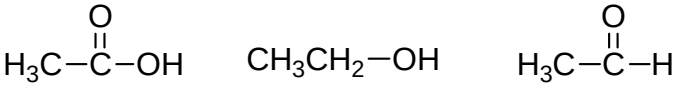
17) Circle the stronger base in the following sets. (6pts)

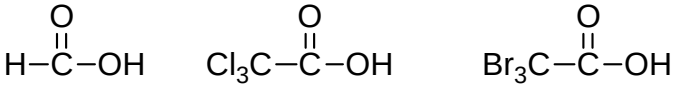
(a) 

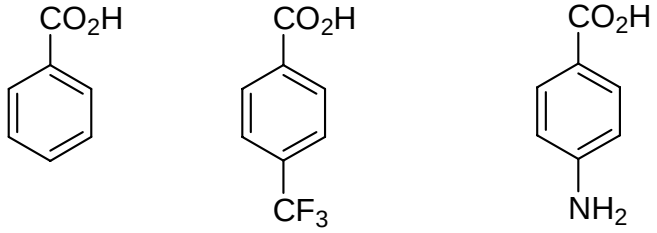
(b) 

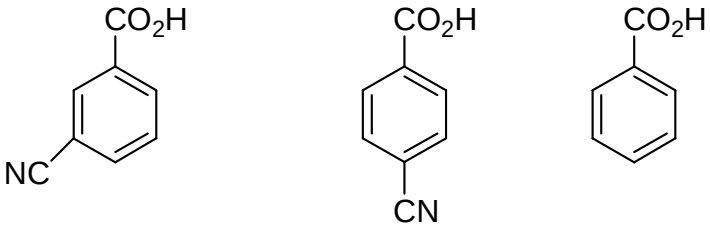
(c) 

18) Circle the stronger acid in the following sets. (8pts)

(a) 

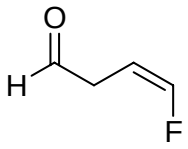
(b) 

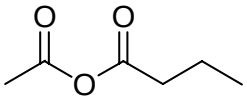
(c) 

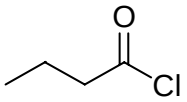
(d) 

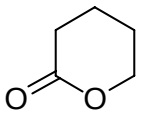
19) Explain what a *Protecting Group* is, and provide an example of one and the group it protects (4pts).

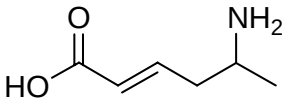
20) Name **five** of the following compounds in IUPAC form (14pts).

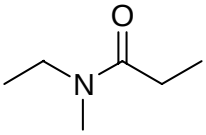




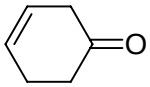








21) Fill in the blanks for **two** of the following reactions. (6pts)

(a) 

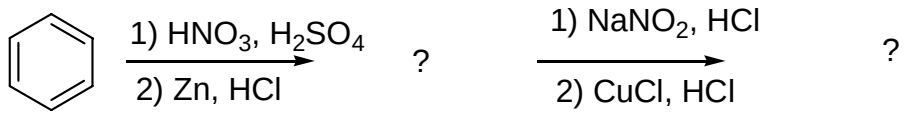
1) $LiAlH_4$; H_2O
2) H_2 gas, Ni catalyst

(b) $CH_3CH_2{-}NH_2$ excess $H_3C{-}\overset{\overset{O}{\|}}{C}{-}Cl$

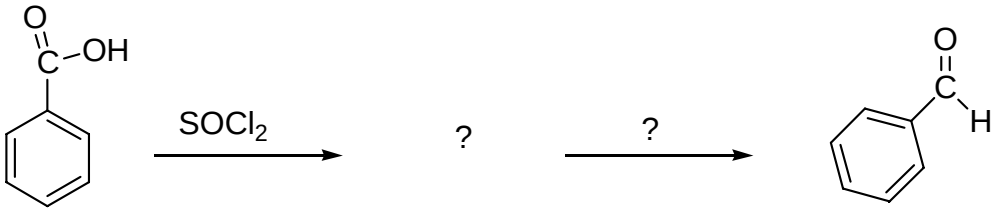
(c) $H_3C{-}\overset{\overset{O}{\|}}{C}{-}CH_3$ excess CH_3OH, H_3O^+

22) Fill in the blanks for **three** of the following reactions. (9pts)

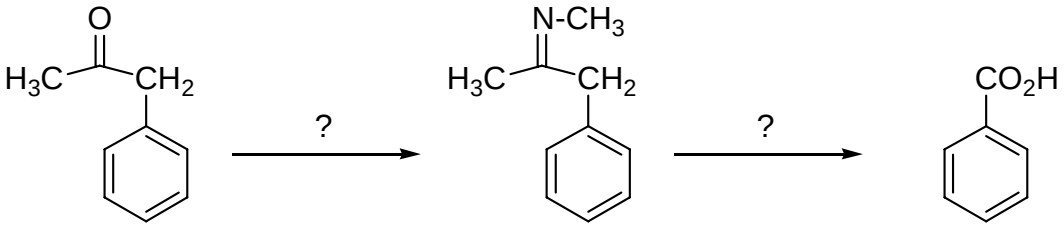
(a)



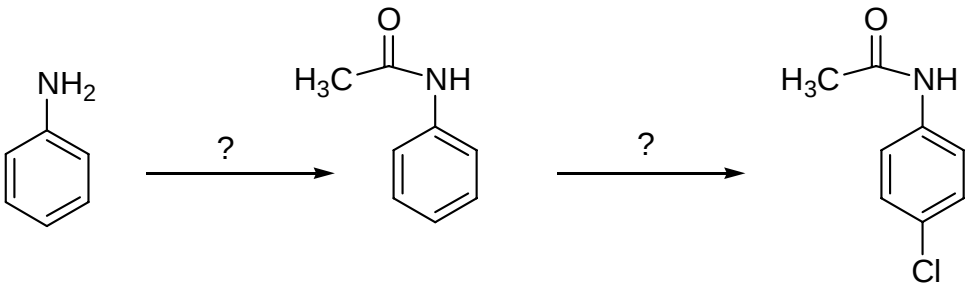
(b)



(c)

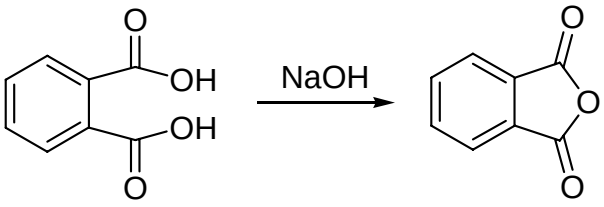


(d)

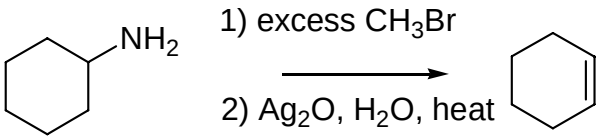


23) Give the mechanism for **two** of the below conversions (16pts)

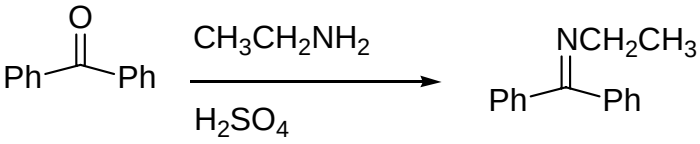
(a)



(b)



(c)



Bonus question (up to 4 points)
My website has 8 images of Eric Cartman. For one point each, describe up to 4 similarities between Eric Cartman and your Organic II experiences.

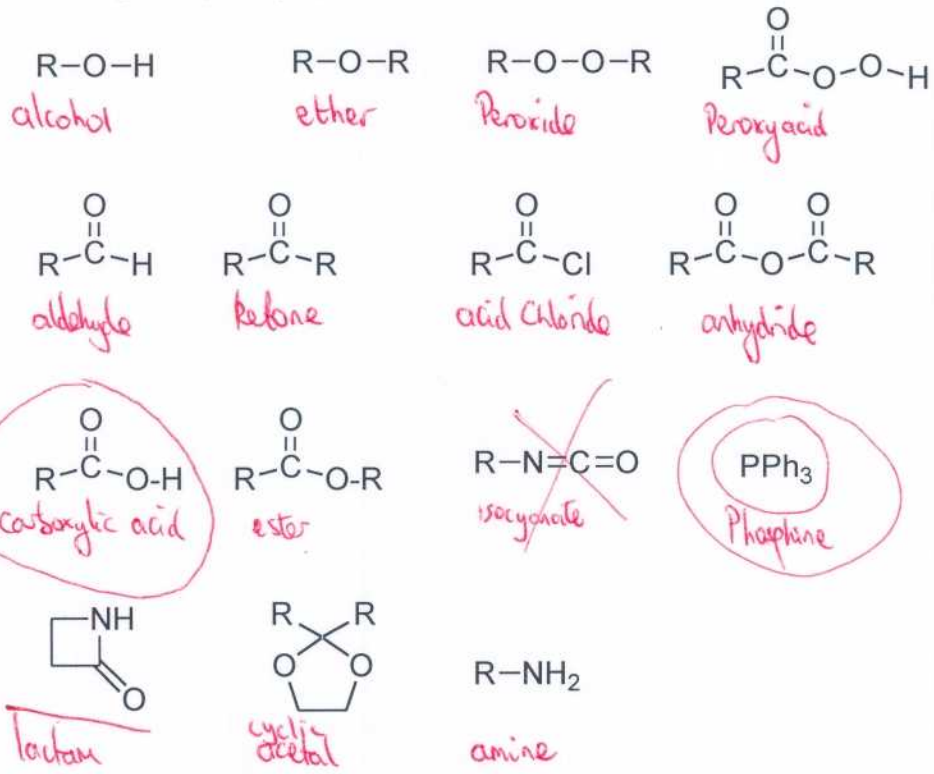
Sp2002 Final Organic II **200pts (Weighted as 300)**

NAME: ERIC MY HERO

To **not** have your graded script placed outside my office please check this box ☐

Good luck ("I believe in you, you can do it", etc.) and please read the questions!

1) Identify the class of compounds each of the following molecules belongs to (22.5pts).



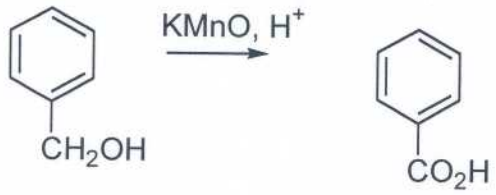
2) Circle the molecule which is most acidic (1.5pts) ✓

3) Double circle the molecule contains aromatic rings (1.5pts) ✓

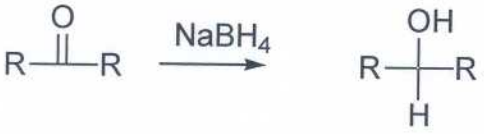
4) Underline the molecule which has the most ring strain (1.5pts) ✓

5) Put a cross through the molecule that contains the shortest carbon-nitrogen bond (1.5pts) ✓

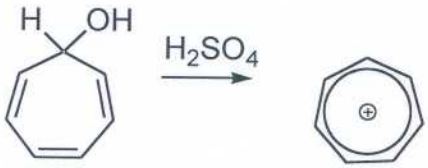
6) Provide one term for each reaction which describes each transformation (e.g. oxidation, electrophilic addition, elimination, etc) (16pts)

(a) 

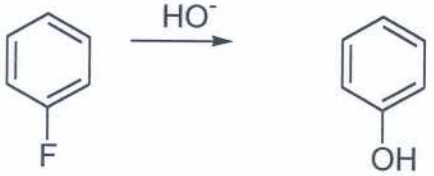
oxidation

(b) 

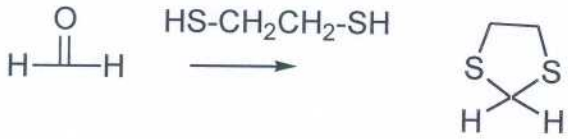
reduction / nucleophilic addition

(c) 

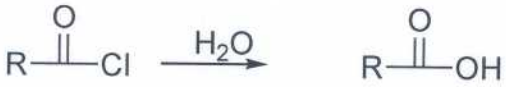
dehydration

(d) 

Nucleophilic Aromatic Substitution

(e) 

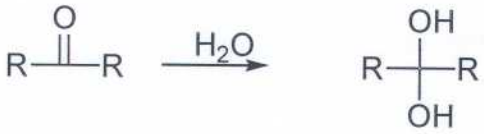
Condensation

(f) 

Nucleophilic Acyl Substitution

(g) 

Nitration / Electrophilic Aromatic Substitution

(h) 

Nuc Addition / Hydration

7) The following reactions are named after their inventors – provide a product that could be formed by each of these reactions (9pts).

(a) Friedel Crafts Alkylation

(b) Birch Reduction

(c) Wittig Reaction

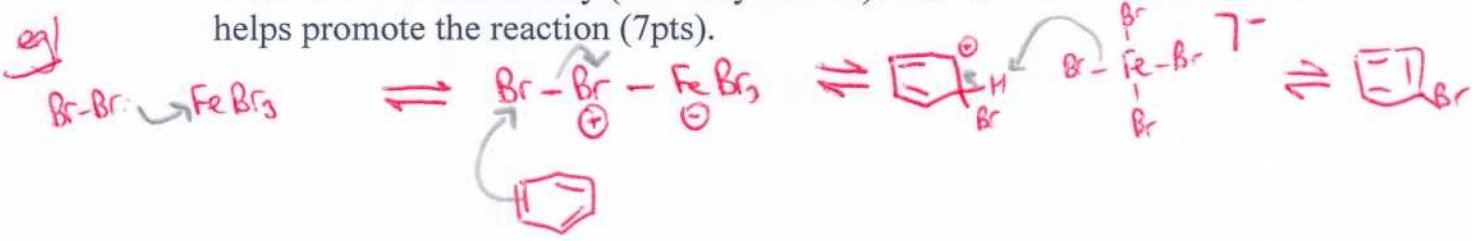
(d) Sandmeyer Reaction

(e) Hoffman Elimination

(f) Hoffman Rearrangement

$CH_3CH_2-NH_2$

8) Choose one example of an electrophilic aromatic substitution of benzene, and show mechanistically (i.e. curly arrows) how the use of a **Lewis acid** helps promote the reaction (7pts).



9) Give two characteristic properties of aromatic compounds (4pts).

- Ring
- Stable
- Substitution Reactions
- Planar
- $(4n+2)\ \pi$ electrons
- Delocalization of e^-s lowers overall energy
-

10) State whether each of the following Molecular orbitals are overall bonding, antibonding or non-bonding (4.5pts).

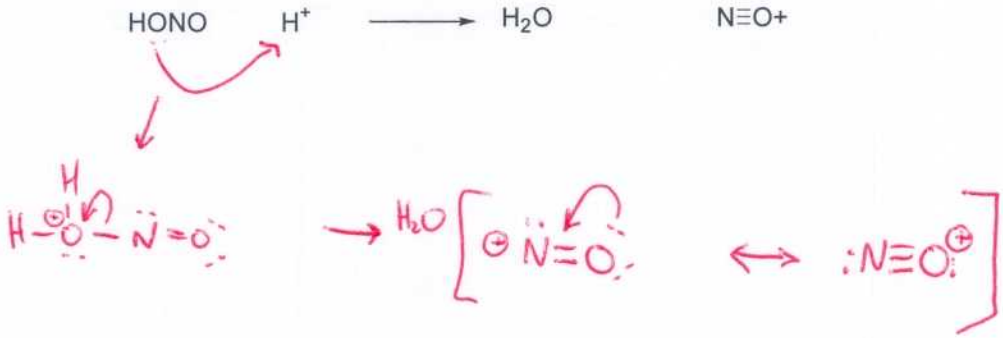
(a)  bonding

(b)  anti-bonding

(c)  Non-bonding

11) Aniline (Ph-NH_2) reacts with nitrous acid (HONO) to form a diazonium salt. Draw a Lewis structure (with lone pairs) for nitrous acid.

During the reaction, Nitrous acid undergoes <u>acid catalyzed dehydration</u> to produce the nitrosonium cation (NO^+). Draw the **mechanism** for this transformation, and show that the nitrosonium cation is **resonance stabilized**. (2+4pts)

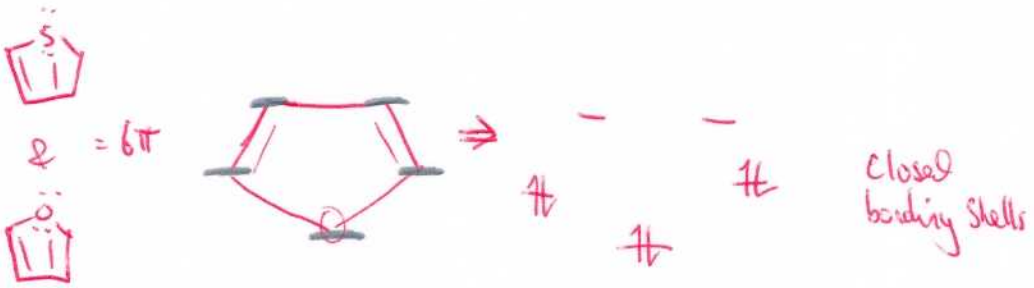


12) Indicate which of the following molecules are aromatic, non-aromatic or anti-aromatic. (Assume all the molecules are planar). (12pts)

Non Non Anti Non

Aromatic 6π Aromatic 6π Anti Aromatic 6π

13) Pick one of the above **aromatic** molecules, and use the polygon rule to demonstrate its **aromaticity**. (8pts)

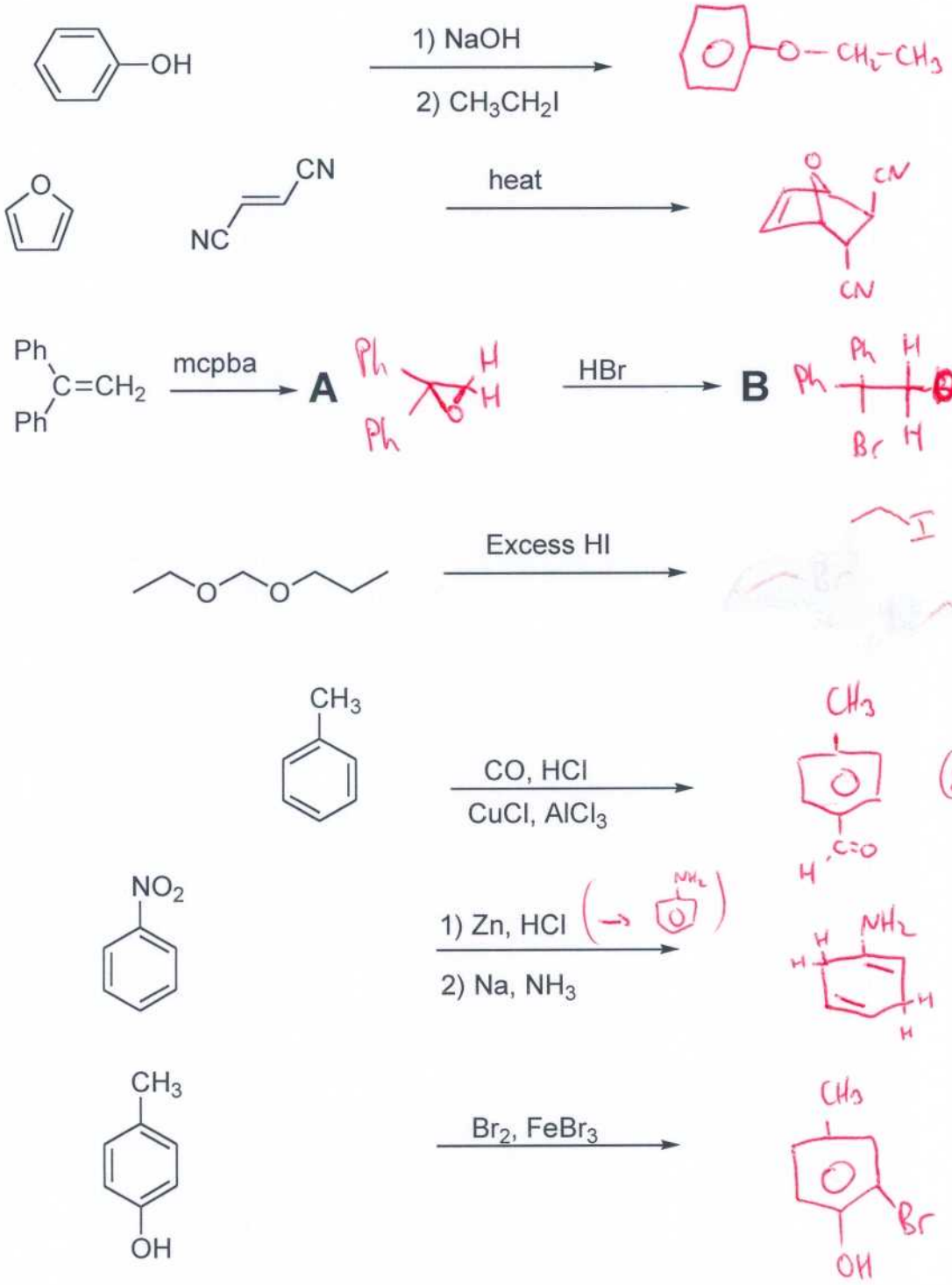


= 6π ⇒ closed bonding shells

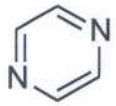
⇒ closed bonding shells.

or 6π

14) Give the products in **six** of the following reactions, paying attention to regio/stereochemistry where applicable. (18pts)



15) The below heterocycle is 6π Hückel aromatic.



What is a heterocycle? (1pt)

A ring that contains atoms other than carbon.

Explain why there are 6 π electrons (3.5pts).

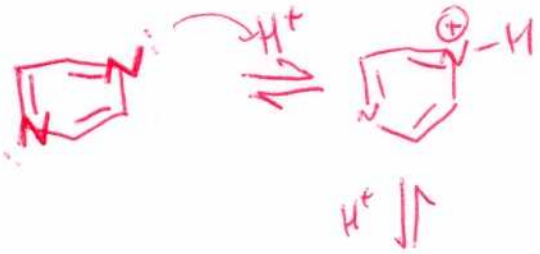
3 double bonds ⇒ 3π bonds = 6π electrons

The Nitrogen atoms are sp^2 hybridized, with lone pairs in sp^2 orbitals pointing away from the ring.

Would you expect this compound to **more** or **less** activated than benzene towards electrophilic aromatic substitution reactions? (1.5pts)

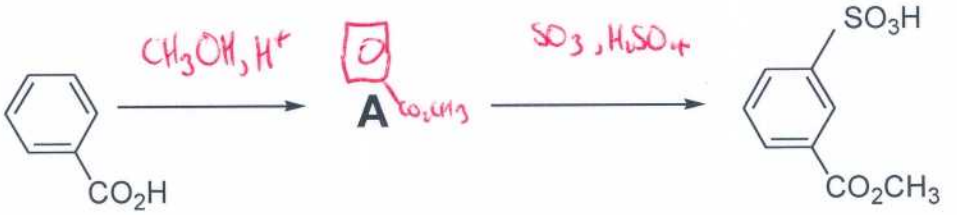
less activated, due to electronegative Nitrogens (deactivating).

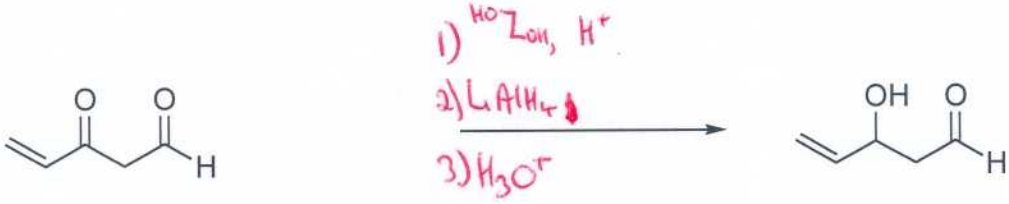
When nitration of the above heterocycle is attempted using a mixture of nitric and sulfuric acids, the reaction is much slower and more difficult than might be initially expected. What is the problem with this reaction? (4pts).

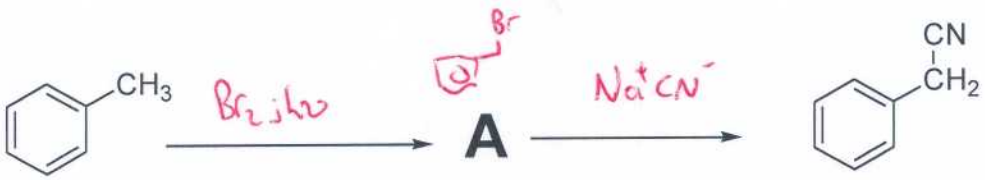


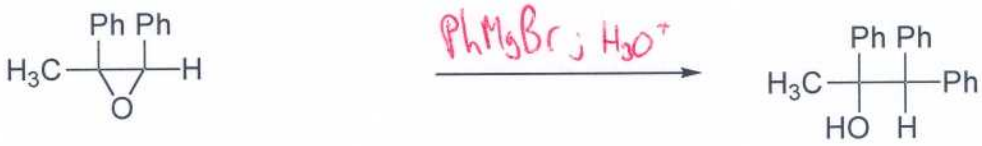
Protonation of the N's creates even more deactivation towards E.A.S.

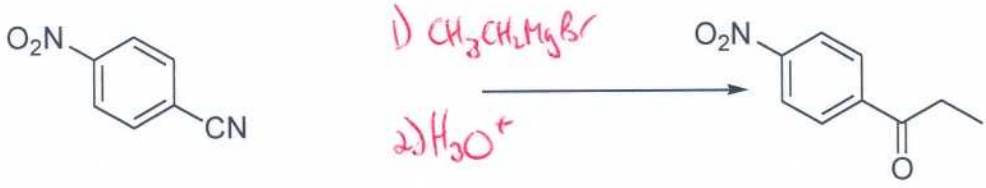
16) Give reagents and conditions to accomplish **five** of the following transformations. (15pts)

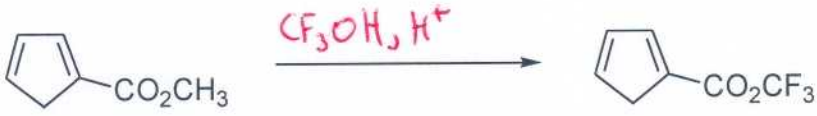




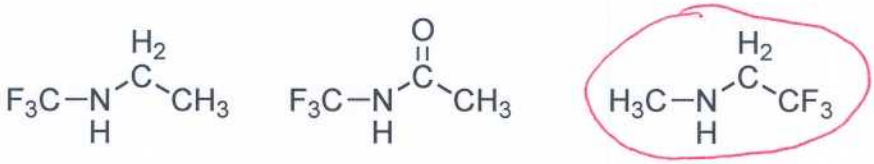


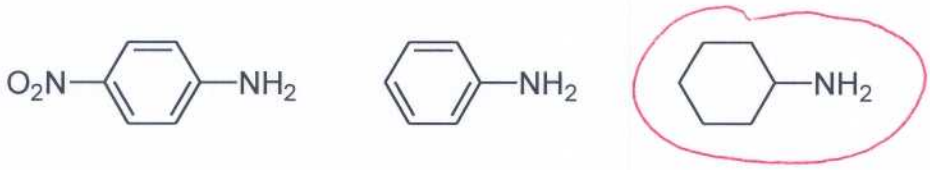


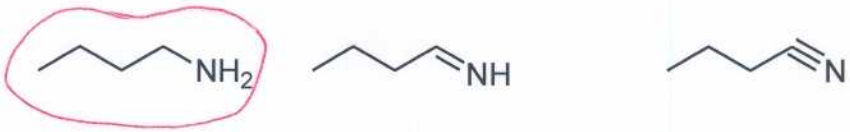




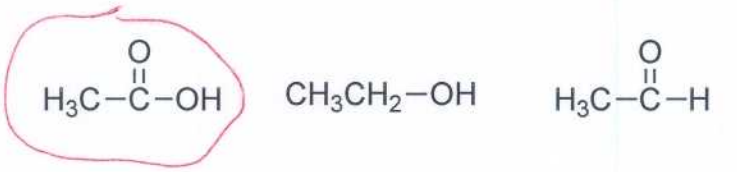
17) Circle the stronger base in the following sets. (6pts)

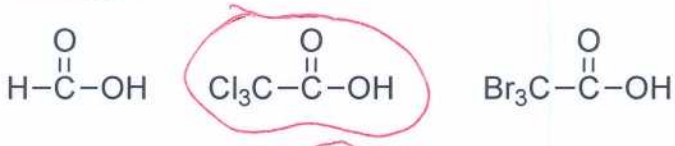
(a) 

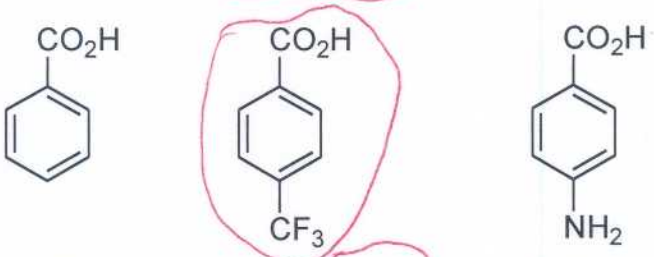
(b) 

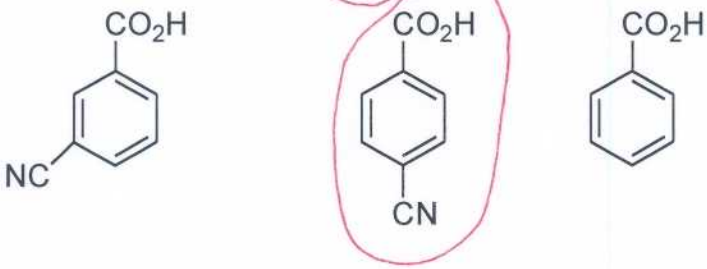
(c) 

18) Circle the stronger acid in the following sets. (8pts)

(a) 

(b) 

(c) 

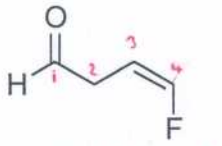
(d) 

19) Explain what a *Protecting Group* is, and provide an example of one and the group it protects (4pts).

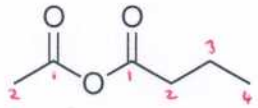
A protecting group is something a reactive functional group is converted into, so that it will not react. Ideally it is easy to convert the protecting group back to the original functional group.

eg  Protected as 

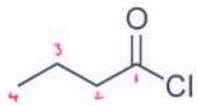
20) Name **five** of the following compounds in IUPAC form (14pts).



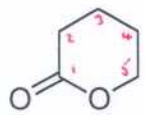
4-Fluoro (3,Z) butenal



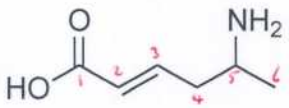
butanoic ethanoic anhydride



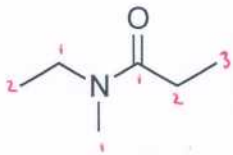
butanoyl chloride



5hydroxypentanoic acid lactone

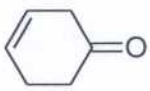


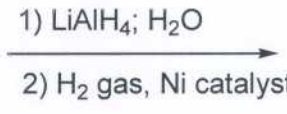
5 amino (2,E) hexenoic acid



N ethyl N methyl - propanamide

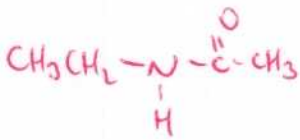
21) Fill in the blanks for **two** of the following reactions. (6pts)

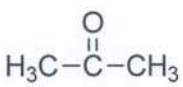
(a) 



(b) $CH_3CH_2-NH_2$

excess $H_3C-\overset{O}{\overset{\|}{C}}-Cl$ →

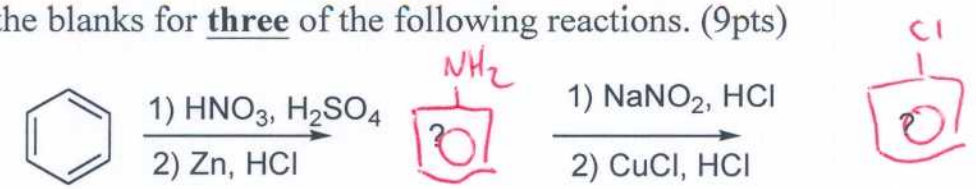


(c) 

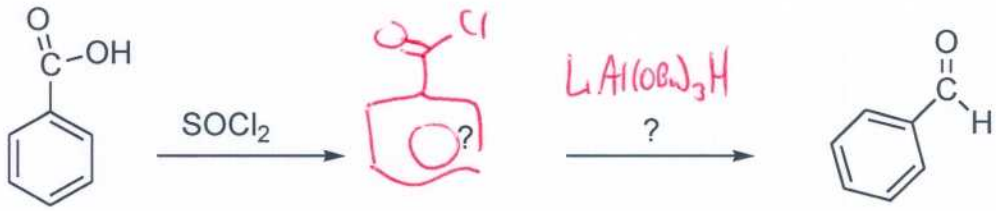
excess CH_3OH, H_3O^+ →

22) Fill in the blanks for **three** of the following reactions. (9pts)

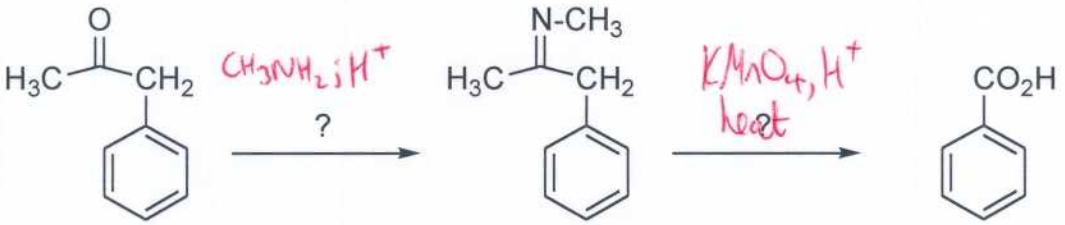
(a)



(b)



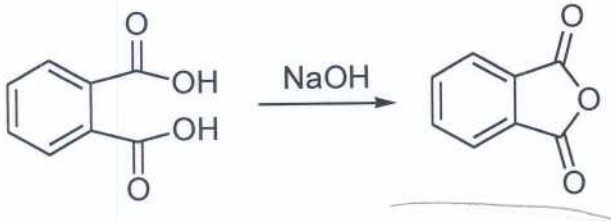
(c)



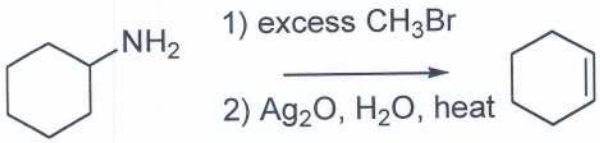
(d)

23) Give the mechanism for **two** of the below conversions (16pts)

(a)



(b)



(c)