

# **Chemistry 2542**

## **Fall Semester 2012; Midterm 3 Exam**

**December 7 (Friday), 11:00 to 11:50 am**

This exam has 5 problems (100 pts) on 7 pages. Make sure your copy is complete and correct.

Printed Name (Last, First) \_\_\_\_\_

Your graded exams will be available Monday, December 10, before class.

Good Luck!

**Chemistry 2542**  
**Fall 2012; Midterm 3 Exam**

This exam has 5 problems on 7 pages. Make sure your copy is complete and correct.

Printed Name (Last, First) \_\_\_\_\_

**Scores:**

Problem 1: \_\_\_\_\_

Problem 2: \_\_\_\_\_

Problem 3: \_\_\_\_\_

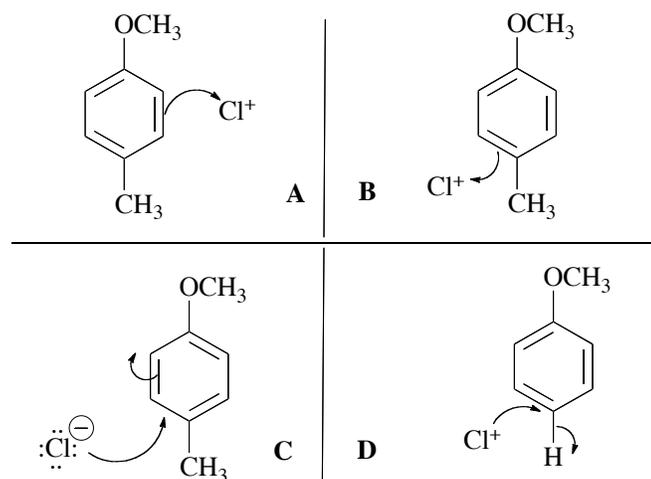
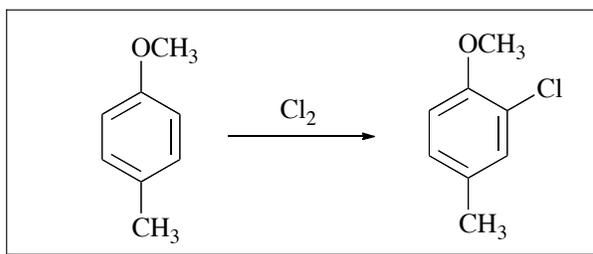
Problem 4: \_\_\_\_\_

Problem 5: \_\_\_\_\_

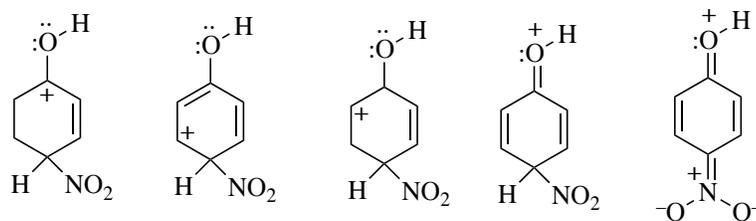
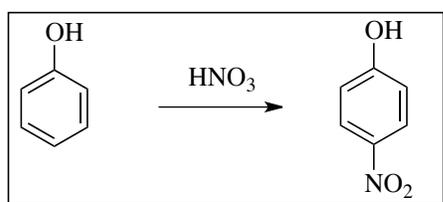
Total: \_\_\_\_\_

1. (15 pts) Answer the questions on mechanisms of the following reactions.

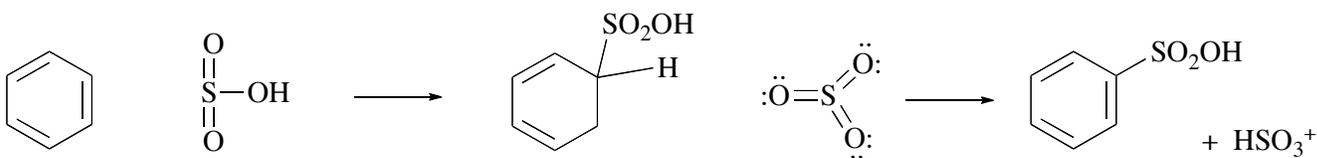
(a) Which one of the following four schemes (A-D) gives the best representation of a step in the mechanism of the reaction in the box (circle the correct answer; 5 pts)



(b) Circle *the most important* resonance contributor of the **intermediate** in the reaction shown in the box that explains the *para*-directing effect of the OH group (5 pts):

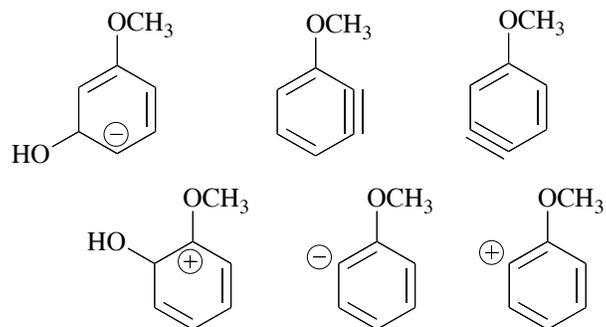
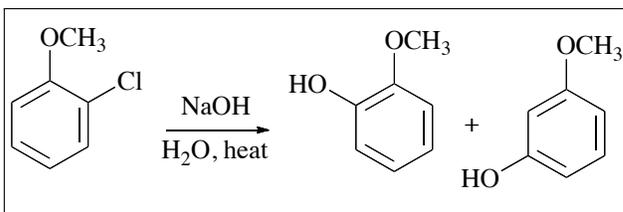


(c) Draw 4 curved **arrows** and show 1 **charge** missing in the following mechanism (5 pts; 1 pt each):

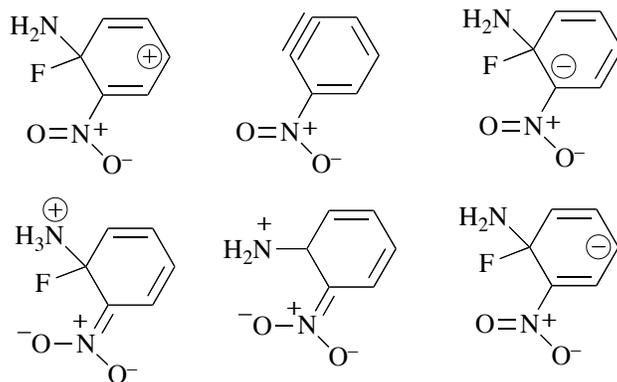
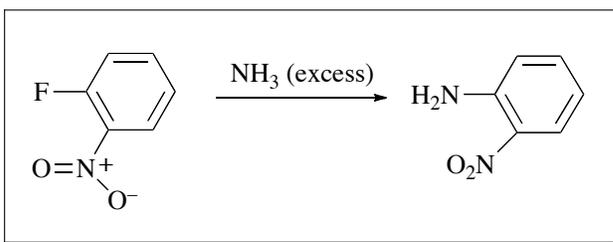


2. (15 pts) Answer the following questions.

(a) Circle the structure of the intermediate in this reaction (5 pts):

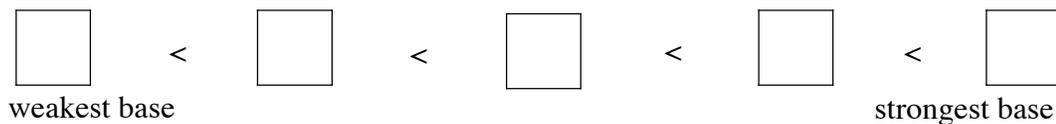


(b) Circle the structure of the *most important resonance contributor* of the intermediate in the following reaction (5 pts):



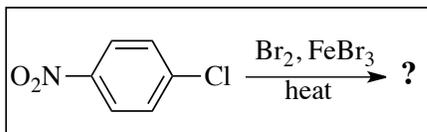
(c) (5 pts) Arrange the following compounds in order of increasing basicity (place a number 1-5 in the appropriate box, 1 pt each box):

(1) ethylamine; (2) diethylamine; (3) aniline; (4) *m*-nitroaniline; (5) *p*-nitroaniline



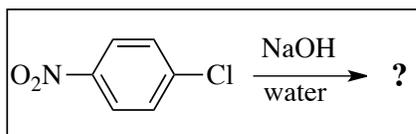
3. (20 pts) Answer the following questions:

(a) Circle the name of a major product in each of the following reactions (4 pts each):



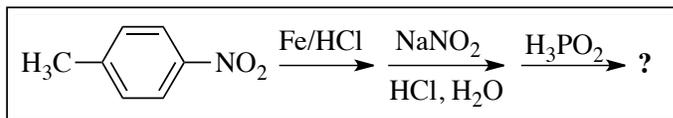
2-bromo-1-chloro-4-nitrobenzene    3-bromo-4-chlorobenzonitrile

1-bromo-4-nitrobenzene    *p*-bromotoluene    *p*-nitrotoluene



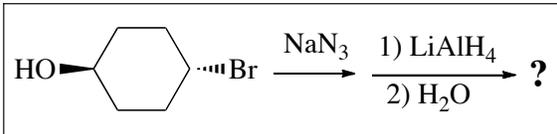
2-chloro-4-nitrophenol    *m*-chlorophenol    *p*-chlorophenol

*p*-nitrophenol    *m*-nitrophenol    2-chloro-5-nitrophenol



phenol    benzene    nitrobenzene

aniline    benzoic acid    toluene

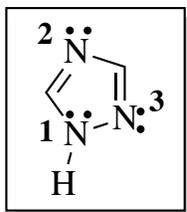


*cis*-4-aminocyclohexanone    *cis*-4-bromocyclohexanamine

*trans*-4-aminocyclohexanol    4-aminophenol

*cis*-4-aminocyclohexanol    *trans*-4-aminocyclohexanone

(b) Which statement regarding the basicity of the aromatic heterocycle (shown in the box) is correct? (circle the answer, 4 pts):



(A) All nitrogen atoms are strongly basic

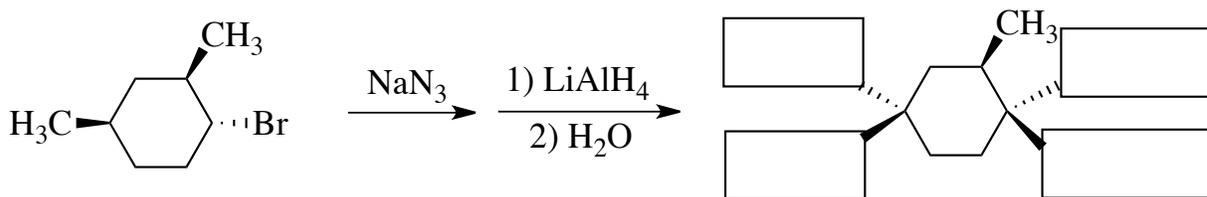
(B) The nitrogen N1 is not basic, N2 and N3 are basic

(C) The nitrogen 2 is more basic, N1 and N3 are not basic

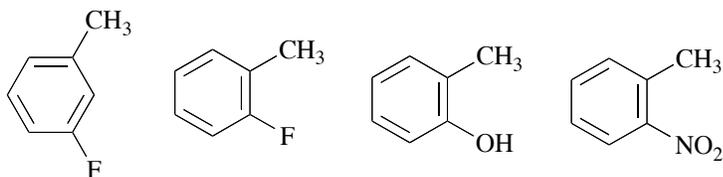
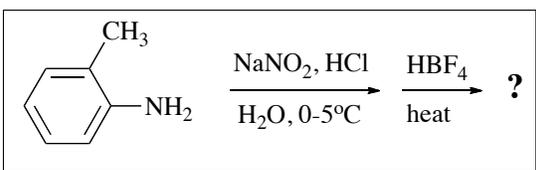
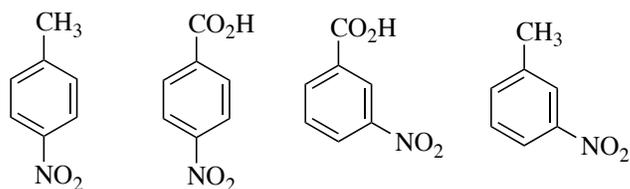
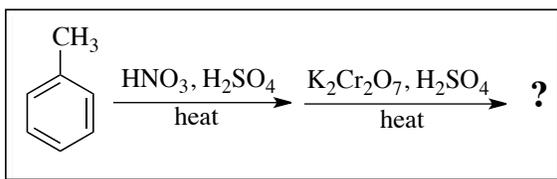
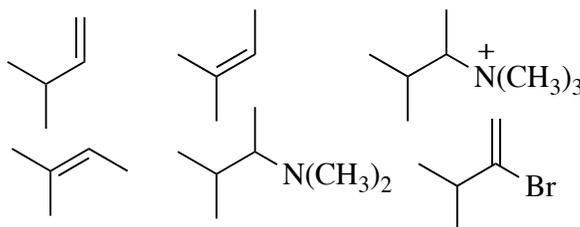
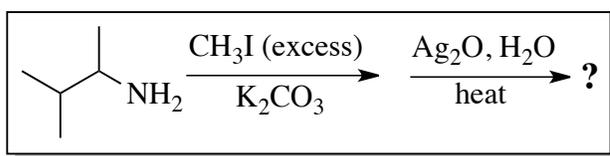
(D) The nitrogens N2 and N3 are not basic, N1 is basic

(E) Neither nitrogen atoms are basic

4. (22 pts) (a) Finish drawing the structure of products in these reactions by placing appropriate substituents (including H) in the boxes on the bonds (2 pt each missing part; total 10 pts):

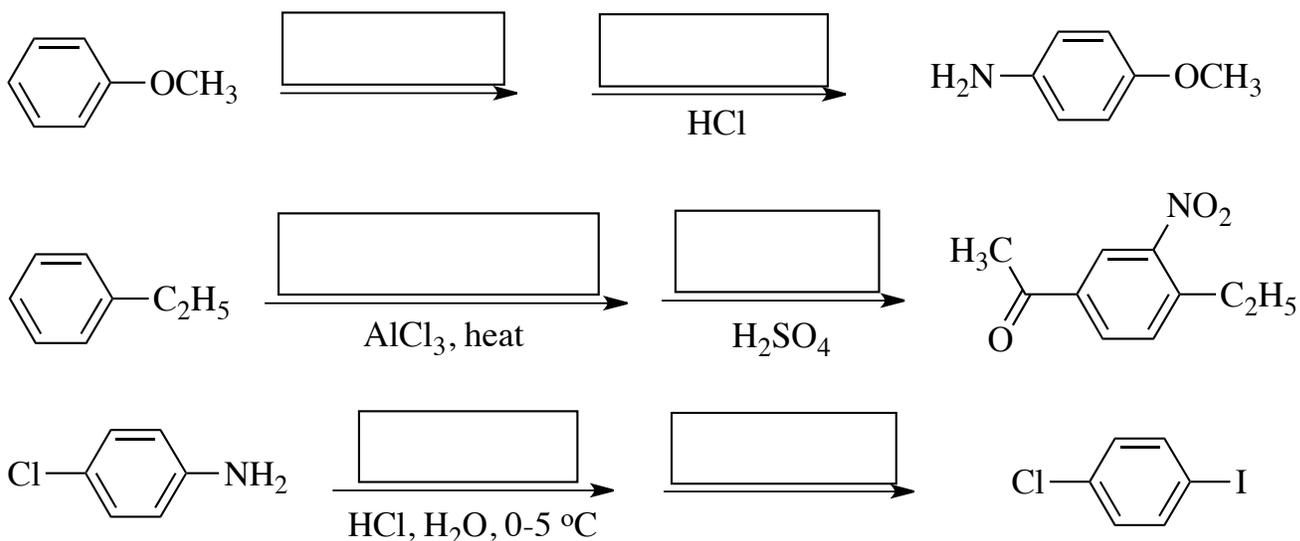


(b) Circle the structure of a major product in each of the following reactions (4 pts each):



5. (28 pts) Answer the following questions:

(a) (12 pts) Place in each box the molecule of a reagent that is required to perform each of the following reactions (2 pts each box):



(b) (4 pts) Which one of the following compounds is the **least reactive** in the **Electrophilic Aromatic Substitution** reaction?

aniline    chlorobenzene    nitrobenzene    methoxybenzene    toluene    phenol

(c) (4 pts) Which one of the following compounds is the **most reactive** in the **Nucleophilic Aromatic Substitution** reaction with NaOH in water at room temperature?

chlorobenzene    iodobenzene    1-chloro-2,4,6-trinitrobenzene    2,4-dinitroaniline    1,3,5-trinitrotoluene

(d) (4 pts) Circle the group that is ***o,p*-directing** in the aromatic electrophilic substitution:

$\text{H}_3\text{N}^+$      $-\text{CN}$      $-\text{SPh}_2^+$      $-\text{CF}_3$      $(\text{CH}_3)_2\text{P}-$      $-\text{NO}_2$      $(\text{CH}_3)_2\text{S}^+$      $-\text{CO}_2\text{CH}_3$

(e) (4 pts) Circle the group that is ***m*-directing** in the aromatic electrophilic substitution:

$\text{H}_2\text{N}-$      $-\text{Cl}$      $-\text{SPh}$      $-\text{OCH}_3$      $(\text{CH}_3)_2\text{P}-$      $-\text{N}(\text{CH}_3)_2$      $-\text{SO}_3\text{H}$      $-\text{CH}_2\text{CH}_3$