CHEM-6430
Advanced Synthesis
Exam 3 – 105 points
March 28, 2024
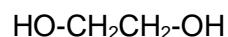
Name:_____ _____
last   first

1. 30 pts _____

2. 20 pts _____

3. 20 pts _____

4. 15 pts _____

5. 20 pts _____

TOTAL: _____

1. For each of the following questions only <u>one answer is correct</u>. Write the number corresponding to the correct answer in the space provided. (3 points each)
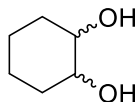
(a) Calculate the formal oxidation number of carbons in the following molecule:
HO-CH$_2$CH$_2$-OH
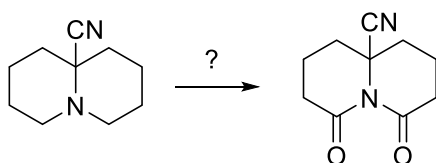(1) -3, (2) -2, (3) -1, (4) 0, (5) +1   (a) 3

(b) Which reagent is not suitable for the synthesis of this compound?

   (1) KMnO$_4$/NaOH(aq.), (2) OsO$_4$, (3) K$_2$Cr$_2$O$_7$/H$_2$SO$_4$, (4) Mg(Hg)   (b) 3

(c) What would be the oxidant of choice in this reaction?

   (1) oxalyl chloride, DMSO, (2) PCC, (3) MnO$_2$, (4) RuO$_4$, (5) NaIO$_4$ (c) 4
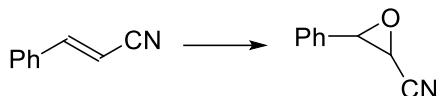
(d) In which oxidative rearrangement an isocyanite cannot be isolated?

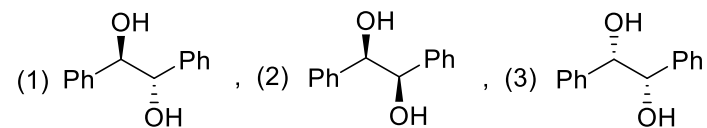   (1) Hofmann, (2) Curtius, (3) Lossen   (d) 1

(e) Which oxidant is not suitable for this reaction?

   (1) NaOH/H$_2$O$_2$, (2) m-CPBA, (3) diacetone diperoxide, (4) NaOH/t-BuOOH   (e) 2

(f) Which diol will undergo an oxidative cleavage with KIO$_4$ to form benzaldehyde at a faster rate?

                                                                                                        (f) 1

(g) Which reagent cannot be used for transfer hydrogenation?
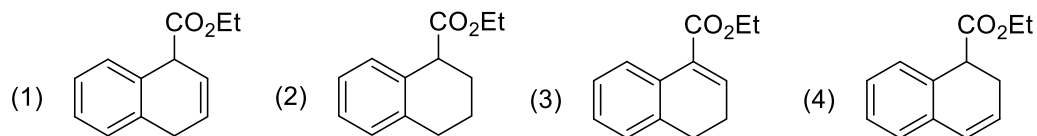
   (1) 2-propanol, (2) cyclohexanol, (3) HCO$_2$NH$_4$, H$_2$O, (4) HCO$_2$Na, H$_2$O, (5) methanol

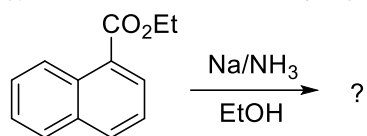   (g) 5

(h) The most active transition metal for catalytic hydrogenation with H$_2$ is:
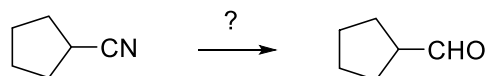   (1) Ni, (2) Rh, (3) Ru, (4) Pt, (5) Pd   (h) 4
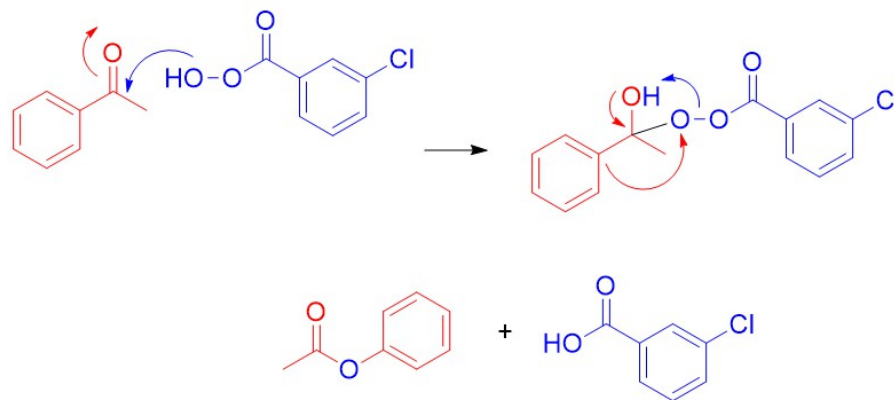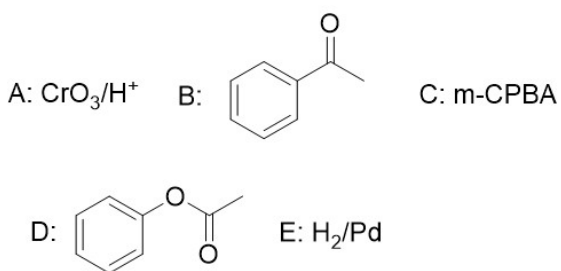
2

(i) What will be the major product of this reaction?

CO₂Et → Na/NH₃ / EtOH → ?

(1) [structure with CO₂Et] (2) [structure with CO₂Et] (3) [structure with CO₂Et] (4) [structure with CO₂Et]

(i) _1_____

(j) What would be the reductant of choice in this reaction?

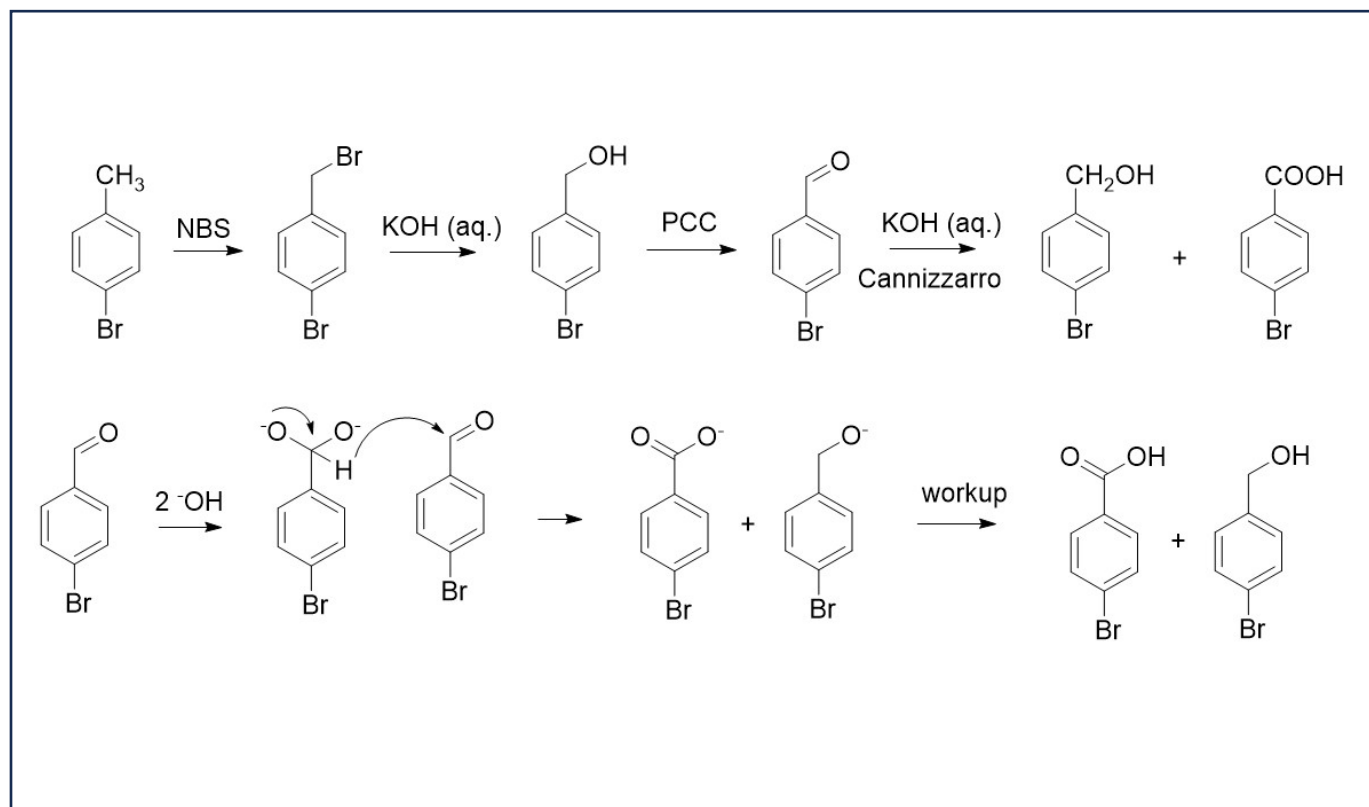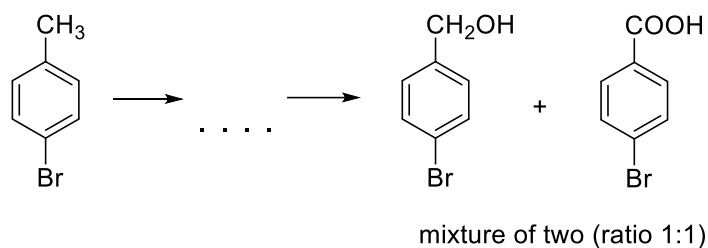[cyclopentane-CN] → ? → [cyclopentane-CHO]

(1) LiAlH₄, (2) NaBH₃CN, (3) BH₃ THF, (4) DIBAL-H, (5) H₂/Pd

(j) _4_____

2. Complete the following synthesis (12 pts) and write a mechanism for the second step (B–D) (8 pts).

[structure: phenyl-CH(OH)-CH₃] → A → B → C → D (ester) → E → CH₃COOH + benzene

A: CrO₃/H⁺   B: [acetophenone structure]   C: m-CPBA

D: [phenyl acetate ester structure]   E: H₂/Pd

3. Complete the following synthesis (12 pts) and write a mechanism for the last step (8 pts).

CH$_3$–(4-Br-phenyl) → · · · · → CH$_2$OH–(4-Br-phenyl) + COOH–(4-Br-phenyl)

mixture of two (ratio 1:1)

CH$_3$–(4-Br-phenyl) —NBS→ CH$_2$Br–(4-Br-phenyl) —KOH (aq.)→ CH$_2$OH–(4-Br-phenyl) —PCC→ CHO–(4-Br-phenyl) —KOH (aq.) Cannizzarro→ CH$_2$OH–(4-Br-phenyl) + COOH–(4-Br-phenyl)

CHO–(4-Br-phenyl) —2 ⁻OH→ [intermediate with C(O⁻)(O⁻)(H) and aldehyde] → [carboxylate + alkoxide products] —workup→ COOH–(4-Br-phenyl) + CH$_2$OH–(4-Br-phenyl)

4. Complete the following synthesis (15 points).

ethyl acetate ⟶ · · · · ⟶ butyraldehyde

2 CH$_3$C(O)OEt —EtONa→ CH$_3$C(O)CH$_2$C(O)OEt —Zn/Hg, HCl→

CH$_3$CH$_2$CH$_2$C(O)OEt —DIBAL-H→ CH$_3$CH$_2$CH$_2$C(O)H

4
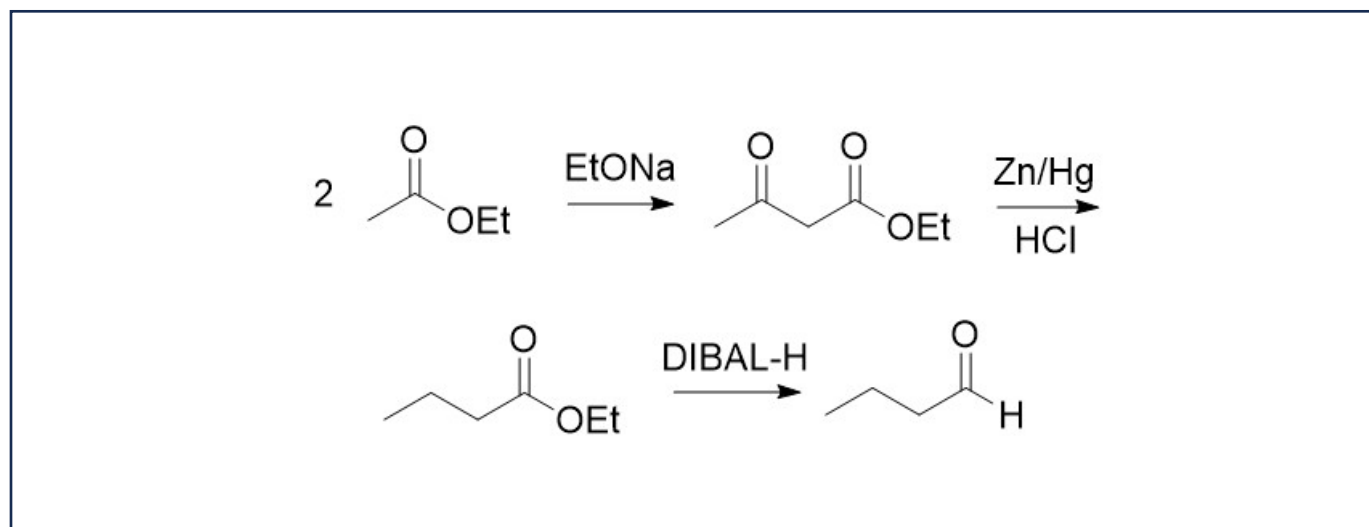
5. Complete the following synthesis (12 pts) and write a mechanism for the last step (8 pts).
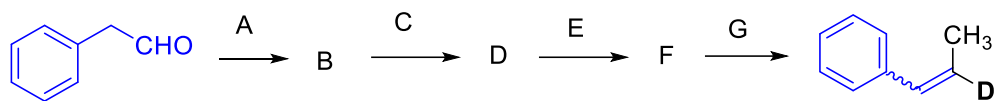
A hint: Use TsNHNH$_2$ at a certain step.

A: MeMgBr; B: Ph [structure with OH]   C: CrO$_3$/H$^+$

D: Ph [ketone structure]   E: TsNHNH$_2$ F: Ph [structure with NNHTs]   G: BuLi

Bu$^-$ H [mechanism structure with NNTs]   Shapiro   Ph [structure with N=N]
                                            - BuH;   - N$_2$
                                            - Ts$^-$

[Ph structure] $\xrightarrow{D_2O}$ Ph [structure with D]