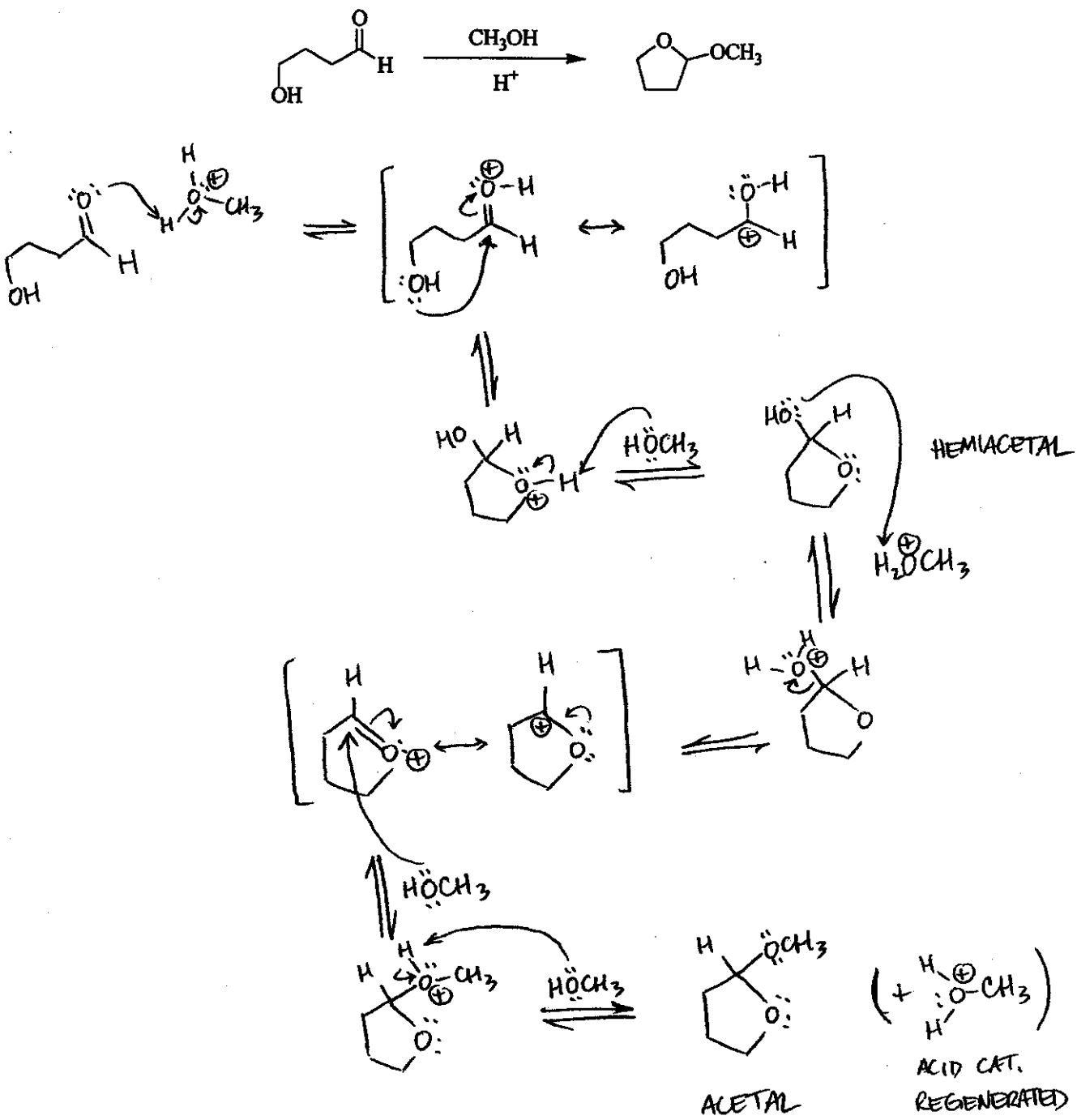
Name: KEY

ID #: _____

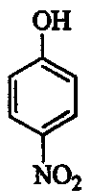
3. When 4-hydroxybutanal is treated with methanol in the presence of an acid catalyst, 2-methoxytetrahydrofuran is formed (see below). Provide a mechanism that explains this reaction. Use curved arrows to show electron pushing. *(25 pts.)*



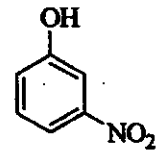
Name: KEY

ID #: _____

4. The hydroxyl proton of phenol is quite acidic. For example, *p*-nitrophenol has a pK_a = 7.14, yet the pK_a of *m*-nitrophenol is only 8.39. Explain the difference in acidities of these two isomers. For full credit, you must show all possible resonance structures to illustrate your explanation. *(25 pts.)*



p-nitrophenol
pK_a = 7.14



m-nitrophenol
pK_a = 8.39

AN ACID IS A PROTON DONOR:

$$H\text{-}A \overset{K_a}{\rightleftharpoons} H^+ + A^- \qquad K_a = \frac{[H^+][A^-]}{[HA]} \quad \& \quad pK_a = -\log K_a$$

∴ lower pK_a is stronger acid ⇒ stronger acid has more stable conjugate base

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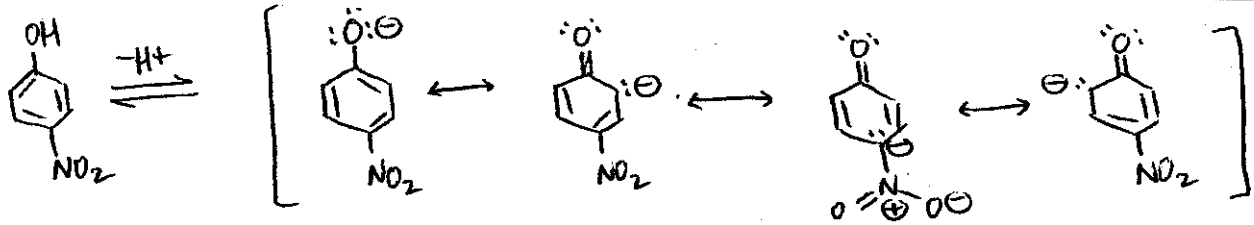
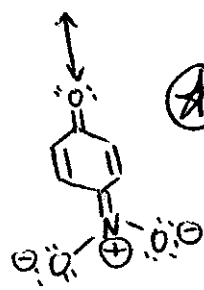
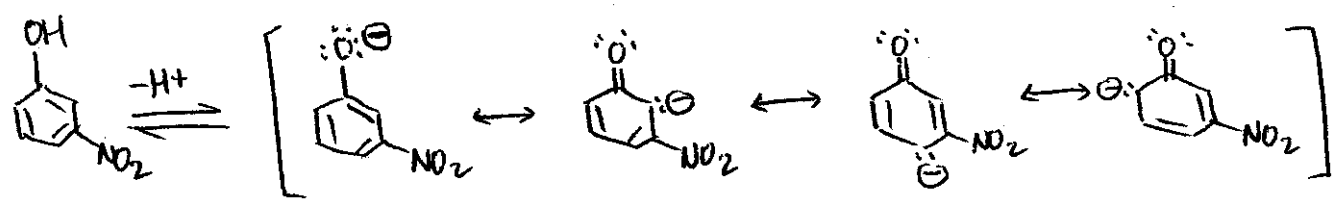




★ NO_2 can stabilize ⊖ charge by resonance in the para-isomer

5.



★ NO_2 stabilizes ⊖ charge by induction (NO_2 is an electron-withdrawing group), but cannot by resonance in the meta-isomer

★ Because there is additional resonance stabilization (by NO_2) in the *p*-isomer, 5 → the conjugate base is more stable, so *p*-isomer is stronger acid.