Statistics: High score, average and low score will be posted on the course web site after exam grading is complete.

A note about exam keys: The answers presented here may be significantly longer than expected from a student taking the exam. An exam key serves not only to reveal what was expected, but to instruct you as well.

To see the final course grade cutoffs, consult the grading scale on the Chem 14D course web page.

1. Tertiary with resonance.

2. S_N_1, E1, and EAS.

3. Nucleophilic carbonyl substitution, oxyanion, and tetrahedral intermediate.

4. Conversion of molecule B into molecule C is a type of electrophilic aromatic substitution named Friedel-Crafts alkylation.

5. Carbocation, arenium ion, Lewis acid, and loss of aromaticity.


7. Molecule C

8. Becomes slower. Trifluoromethyl is a powerful electron-withdrawing group, whereas methyl is a weak electron donor. This change decreases $\delta^+$ C=O, and makes a poorer leaving group.

10. (a) Compared to benzene itself, the aromatic ring of molecule F is best described as activated. The alkyl and methoxy groups are both activators.

(b) When the OCH_3 group is changed into a hydrogen atom, the reaction rate becomes slower. The methoxy group is an activator. Less activators = slower reaction.

11. The most likely mechanism for this reaction is S_N_2. The carbon bonded to the leaving group is primary. The nucleophile is good (a nitranion with resonance), the solvent (CH_3CH_2OH) moderately polar and protic (it's a Goldilocks solvent), and the leaving group is modest.

12. When BrCH_2CH=CH_2 is changed to ICH_2CH=CH_2, the reaction rate becomes faster. Iodide is a better leaving group than bromide.

13. Acetone. This is the least polar Goldilocks solvent choice.
14. Allyl alcohol cannot be used instead of allyl bromide in this reaction because allyl alcohol lacks a leaving group.

15. \[
\begin{align*}
\text{Br} & \quad \text{H}_2\text{C} = \text{C} = \text{CH}_2
\end{align*}
\]

16. The mechanism for the conversion of molecule H into molecule I is not S_N2, S_N1, E2, or E1 because no new pi bond is formed and the leaving group is on an sp^2 carbon.

17. Other catalysts are possible.


19. \[\text{R}_2\text{N} \quad \text{CF}_3 \quad \text{OH} \quad \text{F}_2\text{C} \quad \text{O}^- \quad \text{F}_2\text{C} \quad \text{O}^- \quad \text{F}_2\text{C} \quad \text{O}^- \quad \text{HNR}_2\]

20. TCE = trichloroethylene.

21. Formyl chloride has less resonance stabilization than phosgene, so hydrolysis of formyl chloride is faster than hydrolysis of phosgene.

22. (a) 

(b) Molecule number 1 is not formed because S_N2 cannot occur at a tertiary carbon, and H_3CO^- is not present.

Molecule number 2 is not formed because S_N2 cannot occur at a tertiary carbon.

Molecule number 3 is not formed because H_3CO^- is not present.

Molecule number 5 is not formed because F^- is not present.
23. The reaction shown in question 22 gives no E2 products because H$_3$CS$^-$ is not a strong enough base. Either leaving group is sufficient for E2, and there are eight hydrogen atoms $\beta$ to the chlorine atom (although there are none $\beta$ to the iodine). Even if in your judgment the base is strong enough, there is no other way to rationalize the lack of E2 except by insufficient base strength.

24. The major product of this reaction is molecule $7$. Formation of this product occurs through the most stable radical intermediate.

25. $\text{Br-Br} \rightarrow 2 \text{Br}$

26. $\text{Ph} \text{Br} \rightarrow \text{Ph} + \text{Br}$

27. Atom transfer, initiation, and propagation.

28. (a) $\text{Ac} \xrightarrow{\text{NaOH, H$_2$O}} \text{Ac}$ *Aldol condensation.*

(b) $\text{C} \xrightarrow{(\text{CH}_3)_3\text{CO}, \text{K}^+} \text{C}$ *E2 elimination following Hofmann's rule, because $(\text{CH}_3)_3\text{CO}$ is a sterically-hindered base.*

(c) $\text{Ph} \xrightarrow{\text{HBr, HOOH}} \text{Ph}$ *Anti-Markovnikov addition of HBr via a free radical mechanism. The peroxide effect.*

29. $\text{Ph} \xrightarrow{\text{H, OSO}_3\text{H}} \text{Ph}$ *Atom transfer, initiation, and propagation.*