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 projected course grade cutoffs, consult the grading scale on the Chem 14D course web page.

1. 

2. 

3. 

4. 

5. E2. Substrate is a secondary alkyl halide, so consider E2 first. Strong base, moderate leaving group, and periplanar $\beta$-H all present, so E2 is reasonable.

6. (a) Slower. Fluorine is more electronegative than oxygen.

(b) Slower. Even as part of the electrophile, a tert-butyl group provides more transition state steric hindrance than a methyl group.

(c) Faster. Iodide ion is an excellent leaving group, whereas bromide ion is a moderate leaving group.

(d) Slower. The electron-withdrawing inductive effect of the $\text{CF}_3$ group makes $\text{CF}_3\text{CH}_2\text{O}^-$ a poorer nucleophile than $\text{CH}_3\text{O}^-$.

(e) Slower. $\text{CH}_3\text{O}^-$ lacks the resonance stabilization of the lone pair used for nucleophilicity present in PhO$^-$. 

7. 

8. (a) Methanol; (b) methanol; (c) methanol; (d) methanol; (e) acetone; and (f) acetone.

9. An $\text{S}_\text{N}2$ reaction is not possible because the only leaving group present (Br) is bonded to an $sp^3$ carbon.

10. 

11. Potassium benzoate is a better nucleophile than benzoic acid. *Potassium benzoate has a negative formal charge whereas benzoic acid does not.*

12. (a) The reaction of potassium benzoate with dimethyl sulfate might be faster than the reaction of potassium benzoate with iodomethane because dimethyl sulfate's leaving group gains resonance when it departs whereas iodide does not. *Electronegativity and inductive effects can also be invoked, but resonance is the dominant factor.*

(b) The reaction of potassium benzoate with dimethyl sulfate might be slower than the reaction of potassium benzoate with iodomethane because dimethyl sulfate's leaving group's oxygen has a smaller atomic radius than iodide ion.

13. 

14. 

15. Trans and *E.*

16. Any base at least as strong as HO⁻ is acceptable. Some possible answers are HO⁻, CH₃O⁻, and (CH₃)₃CO⁻.

17. The E2 mechanism requires that the carbon-leaving group bond and β-carbon-hydrogen bond be periplanar in the transition state:

18. Product C is the major product of this E2 reaction because this product is conjugated, internal, and disubstituted (more stable), whereas product D is not conjugated, terminal, and monosubstituted (less stable).

19. Special circumstances - usually doesn't leave in S_N2, S_N1, E2, or E1.

20. The major product of this reaction is alcohol F because formation of this alcohol is derived from nucleophilic attack at the less sterically hindered carbon. *Alcohol F is formed from attack at the primary carbon whereas alcohol G requires attack at the tertiary carbon.*

21. One factor in this reaction which helps the alkoxide be a better leaving group than a alkoxide normally is might be relief of ring strain or (less likely) hydrogen bonding by the protic solvent. *The hydrogen bonding rationale did not earn full credit because we've not seen acyclic alkoxide leaving groups (without ring strain relief) via S_N2 in protic solvent.*