Periodic Table of the Elements
1. Give structure of major product/s in the following reactions.

\[
\text{苯} + \text{Cl}_2 \xrightarrow{\text{FeCl}_3} \text{产物} \quad 4 \, \text{pts}
\]

\[
\text{苯} + \text{HOCl} \xrightarrow{\text{AlCl}_3} \text{产物} \quad 4 \, \text{pts}
\]

\[
\text{OH} + \text{CO} + \text{HCl} \xrightarrow{\text{AlCl}_3} \text{产物} \quad 2 \, \text{pts}
\]

\[
\text{OCH}_3 + \text{NO}_2 \xrightarrow{\text{Fuming H}_2\text{SO}_4} \text{产物} \quad 4 \, \text{pts}
\]

\[
\text{H}_2\text{C} - \text{NH}_2 \xrightarrow{\text{+HNO}_3/\text{H}_2\text{SO}_4} \text{产物} \quad 4 \, \text{pts}
\]

\[
\text{F} + \text{NO}_2 \xrightarrow{\text{H}_2\text{NCO-CH}_3} \text{产物} \quad 4 \, \text{pts}
\]

\[
\text{苯} \xrightarrow{1. \text{HOT}} \text{产物} \xrightarrow{2. \text{H}^+} \text{产物} \quad 4 \, \text{pts}
\]
2. Give structure of the electrophilic reagent in each of the following aromatic substitution reactions

Bromination of benzene \[ \text{Br}^- \]
Friedel-Craft reaction of benzene and methyl iodide \[ \text{CH}_3\text{I}^- \]
Nitration of benzene using nitric acid and sulfuric acid. \[ \text{NO}_2^- \]

3. Give the most stable resonance structure of Meisenheimer intermediate in the nucleophilic aromatic substitution reaction of p-nitrofluorobenzene and methoxide ion (MeO⁻).

4. Give the structure of the intermediate formed when bromobenzene is treated with NaNH₂ in liquid ammonia.

4. Classify each nitrogen in the following as strongly basic or weakly basic according to the availability of the lone pair of electrons on nitrogen.

purine - parent of important nucleic acids
5. Which of the following are aromatic?

6. Propose a high-yield synthesis of n-propylbenzene starting from benzene and any 3-carbon-containing compound. (Anyone who does this in one-step will get little or no credit).

\[ \text{C}_6\text{H}_6 + \text{CH}_3\text{CH}_2\text{CH}_3 \rightarrow \text{C}_8\text{H}_{12} \]

7. Give structures for the following carbonyl compounds.

- Butyraldehyde
- Propiophenone
- Benzaaldehyde

8. Give IUPAC name for the following:

\[ \text{5,7-Dioxo Nonanal} \]
The following compound undergoes McLafferty rearrangement in the mass spectrometer. Predict the masses of the resulting fragments.

3-methyl-2-pentanone

10. Show how you would make 4-phenyl-2-hexanone using the disilane method. You may start with disilane

11. Predict the products from the following reaction.

Benzoic acid (PhCO₂H) + excess PhLi followed by acid workup.

12. Show how the Wittig reaction might be used to synthesize the following reaction. Start with an alkyl halide (yes, you will have to make the Wittig reagent) and a ketone or aldehyde.
13. Give the structures of the carbonyl compounds and amines used to form the following imines.

\[
\text{Glu-CH}_2\text{N(}\text{CH}_2\text{)}_2\text{-Protein backbone}
\]

\[
\text{glu} \quad \text{NH} \quad \text{CH}_2\text{N(}\text{CH}_2\text{)}_2\text{-Pro}
\]

14. Show which alcohol and carbonyl compound give the following derivative.

15. Give mechanism, all steps for Wittig reaction shown below.

\[
\text{Ph}_3\text{P} \quad \text{CH}_2 \quad + \quad \text{H}_2\text{C} \quad \text{CH}_3
\]

\[
\text{O} \quad \text{Ph}_3\text{P} \quad \text{CH}_2 \quad + \quad \text{H}_2\text{C} \quad \text{CH}_3
\]
16. Give mechanism for the conversion of the following hemiacetal to its acetal

\[ \text{H}_2\text{C} \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \xrightarrow{\text{CH}_3\text{OH}} \text{TsOH} \xrightarrow{\text{CH}_3\text{OH}} \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \]

17. Carry out the following synthesis using protecting group methodology (BONUS)

\[ \text{O} \begin{array}{c} \text{CH}_3 \\ \text{H} \end{array} \xrightarrow{\text{HO}} \text{CN} \begin{array}{c} \text{H} \\ \text{CH}_3 \end{array} \]

1,2-ethanediol is a nice alcohol