This is a mock exam representing some of the types of problems you can expect to see on Exam 3. This is not all-inclusive, but provides a good idea of some of the things you can expect, and the concepts that are important.

1. Provide, in one or two sentences, definitions for the following rules/terms.

(a) Markovnikov’s Rule

Electrophiles add to an alkene in such a manner that the most stable carbocation is formed. This leads to nucleophilic substitution on the most substituted end of the double bond.

(b) Zaitsev’s Rule

In an elimination reaction, the major product will be the most stable alkene (the most substituted double bond).

(c) Bromonium Ion

An ion containing a positive bromine atom bonded to two carbon atoms. Intermediate often observed on addition of Br₂ to an alkene.

(d) Carbene

An uncharged species in which carbon is divalent.

(e) Carbonyl

Functional group consisting of a carbon double bonded to an oxygen. Found in aldehydes, esters, ketones, carboxylic acids and other functional groups.

(f) Protecting Group

A group added to prevent reaction at some functional group in a molecule while a transformation is being carried out at some other location. These groups are later removed.

(g) Peroxy Acid

Acid with general formula RCO₃H featuring an O-O bond. Often used in epoxidation reactions.
2. Provide the major product expected for the following organic reactions:

- **1.** Br, Br → 1. 3eq. NaNH₂ → 2. H₃O⁺
- **2.** Br, Br → 1. OsO₄, pyridine → 2. Na₂SO₃/H₂O
- **3.** CH₂I₂, Zn(Cu) → 0 °C
- **4.** 1. O₃, CH₂Cl₂ → -78 °C → 2. Zn/HOAc
- **5.** CH₂I₂, Zn(Cu) →
3. Draw a valid Lewis Structure for diazomethane (CH$_2$N$_2$) and include two valid resonance structures.

![Lewis Structures]

4. Draw an INTERMEDIATE expected in the following reactions with 2,3,3-trimethylbutene as the substrate:

- **Hydroxymercuration/Demercuration**
- **Alkoxymercuration/Demercuration**
- **Hydroboration/Oxidation**
  (Could also do Borate Ester, etc.)
- **KMnO$_4$ Oxidative Cleavage**
5. Show how you would synthesize the following ethers using the Williamson ether synthesis:

\[
\text{ONa} + \text{Br} \rightarrow \text{O} \\
\text{ONa} + \text{Br} \rightarrow \text{O}
\]

6. Choose an appropriate reducing agent for the following transformations:

\[
\text{O} \quad \text{OCH}_3 \quad \text{NaBH}_4, \text{H}_2\text{O} \\
\text{O} \quad \text{OCH}_3 \quad \text{LiAlH}_4/\text{Et}_2\text{O}
\]
7. What is the oxidation state of the indicated carbon (“C”) in the following compounds?

\[
\begin{align*}
\text{O} & \quad +3 \\
\text{Cl} & \quad 0 \\
\text{NH}_2 & \quad -2 \\
\text{BH}_2 & \quad -4 \\
\text{CH}_4 &
\end{align*}
\]

8. Provide a mechanism for the reaction of concentrated HBr with 2-butanol. What would be the product(s) of reaction of (1) PBr\(_3\) and (2) SOCl\(_2\) with 2-butanol?

\[
\begin{align*}
P\text{Br}_3 \text{ Reaction replaces OH w/ Br; SOCl}_2 \text{ Reaction replaces OH w/ Cl}
\end{align*}
\]

9. Show reactions that would convert the hydroxyl group of cyclohexanol into (1) a good leaving group and (2) a silyl ether (a protecting group)

\[
\begin{align*}
\text{OH} & \xrightarrow{\text{TfCl, pyridine}} \text{OTf} \\
\text{OH} & \xrightarrow{\text{TBDMS, pyridine}} \text{OTBDMS}
\end{align*}
\]
10. Provide plausible synthetic routes that will transform the following organic molecules into the indicated products (multiple steps may be involved).

\[
\text{H}_2\text{SO}_4, \Delta \quad \text{Hg(OTf)}_2, \text{HOCH}_2\text{CH}_2\text{CH}_3 \\
1. \text{NaBH}_4, \text{NaOH}
\]

\[
\text{H}_2\text{SO}_4, \Delta \quad \text{NaOH} \\
1. \text{NH}_4\text{Cl} \\
(\text{base catalyzed epoxide opening, could use acid as well})
\]

We’ve looked at many other reactions in Chapters 8, 11 and the first part of 12. All of these are not included in this mock exam, but this covers a good portion of the highlights. You should be familiar with all of the reactions (and any given stereo/regiochemistry) and mechanisms where these were discussed in class).