1) Name the general class of organic compound that each of these molecules belong to, and circle the most reactive molecule with respect to undergoing nucleophilic attack. (7pts)

2) Dioxane can exist as three isomers.

One is accurately described as a peroxide, one is really a cyclic acetal and one is just a poly-ether.

(a) Using arrows, indicate which is which.

(b) When the cyclic acetal is hydrolyzed it goes to a diol and an aldehyde. Draw the diol and aldehyde. (10.5pts)
3) Circle the compound which is more stable, and in a sentence explain your choice. (10pts)

(a) 

(b) 

(c) 

4) Name the following compounds in IUPAC acceptable terms. (12pts)

\[
\text{Cl} \quad \text{O} \quad \text{C} \quad \text{H}
\]
5) Explain why in both pairs, the left hand molecule is more reactive toward nucleophilic attack. (10pts)
6) Fill in the blanks. (18pts)
7) Fill in the blanks for the following reactions. (15pts)

(a) \( \text{CH}_3\text{C} = \text{C-CH}_3 \quad \text{1) CH}_3\text{MgBr} \quad \text{2) H}_3\text{O}^+ \)

(b) \( \begin{array}{c}
\text{Ph} \\
\text{C} \\
\text{O} \\
\text{Ph} \\
\text{C} \\
\text{Ph} \\
\text{C} \\
\end{array} \rightarrow \begin{array}{c}
\text{Ph} \\
\text{C} \\
\text{O} \\
\text{Ph} \\
\text{C} \\
\text{Ph} \\
\text{C} \\
\end{array} \rightarrow \text{PhCH}_2\text{C}_6\text{H}_4\text{CH}_3 \)

(c) \( \text{CH}_3\text{C}O \rightarrow \text{N} \quad \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \)

(d) \( \text{C} = \text{O} \rightarrow \text{N} \quad \text{N} \quad \text{N} \)

(e) \( \text{CH}_3\text{C} = \text{C} = \text{C} \rightarrow \text{H}_3\text{C} \quad \text{CH}_3 \)
8) Write the mechanism for the **acid** catalyzed hydration of ethanal (8.5pts)

9) **EITHER** (a) write the full mechanism for the acid catalyzed reaction of ketone + primary amine → imine + water,  
    **OR** 
    (b) Give reagents for the following transformations. (9pts)

\[
\begin{align*}
\text{H} & \searrow \quad \text{H}_3\text{C} \dashv \text{C} \text{CH}_2\text{CH}_3 \\
\text{H} = \text{CH} & \searrow \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{C} \text{Ph} \\
\text{H} \searrow \text{C} \text{OH} & \searrow \quad \text{C} \text{CH} \\
\end{align*}
\]
*Bonus question* (up to 3pts)
Carbonyl compounds generally prefer to exist in the KETO rather than their ENOL forms. Why does this compound exclusively exist in its enol form?
1) Name the general class of organic compound that each of these molecules belong to, and circle the most reactive molecule with respect to undergoing nucleophilic attack. (7pts)

2) Dioxane can exist as three isomers.

One is accurately described as a peroxide, one is really a cyclic acetal and one is just a poly-ether.

(a) Using arrows, indicate which is which.

(b) When the cyclic acetal is hydrolyzed it goes to a diol and an aldehyde. Draw the diol and aldehyde. (10.5pts)
3) Circle the compound which is more stable, and in a sentence explain your choice. (10pts)

(a)  

(b)  

(c)  

6-membered ring has a lot less ring strain than a 5-membered ring.

The double bonds are CONJUGATED, which allows stabilizing electron delocalization.

An sp$^3$ hybridized carbon wants bond angles of 109°; an sp$^2$ wants 120°. There is less bond angle compression (ie less strain) for an sp$^2$ in a 5-membered ring.

4) Name the following compounds in IUPAC acceptable terms. (12pts)

- Chlorobutanal
- trans-3,3-Dimethylcyclohexanone
- Pent-4-en-2-one
5) Explain why in both pairs, the left hand molecule is more reactive toward nucleophilic attack. (10pts)

The carbonyl functionality on the left is less sterically hindered. This means it is easier for a nucleophile to approach and bond to the carbonyl carbon.

The carbonyl carbon on the left bears more of a true charge. The Cl is more electronegative and pulls electron density towards it. This makes the \(-\text{CH}_2\text{Cl}\) an electron-withdrawing substituent, which makes the carbonyl carbon more true, and thus a nucleophile with its electron pair is electrostatically more attracted to that carbon.
6) Fill in the blanks. (18pts)
7) Fill in the blanks for the following reactions. (15pts)

(a) \[ \text{CH}_3\text{C} = \text{C} - \text{CH}_3 \] 1) CH\textsubscript{3}MgBr
2) H\textsubscript{2}O\textsuperscript{+} 

(b) \[ \text{Ph} \text{O} \rightarrow \text{Ph}-\text{C} = \text{C} \rightarrow \text{PhCH}_2\text{C}_6\text{H}_4\text{CH}_3 \] 
\[ \text{Zn(H}_2\text{)}, \text{HCl} \] or \[ \text{Na}_{x}, \text{H}_2\text{KOH} \]

(c) \[ \text{CONH}_2 \rightarrow \text{CONH}_2 + \text{H}^+ \]

(d) \[ \text{CH}_3\text{CO} \rightarrow \text{Pyridine} \]

(e) \[ \text{CH}_3\text{C} = \text{C} \rightarrow \text{Ph} \]
1) \[ \text{B}^+ \text{r}_{x} \rightarrow \text{Ph}^+ \text{r}_{x} \]
2) \[ \text{Bi}_2 \text{Li} \rightarrow \text{Bi}_2 \text{Li} \text{r}_{x} \]
3) \[ \text{H}_2\text{O} \text{C} \]
8) Write the mechanism for the acid catalyzed hydration of ethanal  (8.5pts)

9) **EITHER** (a) write the full mechanism for the acid catalyzed reaction of ketone + primary amine→imine + water,  
**OR**  
(b) Give reagents for the following transformations. (9pts)
*Bonus question* (up to 3pts)
Carbonyl compounds generally prefer to exist in the KETO rather than their ENOL forms. Why does this compound exclusively exist in its enol form?

\[
\begin{align*}
\text{KETO} & \quad \text{ENOL} \\
\text{The enol form is AROMATIC (Phenol).} \\
\text{This extra stability is not present in} \\
\text{the keto tautomers (it is non-aromatic).}
\end{align*}
\]