QUESTION 1
MC33g

Which best describes the product of the following reaction sequence?

1. 1 Equiv. MeMgBr
2. $\text{H}_3\text{O}^+$
3. PCC
4. Excess NaBH$_4$/EtOH

A) B) C) D)

Remember, all Grignard reactions have to be performed in the absence of any water or other source of protons.
QUESTION 2
MC331

Give the best product for the following reaction

HCl (cat.)

1 Equiv.

the 1 equivalent of the diol must "choose" between the aldehyde and the ketone. Aldehydes are more reactive than ketones, ketones have two weak donating alkyl groups to stabilize the partial positive charge on the carbon of the C=O bond, aldehydes only have one.

neither donating or withdrawing weak donating weak donating

addition of the diol to the aldehyde yields the cyclic acetal

this is a "cute" idea, adding the -OH at one end of the diol to the aldehyde and the other -OH to the ketone, but with two hemiacetals, it can hardly be described as the "best" product

if both oxygens of the diol add to the carbonyl carbon, then the original oxygen must be lost, this is impossible
QUESTION 3

MC33m

Give the best product for the following reaction

\[ \text{HCl (cat.)} \]

the 1 equivalent of the 2° amine must "choose" between the aldehyde and the ketone. Aldehydes are more reactive than ketones, ketones have two weak donating alkyl groups to stabilize the partial positive charge on the carbon of the C=O bond, aldehydes only have one

neither donating or withdrawing

weak donating

weak donating

addition of a 2° amine to a C=O bond forms an ENAMINE

this is the initial nucleophilic addition product, which normally deprotonates to form the enamine, although formed, it can't be described as the "best" product

neither of the 2 possible enamines for the ketone will be formed, since the aldehyde is more reactive
QUESTION 4

The Wittig reaction starts with an alkyl halide and a carbonyl compound and ends with an alkene. Which are the BEST alkyl halide and carbonyl compounds to use in a Wittig synthesis of the alkene below:

A

B

C

D

A makes correct alkene, but needs SN2 on a 2° halide at the start.

B makes incorrect alkene.

C makes incorrect alkene AND Sn2 on 2° halide (poor reaction).

D makes correct alkene, AND SN2 on a benzylic halide, GOOD!
QUESTION 5
MC33s

Give the product of the following reaction sequence
1. NBS/hv
2. K⁺ –O-t-Bu
3. BH₃·THF
4. –OH/H₂O₂
5. PCC
6. MeNH₂/HCl(cat.)

![Reaction sequence diagram]
QUESTION 6
MC32k

For the following reactions indicated as 1, 2 and 3, which is the correct order of INCREASING rate of electrophilic aromatic substitution?

1

\[
\begin{align*}
&\text{as far as the benzene ring is concerned, this is a withdrawing, and thus DEactivating substituent (slows reaction)} \\
&\text{Cl}_2 \xrightarrow{\text{AlCl}_3} \text{this is a very weakly donating, and thus weakly activating substituent (speeds reaction a little bit)} \\
&\text{N} \quad \text{H}
\end{align*}
\]

2

\[
\begin{align*}
&\text{this is a weakly donating, and thus activating substituent (speeds reaction)} \\
&\text{Cl}_2 \xrightarrow{\text{AlCl}_3} \text{this is a strongly donating, and thus strongly activating substituent (speeds reaction a lot)} \\
&\text{N} \quad \text{H}
\end{align*}
\]

3

\[
\begin{align*}
&\text{this is a withdrawing, and thus DEactivating substituent (slows reaction)} \\
&\text{Cl}_2 \xrightarrow{\text{AlCl}_3} \text{this is a strongly donating, and thus strongly activating substituent (speeds reaction a lot)} \\
&\text{N} \quad \text{H}
\end{align*}
\]

A 1 (slowest) < 2 < 3 (fastest)
B 2 (slowest) < 3 < 1 (fastest)
C 1 (slowest) < 3 < 2 (fastest)
D 3 (slowest) < 2 < 1 (fastest)
For the following reactions indicated as 1, 2 and 3, which is the correct order of INCREASING rate of electrophilic aromatic substitution?

1. this is DONATING group due to the resonance effect of the non-bonding electrons (the inductive effect of the C=O bond is very small), so is ACTIVATING, and increases the reaction rate.

2. this is a withdrawing group on a π-system, thus DEACTIVATING, and decreases the rate of the reaction.

3. this is DONATING group, but a weaker donating group than in reaction 1 due to the proximity of the polarized C=O bond, still ACTIVATING, but increases the reaction rate less than in 1.

A 1 (slowest) < 2 < 3 (fastest)
B 2 (slowest) < 3 < 1 (fastest)
C 1 (slowest) < 3 < 2 (fastest)
D 3 (slowest) < 2 < 1 (fastest)
QUESTION 8
MC34u

Rank the following in order of INCREASING Bronsted Acidity

A  I < II < IV < III 
B  I < II < III < IV 
C  III < II < I < IV 
D  IV < I < II < III 

for enolizable hydrogen atoms
aldehydes are more acidic than.... ketones which are more acidic than esters

\[
\begin{align*}
\text{aldehyde} & \\
\text{ketone} & \\
\text{ester} & \\
\end{align*}
\]

\[
\begin{align*}
\text{π-system} & \\
\text{π-system} & \\
\text{π-system} & \\
\end{align*}
\]

\[
\begin{align*}
\text{weak} & \\
\text{donating} & \\
\text{strong} & \\
\end{align*}
\]

\[
\begin{align*}
\text{donating groups destabilize the enolate anion, the stronger the donating group the more the destabilization} & \\
\end{align*}
\]

\[
\begin{align*}
\text{ester} & \\
\text{ketone} & \\
\text{ketone} & \\
\text{aldehyde} & \\
\text{ester} & \\
\text{ester} & \\
\text{ester} & \\
\end{align*}
\]

\[
\begin{align*}
\text{third most stable anion} & \\
\text{second most stable anion} & \\
\text{most stable anion} & \\
\text{least stable anion} & \\
\end{align*}
\]