QUESTION 1

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

1. NO$_2$  
   - This is a STRONG DONATING group on a $\pi$-system, due to the resonance effect of the non-bonding electrons on the nitrogen, thus is ACTIVATING, and increases the rate of the reaction.

2. NH$_2$  
   - This is WEAK WITHDRAWING group, even though the Cl has non-bonding electrons it is so electronegative that the inductive effect outweighs the weak resonance donation effect, Cl is thus DEACTIVATING and decreases the reaction rate somewhat.

3. Cl  
   - This is STRONG WITHDRAWING group due to the formal positive charge on the nitrogen in the nitro group, so is DEACTIVATING, and decreases the reaction rate.

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 2
MC32o

give the product of the following electrophilic aromatic substitution reaction

\[
\begin{align*}
\text{HNO}_3/\text{H}_2\text{SO}_4
\end{align*}
\]

A

B

C

Do not give the answer D

\[
\begin{align*}
\text{electron withdrawing due to dipolar nature of the carbon-nitrogen triple bond, thus META-directing}
\end{align*}
\]
QUESTION 3
MC321

Which of the following structures would undergo electrophilic aromatic substitution fastest?

A

B

C

D

donating groups are ACTIVATING, they make electrophilic aromatic substitution reactions FASTER, the stronger the donating group, the faster the reaction

A

B

C

D

the #2 ring in structure D has both moderate and a strong donating groups, THIS ring on THIS structure is the most activated, reaction would be fastest HERE
QUESTION 4

MC32a

Which of the following is a possible (not necessarily most probable) product of the following reaction sequence?

1. $\text{H}_2\text{COCIO}_3/\text{AlCl}_3$
2. $\text{HNO}_3/\text{H}_2\text{SO}_4$
3. $\text{Zn/Hg/HC}_1/\text{H}_2\text{O}$
4. $\text{Br}_2/\text{AlCl}_3$

![Chemical structures and reaction arrows]
QUESTION 5
MC32e

Which of the following is a possible (not necessarily most probable) product of the following reaction sequence?

1. CH₃CH₂COCl/FeBr₃
2. SO₃/H₂SO₄
3. Zn/Hg/HCl/H₂O
4. HNO₃/H₂O₄
5. Br₂/FeBr₃
QUESTION 6
MC32b

Which of the following is a possible (not necessarily most probable) product of the following reaction sequence?

1. $\text{H}_3\text{CCOCl}/\text{AlCl}_3$
2. $\text{Zn/Hg/HCl/H}_2\text{O}$
3. $\text{NBS/hv}$
4. $\text{Mg.THF}$
5. $\text{H}_3\text{O}^+$

A

B

C

D
QUESTION 7

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

As far as the benzene ring is concerned, this is a withdrawing, and thus DEactivating substituent (slows reaction)

1

\[
\text{Cl}_2 \quad \text{AlCl}_3
\]

this is a very weakly donating, and thus weakly activating substituent (speeds reaction a little bit)

2

\[
\text{Cl}_2 \quad \text{AlCl}_3
\]

this is a weakly donating, and thus activating substituent (speeds reaction)

\[
\text{Cl}_2 \quad \text{AlCl}_3
\]

this is a strongly donating, and thus strongly activating substituent (speeds reaction a lot)

\[
\text{Cl}_2 \quad \text{AlCl}_3
\]

this is a withdrawing, and thus DEactivating substituent (slows reaction)

\[
\text{Cl}_2 \quad \text{AlCl}_3
\]

this is a strongly donating, and thus strongly activating substituent (speeds reaction a lot)

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

MC32q

Which is the correct IUPAC name for the following structure?

A  1-methyl-2-fluoro-6-nitrobenzene
B  2-fluoro-6-nitrotoluene
C  2-nitro-6-fluorotoluene
D  1-nitro-3-fluoro-2-methylbenzene

named as a substituted TOLUENE

carbon #1 by definition

in this case all other things are equal, therefore fluoro comes before nitro alphabetically, so the F gets number 2 and nitro number 6