WORKED ANSWER KEY - Electrophilic Aromatic Substitution

Instructor and self-check copy. Full explanations for six multiple-choice questions plus two constructed-response tasks.

Part A. Concept and product prediction

1. What type of intermediate forms after electrophilic attack on benzene?

Correct: A. An arenium (sigma) ion

Reason: A positively charged arenium ion forms temporarily and loses aromaticity.

2. What restores aromaticity at the end of EAS?

Correct: B. Removal of H+ from the substituted ring carbon

Reason: Deprotonation re-forms the ring pi bond.

3. Which substituent strongly favors meta nitration?

Correct: C. -NO2

Reason: Nitro is a strongly deactivating, meta-directing group.

4. How does bromine direct a second EAS event?

Correct: B. Ortho/para but deactivating

Reason: Halogens are the classic deactivating ortho/para directors.

5. Nitration of benzene most commonly uses

Correct: A. HNO3/H2SO4

Reason: Mixed acids generate nitronium ion under nitration conditions.

6. Why is Friedel-Crafts acylation often easier to control than alkylation?

Correct: B. Acyl electrophiles avoid common alkyl-carbocation rearrangements

Reason: An acylium electrophile does not rearrange like many alkylation electrophiles.

Part B. Show your reasoning

7. Draw the EAS nitration of toluene. Label the electrophile, the favored orientations, and the role of deprotonation.

Worked answer: HNO3/H2SO4 produces NO2+. Methyl directs ortho and para, so ortho- and para-nitrotoluene are favored. Pi electrons attack NO2+, giving an arenium ion; deprotonation restores aromaticity.

8. Predict the major bromination orientation for nitrobenzene with Br2/FeBr3. Explain the electronic effect and relative reaction rate.

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Worked answer: The nitro group is strongly electron withdrawing, deactivates the ring, and directs meta. Meta-bromonitrobenzene is favored; reaction is slower than bromination of benzene.

Use the key to assess chemical reasoning, not just a matching final answer.