SHORT ANSWER (10 pts each)

1. Describe the criteria that compounds must meet in order to be considered aromatic.

2. Is cyclooctatetraene (shown below) aromatic? Why or why not?

![Cyclooctatetraene](image)

3. Pyrimidine and purine (shown below) are biologically important heterocycles; they are major components of DNA and RNA. How many $\pi$ electrons does each of these compounds have? Are either or both of these compounds aromatic?

pyrimidine

purine

$\pi$ electrons: __________  __________

aromatic? (yes/no): __________  __________

4. Show a mechanism for the general electrophilic substitution reaction below:

![Mechanism](image)
MULTIPLE CHOICE (6 pts each):

5. Which of the following compounds is aromatic?

(a) ![Compound A](image1)  (b) ![Compound B](image2)  (c) ![Compound C](image3)  (d) ![Compound D](image4)

6. What purpose does FeCl₃ serve in the electrophilic aromatic substitution reaction of benzene with chlorine?
   (a) It serves as a radical initiator.
   (b) It serves as a Lewis base catalyst by reacting with Cl₂ to generate chloride ion.
   (c) It functions by destabilizing the benzene through formation of a π-complex.
   (d) It serves as a Lewis acid catalyst by reacting with Cl₂, activating it toward attack by benzene's π electrons.

7. The electrophile in a Friedel-Crafts alkylation reaction is which of the following:
   (a) NO₂⁺  (b) [Br-Br-FeBr₃]  (c) a carbocation  (d) none of these

8. How many π electrons are there in the molecule shown below?

(a) 2  (b) 4  (c) 6  (d) 8

9. The cyclopentadienyl carbanion is:
   (a) aromatic  (b) a strong base  (c) sp² hybridized  (d) all of these

10. The reaction shown below is classified as which of the following:

    ![Reaction](image5)

   (a) Friedel Crafts alkylation  (b) chlorination  (c) Friedel Crafts acylation  (d) none of these

11. Which of the following is aromatic?

(a) ![Compound E](image6)  (b) ![Compound F](image7)  (c) ![Compound G](image8)  (d) ![Compound H](image9)
12. Benzene is which of the following?
   (a) a strong nucleophile  (c) a strong electrophile
   (c) a weak nucleophile  (d) a weak electrophile

13. Aromatic molecules contain _____ π electrons.
   (a) 2n  (b) 0  (c) 2n + 4  (d) 4n + 2

14. Which of the following is the electrophilic species in the nitration of an aromatic ring?
   (a) NO₂  (b) HNO₃  (c) NO₂⁻  (d) NO₂⁺

**Bonus: (+5 pts): Show the major product of the reaction shown below.**

\[
\text{C}_6\text{H}_6 + \text{ClCH}_3 \xrightarrow{\text{AlCl}_3} \]

[Image of the reaction: benzene reacting with chloromethane to form a product.]