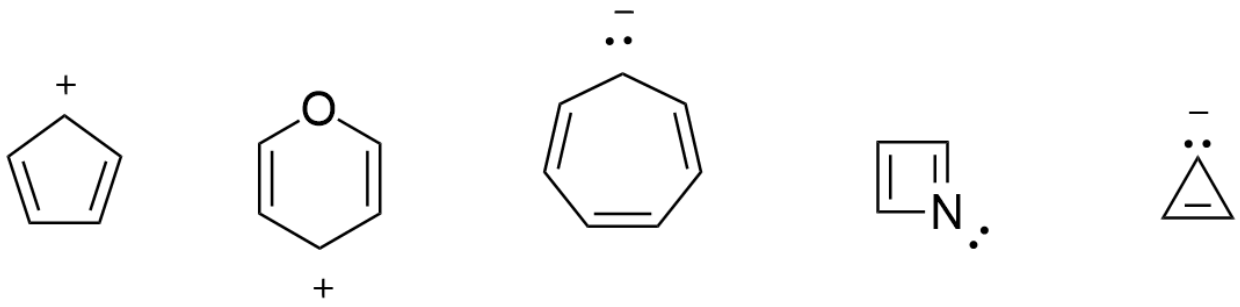
Write out the answers on separate sheets of paper.

1. Draw the structure for the following compounds.
   a. *p*-Bromotoluene
   b. *m*-Dinitrobenzene
   c. 3-Chloro-1-ethoxybenzene
   d. Benzyl bromide
   e. *o*-Chloroanisole
   f. *p*-Nitroaniline
   g. *p*-Bromoacetophenone
   h. 3-Nitrobenzoic acid

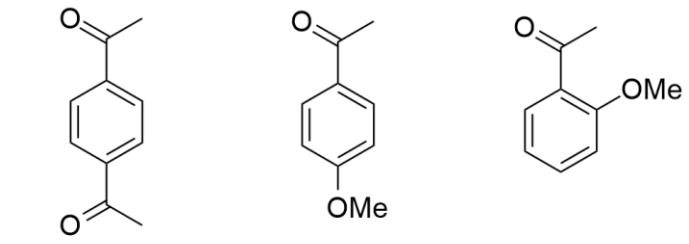
2. Classify the following molecules as aromatic, anti-aromatic, or non-aromatic.

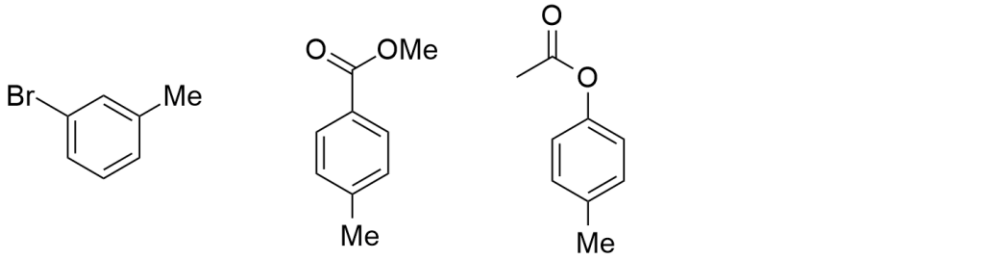


3. NMR of aromatic compounds
   Coupling constants
   Ortho 8-10 Hz, Meta 2-3 Hz, Para 0-1 Hz

   Label the hydrogens (H_a, H_b, H_c, etc…) and the multiplicity for each hydrogen.

   Draw the tree diagram for each different hydrogen.

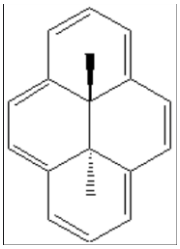




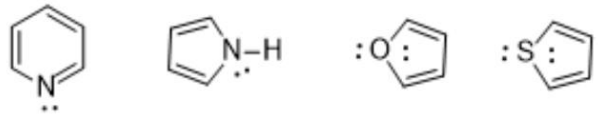
4. The ^{1}H NMR of cyclooctatetraene shows a single line at 5.78 ppm. What does the location of the signal suggest about the possible aromaticity of this compound?

5. Define ring current and how it explains why aromatic protons appear downfield in ^{1}H NMR.

6. In addition to a signal downfield, the ^{1}H NMR spectrum of trans-15,16-dimethyldihydropyrene has a signal at -4.20 ppm. Account for the presence of this high field signal.



7. Fully explain why each of the following heterocyclic aromatic compounds are aromatic.



8. Use resonance theory to account for the fact that phenol (pKa 9.95) is a stronger acid than cyclohexanol (pKa 18).

9. Draw the structure of each compound and arrange each in order of increasing acidity (from least acidic to most acidic).
    a. Cyclohexanol, acetic acid, phenol
    b. Phenol, water, sodium bicarbonate
    c. Benzyl alcohol, p-nitrophenol, phenol

10. Define aromatic, anti-aromatic, and non-aromatic. Give examples of each type of compound.

11. What is Huckel's rule and how can you apply it to the determination of aromaticity in a compound?