These are the homework exercises to accompany the Textmap for McMurry's Organic Chemistry textbook.

15.0 Introduction

15.1 Sources and Names of Aromatic Compounds

15.1 Exercises

Questions

Q15.1.1

State whether the following is para, meta, or ortho substituted.

Q15.1.2

Name the following compounds.

Q15.1.3

Draw the following structures
a. p-chloriodobenzene
b. m-bromotoluene
c. p-chloroaniline
d. 1,3,5-trimethylbenzene

Solutions

S15.1.1

A – meta; B – para; C – ortho

S15.1.2

a. 1,3-Dibromobenzene
b. 1-phenyl-4-methylhexane
c. 1,4-Dichloro-2,5-dimethylbenzene
d. 2-methyl-1,3,5-trinitrobenzene. (Also known as trinitrotoluene, or TNT)

S15.1.3

15.2 Structure and Stability of Benzene

15.2 Exercises
Questions

Q15.2.1

The molecule shown, p-methylpyridine, has similar properties to benzene (flat, 120° bond angles). Draw the pi-orbitals for this compound.

\[
\begin{array}{c}
\text{N} \\
\text{p-methylpyridine}
\end{array}
\]

Solutions

S15.2.1

The nitrogen has a lone pair of electrons perpendicular to the ring.

\[
\begin{array}{c}
\text{N} \\
\text{p-methylpyridine}
\end{array}
\]

15.3 Aromaticity and the Huckel 4n + 2 Rule

15.3 Exercises

Questions

Q15.3.1

To be aromatic, a molecule must be planar conjugated, and obey the 4n+2 rule. The following is the following molecule aromatic?
No, it is not. It does not obey the $4n+2$ rule. Also it is not planar.

15.4 Aromatic Ions

15.4 Exercises

Questions

Q15.4.1

Draw the resonance structures for cycloheptatriene anion. Are all bonds equivalent? How many lines (signals) would you see in a $^1H$ $^{13}C$ NMR?

Q15.4.2

The following reaction occurs readily. Propose a reason why this occurs?

Solutions

S15.3.1

All protons and carbons are the same, so therefore each spectrum will only have one signal each.
The ring becomes aromatic with the addition of two electrons. Thereby obeying the $4n+2$ rule.

15.5 Aromatic Heterocycles: Pyridine and Pyrrole

15.5 Exercises

Questions

Q15.5.1

Draw the orbitals of thiophene to show that is aromatic.

Q15.5.2

The following ring is called a thiazolium ring. Describe how it is aromatic.

Solutions

S15.5.1

This drawing shows it has 6 electrons in the pi-orbital.
S15.5.2

Similar to the last question, the drawing shows that there is only 6 electrons in the pi-system.

15.6 Polycyclic Aromatic Compounds

15.6 Exercises

Questions

Q15.6.1

This is an isomer of naphthalene. Is it aromatic? Draw a resonance structure for it.

Q15.6.2

The following molecule is adenine. It has a purine core. Of the nitrogen in the core, how many electrons are donated into the pi system?
Solutions

S15.6.1

Yes, it is aromatic. 4n+2 pi-electrons.

S15.6.2

There is only one nitrogen of the core that contributes to the pi-system (in red). With this one lone pair the core is aromatic with 10 electrons in the pi-system.

15.7 Spectroscopy of Aromatic Compounds