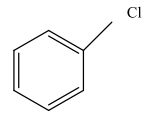
CHAPTER 15 (Benzene and Aromaticity - Practice Exercises) CHEM 2425

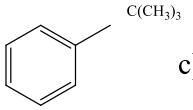
Dr. Pahlavan / Dr. Cherif / Dr. Dessens

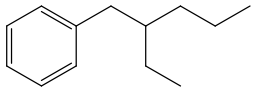
1. Which of the following has the ***highest boiling point***? Explain your answer.

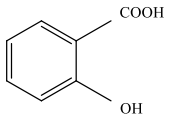
a) Benzene	Toluene	o- Xylene	p- Xylene
b) Aniline	m-Xylene	Toluene	Benzene
c) Toluene	Benzaldehyde	Benzonitrile	Benzene

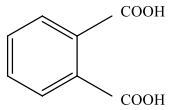
2. Give the proper ***IUPAC*** name for each of the compounds shown below.

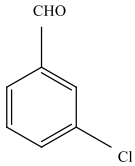
a) 

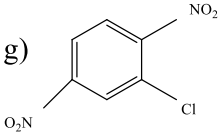
b) 

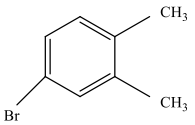
c) 

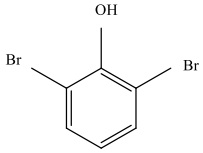
d) 

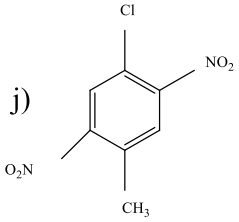
e) 

f) 

g) 

h) 

i) 

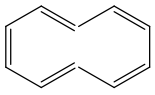
j) 

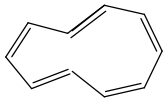
3. Draw the structure corresponding to each of the following ***IUPAC*** names.

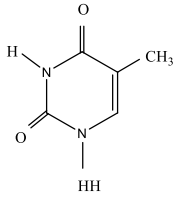
a) Ortho-bromopropylbenzene	b) 2, 3, 5-trinitrophenol	c) 1-fluoro-2, 4- dinitrobenzene
d) (1-bromoethyl) benzene	e) 2-methyl-6-phenylheptane	f) 1-Bromo-2,4-diethylbenzene
g) Sulfanilic acid	h) Benzaldehyde	i) Benzyl bromide j) Vinyl benzene

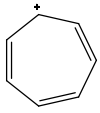
4. Determine how many **monobromo** and **dibromo derivatives** constituents responsible for 1, 3-cyclopentadine.

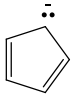
5. Determine if each of the compounds shown below is(are) expected to be ***aromatic***, based on the Hukle (4n+2) criteria.

a) 

b) 

c) 

d) 

e) 

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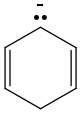
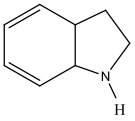
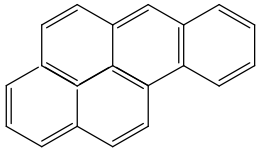
g) 

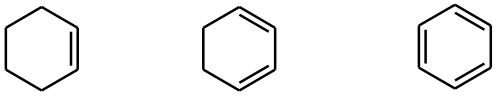
h) 

i) 

j) 

6. Give four reasons for ***unusual stability*** of benzene.

7. Compare the **stability** of cyclohexene, 1, 3-cyclohexadiene, and benzene bases on **heat of hydrogenation**.



8. What are the aromaticity conditions. Give an example of **aromatic** compound, **anti-aromatic**, and **non-aromatic** compound.

9. What are the aromatic **heterocycles aromatic** and **polycyclic aromatic** compounds? Given examples of heterocyclic and polycyclic compounds.

10. What type of reactions benzene and benzene derivatives typically undergo? Provide at least two examples.

ANSWERS

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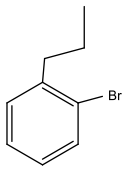
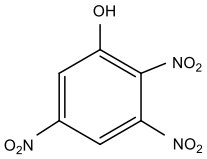
1. a) o – Xylene (144 °C) group crowding b) Aniline (184 °C) hydrogen bonding c) Benzonitrile (191 °C) polarity

2. a) Chlorobenzene b) t-Butylbenzene c) (2-Ethylpentyl)benzene or 2-Ethyl-1-phenylpentane
   d) o – Hydroxybenzoic acid e) 1,2 – benzene dicarboxylic acid or Phthalic acid
   f) m - Chlorobenzaldehyde g) 2 – Chloro -1,4 –dinitrobenzene h) 4 – Bromo- 1,2- dimethylbenzene
   i) 2,6 dibromophenol j) 4 –Chloro- 2,5 –dinitrotoluene j) 4 –Chloro- 2,5 –dinitrotoluene

3.



a)



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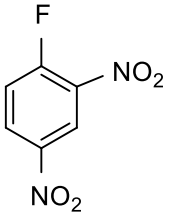

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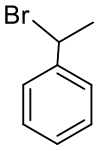

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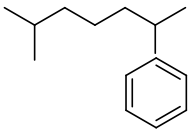

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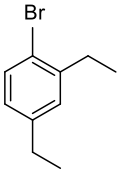

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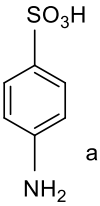
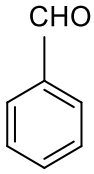


also called (p-aminobenzene sulfonic acid)

g)



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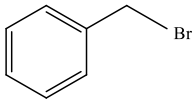
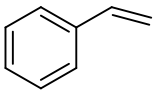
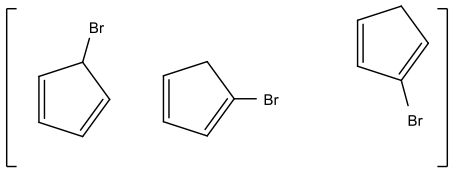


i)

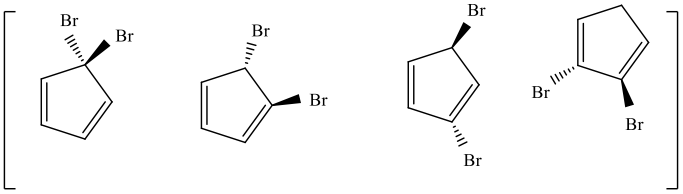


j)

4.



(monosubstituents)



(disubstituents)

5.

a) 10 pi electron, all sp^2 atoms ,not planar, non-aromatic
b) not monocyclic , anti-aromatic
c) conjugated aromatic (partially)
d) 6 pi electrons , aromatic
e) 6 pi electrons, all sp^2, aromatic
f) 6 pi electrons, all sp^2, aromatic
g) 6 pi electrons, not all sp^2, non-aromatic
h) 2 pi electrons , all sp^2, aromatic
i) not monocyclic, not all sp^2 not-aromatic
j) if all sp^2 ,anti-aromatic

6.

i) Benzene is a planar molecule with the shape of regular hexagon

ii) Heat of hydrogenation is less than expected

iii) All C – C – C bond angles are 120 °, all six carbon atoms are sp^2 hybridized

iv) All C – C bonds have the same length (139 pm)

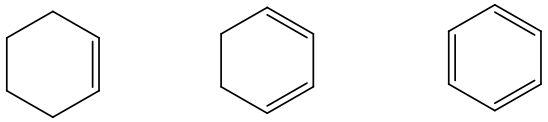
v) Conjugated with p orbital on each carbon vi) Kekule resonance structures

7. Compare heat of hydrogenations

a) Cyclohexane ΔHhyd = - 118 kJ/mol (least stable)

b) 1,3 - Cyclohexadiene Δ Hhyd = 2 x (-118) = - 230 kJ /mol

c) Benzene ΔHhyd = - 206 kJ/mol (most stable)



a) b) c)

8.

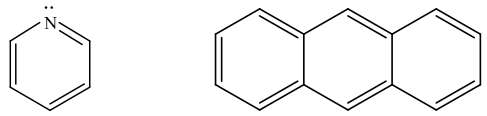
I) Flat- Mono cyclic – completely conjugated

a) Aromatic – obey (4n +2 pi e's rule = 2,6,10, 14, …. Pi electrons)

b) Anti- aromatic – contains 4, 8, 12, 16, … pi electrons

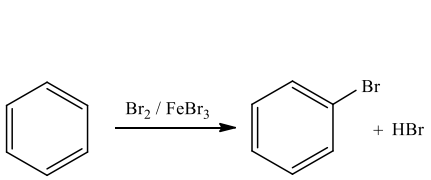
II) Not – Flat , not cyclic, not completely conjugated- nonplanar or non-cyclicor not conjugated ……. The entire ring.

9. Aromatic hetrocyclic is a cyclic compound that contains an atom other than carbon in the ring (pyridine).
Polyaromatic compound is a compounds with two or more benzene-like rings fused together(anthracene).

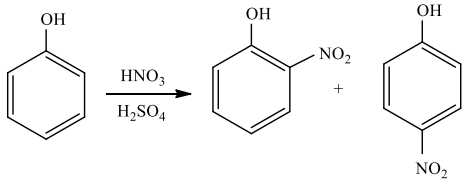


Pyridine anthracene

10. Electophilic Aromatic Substitution (EAS)



i)



ii)