

## Questions and Answers – Aromatic Hydrocarbons

1. Identify the correct statement which is related to aromatic hydrocarbon

- a) It has only sigma bonds
- b) It has only pi bonds
- c) It has a sigma and two pi bonds
- d) It has a sigma and delocalized pi bond

Answer: d

Explanation: An aromatic hydrocarbon always has a sigma as well as a delocalized pi bond found between the carbon atoms.

2. Select the incorrect option:

- a) The aromatic hydrocarbon has a pleasant aroma (smell)
- b) Some of the aromatic compounds are ring-shaped
- c) Aromatic hydrocarbon can be either mono or polycyclic
- d) Benzene is the simplest hydrocarbon

Answer: b

Explanation: All the aromatic hydrocarbon are ring shaped as all of them are sp<sup>2</sup> hybridized with a geometry of trigonal planar.

3. Which among the following is not a property of aromatic hydrocarbon:

- a) These compounds have very good aromaticity
- b) These compounds have excellent stability
- c) These compounds do not undergo nucleophilic substitutions but they undergo electrophilic substitutions
- d) There exists a strong ratio between carbon and hydrogen

Answer: c

Explanation: Aromatic hydrocarbons undergo both electrophilic and nucleophilic aromatic substitutions.

4. Arenes does not undergo:

- a) Dehydrogenation
- b) Coupling reaction
- c) Halogenation
- d) Cyclo additions

Answer: a

Explanations: Arenes undergo hydrogenation reaction and form saturated ring products.

5. Which among these is not a representative arene compound?

- a) Durene
- b) Picric chloride
- c) Aspirin
- d) Mesitylene

Answer: b

Explanation: Picric acid is a representative arene compound but not picric chloride.

6. Which among these is the simplest example for polycyclic arenes?

- a) Benzacephenanthrylene
- b) Naphthalene
- c) Pyrene
- d) Dibenz-anthracene

Answer: b

Explanation: Naphthalene has fused ring of aromaticity and has the simplest structure when compared with other polycyclic aromatic hydrocarbons.

7. Arenes are polar. State true or false

- a) True
- b) False

Answer: b

Explanation: Arenes are insoluble in water and hence they are non polar compounds.

8. Arenes are:

- a) volatile
- b) Water soluble
- c) Non-carcinogenic
- d) Mostly gases

Answer: a

Explanation: Arenes have a very low boiling point and hence they are volatile in nature.

9. The main sources of these arenes are:

- a) Petroleum
- b) Biogas and petroleum
- c) Petroleum and coal tar
- d) Natural gas

Answer: c

Explanation: As these petroleum and natural gas comprise of naturally occurring compounds such as carbon and hydrogen in abundance, these serve as the main source of arenes.

10. Benzene has a stronger Vander-Waal's force than Methylbenzene. State true or false

- a) False
- b) True

Answer: a

Explanation: The benzene molecule is smaller than that of the methylbenzene and hence it does not have the Vander-Waal's forces as equal to those of methylbenzene.

## Questions and Answers – Carbanions

1. Select the correct statement from the following option.

- a) Carbanion is the intermediate compound
- b) In carbanion, central carbon atom carries negative charge
- c) It possess an unshared pair of electron
- d) All of the mentioned

Answer: d

Explanation: Carbanion is the intermediate compound in which central carbon atom carries a negative charge and it possess the unshared pair of electron. It is an anion in which carbon has an unshared pair of electrons and bears a negative charge usually with three substituents for a total of eight valence electrons.

2. The hybridisation of carbanion is \_\_\_\_\_

- a) Sp
- b) Sp<sup>2</sup>
- c) Sp<sup>3</sup>
- d) Sp<sup>3</sup>d

Answer: c

Explanation: The hybridisation of carbanion is sp<sup>3</sup>. A carbanion is an anion in which carbon has an unshared pair of electrons and bears a negative charge usually with three substituents for a total of eight valence electrons.

3. The formal charge at the carbanion is \_\_\_\_\_

- a) +1
- b) -1
- c) 0
- d) +2

Answer: b

Explanation: The formal charge at the carbanion is -1. A carbanion is an anion in which carbon has an unshared pair of electrons and bears a negative charge usually with three substituents for a total of eight valence electrons.

4. The geometry of carbanion is \_\_\_\_\_

- a) Pyramidal
- b) Linear
- c) Tetrahedral
- d) Trigonal planar

Answer: a

Explanation: The geometry of carbanion is pyramidal. A carbanion is an anion in which carbon has an unshared pair of electrons and bears a negative charge usually with three substituents for a total of eight valence electrons.

5. The structure of carbanion is pyramidal but it undergoes rapid inversion similar to those of amines.

- a) True
- b) False

Answer: a

Explanation: The structure of carbanion is pyramidal but it undergoes rapid inversion similar to those of amines. The carbanion exists in a trigonal pyramidal geometry. Formally, a carbanion is the conjugate base of a carbon acid.

6. Negative charge of carbanion can be dispersed by \_\_\_\_\_

- a) (+I) effect and resonance
- b) (-I) effect and resonance
- c) Hyperconjugation
- d) (+M) effect and resonance

Answer: b

Explanation: Negative charge of carbanion can be dispersed by (+I) effect and resonance. A carbanion is a nucleophile. The stability and reactivity of a carbanion is determined by several factors.

7. Which of the following carbanion is least stable?

- a)  $1^{\ominus}$
- b)  $2^{\ominus}$
- c)  $3^{\ominus}$
- d)  $\text{CH}_3$

Answer: c

Explanation:  $3^{\ominus}$  carbanion is the least stable carbanion. The same factors that determine the stability of the carbanion also determine the order in pKa in carbon acids.

8. Which of the following carbanion is most stable?

- a)  $1^{\ominus}$
- b)  $2^{\ominus}$
- c)  $3^{\ominus}$
- d)  $\text{CH}_3$

Answer: d

Explanation:  $\text{CH}_3$  carbanion is the most stable carbanion. The same factors that determine the stability of the carbanion also determine the order in pKa in carbon acids.

9. On increasing the number of alkyl groups, the stability of carbanions \_\_\_\_\_

- a) Increases
- b) Decreases
- c) Remains same
- d) None of the mentioned

Answer: b

Explanation: On increasing the number of alkyl groups, the stability of carbanions decreases. The alkyl groups have (-I) effect.

10. Due to (+I) effect, the methyl groups are electron accepting in nature.

- a) True
- b) False

Answer: b

Explanation: Due to (+I) effect, the methyl groups are electron releasing in nature. The same factors that determine the stability of the carbanion also determine the order in pKa in carbon acids.

### Questions and Answers – Electrophilic Aromatic Substitution

1. What will be the product formed when phenol reacts with Br<sub>2</sub> in CCl<sub>4</sub> medium?

- a) 3-Bromophenol
- b) 4- Bromophenol
- c) 3,5-Dibromophenol
- d) 2,4,6-Tribromophenol

Answer: b

Explanation: Because the non-polar solvent (i.e. CCl<sub>4</sub>) induces a weaker dipole in Br-Br as compared to the polar solvent (i.e. water), a weaker electrophile (Br<sup>+</sup>) is produced that undergoes electrophilic aromatic substitution with the benzene ring. Consequently, we get mono-bromination with Br (in CCl<sub>4</sub>) with compared with tri-bromination Br (in aq.).

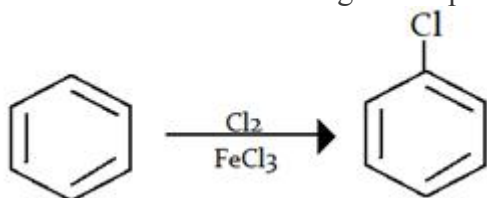
2. What is the electrophile in the electrophilic substitution reaction of benzene using oleum and conc. H<sub>2</sub>SO<sub>4</sub>?

- a) SO<sub>3</sub>
- b) NO<sub>3</sub>
- c) NO<sub>2</sub><sup>+</sup>
- d) NO<sup>+</sup>

Answer: a

Explanation: This reaction is sulphonation of benzene ring in which SO<sub>3</sub> is the real attacking electrophile and oleum will increase the concentration of SO<sub>3</sub>.

3. What will be the attacking electrophile in this reaction?



- a) Carbanion
- b) Halonium
- c) Radical
- d) Transition state

Answer: b

Explanation: In halogenation of benzene ring halonium ion ( $\text{Cl}^+$ ) will attack at benzene ring.

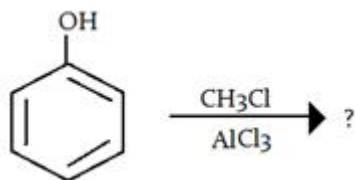
4. Which of the following aromatic compounds undergo Friedel–Crafts alkylation with methyl chloride and aluminum chloride?

- a) Benzoic acid
- b) Nitrobenzene
- c) Toluene
- d) Aniline

Answer: c

Explanation: Toluene will undergo Friedel–Crafts alkylation with methyl chloride and aluminum chloride as because as weak electron withdrawing functional group — will not make the ring less electron dense, hence more reactive in an aromatic electrophilic substitution as compared to electron withdrawing group (benzoic acid, nitrobenzene, aniline).

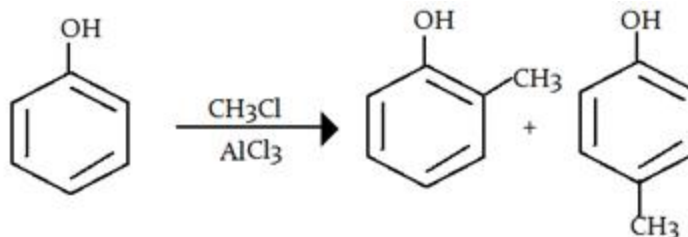
5. What will be the product in the given reaction?



- a) m-chlorophenol
- b) o-chlorophenol and p-chlorophenol
- c) o-hydroxytoluene and p-hydroxytoluene
- d) m-hydroxytoluene

Answer: c

Explanation:  $-\text{OH}$  is a ortho and para directing group so attack of electrophile (carbocation-  $\text{CH}_3$ )



will attack there, as shown below:

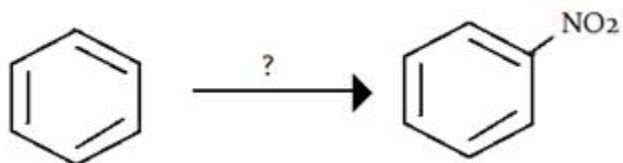
6. What is the electrophile in the acylation of benzene?

- a)  $\text{AlCl}_3$
- b)  $\text{CO}^+$
- c)  $\text{Cl}^+$
- d)  $\text{R-CO}^+$

Answer: d

Explanation: The electrophile in the electrophilic substitution reaction of acetyl chloride ( $\text{CH}_3\text{COCl}$ ) and  $\text{AlCl}_3$  reacting with benzene is  $\text{R-CO}^+$ .

7. How would you synthesis the following reaction?

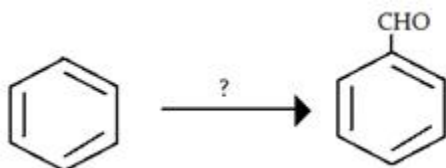


- a) conc. HNO<sub>3</sub> + conc. H<sub>2</sub>SO<sub>4</sub>
- b) conc. HNO<sub>3</sub>
- c) anhydrous AlCl<sub>3</sub> + Ph-NO<sub>2</sub>
- d) conc. H<sub>2</sub>SO<sub>4</sub> + Oleum

Answer: a

Explanation: This reaction is nitration of benzene and conc. HNO<sub>3</sub> and conc. H<sub>2</sub>SO<sub>4</sub> is used to carry out this synthesis although HNO<sub>2</sub> + HNO<sub>3</sub> can also be used.

8. Which of the following reactants can be used to carry out following reaction?

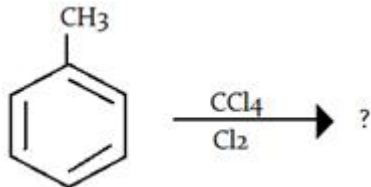


- a) conc. HNO<sub>3</sub> + conc. H<sub>2</sub>SO<sub>4</sub>
- b) HCl + CO + AlCl<sub>3</sub>
- c) anhydrous AlCl<sub>3</sub> + Ph-NO<sub>2</sub>
- d) conc. H<sub>2</sub>SO<sub>4</sub> + Oleum

Answer: b

Explanation: This is Gattermann Koch Reaction in which HCl + CO + AlCl<sub>3</sub> are used as reactant. H-CO<sup>+</sup> is the real attacking electrophile.

9. What will be the product in the given reaction?



- a) m-chlorotoluene
- b) o-chlorotoluene and p-chlorotoluene
- c) 1-chloro-3-methylbenzene
- d) no reaction

Answer: d

Explanation: Here no reaction will take place because CCl<sub>4</sub> + Cl<sub>2</sub> show addition reaction and benzene don't give addition reaction.

10. Which of the following is the most activating in electrophilic aromatic substitution?

- a)  $-\text{NO}_2$
- b)  $-\text{NHCOCH}_3$
- c)  $-\text{CN}$
- d)  $-\text{NH}_2$

Answer: d

Explanation: Groups with unshared pairs of electrons, such as the amino group of aniline, are strongly activating and ortho/para-directing by resonance. Such activating groups donate those unshared electrons to the pi system, creating a negative charge on the ortho and para positions. These positions are thus the most reactive towards an electron-poor electrophile. The highest electron density is located on both ortho and para positions, although this increased reactivity might be offset by steric hindrance between substituent and electrophile.

### Questions and Answers – Electrophiles

1. Which of the following statement is incorrect about electrophiles?

- a) Electrophiles are positively charged or neutral species having vacant orbitals
- b) The electrophiles are attacked by the most electron-populated part of one nucleophile
- c) Chemical species that do not satisfy the octet rule such as carbenes and radicals are electrophiles
- d) Electrophiles are Lewis base

Answer: d

Explanation: Because electrophiles accept electrons, they are Lewis acids not Lewis base, according to Acid-Base reaction theories.

2. In addition of halogen (Bromine) to an alkene, how can we isolate a bromonium in the reaction?

- a) increasing concentration of bromide ion
- b) decreasing concentration of bromide ion
- c) alkene with cation stabilising groups
- d) alkene with less electrophilic centre

Answer: c

Explanation: A bromo-carbenium ion intermediate may be predominant instead of vicinyl dibromide if the alkene has a cation-stabilizing substituent like phenyl group. There is an example of the isolation of the bromonium ion.

3. Which of the following is not an electrophile?

- a)  $(\text{CH}_3)_4\text{N}^+$
- b)  $\text{Cl}_2$
- c)  $\text{HBr}$
- d)  $\text{Br}_2$

Answer: a

Explanation: The ammonium ion cannot react at the N with a nucleophile because the N already has an octet of electrons.



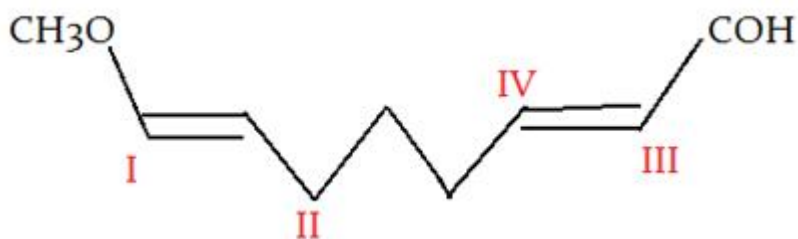
4. Which of the following is not an electrophile?

- a)  $\text{H}_2\text{O}$
- b)  $\text{Cl}_2$
- c)  $\text{HBr}$
- d)  $\text{Br}_2$

Answer: c

Explanation: Hydrogen bromide is a strong acid, it is able to donate a proton to a molecule or anion with a nucleophilic site.

5. In the given molecule where will electrophile will attack?

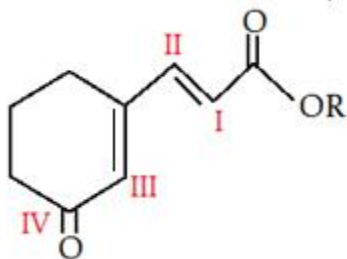


- a) I
- b) II
- c) III
- d) IV

Answer: a

Explanation:  $-\text{CH}_3\text{O}$  is a +M group, so it has lone pair to donate to upcoming electrophile.

6. In the given molecule where will electrophile will attack?

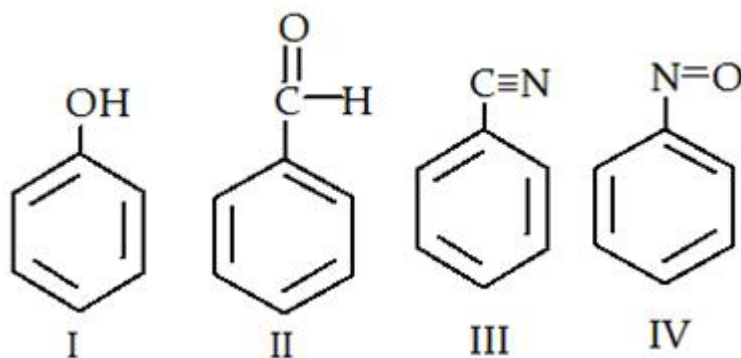


- a) I
- b) II
- c) III
- d) IV

Answer: a

Explanation:  $-\text{OCOR}$  is a +M group, it is more electron rich than rest of the groups, so it has lone pair to donate to upcoming electrophile.

7. Which of the following is most readily undergo electrophilic attack?

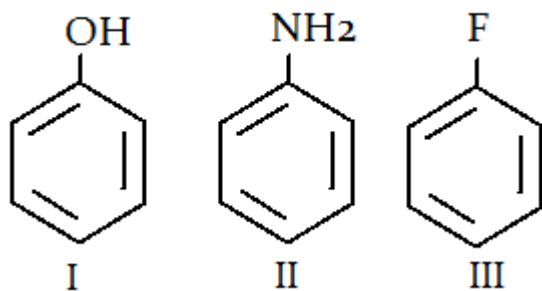


- a) I
- b) II
- c) III
- d) IV

Answer: a

Explanation: I is most reactive towards electrophilic attack, as -OH is +M group therefore, here benzene will have more e- density than rest of the others.

8. What is the correct order for the rate of reaction for the electrophilic attack of the given compounds?

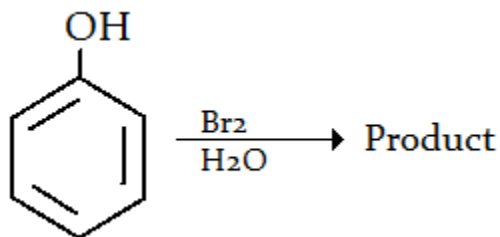


- a) I > II > III
- b) II > I > III
- c) I < II < III
- d) III > I > II

Answer: b

Explanation: Electronegativity trend is  $N < O < F$ , so III is the least electron rich ring therefore least favourable for electrophilic attack. Similarly, II is the most electron rich ring therefore most favourable for electrophilic attack.

9. Which of the following is the product for the given reaction?

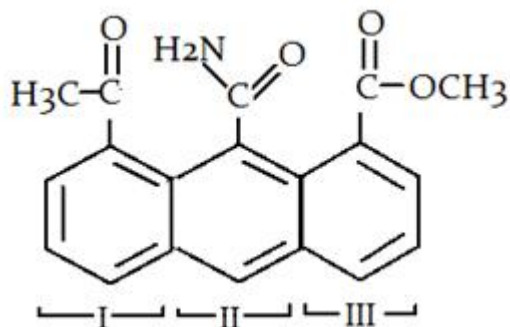


- a) 3-Bromophenol
- b) 4- Bromophenol
- c) 3,5-Dibromophenol
- d) 2,4,6-Tribromophenol

Answer: d

Explanation: The polar solvent (i.e. water) induces a stronger dipole in Br-Br. A stronger electrophile (Br<sup>+</sup>) is produced that undergoes electrophilic aromatic substitution with the benzene ring more readily. Consequently, you get tri-bromination with Br(aq.).

10. Which ring will readily undergo electrophilic attack?



- a) I
- b) II
- c) III
- d) Both I and III

Answer: b

Explanation: Due to the presence of -NH<sub>2</sub> group electron will be transferred to the C of -CONH<sub>2</sub> group and that's why it will not withdraw electron from benzene ring. So, electron density of ring II is most in all three rings and that is why electrophile will attack at ring II.

### Questions and Answers – Resonance and Aromaticity

1. Resonance forms are in equilibrium with each other. State true or false

- a) True
- b) False

Answer: b

Explanation: Resonance forms are hybrid in nature and hence it is not correct to say that they are in equilibrium with each other.

2. Identify the false statement regarding resonance

- a) As the number of charges increases, the resonance forms gets more significant
- b) Zero charge of resonance is the most significant one
- c) Atoms with full octet resonance form are more stable when compared with the one with unfilled octet
- d) Resonance is unstable in case of unfilled octet of nitrogen atom

Answer: a

Explanation: Greater the number of charges, less stable and less significant gets the resonance form.

3. Identify the correct sequence according to electronegativity

- a)  $F > NH_2 > CH_3 > OH$
- b)  $NH_2 > F > CH_3 > OH$
- c)  $NH_2 > OH > CH_3 > F$
- d)  $F > OH > NH_2 > CH_3$

Answer: d

Explanation: In the sequence " $F > OH > NH_2 > CH_3$ ", F is the most stable one and  $CH_3$  is the least stable one, as the stability of the anions increases on moving towards the right of the periodic table.

4. Identify the correct sequence with respect to Inductive effects

- a)  $CF_3 > CH_2F > CHF_2 > CF_3$
- b)  $CF_3 > CHF_2 > CH_2F > CH_3$
- c)  $CH_3 > CH_2F > CHF_2 > CF_3$
- d)  $CH_3 > CHF_2 > CH_2F > CF_3$

Answer: b

Explanation: As electron withdrawing substituent is greater in  $CF_3$ , it is more stable and  $CH_3$  is the least stable one and hence the sequence.

5. Stability sequence: primary carbocation > secondary carbocation > tertiary carbocation.

Is this sequence correct?

- a) Yes
- b) No

Answer: b

Explanation: The tertiary carbocation has the highest stability and the primary carbocation has the least stability, as it lies close to electron withdrawing group and hence the sequence is not correct.

6. Identify the incorrect statement regarding aromaticity

- a) It is the extra stability possessed by a molecule
- b) p-orbitals must be planar and overlap
- c) Cyclic delocalization takes place
- d) It does not follow Huckel's rule

Answer: d

Explanation: It follows Huckel's rule, according to which a molecule must possess specific number of pi electrons within a closed ring of p-orbitals.

7. Aromatic rings do not have resonance structures. State true or false

- a) False
- b) True

Answer: a

Explanation: Aromatic rings have resonance structure due to cycling double bonds and all aromatic rings must have resonance but the converse need not be satisfied.

8. Select the correct statement regarding the aromatic nitrogen molecule

- a) It is not hybridized
- b) It is sp hybridized
- c) It is sp<sup>2</sup> hybridized
- d) It is sp<sup>3</sup> hybridized

Answer: c

Explanation: As a result of its overall structure and electron delocalization, it becomes a sp<sup>2</sup> hybridized, aromatic molecule.

9. Can a linear molecule have aromaticity?

- a) Yes
- b) No

Answer: b

Explanation: A molecule can have aromaticity if it is closed loop or ring-shaped or has p-orbitals and hence linear molecule cannot have aromaticity.

10. Select the incorrect statement:

- a) A resonance may sometimes cause sp<sup>3</sup> atoms to become sp<sup>2</sup> hybridized
- b) Delocalizing one lone pair causes aromaticity
- c) One lone pair will be counted as two pi electrons according to Huckel's equation
- d) Two sigma bonds make up a double bond

Answer: d

Explanation: A double bond is one which has a sigma bond and a pi bond. Each pi bond has two pi electrons.