CHEMISTRY

CLASS XI

COMPETENCY BASED EXAM – JANUARY 2026

Hydrocarbons MCQs Class XI

1. **Which of the following statements about resonance energy and heat of hydrogenation is correct?**
   A. A compound with larger resonance energy shows larger heat of hydrogenation.
   B. Heat of hydrogenation measures loss of π-stabilization on hydrogenation; larger resonance energy → smaller heat of hydrogenation.
   C. Resonance energy and heat of hydrogenation are unrelated.
   D. Resonance energy equals heat of hydrogenation for conjugated dienes.

Answer: B
Reasoning: Heat of hydrogenation reflects how much energy is released when π-bonds are removed; aromatic or strongly resonance-stabilized systems release less energy (smaller heat) because they are already low in energy.

2. **Which species is aromatic?**
   A. Cyclopentadienyl anion ($C_5H_5^-$)
   B. Cyclopentadienyl radical ($C_5H_5\cdot$)
   C. Cyclopentadienyl cation ($C_5H_5^+$)
   D. Cyclobutadiene (C_4H_4)

Answer: A
Reasoning: Cyclopentadienyl anion has 6 π electrons (4n+2, n=1) and is planar and conjugated → aromatic. Radical has 5 π electrons (not aromatic), cation has 4 π electrons (antiaromatic), cyclobutadiene is antiaromatic.

3. **The product distribution in the free radical bromination of 2-methylbutane (at low temperature, Br_2, hv) is best explained by:**
   A. Relative bond dissociation energies only
   B. Stability of intermediate radicals and statistical number of H atoms at each site
   C. Polar effects only
   D. Steric hindrance only

Answer: B
Reasoning: Radical bromination selectivity depends on radical stability (tertiary > secondary > primary) and the number of equivalent hydrogens; bromination is highly selective due to endothermic H-abstraction transition state favoring more stable radical.

4. **Assertion–Reason**
   Assertion (A): 1,3-Butadiene gives both 1,2- and 1,4-addition products with HBr.
   Reason (R): Resonance-stabilized allylic carbocation intermediate leads to two resonance forms that give different regiochemical products.

A. Both A and R are true, and R explains A
B. Both A and R are true, but R does not explain A
C. A true, R false
D. A false, R true

Answer: A
Reasoning: Protonation forms an allylic carbocation with resonance; nucleophile can attack at two positions → 1,2- and 1,4-products.

5. **Which statement about benzene and cyclohexatriene models is correct?**
   A. Benzene is best described as alternating single and double bonds.
   B. Benzene has localized double bonds that rapidly interconvert.
   C. Benzene has delocalized π-electrons over six carbons giving equal C–C bond lengths intermediate between single and double.
   D. Benzene is non-planar to avoid antiaromaticity.

Answer: C
Reasoning: Benzene's π-electrons are delocalized (aromatic), producing equal bond lengths and extra stabilization (resonance energy).

6. **Which of the following will undergo benzylic oxidation with $KMnO_4$ to benzoic acid under mild conditions?**
   A. Toluene
   B. Ethylbenzene
   C. Isopropylbenzene (cumene)
   D. All of the above (provided at least one benzylic hydrogen is present)

Answer: D
Reasoning: $KMnO_4$ oxidizes any benzylic C–H (on carbon directly attached to ring) to carboxyl group if at least one benzylic hydrogen exists.

7. **Assertion–Reason**
   Assertion (A): Cyclooctatetraene (COT) is not aromatic.
   Reason (R): COT adopts a tub conformation to avoid planarity and 8 π electrons would make it antiaromatic if planar.

A. Both A and R are true, and R explains A
B. Both A and R are true, but R does not explain A
C. A true, R false
D. A false, R true

Answer: A
Reasoning: Planar 8 π-electron system would be antiaromatic (4n), so COT becomes nonplanar to avoid antiaromaticity.

8. **Which reagent and condition selectively brominates the allylic position of cyclohexene without adding across the double bond?**
   A. Br_2 in CCl_4, dark
   B. NBS (N-bromosuccinimide) in CCl_4, hv or peroxides
   C. HBr, peroxide
   D. Br_2, hv

Answer: B
Reasoning: NBS provides low, steady Br_2 concentration and radical conditions favor allylic bromination; Br_2 in hv can give addition across double bond as well.

9. **Consider hydrogenation heats: benzene → cyclohexane releases −208 kJ/mol; hypothetical cyclohexatriene → cyclohexane would release −360 kJ/mol. The resonance energy of benzene is approximately:**
   A. 152 kJ/mol
   B. 208 kJ/mol
   C. 360 kJ/mol
   D. 52 kJ/mol

Answer: A

Reasoning: Resonance energy ≈ difference between expected hydrogenation (−360) and observed (−208) ⟶ ≈ 152 kJ/mol.

10. **Assertion–Reason**
    Assertion (A): Alkynes undergo anti-Markovnikov hydration in presence of BH_3 followed by H_2O_2/OH^- to give aldehydes (for terminal alkynes).
    Reason (R): Hydroboration–oxidation of alkynes proceeds via syn addition of BH_2 then oxidation to enol which tautomerizes to carbonyl; for terminal alkynes this gives aldehydes.

A. Both A and R are true, and R explains A
B. Both A and R are true, but R does not explain A
C. A true, R false
D. A false, R true

Answer: A

Reasoning: Hydroboration–oxidation of terminal alkynes yields anti-Markovnikov addition of water overall; enol tautomerizes to aldehyde.