

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 Equal intermediate C–C bond lengths; hydrogenation less exothermic than three isolated double bonds predict. Accept appropriate IR evidence in place of either.

2.2 Three-bond prediction = $3(-118) = -354 \text{ kJ mol}^{-1}$. Difference = 148 kJ mol^{-1} , benzene lower in starting enthalpy/more stable.

2.3 Benzene needs a halogen carrier such as FeBr_3 . Phenol reacts without that catalyst, making white 2,4,6-tribromophenol and decolourising bromine water.

3.1 $\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + \text{HSO}_4^- + \text{H}_2\text{O}$. NO_2^+ is nitronium. Ring attack temporarily breaks delocalisation; loss of H^+ restores it.

3.2 Ethylbenzene: chloroethane/anhydrous AlCl_3 . Phenylethanone: ethanoyl chloride/anhydrous AlCl_3 , the acylation reaction.

3.3 Its electrons are delocalised and addition would lose stabilisation, so it resists the usual bromine-water addition test. Sulfonation uses fuming sulfuric acid.