Chapter 26 – Answers to questions (for in-chapter questions)

1  a  i 4290 kJ mol\(^{-1}\), ii 1308 kJ mol\(^{-1}\),
   b  i 1038 kJ mol\(^{-1}\), ii 1830 kJ mol\(^{-1}\), iii 2478 kJ mol\(^{-1}\),
   c  +252 kJ mol\(^{-1}\),
   d  The experimental value is less positive than the calculated value.
   e  ‘Real’ benzene is more stable than the Kekulé structure.

2  a

\[
\text{CH}_3
\]

b

\[
\text{OH}
\]

\[
\text{CH}_3
\]

c

\[
\text{NO}_2
\]

\[
\text{NO}_2
\]

3  a  i Bromobenzene, ii 2-methylbenzoic acid, iii 2,4,6-trinitromethylbenzene
   b  Substituents are given the lowest number possible, therefore 5-chloromethylbenzene is actually 3-chloromethylbenzene, and 6-chloromethylbenzene is actually 2-chloromethylbenzene.

4  a  i Cyclohexene undergoes addition with bromine in the dark because the bromine is decolourised and no HBr is formed. ii Benzene does not undergo addition with bromine in the dark as there is no evidence of reaction.
   b  i Benzene does not undergo addition because the production of HBr implies H has been replaced by Br. ii Benzene undergoes substitution in the presence of iron filings because HBr is formed; H is substituted for Br.
   c  No.

5  a  Benzene is electron dense and so will be easily attacked by positively charged electrophiles, and not by nucleophiles.
   b  Benzene has a ring of delocalised electrons which needs additional energy to break, so addition reactions are not favoured.
6
\[
\text{Br} + \text{HCl}
\]

7 The chlorine is much more electronegative than iodine and so the iodine has a strong $\delta^+$ charge, meaning that it can attack the electron dense benzene ring.

8 Poly(phenylethene), also called polystyrene.

9 Using chloroethene produces HCl as a by-product, which has to be disposed of. Ethene produces no by-product, and is also cheaper than chloroethene.

10 Benzene has a delocalised electron ring system, which requires high energy to break into, but once one double bond is broken, the delocalised electron system is disrupted and the other double bonds break much more easily.

11
\[
\begin{array}{c}
\text{CHCl}_2 \\
\text{CCl}_3
\end{array}
\]

12 In the presence of AlCl$_3$ catalyst.

13 a Heat in the presence of Zn at 600°C to form phenylethene, then add HBr. b React with bromine in the presence of AlBr$_3$.

14 a CH$_3$–, –OH and –NH$_2$.
   b –NO$_2$ and –COOH.
   c Yes; groups directing to positions 2 and 4 react faster than benzene, and groups directing to position 3 react slower.

15 a
\[
\begin{array}{c}
\text{or}
\end{array}
\]

b
\[
\begin{array}{c}
\text{NO}_2 \\
\text{Cl}
\end{array}
\]
16  a  D,  b  A and C,  c  B.

17  a  \[ 2H^+ + 2Na \rightarrow H_2 + 2Na^+ \].
    b  Phenol,  c  Phenol

18  a  React with ethanoyl chloride.
    b  To deprotonate the phenol group, forming the negative phenoxide ion which reacts faster with the acyl halide.