Answers | Marks | Examiner’s tips
--- | --- | ---
1 conc HNO₃  
conc H₂SO₄  
HNO₃ + 2H₂SO₄ → NO₃⁻ + H₂O⁺ + 2HSO₄⁻  
or HNO₃ + H₂SO₄ → NO₂⁺ + H₂O + HSO₄⁻  
or HNO₃ + H⁺ → NO₂⁺ + H₂O  | 2 | If both ‘conc’ missing you can score one for both acids.  
This can also be done in two equations.  
Benzene can also be written as C₆H₆ and nitrobenzene as C₆H₅NO₂.

Electrophilic substitution

2 CH₃COCl + AlCl₃ → CH₃⁺CO + AlCl₄⁻  | 2 | One mark is for the correct reactive species and 1 for the equation.  
This cannot be F/C acylation.

Electrophilic substitution

3 CH₃COCl + AlCl₃ → CH₃⁺CO + AlCl₄⁻  | 2 | There is no mark for the acylium ion here. The mark is for the aluminium chloride and the second mark is for the balanced equation.  
You could have FeCl₃.  
The position of + on electrophile can be on O or C.  
The M1 arrow from within hexagon to C or to + on C.  
The + must be on C of RCO.

Electrophilic substitution
4  a) \( \text{CH}_3\text{CO}^- \)

b) 

\[
\begin{align*}
\text{CH}_3\text{C} & \longrightarrow \text{H} \\
\text{O} & \quad \text{COCH}_3
\end{align*}
\]

Horseshoe must not extend beyond C2 to C6.
The + must be on the C of RC'O.

5  \([\text{CH}_3\text{CH}_2\text{CO}]^+\)

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{COCl} + \text{AlCl}_3 & \rightarrow \\
[\text{CH}_3\text{CH}_2\text{CO}]^+ + \text{AlCl}_4^- 
\end{align*}
\]

You can gain the electrophile mark from the equation if not stated separately. Therefore the correct balanced equation is worth 2 marks.

In the equation, the position of the + can be on O or C or outside square brackets, however you do not need to show the square brackets.

The arrow for M1 must be to C or to the + on C.
The horseshoe should extend from C2 to C6 only.

6  Cyclohexane evolves 120 kJ mol\(^{-1}\)
Therefore expect triene to evolve 360 kJ mol\(^{-1}\);
or 3 \times 120 = 360 \text{ kJ mol}^{-1}
360 - 208 = 152 \text{ kJ};
Benzene lower in energy / more stable; due to delocalisation;

Cannot estimate 150 kJ, you must use the values in the question. Therefore 152 kJ can score first 2 marks in this part.
Any mention of ‘bond breaking needing energy’ will not score marks.