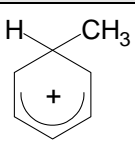
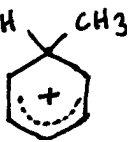
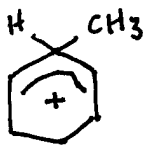


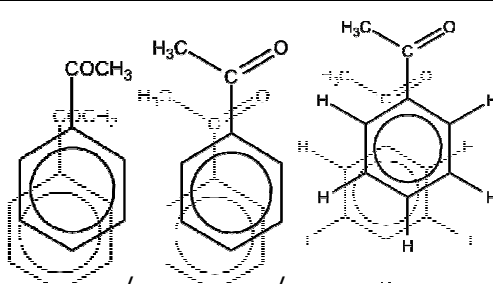
| Question Number | Acceptable Answers | Reject | Mark |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------|----------|
| 1 (a)(i) | CH ₃ Cl / CH ₃ Br / CH ₃ I Ignore name and state symbols Allow displayed formula | Name alone | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------|
| 1 (a)(ii) | CH ₃ Cl + AlCl ₃ → CH ₃ ⁺ + AlCl ₄ ⁻ Allow CH ₃ ^{δ+} AlCl ₄ ^{δ-} and other halogens Ignore state symbols and curly arrows | CH ₃ ^{δ+} -AlCl ₃ ^{δ-} + Cl ⁻ | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1 (a)(iii) |  <p>Ignore curly arrows and use of wedges/dashes</p> <p>Ignore attempts to complete mechanism if intermediate is correct</p> <p>Must show reasonable delocalisation over at least 3 carbon atoms</p> <p>Allow positive charge anywhere inside benzene ring</p> <p>Allow delocalization shown as dashed line e.g.</p>  <p>Allow correct Kekulé structure</p> | <p>Complete circle of delocalization</p> <p>'Upside down' delocalization e.g.</p>  | 1 |

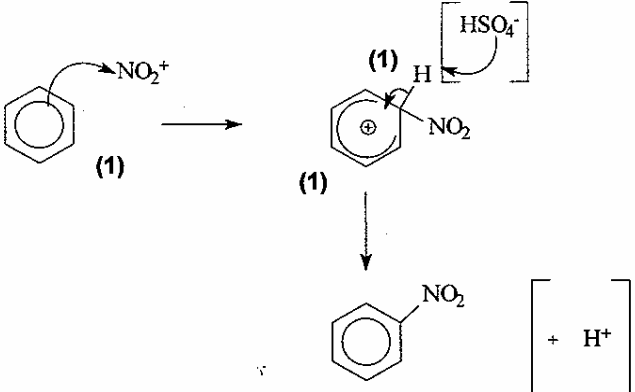
| Question Number | Acceptable Answers | Reject | Mark |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------|
| 1 (b)(i) | (Methyl group) donates/increases electron density to the ring/feeds electrons into ring Allow the methyl group is electron releasing | Donates lone pair of electrons Ring becomes more electronegative Just 'inductive effect' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|
| 1 (b)(ii) | (Methylbenzene) is more susceptible to electrophilic attack/attack by positive species/makes it a stronger nucleophile Ignore comments about ring stability Allow methyl group stabilizes carbocation | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|
| 1 (c)(i) |  <chem>C6H5COCH3</chem> / Allow displayed or skeletal formulae or Kekulé | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1 (c)(ii) | Any 2 from 4 Lower energy input (to heat reaction)/less heat losses/more efficient heating (1) Electrical energy can be obtained from renewable resources whereas gas is non renewable (1) Easier separation of catalyst/(easier to) re-use catalyst (1) Involves less chlorine/chlorine compounds (1) Ignore any comments regarding carbon dioxide level/global warming | Faster reaction because using a catalyst Just 'uses less fuel' Just uses less toxic/harmful chemicals | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|----------|
| 1 (d) | Fuming sulfuric acid / oleum / sulfur trioxide (dissolved) in concentrated sulfuric acid Allow fuming <chem>H2SO4</chem> / <chem>H2S2O7</chem> / <chem>SO3</chem> (dissolved) in concentrated <chem>H2SO4</chem> | Just sulfuric acid or sulfur trioxide | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|
| 2(a)(i) | <p> $H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$ OR $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$ </p> <p>Both needed</p> <p> $H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$ OR $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$ </p> <p style="text-align: right;">(1)</p> <p>Ignore state symbols even if wrong</p>  <p> arrow showing attack on the nitronium ion with arrow going to N atom, or into the C - N gap (1) </p> <p> Arrow must start at or inside ring </p> <p> Ignore position of + charge </p> <p> structure of the intermediate showing reasonable delocalisation (over at least 3 carbon atoms) (1) </p> <p> arrow from the bond showing the loss of H⁺ from the intermediate. Removal by hydrogen sulphate ion preferable but not essential (1) </p> <p> Kekulé structures score full marks </p> <p> If the electrophile is incorrect then the intermediate structure mark is lost </p> | | 4 |

Delocalisation mustn't go over C where NO₂⁺ is attached

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------|
| 2(a)(ii) QWC | <p>First mark: (lone pair of) electrons on the oxygen atom or on the OH group is delocalised / incorporated into the ring (1)</p> <p>OR</p> <p>the OH group is electron donating (1)</p> <p>Second mark: so the ring in phenol is more negative / has increased electron density / ring is more nucleophilic / hence more susceptible to electrophilic attack (1)</p> <p>OR</p> <p>the OH group activates the ring (1)</p> <p>Second mark stand alone</p> | <p>Reject hydroxide for first mark only</p> <p>Nucleophilic attack on the ring</p> <p>'Makes it more reactive' on its own</p> | 2 |

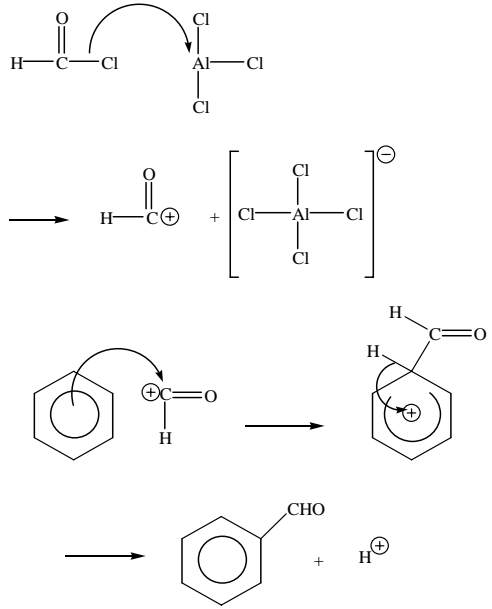
| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------|
| 2(a)(iii) | <p>tin (1) and concentrated hydrochloric acid (1)</p> <p>Formulae acceptable.</p> <p>If NaOH is added after HCl then ignore; if implication that HCl and NaOH are added together then second mark is lost</p> <p>OR</p> <p>iron (1) and concentrated hydrochloric acid (1) 2nd mark conditional on a metal</p> <p>OR</p> <p>hydrogen (1) and platinum / palladium catalyst (1)</p> | <p>lithium aluminium hydride sodium borohydride</p> <p>Nickel Raney Nickel</p> | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|
| 2(a)(iv) | <p>ethanoyl chloride OR acetyl chloride OR CH_3COCl OR equivalent displayed formula</p> <p>OR</p> <p>ethanoic anhydride OR acetic anhydride OR $(\text{CH}_3\text{CO})_2\text{O}$ OR equivalent displayed formula</p> <p>Right name but wrong formula does not score</p> <p>Ignore minor spelling errors if the formula is correct</p> | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(b) QWC | <p>First mark: steam is passed into the mixture</p> <p>OR</p> <p>water is added and mixture boiled or distilled or heated (1)</p> <p>Second mark: and the 2-nitrophenol / product vapour distilled off with the water (and condensed) (1)</p> <p>Advantage: The 2-nitrophenol / product distils at a lower temperature / prevents decomposition(1) Stand alone</p> | <p>Passed over; anything that implies external heating with a steam bath or water bath</p> <p>any implication of fractional distillation</p> <p>any suggestion that separation based on differing boiling temperature</p> <p>water-soluble</p> | 3 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|
| 2(c) | <p>Read the whole answer to get the sense</p> <p>The (ring) hydrogen atoms are on carbon atoms which have one / a hydrogen on an adjacent carbon atom, so are doublets (1)</p> <p>All the other hydrogen atoms have no adjacent hydrogen (bearing carbon) atoms, so are singlets (1)</p> | <p>nearby</p> | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|
| 3(a)(i) | <p>The delocalization of the (π) electrons of the ring make benzene more stable (than 1,3,5-cyclohexatriene) (1)</p> <p>IGNORE bonding in benzene is strong Substitution retains this (stable) arrangement OR Addition removes this (stable) arrangement (1)</p> | | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|
| 3(a)(ii) |  <p>Formation of electrophile (curly arrow, structural formulae not required). Positive charge may be anywhere on the electrophile ALLOW HCl + CO for HCOCl ALLOW Non-displayed electrophile (1)</p> <p>Curly arrow from benzene ring to electrophile (1)</p> <p>Wheland structure with gap opposite tetrahedral carbon (1)</p> <p>Curly arrow from C—H bond into ring and formation of correct organic product OR Kekulé structures (1)</p> <p>IGNORE Use of AlCl₄⁻ to pick off proton Proton product</p> <p>First curly arrow may come from any part of the delocalisation circle Second curly arrow may come from any part of the C—H bond Positive charge on the Wheland structure may be in any part of the horseshoe</p> | - <chem>COH</chem> / - <chem>HCO</chem> Positive charge on the tetrahedral carbon | 4 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|----------|
| 3(a)(iii) | <p>In each step the second mark is dependent on the first</p> <p>Step 2 Potassium dichromate((VI)) / $K_2Cr_2O_7$ / sodium dichromate((VI)) / $Na_2Cr_2O_7$ ALLOW Potassium manganate ((VII)) / $KMnO_4$ Sodium manganate ((VII)) / $NaMnO_4$ (1)</p> <p>Stand alone mark</p> <p>Sulfuric acid / H_2SO_4 (ALLOW nitric acid) (1) Ignore 'concentrated'</p> <p>ALLOW Acidified potassium (/ sodium) dichromate((VI)) OR Acid and potassium (/ sodium) dichromate((VI)) (2)</p> <p>$Cr_2O_7^{2-}$ and H^+ OR acidified dichromate((VI)) (1)</p> <p>Step 3 Lithium tetrahydridoaluminate((III)) / $LiAlH_4$ OR Lithium aluminium hydride (1)</p> <p>Stand alone mark</p> <p>(Dry) ether / ethoxyethane / (di)ethyl ether (1)</p> <p>Sodium borohydride / $NaBH_4$ in ethanol, alkali or water scores 1/2 (1)</p> | <p>Incorrect oxidation number</p> <p>Hydrochloric acid</p> <p>Hydrogen and catalyst / Tin and HCl</p> | 4 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|
| 3(b) | <p>Marking Point 1 Electron density of the ring increased (1)</p> <p>Stand alone mark</p> <p>Marking Point 2 Due to donation of oxygen / OH group lone pair to the ring (1)</p> <p>Marking Point 3 and 4 Any two from</p> <p>in phenol oxygen / OH group attached directly to ring</p> <p>Oxygen / OH group in phenylmethanol too far away / not attached directly to ring</p> <p>(In phenol) lone pair overlaps with the π electrons / delocalised electrons (of the ring) ALLOW p orbital for lone pair for this mark (2)</p> | | 4 |