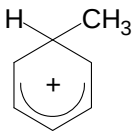
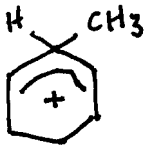
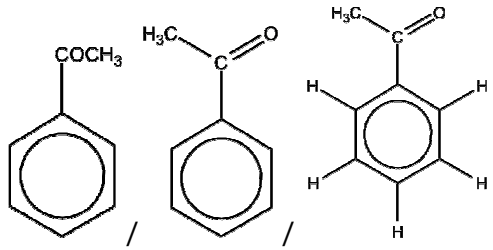
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1 (a)(i)** | $CH_3Cl$ / $CH_3Br$ / $CH_3I$<br>Ignore name and state symbols<br><br>Allow displayed formula | Name alone | **1** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1 (a)(ii)** | $CH_3Cl + AlCl_3 \rightarrow CH_3^+ + AlCl_4^-$<br>Allow $CH_3^{\delta+}\ AlCl_4^{\delta-}$ and other halogens<br><br>Ignore state symbols and curly arrows | $CH_3^{\delta+}$-$AlCl_3^{\delta-}$ + $Cl^-$ | **1** |

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

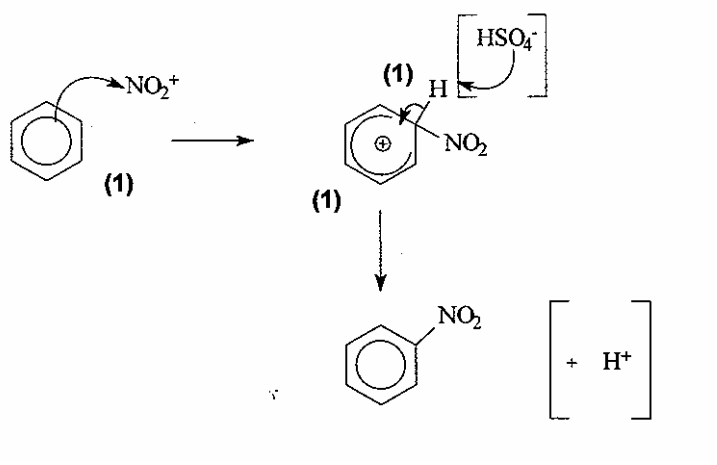
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1 (b)(i)** | (Methyl group) donates/increases electron density to the ring/feeds electrons into ring<br><br>Allow the methyl group is electron releasing | Donates **lone** pair of electrons<br>Ring becomes more electronegative<br>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<br><br>Ignore comments about ring stability<br><br>Allow methyl group stabilizes carbocation | | **1** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1 (c)(i)** |  <br><br>$C_6H_5COCH_3$ / / / <br>Allow displayed or skeletal formulae or Kekulé | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1 (c)(ii)** | **Any 2 from 4**<br>Lower energy input (to heat reaction)/less heat losses/more efficient heating **(1)**<br><br>Electrical energy can be obtained from renewable resources whereas gas is non renewable **(1)**<br><br>Easier separation of catalyst/(easier to) re-use catalyst **(1)**<br><br>Involves less chlorine/chlorine compounds **(1)**<br><br>Ignore any comments regarding carbon dioxide level/global warming | Faster reaction because using a catalyst<br>Just 'uses less fuel'<br><br>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<br><br>Allow fuming $H_2SO_4$ /$H_2S_2O_7$ / $SO_3$ (dissolved) in concentrated $H_2SO_4$ | Just sulfuric acid or sulfur trioxide | **1** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **2(a)(i)** | $H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$<br>OR<br>$H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$<br>$H_2NO_3^+ \rightarrow NO_2^+ + H_2O$<br><br>Both needed<br><br>OR<br><br>$2H_2SO_4 + HNO_3 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$<br>**(1)**<br><br>Ignore state symbols even if wrong<br><br>  <br><br><br>arrow showing attack on the nitronium ion with arrow going to N atom, or into the C – N gap **(1)**<br><br>Arrow must start at or inside ring<br><br>Ignore position of + charge<br><br>structure of the intermediate showing reasonable delocalisation (over at least 3 carbon atoms) **(1)**<br><br>arrow **from the bond** showing the loss of $H^+$ from the intermediate. Removal by hydrogen sulphate ion preferable but not essential **(1)**<br><br>Kekulé structures score full marks<br><br>If the electrophile is incorrect then the intermediate structure mark is lost | Delocalisation mustn't go over C where $NO_2^+$ is attached | **4** |

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

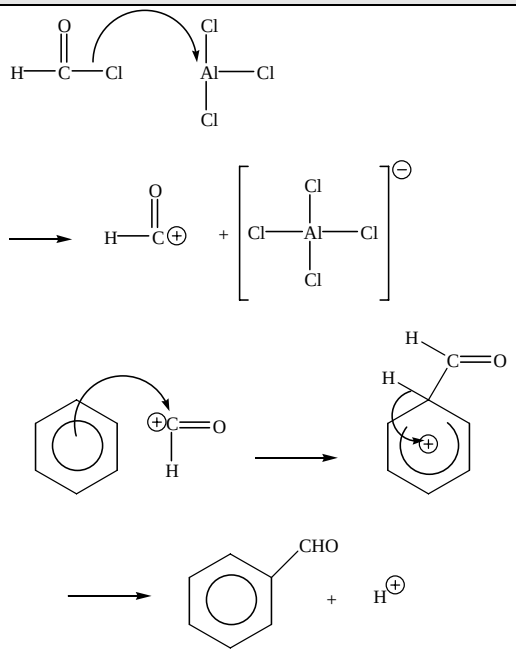
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **2(a)(iii)** | tin **(1)** and **concentrated** hydrochloric acid **(1)**<br><br>Formulae acceptable.<br><br>If NaOH is added after HCl then ignore;<br>if implication that HCI and NaOH are added together then second mark is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

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **2(a)(iv)** | ethanoyl chloride OR acetyl chloride OR $CH_3COCl$ OR equivalent displayed formula<br><br>OR<br><br>ethanoic anhydride OR acetic anhydride OR $(CH_3CO)_2O$ OR equivalent displayed formula<br><br>Right name but wrong formula does not score<br><br>Ignore minor spelling errors if the formula is correct | | **1** |

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

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

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

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **3(a)(ii)** |  <br>Formation of electrophile (curly arrow, structural formulae not required). Positive charge may be anywhere on the electrophile<br>ALLOW HCl + CO for HCOCl<br>ALLOW Non-displayed electrophile **(1)**<br><br>Curly arrow from benzene ring to electrophile **(1)**<br><br>Wheland structure with gap opposite tetrahedral carbon **(1)**<br><br>Curly arrow from C—H bond into ring and formation of **correct** organic product<br>OR<br>Kekulé structures **(1)**<br><br>IGNORE<br>Use of $AlCl_4^-$ to pick off proton<br>Proton product<br><br>First curly arrow may come from any part of the delocalisation circle<br>Second curly arrow may come from any part of the C–H bond<br>Positive charge on the Wheland structure may be in any part of the horseshoe | -COH /-HCO<br><br>Positive charge on the tetrahedral carbon | **4** |

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

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