
RECOGNISING ACHIEVEMENT

# Mark Scheme 2854
# January 2005

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| **Abbreviations, annotations and conventions used in the Mark Scheme** | / = alternative and acceptable answers for the same marking point<br>; = separates marking points<br>NOT = answers which are not worthy of credit<br>( ) = words which are not essential to gain credit<br>____ = (underlining) key words which **must** be used to gain credit<br>ecf = error carried forward<br>AW = alternative wording<br>ora = or reverse argument |

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|---|---|---|
| 1 a i | carbon (1); hydrogen (1) | 2 |
| 1 a ii | $CH_2OOCR$<br>\|<br>$CHOOCR$<br>\|<br>$CH_2OOCR$<br><br>three OH groups reacted (1)<br><br>ester groups correct (1) | 2 |
| 1 a iii | permanent dipole-permanent dipole (2); "dipole"/single "permanent dipole scores (1) | 2 |
| 1 a iv | conc. sulphuric acid (1); heat/reflux (if first mark awarded) (1) (sulphuric acid + reflux scores 1) | 2 |
| 1 b i | unsaturated/C=C double bonds | 1 |
| 1 b ii | oxidative AW(1); cross-linking (1) | 2 |
| 1 c i | *4 from*<br>hydrogen bond formed between H and O ;<br>$\partial+$ on H and, $\partial-$ on O/attract;<br>linear O – H – O link;<br>$\partial-$ on O due to high electronegativity / difference in electronegativity between O and H;<br>H-bond formed through lone pair on O;<br>polarity of O-H bond in water or glycerol | 4 |
| 1 c ii | (water-soluble) many/strong (1); hydrogen bonds formed with water (1)<br>(high boiling) hydrogen bond between molecules (1); lot of energy needed to separate molecules / overcome / break H-bonds(1) | 4 |
| 1 d i | propene | 1 |
| 1 d ii | crude oil / natural gas | 1 |
| 1 d iii | substitution | 1 |

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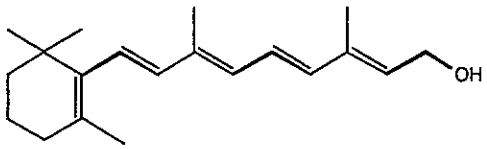
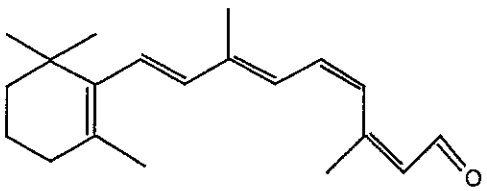
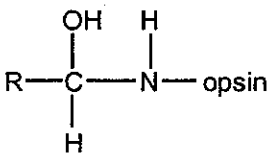
|---|---|---|
| 1 d iv | NaOH | 1 |
| 1 d v | $CH_2OH$ $CHCl$ $CH_2OH$ or $CH_2OH$ $CHOH$ $CH_2Cl$<br><br>one Cl or OH on adjacent carbon atoms(1)<br><br>OH group on remaining carbon atom (if first mark given) (1) | 2 |
| 1 d vi | Mr glycerol = 92 and Mr propene = 42 (1)<br>amount glycerol = 2/92 (= 0.0217 mol) and amount propene = 30/42 (= 0.714 mol) (stated or implied) / $\frac{42}{92} \times \frac{2}{30}$ (1) (allow ecf)<br>% = 0.0217 x 100/0.714 = 3% / = 0.03 x 100 = 3% (1) (allow ecf) | 3 |

| Question | Expected Answers | Marks |
|---|---|---|
| 2 a i | $C_{20}H_{28}O$ (1) for C and O; (1) for H | 2 |
| 2 a ii |  <br>–OH (1)<br>correct arrangement of bonds (1) | 2 |
| 2 a iii | alkene | 1 |
| 2 b i | acidified/named acid/$H^+$ (1); (potassium/sodium) dichromate/$Cr_2O_7^{2-}$ (1); distil (1) (if dichromate mark given) | 3 |
| 2 b ii | 5 | 1 |
| 2 c |  <br>idea of cis (1);<br>correct arrangement of bonds (1) | 2 |
| 2 d i | amine | 1 |
| 2 d ii | nucleophilic (1); addition (1) | 2 |
| 2 d iii |  | 1 |
| 2 e | *two from*<br>protein has shape/tertiary structure (1); cis molecule fits into / has complementary shape to protein/cleft/*allow* active site (1); trans is different shape/does not fit (1) | 2 |

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| 2 f | molecule has conjugated system/alternate double bonds;<br>*and 4 from:*<br>these allow delocalisation;<br>energy level above ground state is closer;<br>electron absorbs energy when moves up / electron moves to a higher energy level / electron becomes excited;<br>(Δ)E = hν;<br>(Δ)E / energy difference (*allow frequency*) corresponds to absorption is in the visible region;<br><br>(Maximum of 2 marks if emission is discussed or described)<br><br>QWC *2 sentences, correct grammar, punctuation, spelling (1 error allowed)* | 5<br><br>1 |

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| 3 a | $Li_2O$; BeO (1) for element; (1) for formula if element correct | 2 |
| 3 b i | $K_a = [H^+]\,[HCO_3^-]/[CO_2]$ (1) for top or bottom correct or wrong way up; [2] completely correct<br><br>Units mol $dm^{-3}$ (1) | 3 |
| 3 b ii | $[H^+] = \sqrt{K \times [CO_2]}$ (1) ; $= 2.32 \times 10^{-6}$ (mol $dm^{-3}$) (1); pH = 5.6 (1) | 3 |
| 3ci | $5H_2O$ (1); (l) (1) | 2 |
| 3 cii | $[H^+] = 10^{-6}$ (1); $K_c = (9 \times 10^{11})^2/(10^{-6})^2$ (*allow* $10^{-20}/10^{-36}$) (1); = $8.1 \times 10^{15}$ (*allow* $1 \times 10^{16}$ *if* $10^{-20}/10^{-36}$ *awarded previous mark*) (1) | 3 |
| 3 c iii | $[Al^{3+}] = \sqrt{K \times [H^+]^6}$ (1); $= \sqrt{1 \times 10^{-8}}$ (1); $= 1 \times 10^{-4}$ (1) | 3 |
| 3 d i | electrons in *outer shell* (1); lost (1); to give *full shell/stable configuration* (1)<br><br>same number/*arrangement of electrons* (1)<br><br>more *protons* Na to Al(1); attract electrons more/ pull in more tightly (1)<br><br>*QWC [2] 3 sentences, logical two italicised phrases.*<br>*(1) 2 sentences, logical one italicised phrase* | 6<br><br>2 |
| 3 d ii | *2 from*<br>highest charge (1); smallest radius / ion (1) *"highest charge density" scores both marks* *(high charge, small ion scores 1)*<br><br>attracts more water molecules (1) | 2 |

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| 4 a | $2NO + O_2 \rightarrow 2NO_2$ | 1 |
| 4 b | car engines/ lightning/power stations | 1 |
| 4 c | +2 +2 +4 (1) each. *Max 2 if plus signs after numbers* | 3 |
| 4 di | amount $NO_2$ = 1(000)/46(= 0.00217); mass $HNO_3$ = 0.0217 x 63 = 1.4 kg<br><br>or $\frac{63}{46}$ x 1(000) = 1.4 kg<br><br>Mr correct (1); calculation (1);<br>2 sig figs *mark separately if some working shown*(1) | 3 |
| 4 d ii | Advantage: fertilizer / increases nitrogen content (1).<br>Disadvantage: consequence of being acid (1) | 2 |
| 4 e | ionic (1);<br>*plus two from:*<br>solid (at room temperature) (1); crystalline (1)<br>white (1);<br>soluble in water (1)<br>solution conducts/solid does not conduct (1) | 3 |
| 4 f i | (negative) fewer molecules on right | 1 |
| 4 f ii | $\Delta S_{surr}$ positive (1); less positive / smaller at high temps (1); $\Delta S_{tot}$ less positive at high temps (1) | 3 |
| 4 g i | larger | 1 |
| 4 g ii | Rate larger (1);<br>but $[N_2O_2]$ lower at higher T (1);<br>second effect outweighs first (1) | 3 |
| | | 21 |

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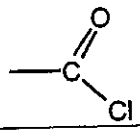
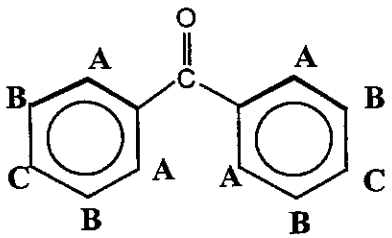
|---|---|---|
| 5 a i | benzene | 1 |
| 5 a ii |  | 1 |
| 5 b | absorb (1); <u>uv</u> light/<u>uv</u> radiation (1) | 2 |
| 5 c | Friedel (1); Crafts (1) | 2 |
| 5 d | *3 from:*<br>(further) polarises (*accept breaks*) C–Cl bond;<br>to create <u>electrophile</u>;<br>and $AlCl_4^-$;<br>electrophile / $C_6H_5CO^+$ attacks benzene, liberating a <u>proton / $H^+$</u> | 3 |
| 5 e i | $AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$ / $2AlCl_3 + 3H_2O \rightarrow Al_2O_3 + 6HCl$<br>(1) for LHS; (1) for RHS; (1) for correct balancing *provided one other mark scored* | 3 |
| 5 e ii | *two marks for any correct pair (mark for pollutant can be scored alone but NOT effect)*<br><br>aluminium; forms toxic waste;<br>HCl; toxic / acid<br>aluminium; wasted<br>benzene; toxic / carcinogenic | 4 |
| 5 f i | 2 pairs from: 1450-1650 ($cm^{-1}$) (1); C-C bonds in arenes (1);, 1720–1725 ($cm^{-1}$) (1); C=O (1); , 3000 – 3100 ($cm^{-1}$) (1); C–H (1); | 4 |
| 5 f ii |  <br>all ten protons labelled in some way (1);<br>correct letters (**A,B,C**) in any order (1)<br><br>*correct letters on one ring only scores (1)* | 2 |
| | | 22 |
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