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| **1.** | (a) | C3H6 + Br2 🡪 C3H6Br2 (M1), electrophilic addition (M2) |
|  | (b) | Dipole on Br-Br, curly arrow from C=C to Brδ+, curly arrow from Br-Br to Br, CH3CHBrCH2+ or CH3CH+CH2Br, Br-, curly arrow from lone pair on Br- to C+, CH3CHBrCH2Br formed (any 6 = 3, any 4 = 2, any 2 = 1) (M3, M4, M5)  [5] |
| **2.** | (a) | C3H7Cl + 2NH3 🡪 C3H7NH2 + NH4Cl or C3H7Cl + NH3 🡪 C3H7NH2 + HCl (M1), nucleophilic substitution or SN2 (M2) |
|  | (b) | Dipole on C-Cl(δ+, δ-), curly arrow from lone pair on N in NH3 to C in C-Cl, curly arrow simultaneously from C-Cl to Cl, Cl- formed, CH3CH2CH2NH3+ with + on N, curly arrow from N-H to N+, H+ or NH4+ or HCl formed, CH3CH2CH2NH2 formed (any 6 = 3, any 4 = 2, any 2 = 1) (M3, M4, M5) |
|  | (c) | NH3 involved in rate determining step or collision frequency increases (M6)  [max 5] |
| **3.** | (a) | C4H9Br + OH- 🡪 C4H10O + Br- (M1), nucleophilic substitution or SN1 (M2) |
|  | (b) | Dipole on C-Br(δ+, δ-), curly arrow from C-Br to Br, Br- formed, (CH3)3C+ formed, curly arrow from lone pair on O in OH- to C+, (CH3)3COH formed (any 5 = 2, any 3 = 1) (M3, M4) |
|  | (c) | OH- not in rate determining step or OH- step is fast (M5)  [5] |
| **4.** | (a) | C3H7Cl + OH- 🡪 C3H6 + H2O + Br- (M1), elimination (M2) |
|  | (b) | Curly arrow from lone pair on O in OH- to H attached to C adjacent to C-Cl, simultaneous curly arrow from same C-H to C=C adjacent to C-Cl on same side, dipole on C-Cl(δ+, δ-), simultaneous curly arrow from C-Cl to Cl, Cl- formed, H2O formed, CH3CH=CH2 formed (any 5 = 2, any 3 = 1) (M3, M4) |
|  | (c) | Base  [5] |
| **5.** | (a) | C4H10O 🡪 C4H8 + H2O (allow any type of formulae provided correct and balanced) |
|  | (b) | Curly arrow from lone pair on O on O-H to H+, C2H5CH(OH2+)CH3, dipole on C-O) (δ+, δ-), curly arrow from C-H to C=C, simultaneous curly arrow from C-O to O, correct structure of butan-1-ol or butan-2-ol consistent with mechanism, H2O (any 6 = 3, any 4 = 2, any 2 = 1) (M2, M3, M4) |
|  | (c) | If but-1-ene formed in (b) then correct structures of cis but-2-ene (M5) and trans but-1-ene (M6)  If cis but-2-ene formed in (b) then correct structures of but-1-ene (M5) and trans but-2-ene (M6)  If trans but-1-ene formed in (b) then correct structures of but-1-ene (M5) and cis but-2-ene (M6)  [5] |
| **6.** | (a) | It would increase (M1) because C-Br is weaker than C-Cl (ORA) (M2) |
|  | (b) | Ethanol as solvent (M3), Distillation (M4), Higher temperature (M5)  [5] |
| **7.** | (a) | C3H8 + Cl2 🡪 CH3CHClCH3 + HCl (M1) radical substitution (M2) |
|  | (b) | Cl2 🡪 2Cl (M3), Cl + C3H8 🡪 CH3CHCH3 + HCl (M4), CH3CHCH3 + Cl2 🡪 CH3CHClCH3 + Cl (M5), UV light (M6) |
|  | (c) | CH3CH2CH2, then CH3CH2CH2Cl, then CH3CH2CHCl, further propagation or suitable equation  (any 3 = 2, any 2 = 1) (M7, M8) |
|  | (d) | CH3CH2CH2 (M9) 2CH3CH2CH2 🡪 CH3CH2CH2CH2CH2CH3 or termination of two propyl radicals (M10)  [10] |