

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 reasoning. Completed drawings are original answers; only the reactive lone pairs need be shown.

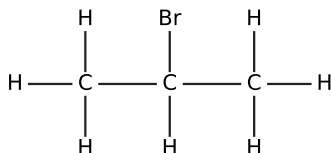
2.1 In order: addition; elimination; substitution; oxidation; reduction; hydrolysis (also substitution); polymerisation. B1 per two correctly classified conversions, up to three marks for the first six; B1 for polymerisation and recognising hydrolysis as substitution. In hydrolysis, water replaces the halogen and supplies the OH group; the categories can overlap.

2.2 Primary, secondary, tertiary respectively; tertiary > secondary > primary under these conditions. Comparative rate ratio = $(1/5.0)/(1/180) = 36$. Precipitate visibility depends on mixing/detection threshold; 1/t assumes the same extent is reached and is not a complete rate law. All three have formula C_4H_9Br and release the same halide.

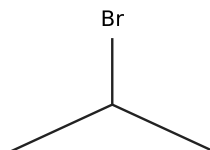
2.3

2-Bromopropane: $CH_3CHBrCH_3$

Displayed formula

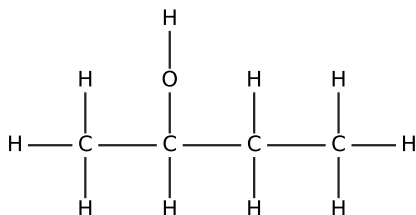


Skeletal formula

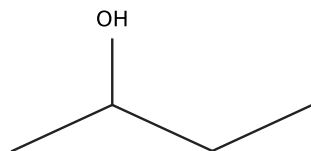


Butan-2-ol: $CH_3CH(OH)CH_2CH_3$

Displayed formula



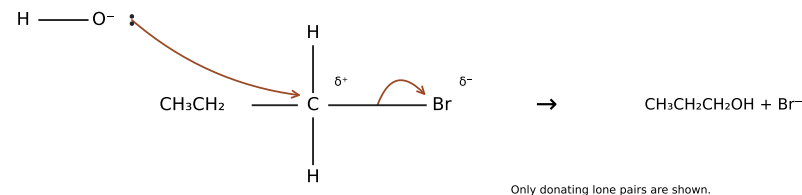
Skeletal formula



B1 for each correct name, displayed formula and skeletal formula (six marks). The middle carbon has one H and one Br in 2-bromopropane; the OH-bearing carbon has one H in butan-2-ol. An omitted O–H hydrogen makes the displayed alcohol incomplete.

3.1

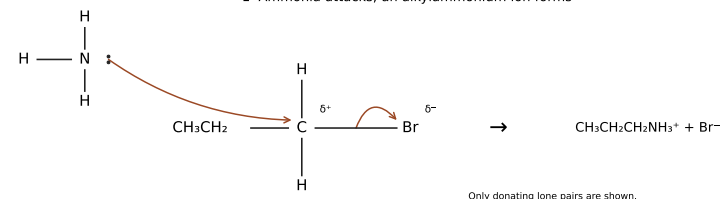
Hydroxide substitutes for bromide



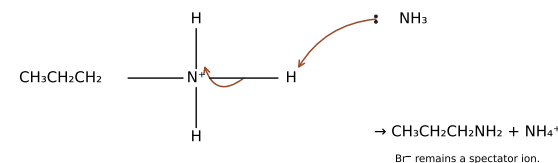
B1 for the O lone-pair arrow to the carbon bearing Br; B1 for the C–Br bond-pair arrow to Br; B1 for correct $C\delta^+/Br\delta^-$ and neutral alcohol plus Br^- ; B1 for propan-1-ol. Total charge is -1 on each side.

3.2

1. Ammonia attacks; an alkylammonium ion forms



2. A second ammonia removes a proton



B1 for NH_3 lone-pair attack on carbon; B1 for C–Br pair to Br; B1 for $CH_3CH_2CH_2NH_3^+$ and Br^- ; B1 for the second NH_3 lone-pair arrow to an N-bound H; B1 for the N–H pair returning to N and propan-1-amine plus NH_4^+ . The amine's nitrogen retains a lone pair and can attack another halogenoalkane, causing further substitution. Excess ammonia favours the primary amine; it does not make further substitution impossible.

3.3 Primary, secondary, tertiary respectively. The OH-bearing carbon is attached to one carbon in the first and three carbons in the last; total carbon count is irrelevant.