

SN1 / SN2 / E1 / E2 Reaction Pathways — ANSWER KEY

Mechanism selection • Substrate, reagent, solvent, temperature, major product and reasoning

Instructor key: responses in red. Alternative correctly justified predictions may earn credit where competition is plausible.

1. SN2 — Acetonitrile (CH_3CN)

Cyanide displaces iodide by backside attack in a concerted substitution. A methyl halide strongly favors SN2 under these conditions. NOTE: When CN^- reacts through carbon, it adds one carbon to the carbon skeleton.

2. SN2 — 1-Azidobutane

The primary substrate is accessible to backside attack; azide substitutes bromide in one step. NOTE: Azide-containing substances may pose significant laboratory hazards. This is a conceptual exercise, not an experimental procedure.

3. SN2 — Butan-2-thiol, with inversion at the reacting stereocenter

Hydrosulfide can attack by SN2; inversion occurs at the carbon bearing bromine. Avoid automatically claiming the product has an S descriptor: CIP priorities must be reassigned. NOTE: Some competing elimination is possible in real systems; the expected major pathway in this teaching example is substitution.

4. SN2 — 1-Iodobutane

Iodide is a strong nucleophile and weak base. SN2 substitution is favored; NaCl precipitation in acetone can help drive the exchange. NOTE: Practical conversion depends on solubility, concentration, and time.

5. E2 — Main alkene: trans-2-butene; cis-2-butene and 1-butene can also form

Ethoxide abstracts a beta hydrogen as bromide leaves in one step. The more substituted 2-butene usually dominates, with the trans isomer favored among 2-butene products. NOTE: SN2 can still compete, and product ratios are not universal.

6. E2 — 2-Methylpropene

A strong base removes a beta proton at the same time the C-Br bond breaks. Tertiary alkyl halides cannot undergo ordinary SN2. NOTE: Ionization pathways may also occur in protic media, but the intended dominant pathway with strong base and heat is E2.

7. E2 — 2-Methylpropene

Bulky tert-butoxide disfavors backside substitution relative to beta-hydrogen abstraction, especially on heating; elimination gives 2-methylpropene. NOTE: A primary substrate can still undergo SN2 under some conditions; E2 is the expected dominant trend for this selected example.

8. E2 — Cyclohexene

A chair conformer with axial bromine can present an axial beta hydrogen anti to the leaving group. Concerted E2 forms cyclohexene. NOTE: Ring flip may be needed to access the reactive chair conformation.

9. E1 — 2-Methyl-2-butene (major); 2-methyl-1-butene (minor)

Acid catalysis converts OH into a better leaving group. Water leaves, giving a tertiary carbocation; deprotonation forms the alkenes. The more substituted alkene is generally favored. NOTE: This is acid-catalyzed alcohol dehydration, not direct displacement of OH[−].

10. E1 — 1-Methylcyclohexene favored; methylenecyclohexane can also form

Protonation and loss of water generate a tertiary carbocation; beta-deprotonation forms alkenes. The endocyclic, more substituted alkene is generally favored. NOTE: Actual ratios depend on reaction conditions.

11. E1 — 2-Methylpropene

After protonation, water leaves; a tert-butyl carbocation loses a beta proton to form 2-methylpropene. NOTE: A carbocation intermediate is possible because the starting alcohol is tertiary.

12. SN1 + E1 — tert-Butanol (typically the main substitution product) and some 2-methylpropene

The tertiary chloride can ionize to a carbocation. Water attacks to give substitution, or water removes a beta proton for E1 elimination. NOTE: At room temperature substitution is commonly emphasized, but this is not an exclusive SN1 outcome and product fractions vary.

13. SN1 + E1 — 2-Ethoxy-2-methylbutane (substitution) plus 2-methyl-2-butene and 2-methyl-1-butene (elimination)

A tertiary carbocation is accessible. Ethanol can attack the carbocation (SN1), or remove a beta proton (E1). Heating generally increases elimination relative to substitution. NOTE: Do not assert a fixed major reaction class or exact product ratio without quantitative reaction conditions.

14. SN1 — 1-Methoxyethylbenzene (substitution; a mixture of stereoisomers is expected from a chiral starting material)

Benzylic stabilization supports leaving-group ionization; methanol can trap the planar carbocation to give a substitution product. At lower temperature, substitution is typically favored over elimination. NOTE: An E1 side reaction forming styrene remains possible; SN1 means the expected major pathway, not a perfectly exclusive reaction or necessarily a 50:50 enantiomeric mixture.

15. SN2 — 1-Methoxypropane (methyl propyl ether)

Methoxide attacks the primary carbon and displaces bromide. Although methoxide is also a strong base, substitution is commonly favored on unhindered primary substrates at lower temperatures. NOTE: E2 remains a possible side reaction, especially at higher temperatures.