Mechanism Drawing & Stereochemistry — ANSWER KEY

Ten multi-step questions • Instructor worked explanations

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

These answers describe the expected curved arrows and products in words. Students should supply correctly drawn structures and arrows. Use the supplemental mechanism diagrams and standard chemical drawing conventions when reviewing.

1. Iodomethane + NaCN in DMSO. Draw electron-pushing arrows for the substitution and name the organic product.

1. Expected answer

SN2. Show the carbon end of cyanide attacking the methyl carbon while the C–I bond electrons move to I. Product: acetonitrile, CH3CN. Carbon attack by cyanide increases the carbon count by one.

2. 1-Bromobutane + NaN3 in DMF. Draw the arrow-pushing pattern and identify the product.

2. Expected answer

SN2. A terminal azide nitrogen attacks C1 as the C–Br bond breaks to bromide. Product: 1-azidobutane. This is a conceptual classroom exercise, not a lab preparation.

3. (R)-2-Bromobutane + NaSH in DMSO. Draw the substitution product using wedge/dash stereochemistry. Explain how the stereocenter changes.

3. Expected answer

SN2 is expected to be important: butan-2-thiol with inversion of geometry at C2. Place the new S-containing group opposite the former leaving-group face. Reassign CIP priorities in the product before assigning its R/S label; do not simply flip letters by memorization.

4. 2-Bromo-2-methylpropane + NaOEt in ethanol, heated. Draw the major organic product and all three electron-flow arrows for the elementary elimination.

4. Expected answer

E2. Product: 2-methylpropene. Arrows: ethoxide oxygen lone pair to a beta H; Cβ–H bond to form Cα=Cβ; Cα–Br bond to Br. The concerted step forms ethanol and bromide as byproducts.

5. 2-Methyl-2-butanol + sulfuric acid, heated. Draw the steps that make the leaving group favorable and identify the major and minor alkenes.

5. Expected answer

E1 dehydration: protonate the alcohol oxygen; water leaves from the tertiary center; a base removes a beta H to form an alkene. 2-Methyl-2-butene is generally major, 2-methyl-1-butene minor. Do not draw OH− departing directly.

6. tert-Butyl chloride in water at room temperature. Name two mechanistic pathways and their principal organic products.

6. Expected answer

SN1 and E1 compete through a common tert-butyl carbocation. Water attack followed by deprotonation gives tert-butanol; beta deprotonation gives 2-methylpropene. Substitution commonly dominates in cool aqueous solvolysis, but exact ratios vary.

7. Bromocyclohexane + KOtBu in tert-butanol, heated. State the required chair geometry, whether a ring flip can help, and the product.

7. Expected answer

E2 gives cyclohexene. The reactive chair needs axial bromine and an anti-periplanar axial beta H (trans-diaxial). A ring flip may be needed, and preserves up/down stereochemistry.

8. 2-Bromobutane + NaOEt in ethanol, heated. Identify the typical major alkene stereoisomer and at least two competing alkene products.

8. Expected answer

E2: trans-2-butene is generally the predominant alkene isomer; cis-2-butene and 1-butene may also form. Some SN2 is possible. A strong base and heat favor elimination and Zaitsev alkene formation.

9. Neopentyl bromide, (CH3)3CCH2Br, with NaI in acetone at room temperature. Explain why substitution is unusually slow and why E2 is unavailable.

9. Expected answer

SN2 is unusually slow because branching adjacent to the primary reaction center severely hinders backside approach. E2 cannot occur because the beta carbon is quaternary and has no beta hydrogen. SN1 would require an unfavorable primary carbocation, so no rapid simple substitution/elimination is expected under ordinary room-temperature conditions.

10. 1-Methylcyclohexanol with phosphoric acid, heated. Explain the likely mechanism and draw the more-substituted alkene product.

10. Expected answer

E1 acid-catalyzed dehydration: protonation of OH, loss of water to a tertiary carbocation, and beta deprotonation. 1-Methylcyclohexene is generally favored; methylenecyclohexane is another possible elimination product.