Reaction Mechanism Practice

INSTRUCTOR ANSWER KEY — COMPLETE EXPLANATIONS

Directions: Answers are in red. Key includes a concise rationale for each item.

1. **1-Bromobutane is treated with NaI in acetone. Which pathway is favored?**

   A. SN1

   B. SN2

   C. E1

   D. E2

   Reasoning: A primary alkyl bromide reacts with iodide by backside attack in polar aprotic acetone: SN2.

2. **2-Bromobutane is heated with sodium ethoxide in ethanol. Which pathway is generally favored?**

   A. SN1

   B. SN2

   C. E1

   D. E2

   Reasoning: A secondary substrate with a strong base under heated conditions generally favors concerted E2; substitution may compete.

3. **2-Bromobutane with NaN3 in DMSO: which pathway is generally favored?**

   A. SN2

   B. SN1

   C. E1

   D. Radical substitution

   Reasoning: Azide is a strong nucleophile but a weak base; polar aprotic DMSO favors SN2 on a secondary substrate.

4. **tert-Butyl bromide with potassium tert-butoxide: which pathway is favored?**

   A. SN2

   B. E2

   C. Electrophilic addition

   D. SN1 only

   Reasoning: The tertiary carbon blocks SN2, while a strong bulky base promotes E2 elimination.

5. **Iodomethane and NaCN in DMSO: expected mechanism?**

   A. SN1

   B. E1

   C. SN2

   D. E2

Reasoning: Methyl substrates cannot form stable free carbocations and have no beta carbon; cyanide attacks by SN2.

6. Which elementary event occurs in a concerted E2 elimination?

A. Leaving group departs before base acts

B. Base removes beta H as leaving group leaves

C. Carbocation rearranges first

D. Nucleophile adds to alkene

Reasoning: E2 is a single concerted step with beta proton removal, C=C formation and leaving-group departure.

7. Which factor most strongly makes SN2 attack on neopentyl bromide unusually slow?

A. Resonance of C–Br bond

B. Beta branching creates steric hindrance

C. Carbocation stability

D. Aromaticity

Reasoning: Severe steric congestion near the reactive primary center retards backside attack.

8. An SN2 reaction follows which idealized rate law?

A. rate = k[RX]

B. rate = k[Nu]

C. rate = k[RX][Nu]

D. rate = $k[RX]^2$

Reasoning: Both substrate and nucleophile participate in the rate-limiting bimolecular step.

9. For E2 on a cyclohexane chair, which arrangement is normally required?

A. Leaving group equatorial and beta H equatorial

B. Leaving group axial and beta H axial anti

C. Leaving group and beta H on same carbon

D. No beta hydrogen needed

Reasoning: The leaving group and beta H must be anti-periplanar, usually a trans-diaxial pair in a chair.

10. Which solvent often favors SN2 relative to the same reaction in a protic solvent?

A. DMSO

B. Water

C. Methanol

D. Ethanol

Reasoning: Polar aprotic DMSO does not strongly hydrogen-bond to anionic nucleophiles, often raising their SN2 reactivity.

11. At a stereogenic carbon, an SN2 reaction normally produces which geometric outcome?

A. Retention

B. Inversion

C. Complete racemization

D. No stereochemical change

Reasoning: Backside attack causes inversion of the tetrahedral arrangement; the R/S label may or may not change if priorities differ.

12. A planar carbocation is formed in an SN1 solvolysis. Which outcome is generally expected?

A. Only inversion

B. Only retention

C. Loss of stereospecificity with both faces available

D. No substitution

Reasoning: Attack from either face leads to reduced stereospecificity; ion-pair effects can prevent a perfectly racemic mixture.

13. For alkenes, E/Z labels depend on:

A. Molecular mass only

B. Highest CIP-priority substituent on each alkene carbon

C. Hydrogen count alone

D. Whether the alkene is terminal

Reasoning: Determine CIP priority on each doubly bonded carbon and compare the positions of the highest-priority groups.

14. Two highest-priority groups on an alkene are on opposite sides. It is:

A. E

B. Z

C. R

D. S

Reasoning: E (entgegen) denotes opposite sides for the highest-priority substituents.

15. Two highest-priority groups on an alkene are on the same side. It is:

A. E

B. Z

C. R

D. S

Reasoning: Z (zusammen) denotes the same side for the highest-priority substituents.