Organic Chemistry Practice Exam A

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. **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.

3. **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.

4. **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.

5. **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.

6. Which group has higher CIP priority when directly attached to a stereocenter?

A. Carbon

B. Hydrogen

C. Oxygen

D. Nitrogen

Reasoning: Compare the atomic numbers of directly attached atoms: O (8) > N (7) > C (6) > H (1).

7. Which pairing describes enantiomers?

A. Different connectivity

B. Non-superimposable mirror images

C. Same compound in two chair conformations

D. Compounds differing only by a proton

Reasoning: Enantiomers are stereoisomeric non-superimposable mirror images.

8. A broad IR band spanning roughly 3200–3600 cm−1 often indicates:

A. Alcohol O–H

B. Nitrile C≡N

C. Alkyne C≡C only

D. Carbonyl C=O

Reasoning: Hydrogen-bonded alcohol O–H stretching typically produces a broad absorption in this region.

9. An aldehydic ^{1}H NMR signal commonly appears near:

A. 0–1 ppm

B. 2–3 ppm

C. 9–10 ppm

D. 14–16 ppm

Reasoning: The proton directly bonded to a carbonyl carbon in an aldehyde is strongly deshielded.

10. A 6H doublet plus 1H septet can support which fragment?

A. Methoxy group

B. Isopropyl group

C. Ethene

D. Aldehyde

Reasoning: Two equivalent methyl groups coupled to one methine proton commonly show 6H doublet + 1H septet.

11. Which reagent converts 1-bromobutane to 1-iodobutane most directly?

A. NaI in acetone

B. H2/Pd

C. PCC

D. H_2SO_4/H_2O

Reasoning: The Finkelstein halide exchange proceeds by SN2 with iodide; acetone favors the exchange.

12. Which reagent adds HBr across ethene to produce bromoethane?

A. HBr

B. $NaBH_4$

C. NaI in acetone

D. PCC

Reasoning: Electrophilic addition of HBr to symmetric ethene produces bromoethane.

13. Excess H_2/Pd converts 1-butyne into:

A. 1-butene

B. cis-2-butene

C. Butane

D. Butanal

Reasoning: Unrestricted catalytic hydrogenation reduces both alkyne π bonds to yield the alkane.

14. Bromoethane reacts with sodium methoxide. The principal substitution product is:

A. Ethene

B. Methoxyethane

C. Ethanol

D. Ethanal

Reasoning: A primary alkyl bromide undergoes Williamson ether synthesis by SN2 with methoxide; some E2 competition is possible.

15. PCC oxidation of a simple primary alcohol under anhydrous conditions normally stops at:

A. A ketone

B. An aldehyde

C. An ester

D. An alkene

Reasoning: Under typical dry PCC conditions, primary alcohols yield aldehydes.

16. Ketone + Grignard reagent, then H_3O^+ workup, generally gives:

A. Primary alcohol

B. Secondary alcohol

C. Tertiary alcohol

D. Carboxylic acid

Reasoning: Grignard carbon addition to a ketone adds a third carbon substituent to the alcohol carbon.

17. **An acyl chloride reacting with excess methanol typically yields:**

A. An ester

B. An aldehyde

C. A ketone

D. An alkene

Reasoning: Nucleophilic acyl substitution replaces chloride with methoxy to form a methyl ester.

18. **Lower pKa generally indicates:**

A. Stronger acid

B. Weaker acid

C. Stronger base only

D. No connection to acidity

Reasoning: For comparable conditions, lower pKa corresponds to larger Ka and stronger acidity.

19. **What is the degree of unsaturation for C6H6?**

A. 2

B. 3

C. 4

D. 5

Reasoning: DBE = $(2\times6 + 2 - 6)/2 = 4$.

20. **Which molecule has a carbonyl group?**

A. Propanone

B. Propane

C. Cyclohexane

D. Ethene

Reasoning: Propanone contains a C=O bond; the other choices do not.