

TEXAS A&M UNIVERSITY (TAMU) CHEM 222 ELEMENTS OF ORGANIC AND BIOLOGICAL CHEMISTRY EXAM 1 PRACTICE (SAMPLE) STUDY GUIDE



SAMPLE STUDY GUIDE WITH LIMITED QUESTIONS

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THE FULL VERSION STUDY GUIDE

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Introduction

Preparing for a certification exam can feel overwhelming, but with the right tools, it becomes an opportunity to build confidence, sharpen your skills, and move one step closer to your goals. At Examzify, we believe that effective exam preparation isn't just about memorization, it's about understanding the material, identifying knowledge gaps, and building the test-taking strategies that lead to success.

This guide was designed to help you do exactly that.

Whether you're preparing for a licensing exam, professional certification, or entry-level qualification, this book offers structured practice to reinforce key concepts. You'll find a wide range of multiple-choice questions, each followed by clear explanations to help you understand not just the right answer, but why it's correct.

The content in this guide is based on real-world exam objectives and aligned with the types of questions and topics commonly found on official tests. It's ideal for learners who want to:

- Practice answering questions under realistic conditions,
- Improve accuracy and speed,
- Review explanations to strengthen weak areas, and
- Approach the exam with greater confidence.

We recommend using this book not as a stand-alone study tool, but alongside other resources like flashcards, textbooks, or hands-on training. For best results, we recommend working through each question, reflecting on the explanation provided, and revisiting the topics that challenge you most.

Remember: successful test preparation isn't about getting every question right the first time, it's about learning from your mistakes and improving over time. Stay focused, trust the process, and know that every page you turn brings you closer to success.

Let's begin.

How to Use This Guide

This guide is designed to help you study more effectively and approach your exam with confidence. Whether you're reviewing for the first time or doing a final refresh, here's how to get the most out of your Examzify study guide:

1. Start with a Diagnostic Review

Skim through the questions to get a sense of what you know and what you need to focus on. Your goal is to identify knowledge gaps early.

2. Study in Short, Focused Sessions

Break your study time into manageable blocks (e.g. 30 – 45 minutes). Review a handful of questions, reflect on the explanations.

3. Learn from the Explanations

After answering a question, always read the explanation, even if you got it right. It reinforces key points, corrects misunderstandings, and teaches subtle distinctions between similar answers.

4. Track Your Progress

Use bookmarks or notes (if reading digitally) to mark difficult questions. Revisit these regularly and track improvements over time.

5. Simulate the Real Exam

Once you're comfortable, try taking a full set of questions without pausing. Set a timer and simulate test-day conditions to build confidence and time management skills.

6. Repeat and Review

Don't just study once, repetition builds retention. Re-attempt questions after a few days and revisit explanations to reinforce learning. Pair this guide with other Examzify tools like flashcards, and digital practice tests to strengthen your preparation across formats.

There's no single right way to study, but consistent, thoughtful effort always wins. Use this guide flexibly, adapt the tips above to fit your pace and learning style. You've got this!

Questions

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1. In SN2 reactions, how does changing nucleophile concentration affect the reaction rate?
 - A. Rate depends on both substrate and nucleophile; doubling nucleophile doubles rate.
 - B. Rate depends only on substrate.
 - C. Rate depends only on nucleophile.
 - D. Rate depends on neither substrate nor nucleophile.
2. Predict the major product of terminal alkyne hydration with HgSO₄/H₂SO₄.
 - A. A methyl ketone: R-CO-CH₃ (for HC C-R, product is R-CO-CH₃).
 - B. An aldehyde R-CHO.
 - C. An alcohol R-CH₂OH.
 - D. A carboxylic acid R-COOH.
3. A bond between two nonmetals with a relatively large electronegativity difference is typically what type of bond?
 - A. Ionic
 - B. Polar covalent
 - C. Nonpolar covalent
 - D. Metallic
4. Rank carbocation stability and name common rearrangements that occur in SN1 reactions.
 - A. 3° > 2° > 1°; resonance-stabilized cations are especially stable; hydride and methyl shifts are common rearrangements.
 - B. 2° > 3° > 1°; rearrangements are rare.
 - C. 1° > 2° > 3°; carbocations do not rearrange.
 - D. Resonance has no effect on stability; methyl shifts are not possible.
5. Which statement lists the correct maximum number of bonds for H, C, N, O, and F/Cl/Br/I?
 - A. H:1, C:3, N:4, O:2, F:1
 - B. H:1, C:4, N:2, O:3, F:1
 - C. H:2, C:4, N:3, O:2, F:2
 - D. H:1, C:4, N:3, O:2, F:1

6. When a salt dissolves in water, the dominant intermolecular interaction is typically ...
- A. Hydrogen Bonds
 - B. London Forces
 - C. Dipole-Dipole Interactions
 - D. Ion-Dipole Interactions
7. What does the Tollens test indicate in organic analysis?
- A. The presence of an aldehyde
 - B. The presence of a ketone
 - C. The presence of an alcohol
 - D. The presence of a carboxylic acid
8. A triple bond consists of
- A. One sigma and two pi.
 - B. Three sigma bonds.
 - C. Two sigma and one pi.
 - D. Three pi bonds.
9. Which statement correctly describes SN1 and SN2 mechanisms?
- A. Synopsis: SN1 rate = $k[\text{substrate}]$, SN2 rate = $k[\text{substrate}][\text{nucleophile}]$.
 - B. SN1 rate = $k[\text{substrate}]$, SN2 rate = $k[\text{substrate}][\text{nucleophile}]$.
 - C. SN1 favors primary substrates and strong nucleophiles.
 - D. SN2 leads to racemization at a stereocenter.
10. In ^1H NMR, a tert-butyl group typically appears as a singlet around which range integrating to how many hydrogens?
- A. 7-8 ppm, 9 H
 - B. 2-3 ppm, 6 H
 - C. 0.8-1.2 ppm, 9 H
 - D. 0-1 ppm, 6 H

Answers

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1. A
2. A
3. B
4. A
5. D
6. D
7. A
8. A
9. B
10. C

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Explanations

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1. In SN2 reactions, how does changing nucleophile concentration affect the reaction rate?

- A. Rate depends on both substrate and nucleophile; doubling nucleophile doubles rate.
- B. Rate depends only on substrate.
- C. Rate depends only on nucleophile.
- D. Rate depends on neither substrate nor nucleophile.

In SN2 reactions, the rate is determined by a single bimolecular collision between the nucleophile and the substrate in the rate-determining step. The rate law is $\text{rate} = k [\text{substrate}] [\text{nucleophile}]$, so both concentrations matter. If you double the nucleophile while keeping the substrate constant, the rate doubles. The same logic applies to the substrate: doubling it (with the nucleophile constant) also doubles the rate. If you double both, the rate increases by a factor of four. This second-order dependence on two reactants is what sets SN2 apart from mechanisms where the rate depends on just one species.

2. Predict the major product of terminal alkyne hydration with HgSO₄/H₂SO₄.

- A. A methyl ketone: R-CO-CH₃ (for HC C-R, product is R-CO-CH₃).
- B. An aldehyde R-CHO.
- C. An alcohol R-CH₂OH.
- D. A carboxylic acid R-COOH.

Hydration of alkynes with HgSO₄/H₂SO₄ proceeds by Markovnikov addition of water followed by tautomerization to a carbonyl. For a terminal alkyne HC C-R, the water adds so that the OH attaches to the internal carbon bearing R and H attaches to the terminal carbon. This forms a vinyl mercuric intermediate that, after demercuration and tautomerization, becomes a carbonyl compound where the carbonyl carbon is the one adjacent to R, giving the product R-CO-CH₃. In other words, you end up with a methyl ketone because the terminal carbon becomes the CH₃ group. The aldehyde would only arise in the special case where the terminal alkyne has no R (acetylene), while the hydration under these conditions does not produce an alcohol or a carboxylic acid in this general scenario.

3. A bond between two nonmetals with a relatively large electronegativity difference is typically what type of bond?

- A. Ionic
- B. Polar covalent
- C. Nonpolar covalent
- D. Metallic

Electronegativity difference controls how electrons are shared in a bond. When two nonmetals bond, electrons are shared rather than transferred. If the difference in electronegativity is relatively large, the shared electrons are pulled closer to the more electronegative atom, creating partial charges on each atom. That gives a polar covalent bond. Ionic bonds arise from complete electron transfer and are most typical between metals and nonmetals, not two nonmetals. Metallic bonds involve a lattice of metal atoms sharing a sea of electrons. So, for two nonmetals with a sizable electronegativity difference, the bond is best described as polar covalent.

4. Rank carbocation stability and name common rearrangements that occur in SN1 reactions.

- A. $3^\circ > 2^\circ > 1^\circ$; resonance-stabilized cations are especially stable; hydride and methyl shifts are common rearrangements.
- B. $2^\circ > 3^\circ > 1^\circ$; rearrangements are rare.
- C. $1^\circ > 2^\circ > 3^\circ$; carbocations do not rearrange.
- D. Resonance has no effect on stability; methyl shifts are not possible.

In SN1, the stability of the carbocation formed after the leaving group departs largely governs the reaction pathway. The more stable the cation, the more likely it is to persist long enough to react with the nucleophile, and this stability drives what product you end up with. Carbocation stability follows the order: tertiary cations are more stable than secondary, which are more stable than primary. The reason is that each additional alkyl group donates electron density through hyperconjugation and inductive effects, helping to delocalize and stabilize the positive charge. And when the carbocation is adjacent to a system that allows charge delocalization, such as a double bond or an aromatic ring, resonance stabilization can further boost stability, sometimes even above that of simple tertiary cations. Because stability can be increased by moving the positive charge to a more substituted or resonance-stabilized position, rearrangements are common in SN1. Hydride shifts (moving a hydrogen with its two electrons) or methyl shifts (moving a methyl group with its bond) can relocate the charge to a more stable center, often converting a less stable cation into a more stable tertiary or resonance-stabilized form before nucleophilic attack occurs. This is why SN1 reactions frequently produce products that reflect such rearrangements. So the best statement captures that stability ranks as tertiary > secondary > primary, recognizes that resonance-stabilized cations are especially stable, and notes that hydride and methyl shifts are common rearrangements. The other ideas—claiming the ranking is different, or that rearrangements are rare, or that resonance has no effect—don't fit what's observed in SN1 chemistry.

5. Which statement lists the correct maximum number of bonds for H, C, N, O, and F/Cl/Br/I?

- A. H:1, C:3, N:4, O:2, F:1
- B. H:1, C:4, N:2, O:3, F:1
- C. H:2, C:4, N:3, O:2, F:2
- D. H:1, C:4, N:3, O:2, F:1

The idea being tested is how many covalent bonds atoms typically form in neutral compounds based on their valence electrons and the octet rule. Hydrogen uses one bond to share its single electron and reach two electrons around it. Carbon has four valence electrons and can form four covalent bonds to complete its octet. Nitrogen has five valence electrons and, in neutral molecules, usually makes three covalent bonds and keeps a lone pair, giving eight electrons around it. Oxygen has six valence electrons and typically forms two covalent bonds (often as a double bond) with two lone pairs, also reaching eight electrons. The halogens (F, Cl, Br, I) have seven valence electrons and generally form one covalent bond, with three lone pairs, to complete their octet. So the counts align as H:1, C:4, N:3, O:2, and F/Cl/Br/I:1.

6. When a salt dissolves in water, the dominant intermolecular interaction is typically ...

- A. Hydrogen Bonds
- B. London Forces
- C. Dipole-Dipole Interactions

D. Ion-Dipole Interactions

When a salt dissolves in water, the dominant interaction is ion-dipole interactions. Water is a polar molecule, with oxygen carrying a partial negative charge and hydrogens carrying partial positive charges. The charged ions from the salt are attracted to these opposite partial charges: cations are stabilized by the lone pairs on oxygen, and anions are stabilized by the hydrogens. This leads to hydration shells where water molecules orient themselves around each ion, providing a strong stabilizing interaction that helps pull the ions apart from the solid lattice and keep them dissolved. Hydrogen bonds between water molecules still exist, and dipole-dipole interactions between water molecules are present, but the key force responsible for solvation of the ions in solution is the ion-dipole interaction with water.

7. What does the Tollens test indicate in organic analysis?

- A. The presence of an aldehyde**
- B. The presence of a ketone
- C. The presence of an alcohol
- D. The presence of a carboxylic acid

The Tollens test is a qualitative test for aldehydes. It uses the ammoniacal silver nitrate reagent, which oxidizes an aldehyde to its carboxylate while the silver ion is reduced to metallic silver, producing a shiny silver mirror on the inner surface of the test tube. Ketones don't get oxidized by this mild reagent, so they don't give the silver mirror. Alcohols aren't readily oxidized by Tollens under these conditions, and carboxylic acids don't reduce Ag^+ . Therefore a positive Tollens test indicates the presence of an aldehyde.

8. A triple bond consists of

- A. One sigma and two pi.**
- B. Three sigma bonds.
- C. Two sigma and one pi.
- D. Three pi bonds.

A triple bond is made up of one sigma bond plus two pi bonds. The sigma bond forms from the end-to-end overlap of hybridized orbitals along the internuclear axis, providing the main, strong connection between the two atoms. The two pi bonds come from the side-to-side overlap of the unhybridized p orbitals on each atom, oriented above and below the bond axis. This arrangement explains why a triple bond is shorter and stronger than a double bond and why rotation about the bond is restricted. The other descriptions don't fit this pattern: you don't get three sigma bonds between the same two atoms in a simple two-atom bond, and two sigma plus one pi would describe a different bonding scenario. Three pi bonds aren't possible without the sigma framework for those overlaps to occur.

9. Which statement correctly describes SN1 and SN2 mechanisms?

- A. Synopsis: SN1 rate = $k[\text{substrate}]$, SN2 rate = $k[\text{substrate}][\text{nucleophile}]$.
B. SN1 rate = $k[\text{substrate}]$, SN2 rate = $k[\text{substrate}][\text{nucleophile}]$.
C. SN1 favors primary substrates and strong nucleophiles.
D. SN2 leads to racemization at a stereocenter.

The key idea here is how the reaction rate depends on the reacting species for each mechanism. SN1 is unimolecular: the slow, rate-determining step is the leaving group departing to form a carbocation, so the rate depends only on the substrate concentration, giving rate = $k[\text{substrate}]$. SN2 is bimolecular: the nucleophile attacks in the same step as the leaving group leaves, so the rate depends on both the substrate and the nucleophile, giving rate = $k[\text{substrate}][\text{nucleophile}]$. The statement that SN1 rate = $k[\text{substrate}]$ and SN2 rate = $k[\text{substrate}][\text{nucleophile}]$ captures these distinct rate laws, making it the correct description. Context helps: SN1 typically occurs with tertiary or benzylic substrates and can proceed with relatively weak nucleophiles; SN2 favors primary substrates with strong nucleophiles. Stereochemistry provides a check: SN1 can lead to racemization because the carbocation is flat and can be attacked from either side, whereas SN2 causes inversion at a stereocenter due to backside attack. This makes the statement about the rate laws the best description among the options.

10. In ^1H NMR, a tert-butyl group typically appears as a singlet around which range integrating to how many hydrogens?

- A. 7-8 ppm, 9 H
B. 2-3 ppm, 6 H
C. 0.8-1.2 ppm, 9 H
D. 0-1 ppm, 6 H

A tert-butyl group gives a single signal because its three methyl groups are equivalent and there are no neighboring hydrogens to split them. All nine protons reside in the same chemical environment, so they appear as one peak that integrates to 9 H. These protons are alkyl and highly shielded, placing the resonance upfield around 0.8–1.2 ppm. The combination of a singlet, at about 0.8–1.2 ppm, with integration for 9 hydrogens is the hallmark of a tert-butyl group. If you saw signals at 7–8 ppm, that would be aromatic protons; at 2–3 ppm, protons near carbonyls or other deshielding groups; and at 0–1 ppm with only 6 H, you'd be looking at a different alkyl pattern since there are nine tert-butyl hydrogens.

Next Steps

Congratulations on reaching the final section of this guide. You've taken a meaningful step toward passing your certification exam and advancing your career.

As you continue preparing, remember that consistent practice, review, and self-reflection are key to success. Make time to revisit difficult topics, simulate exam conditions, and track your progress along the way.

If you need help, have suggestions, or want to share feedback, we'd love to hear from you. Reach out to our team at hello@examzify.com.

Or visit your dedicated course page for more study tools and resources:

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We wish you the very best on your exam journey. You've got this!

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