

# American Chemical Society (ACS) Chemistry Practice Exam (Sample)

## Study Guide



**Everything you need from our exam experts!**

**This is a sample study guide. To access the full version with hundreds of questions,**

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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. Don't worry about getting everything right, 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, and take breaks to retain information better.**

## 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.**

## 7. Use Other Tools

**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!**

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## **Questions**

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- 1. Which type of acid has two ionizable protons?**
  - A. Monoprotic acid**
  - B. Diprotic acid**
  - C. Triprotic acid**
  - D. Weak acid**
- 2. What does ionization energy measure and what is its periodic trend?**
  - A. The energy to gain an electron; largest is top left**
  - B. The energy to remove an electron; largest is top right**
  - C. The energy added to form ions; smallest at bottom**
  - D. The energy released when forming bonds; largest at middle**
- 3. A molecule with 5 electron domains and all bonding pairs has what type of electron domain geometry?**
  - A. Tetrahedral**
  - B. Trigonal bipyramidal**
  - C. Octahedral**
  - D. Square planar**
- 4. How soluble is methyl carbonate ( $C_2H_3O_2$ )?**
  - A. Insoluble**
  - B. Soluble in water**
  - C. Partially soluble in water**
  - D. Soluble in organic solvents only**
- 5. What are isomers?**
  - A. Compounds with the same atomic mass**
  - B. Compounds that have distinct physical properties**
  - C. Two or more compounds with the same formula but different arrangements of atoms**
  - D. Compounds that differ only by their phase of matter**

**6. What type of electron domain does a bonding electron domain represent?**

- A. A single bond**
- B. A double bond**
- C. A bond, single or multiple**
- D. A lone pair of electrons**

**7. What experimental observation led Rutherford to conclude that atoms are mostly empty space?**

- A. Alpha particles were absorbed by the foil**
- B. Most alpha particles passed through metal foil without deflection**
- C. Alpha particles were repelled by most elements**
- D. Alpha particles created a visible light when colliding with foil**

**8. In a redox reaction, what role does the oxidizing agent play?**

- A. It donates electrons**
- B. It accepts electrons**
- C. It is unchanged**
- D. It converts to an ion**

**9. What occurs when a molecule has three bonding electron domains and one non-bonding electron domain?**

- A. Bent shape**
- B. Trigonal planar**
- C. Tetrahedral**
- D. See-saw shape**

**10. What type of hybridization occurs with two electron domains?**

- A.  $sp^2$**
- B.  $sp^3$**
- C.  $sp$**
- D.  $sp^3d$**

## **Answers**

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

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## **Explanations**

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## 1. Which type of acid has two ionizable protons?

- A. Monoprotic acid
- B. Diprotic acid**
- C. Triprotic acid
- D. Weak acid

A diprotic acid is characterized by having two ionizable protons, meaning it can donate two protons ( $H^+$ ) when it reacts with a base or in solution. Typical examples of diprotic acids include sulfuric acid ( $H_2SO_4$ ) and carbonic acid ( $H_2CO_3$ ), both of which can lose two protons in a stepwise manner. In contrast, a monoprotic acid has only one ionizable proton, while a triprotic acid contains three ionizable protons. The classification of weak acid refers to the strength of the acid in terms of its ability to dissociate in solution, but it does not directly indicate the number of ionizable protons. Therefore, in the context of this question, the focus on the number of ionizable protons clearly identifies diprotic acid as the correct choice.

## 2. What does ionization energy measure and what is its periodic trend?

- A. The energy to gain an electron; largest is top left
- B. The energy to remove an electron; largest is top right**
- C. The energy added to form ions; smallest at bottom
- D. The energy released when forming bonds; largest at middle

Ionization energy measures the energy required to remove an electron from an atom or ion in its gaseous state. This energy is pivotal in understanding the reactivity of elements; elements with low ionization energy tend to lose electrons easily and thus are more reactive, particularly in metals. The periodic trend for ionization energy shows that it generally increases across a period (from left to right on the periodic table) and decreases down a group (from top to bottom). This is because, as you move right across a period, the nuclear charge (number of protons in the nucleus) increases while the atomic radius decreases, resulting in a stronger attraction between the nucleus and the electrons. Conversely, as you move down a group, additional electron shells are added, which increases the distance between the nucleus and the outer electrons, effectively reducing the pull on these electrons and making them easier to remove. Thus, the largest ionization energies are found in the top right corner of the periodic table, where elements like helium and neon exhibit very high ionization energies due to their high effective nuclear charge and small atomic radii.

**3. A molecule with 5 electron domains and all bonding pairs has what type of electron domain geometry?**

- A. Tetrahedral**
- B. Trigonal bipyramidal**
- C. Octahedral**
- D. Square planar**

A molecule with five electron domains, where all are bonding pairs, exhibits trigonal bipyramidal electron domain geometry. This configuration arises because five electron domains arrange themselves in a way that minimizes electron-electron repulsion as described by VSEPR (Valence Shell Electron Pair Repulsion) theory. In trigonal bipyramidal geometry, there are two distinct types of positions for the bonded atoms: three in a plane forming a triangle (equatorial positions) and two above and below this plane (axial positions). This arrangement allows for optimal spacing between the electron domains, each at approximately 120° in the equatorial plane and 90° between equatorial and axial positions. Other geometries, like tetrahedral, octahedral, and square planar, correspond to different numbers of electron domains, and thus would not apply to a molecule with five electron domains. Tetrahedral geometry, for instance, is associated with four electron domains; octahedral with six; and square planar, which arises from a central atom surrounded by four equivalent atoms in a square configuration, involves a total of six electron domains as well. Therefore, the presence of five electron domains exclusively debunks these other geometries, affirming that a trigonal bipyramidal arrangement

**4. How soluble is methyl carbonate (C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)?**

- A. Insoluble**
- B. Soluble in water**
- C. Partially soluble in water**
- D. Soluble in organic solvents only**

Methyl carbonate (C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>), also known as methyl ester of carbonic acid, exhibits notable solubility in water due to its polar nature. The compound contains an ester functional group, which facilitates interactions with water molecules. The presence of the carbonyl (C=O) and the ether-like (C-O) groups contributes to its ability to form hydrogen bonds with water, enhancing its solubility. Comparatively, many organic molecules that are completely non-polar or lack functional groups that can interact with water tend to be insoluble or only partially soluble. Given methyl carbonate's structural features, it does not fall into these categories, allowing for a strong interaction with water molecules. While it is indeed soluble in organic solvents due to its organic structure, the most accurate characterization regarding its behavior in water is that it is soluble in water, making the selection of this choice true.

## 5. What are isomers?

- A. Compounds with the same atomic mass**
- B. Compounds that have distinct physical properties**
- C. Two or more compounds with the same formula but different arrangements of atoms**
- D. Compounds that differ only by their phase of matter**

Isomers are defined as two or more compounds that have the same molecular formula but differ in the arrangement of their atoms. This can refer to different structural arrangements, such as in structural isomers, where the atoms are connected in different ways, or stereoisomers, where the spatial arrangement of the atoms differs while the connectivity remains the same. This distinction is significant in chemistry because different isomers can exhibit varied chemical and physical properties despite having the same number and types of atoms in their molecular formula. Understanding isomerism is crucial because it plays a vital role in the behavior and reactivity of chemical compounds, impacting everything from the synthesis of new materials to biological processes. The other choices describe different concepts not accurately defining isomers. Some might pertain to characteristics of compounds, but only option C captures the essence of isomerism.

## 6. What type of electron domain does a bonding electron domain represent?

- A. A single bond**
- B. A double bond**
- C. A bond, single or multiple**
- D. A lone pair of electrons**

A bonding electron domain encompasses the presence of any type of bond between atoms, whether it is a single bond, a double bond, or a triple bond. Each of these types of bonds represents a way that atoms can share electrons, and they all contribute to the overall electron domain around a central atom. In molecular geometry, each of these bond types is considered a separate domain that influences the spatial arrangement of other electron domains. For instance, a single bond consists of one pair of shared electrons, while a double bond involves two pairs of shared electrons, effectively acting as one electron domain but representing a stronger interaction between the connected atoms. Lone pairs, on the other hand, do not represent bonding interactions but rather the presence of non-bonding electrons on an atom, and thus they are considered in a different category of electron domains. Therefore, identifying a bonding electron domain as a bond, whether single or multiple, is a comprehensive and inclusive approach to describing the types of interactions that exist between atoms in a molecule.

**7. What experimental observation led Rutherford to conclude that atoms are mostly empty space?**

- A. Alpha particles were absorbed by the foil**
- B. Most alpha particles passed through metal foil without deflection**
- C. Alpha particles were repelled by most elements**
- D. Alpha particles created a visible light when colliding with foil**

The conclusion that atoms are mostly empty space stems from the observation that most alpha particles passed through the metal foil without any deflection. In Rutherford's gold foil experiment, a source of alpha particles was directed at a very thin sheet of gold foil. If atoms were densely packed with positive charge, as was the prevailing belief at that time, one would expect that the majority of the alpha particles would be deflected at large angles due to repulsion from the dense positive charge of the gold atoms. However, the fact that most alpha particles passed through the foil undisturbed suggested that there was a significant amount of empty space within the atom. This indicated that the positive charge was concentrated in a very small central region of the atom—the nucleus—while the rest of the atomic structure was largely empty. This pivotal observation led to a new understanding of atomic structure, shifting away from the previous models that depicted atoms as solid spheres.

**8. In a redox reaction, what role does the oxidizing agent play?**

- A. It donates electrons**
- B. It accepts electrons**
- C. It is unchanged**
- D. It converts to an ion**

In a redox reaction, the oxidizing agent is the species that accepts electrons from another substance. This process is central to the concept of oxidation and reduction: oxidation refers to the loss of electrons, while reduction involves the gain of electrons. Consequently, the oxidizing agent itself undergoes a reduction as it gains electrons, leading to a decrease in its oxidation state. When the oxidizing agent accepts electrons, it facilitates the oxidation of the other reactant, which donates electrons. This exchange is critical in many chemical and biological processes, including cellular respiration and combustion reactions. The identification of the oxidizing agent is often key to understanding the overall reaction and its mechanism. Thus, in the context of the provided question, recognizing the role of the oxidizing agent as the electron acceptor is essential.

**9. What occurs when a molecule has three bonding electron domains and one non-bonding electron domain?**

- A. Bent shape**
- B. Trigonal planar**
- C. Tetrahedral**
- D. See-saw shape**

When a molecule has three bonding electron domains and one non-bonding electron domain, it exhibits a bent shape due to the repulsion between the electron domains. In this arrangement, the three bonding domains, which can come from bonds to other atoms, create a geometric arrangement that would ideally be trigonal planar. However, the presence of the non-bonding domain (lone pair) alters this ideal shape, pushing down on the bonding pairs. The lone pair occupies more space and exerts repulsive forces on the adjacent bonding pairs, which causes the bond angles between the atoms to decrease from the ideal angle of 120 degrees typical of a trigonal planar configuration. This results in a bent shape instead. A common example of a molecule with this geometry is water ( $\text{H}_2\text{O}$ ), where the two hydrogen atoms and the lone pair on the oxygen result in a bent molecular shape. The other options represent different molecular geometries that do not match the condition of having three bonding domains and one lone pair of electrons. Trigonal planar and tetrahedral geometries imply all domains are bonding, while the see-saw shape corresponds to a different arrangement often seen with five electron domains, typically involving a central atom with four bonding domains and one lone pair.

**10. What type of hybridization occurs with two electron domains?**

- A.  $\text{sp}^2$**
- B.  $\text{sp}^3$**
- C. sp**
- D.  $\text{sp}^3\text{d}$**

When there are two electron domains around a central atom, the hybridization that occurs is  $\text{sp}$ . This hybridization involves the mixing of one s orbital and one p orbital to form two equivalent  $\text{sp}$  hybrid orbitals. The geometrical arrangement of these two hybrid orbitals is linear, which results in a bond angle of 180 degrees. This type of hybridization is typically seen in molecules where the central atom is forming two sigma bonds, such as in diatomic molecules or in molecules with triple bonds, as exemplified by acetic acid's carbon atom bonded to another carbon atom. The  $\text{sp}$  hybridization helps to minimize electron repulsion by positioning the electron domains as far apart as possible, which is consistent with the principles of VSEPR (Valence Shell Electron Pair Repulsion) theory. In contrast,  $\text{sp}^2$  hybridization involves three electron domains and results in a trigonal planar shape, while  $\text{sp}^3$  hybridization pertains to four electron domains with a tetrahedral geometry. The  $\text{sp}^3\text{d}$  hybridization corresponds to five electron domains, leading to a trigonal bipyramidal geometry. This context helps illustrate why  $\text{sp}$  is the appropriate hybridization for a scenario with only two electron domains.

# 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](mailto:hello@examzify.com).**

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

**<https://acs-chemistry.examzify.com>**

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

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