

# ACS Inorganic Chemistry Practice Test (Sample)

## Study Guide



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

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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. What is solvatochromism?**
  - A. The change in spectral properties due to ligand exchange**
  - B. Variation in the transition frequency with change in solvent permittivity**
  - C. The effect of temperature on electronic transitions**
  - D. A chemical reaction driven by the solvent**
  
- 2. What does NEXAFS stand for?**
  - A. Near edge X-ray absorption fine structure**
  - B. Next level X-ray absorption fine structure**
  - C. Natural edge X-ray analysis feature series**
  - D. Nuclear edge X-ray absorption frequency spectrum**
  
- 3. How many total possible orientations can ML have?**
  - A.  $2L+1$**
  - B.  $2S+1$**
  - C.  $L+1$**
  - D.  $S+1$**
  
- 4. Which type of isomer can form due to the exchange of a ligand with a counter-ion dissolved in solution?**
  - A. Hydrate isomers**
  - B. Linkage isomers**
  - C. Ionization isomers**
  - D. Coordination isomers**
  
- 5. What characterizes a sigma mirror plane?**
  - A. It bisects the principal axis**
  - B. It contains the z-axis in vertical mirror operations**
  - C. It only exists in high symmetry molecules**
  - D. It represents a horizontal reflection**

- 6. What does  $E_{\text{max}}$  measure in the context of ligand field transitions?**
- A. The absorption strength**
  - B. The emission wavelength**
  - C. The molar absorptivity**
  - D. The ionization potential**
- 7. What happens in step 3 of the cyclic voltammetry process?**
- A. The current stabilizes at a fixed value**
  - B. The sweep reverses once the upper limit is reached**
  - C. The voltage remains unchanged**
  - D. The current continues to increase indefinitely**
- 8. What occurs during charge transfer in inorganic chemistry?**
- A. An electron migrates from a metal to a ligand**
  - B. An electron migrates to an orbital that is primarily metal or ligand in character**
  - C. An electron is added to the metal complex**
  - D. An electron is lost from the ligand complex**
- 9. Which of the following elements would typically have the highest ionization energy?**
- A. Lithium (Li)**
  - B. Fluorine (F)**
  - C. Sodium (Na)**
  - D. Potassium (K)**
- 10. Which configuration is typically adopted by a central ion with a  $d^8$  electron configuration when all ligands are identical?**
- A. Square planar**
  - B. Tetrahedral**
  - C. Octahedral**
  - D. Linear**



## Answers

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

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## **Explanations**

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## 1. What is solvatochromism?

- A. The change in spectral properties due to ligand exchange
- B. Variation in the transition frequency with change in solvent permittivity**
- C. The effect of temperature on electronic transitions
- D. A chemical reaction driven by the solvent

Solvatochromism refers to the phenomenon where the color of a compound changes in response to variations in the solvent in which it is dissolved. This effect occurs due to alterations in the electronic environment of the solute, primarily influenced by the solvent's dielectric properties and polarity. When a solute is placed in a solvent, the solvent molecules can interact with the solute through various intermolecular forces, causing the energy levels of the electronic transitions to shift. These shifts can lead to changes in absorption and emission spectra, effectively altering the wavelengths of light that the compound absorbs or emits. In this context, the statement about variation in the transition frequency with change in solvent permittivity captures the essence of how solvatochromism works, as solvent permittivity is closely related to the solvent's ability to stabilize different electronic states of the solute. The other options describe different phenomena or processes that do not align with the specific definition of solvatochromism. For instance, ligand exchange involves changing the ligands coordinating to a central atom in a complex, which is a different type of chemical interaction. Temperature effects on electronic transitions pertain to how thermal energy influences the behavior of electrons but do not encapsulate the nuances of solvatochromism.

## 2. What does NEXAFS stand for?

- A. Near edge X-ray absorption fine structure**
- B. Next level X-ray absorption fine structure
- C. Natural edge X-ray analysis feature series
- D. Nuclear edge X-ray absorption frequency spectrum

NEXAFS stands for Near Edge X-ray Absorption Fine Structure. This term is used in the context of spectroscopy to describe a technique that probes the electronic structure of materials by measuring their absorption of X-rays in the vicinity of an absorption edge. Specifically, it provides information about the unoccupied electronic states of a material and is particularly useful in the analysis of organic and inorganic materials, surfaces, and interfaces. The term "near edge" emphasizes the position of the measurement just below and above the edge corresponding to a core electron transition, which is key to understanding the fine structure arising from interactions of X-rays with the material. NEXAFS is a vital technique for studying various phenomena in materials science, chemistry, and biochemistry, as it yields insights into molecular and electronic structures.

### 3. How many total possible orientations can ML have?

- A.  $2L+1$**
- B.  $2S+1$
- C.  $L+1$
- D.  $S+1$

In molecular and atomic orbital theory, the term "ML" typically refers to the magnetic quantum number, which is associated with the orientation of orbitals in a magnetic field. The number of possible orientations of a given quantum number can be derived from the angular momentum quantum number (L), which defines the shape of the orbital. The total number of possible orientations that an orbital can have is given by the formula  $2L + 1$ . This formula arises from the fact that for a given value of L, the magnetic quantum number (ML) can take values ranging from -L to +L, including zero. Therefore, the actual values that ML can assume are: - L (positive), - 0 (zero), - -L (negative). For each integer value of L, the total count of these values is the set  $\{-L, \dots, 0, \dots, L\}$ , which consists of  $(2L + 1)$  distinct values. For example: - If  $L = 0$ , ML can only be 0 (1 orientation). - If  $L = 1$ , ML can be -1, 0, or +1 (3 orientations). - If  $L = 2$ , ML can be -2

### 4. Which type of isomer can form due to the exchange of a ligand with a counter-ion dissolved in solution?

- A. Hydrate isomers
- B. Linkage isomers
- C. Ionization isomers**
- D. Coordination isomers

Ionization isomers arise when a ligand in a complex can be replaced or exchanged with an anion (counter-ion) present in the solution. This type of isomerization significantly changes the overall composition of the complex by altering its ionic components while keeping the coordination number of the metal center the same. For example, consider a coordination complex like  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ . When the ammonia ligand is replaced by the sulfate ion from the solution, a different isomer like  $[\text{Cu}(\text{NH}_3)_3(\text{SO}_4)](\text{NO}_3)$  can form, where the composition of the counter-ions is different. The presence of different counter-ions leads to different behaviors in solution, changes in solubility, and often different chemical properties. Other types of isomers, such as hydrate, linkage, and coordination isomers, involve different structural or connectivity changes. Hydrate isomers involve the presence of water molecules in different positions, linkage isomers arise from ligands being able to bind through different atoms, and coordination isomers involve changes in the arrangement of ligands within different complexes. However, these processes do not involve the exchange with counter-ions as seen in ionization isomerism.

## 5. What characterizes a sigma mirror plane?

- A. It bisects the principal axis
- B. It contains the z-axis in vertical mirror operations**
- C. It only exists in high symmetry molecules
- D. It represents a horizontal reflection

A sigma mirror plane, often denoted as  $\sigma$ , is a symmetry element in which one half of an object is a mirror image of the other half. This plane reflects all points on one side of it to corresponding points on the opposite side, which is central to understanding the molecule's symmetry. The statement that it contains the z-axis in vertical mirror operations correctly highlights the nature of sigma mirror planes in the context of three-dimensional molecular geometry. When we reference vertical mirror operations, we are typically discussing planes that include the principal axis of the molecule, often the z-axis in a conventional coordinate system. This results in a reflection of the structure across that plane. In contrast, while a sigma mirror plane can indeed bisect the principal axis, this is not its defining characteristic since it does not apply to all orientations or definitions of sigma planes, particularly in lower symmetry molecules. Similarly, stating that sigma mirror planes only exist in high symmetry molecules overlooks their presence in lower symmetry scenarios. Lastly, the notion that they represent horizontal reflections is inaccurate as it doesn't define the broad scope of sigma planes which can be oriented in various directions based on the molecule's structure and can include vertical or horizontal reflection planes depending on the context. The key focus here is how the sigma mirror

## 6. What does E<sub>max</sub> measure in the context of ligand field transitions?

- A. The absorption strength**
- B. The emission wavelength
- C. The molar absorptivity
- D. The ionization potential

E<sub>max</sub> is a term often used to refer to the maximum absorbance in the context of ligand field transitions. Ligand field theory discusses how the presence of ligands around a metal center affects its electronic structure and energy levels, leading to color and absorption characteristics in coordination compounds. The measurement of E<sub>max</sub> is critical because it reflects the strength of absorption at a specific wavelength, indicating how effectively a complex can absorb light due to electronic transitions. In ligand field transitions, this is particularly relevant as it showcases the energy difference between the split d-orbitals caused by the ligands interacting with the metal ion. Thus, E<sub>max</sub> provides insight into the ligand field strength and the surrounding environment's influence on the metal's electrons, which is crucial for understanding the properties of transition metal complexes, including their colors and reactivities.

## 7. What happens in step 3 of the cyclic voltammetry process?

- A. The current stabilizes at a fixed value
- B. The sweep reverses once the upper limit is reached**
- C. The voltage remains unchanged
- D. The current continues to increase indefinitely

In step 3 of the cyclic voltammetry process, the sweep reverses once the upper limit is reached. This reversal is a key characteristic of cyclic voltammetry, which involves a triangular wave-like potential sweep where the potential is ramped in one direction to a predetermined upper limit and then reversed back to the starting point. During this reversal, the electrochemical reactions that occurred in the forward sweep (where oxidation or reduction takes place) are typically reversed. As a result, capturing the resulting current provides valuable information about the electrochemical processes, including reaction kinetics, reversibility, and diffusion properties. The other options reflect different phenomena that do not occur at this specific step in cyclic voltammetry. For instance, the current stabilizing at a fixed value suggests a steady state not characteristic of this dynamic process. Similarly, the notion that the voltage remains unchanged conflicts with the fundamental characteristic of cyclic voltammetry, where the voltage is actively being swept. The idea that the current continues to increase indefinitely is also inaccurate, as current levels typically oscillate based on the electrochemical reactions taking place at the electrode. Hence, the reversal of the sweep at the upper limit is what defines this step in the cyclic voltammetry process and marks the transition to the

## 8. What occurs during charge transfer in inorganic chemistry?

- A. An electron migrates from a metal to a ligand
- B. An electron migrates to an orbital that is primarily metal or ligand in character**
- C. An electron is added to the metal complex
- D. An electron is lost from the ligand complex

Charge transfer in inorganic chemistry primarily refers to the process where an electron is transferred between different parts of a molecule, typically between a metal and a ligand. In the context of the chosen option, when an electron migrates to an orbital that is primarily metal or ligand in character, it means that the electron is indeed involving itself in the electronic structure of either the metal center or the ligand and contributing to the overall bonding and electronic properties of the complex. This concept is critical because it explains phenomena such as color in transition metal complexes. In these complexes, the absorption of light energy corresponds to the promotion of an electron from a lower energy d-orbital (often metal-based) to a higher energy level that could be ligand-based or a combination of both, thereby leading to charge transfer transitions. The ability of the complex to engage in charge transfer heavily influences its reactivity, stability, and spectroscopic properties. Thus, understanding that an electron migrates to an orbital associated with either the metal or the ligand is essential for grasping how charge transfer mechanisms can alter the characteristics of a compound in various chemical scenarios.

**9. Which of the following elements would typically have the highest ionization energy?**

- A. Lithium (Li)
- B. Fluorine (F)**
- C. Sodium (Na)
- D. Potassium (K)

Fluorine typically has the highest ionization energy among the elements listed because it is located further to the right in the periodic table, within the same period as sodium, lithium, and potassium. Ionization energy generally increases across a period due to the increasing nuclear charge, which enhances the attraction between the nucleus and the valence electrons, making them more difficult to remove. Fluorine, being in Group 17, has a high effective nuclear charge and only needs to remove one valence electron to achieve a stable electronic configuration, akin to noble gases. This stability desired by achieving a full outer electron shell contributes to its high ionization energy. In contrast, lithium, sodium, and potassium are alkali metals found in Group 1. As you move down the group, ionization energy decreases due to the increasing electron shielding from inner electron layers and the larger atomic radius, which makes the outermost electron easier to remove. Therefore, the ionization energies of lithium, sodium, and potassium are significantly lower than that of fluorine. This trend reflects the principles governing atomic structure and periodic trends.

**10. Which configuration is typically adopted by a central ion with a d8 electron configuration when all ligands are identical?**

- A. Square planar**
- B. Tetrahedral
- C. Octahedral
- D. Linear

A central ion with a d8 electron configuration often adopts a square planar geometry when all ligands are identical. This preference can be attributed to the electronic and steric factors that influence the arrangement of ligands around the metal center. In the case of d8 metal ions, such as Ni(II) and Pt(II), the square planar configuration allows for effective overlap of the metal's d orbitals with those of the ligands, leading to strong bonding interactions. This arrangement stabilizes the complex due to minimal electronic repulsion among the ligands, which are positioned at 90-degree angles to each other. Moreover, the square planar geometry also helps in accommodating the specific spatial requirements of d8 configurations, where the presence of paired electrons in the metal's orbitals can lead to less steric hindrance compared to other geometries. This is particularly relevant when considering ligand size and the potential for steric clashes in arrangements like octahedral or tetrahedral. In summary, the square planar configuration is favored for d8 metal complexes with identical ligands due to its balance of electrostatic and steric factors, resulting in enhanced stability and effective orbital overlap.



## 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://acsinorganicchem.examzify.com>**

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

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