EPRI REACTOR THEORY PRACTICE EXAM (SAMPLE)

STUDY GUIDE

SAMPLE STUDY GUIDE WITH LIMITED 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. 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

1. Explain the concept of adjoint flux in reactor theory.

A. The adjoint flux is the neutron flux itself.

B. The adjoint flux is the solution to the adjoint transport equation that weights importance of neutrons to a given response; used in perturbation and sensitivity analyses.

C. Adjoint flux measures neutron speed.

D. Adjoint flux is used to compute reactor power only.

2. What is the effect of xenon-135 on reactor reactivity and how does it arise?

A. Xenon-135 is produced in fission and from iodine decay; its buildup strongly absorbs neutrons and reduces reactivity, lowering reactor power until it decays away.

B. Xenon-135 acts as a moderator that slows neutrons, increasing reactivity.

C. Xenon-135 is stable and has no impact on reactivity.

D. Xenon-135 immediately decays into harmless gas with no effect.

3. What does the spectral effect necessitate in cross section data representation?

A. Multigroup data

B. Single-group data

C. Thermal-only data

D. Macroscopic cross sections only

4. In a PWR, injecting a slug of cold water into the core will have what effect on reactivity?

A. Decrease reactivity

B. Increase reactivity

C. No effect

D. Immediate reactor scram

5. What is the sign of the moderator temperature coefficient in typical light-water reactors?

A. Change in reactivity with moderator temperature; typically positive.

B. Change in reactivity with moderator temperature; sign is always negative.

C. Change in reactivity with moderator temperature; typically negative.

D. Change in reactivity with moderator pressure; negligible.

6. The workforce and its corrective action program constitute the first line of defense against accidents. Which statement describes this?

A. The workforce must be diligent in reducing human errors and promptly addressing issues via the corrective action program

B. The first line of defense is the built-in barriers alone

C. Only emergency systems determine safety

D. Operator actions are optional

7. Boron dilution in a PWR refers to which situation?

A. Water with low boron concentration injected into the primary loop

B. Water with high boron concentration injected into the primary loop

C. Boron-free water used for refueling

D. Boron is removed from the primary loop during operation

8. Which statement correctly describes gamma decay?

A. Releases gamma rays without changing the number of neutrons or protons.

B. Changes the neutron number but not the proton number.

C. Produces alpha particles.

D. Changes the proton number.

9. Doppler (fuel temperature) coefficient: typical sign in thermal reactors?

A. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; typically positive.

B. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; sign is unpredictable.

C. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; typically negative.

D. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; sign depends on moderator.

10. In a BWR, reactor power is controlled by what mechanisms?

A. Turbine load only

B. Rods and recirculation flow

C. Boron concentration

D. Pressure changes

Answers

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

Explanations

1. Explain the concept of adjoint flux in reactor theory.

A. The adjoint flux is the neutron flux itself.

B. The adjoint flux is the solution to the adjoint transport equation that weights importance of neutrons to a given response; used in perturbation and sensitivity analyses.

C. Adjoint flux measures neutron speed.

D. Adjoint flux is used to compute reactor power only.

The adjoint flux represents how important neutrons are to a specific response you care about in the reactor. It is the solution of the adjoint transport equation, which is constructed so that it weights neutrons by their contribution to that chosen response. In practice, you think of it as an importance field: for neutrons at a given point, direction, and energy, the adjoint flux tells you how much that neutron would affect your target outcome (detector reading, reaction rate in a region, etc.). This usefulness becomes clear in perturbation and sensitivity analyses. When a small change occurs in a cross section or material property, the resulting fractional change in the response can be expressed by integrating the product of the forward neutron flux, the adjoint flux, and the perturbation over space, angle, and energy. So the adjoint flux is not the actual neutron population, nor a measure of speed, and it's not limited to calculating reactor power; it's a general weighting function tied to the particular response you're studying.

2. What is the effect of xenon-135 on reactor reactivity and how does it arise?

A. Xenon-135 is produced in fission and from iodine decay; its buildup strongly absorbs neutrons and reduces reactivity, lowering reactor power until it decays away.

B. Xenon-135 acts as a moderator that slows neutrons, increasing reactivity.

C. Xenon-135 is stable and has no impact on reactivity.

D. Xenon-135 immediately decays into harmless gas with no effect.

Xenon-135 is a very strong neutron absorber at thermal energies, so its presence directly reduces reactor reactivity by removing neutrons from the chain reaction. It is created in fission and also produced from the decay of iodine-135, another fission product. As irradiation continues, Xe-135 builds up and its neutron absorption depresses the neutron flux, causing the reactor power to fall. When irradiation stops, production drops but the existing Xe-135 decays away over a timescale of several hours, so reactivity gradually recovers. This is why xenon poisoning is a classic dynamic in reactor control: the fuel can be at high power, then a buildup of Xe-135 reduces reactivity, impairing power; later, decay allows reactivity to return. Xenon-135 is not a moderator, it is not stable, and it does not vanish instantly.

3. What does the spectral effect necessitate in cross section data representation?

A. Multigroup data

B. Single-group data

C. Thermal-only data

D. Macroscopic cross sections only

Accounting for spectral effects requires keeping energy information in the cross sections. The neutron spectrum determines how often reactions occur, and cross sections vary with energy. If cross sections are represented as a single group, that energy dependence is averaged out, so you lose the ability to reflect how the spectrum influences reaction rates. Representing cross sections in multiple energy groups (multigroup data) lets you average within each energy band using the actual spectrum in that band, enabling accurate folding of the spectrum with the cross sections to predict reaction rates. Thermal-only data would ignore higher-energy neutrons, and macroscopic cross sections, while useful, still lack the energy resolution needed to capture how the spectrum shapes reactions. So the spectral effect is captured by multigroup data rather than a single-group representation.

4. In a PWR, injecting a slug of cold water into the core will have what effect on reactivity?

A. Decrease reactivity

B. Increase reactivity

C. No effect

D. Immediate reactor scram

Injecting a slug of cold water into the core increases the local moderator density. Denser moderator slows neutrons more effectively, boosting the probability that they cause fission and raising the effective multiplication factor momentarily. So the immediate effect is a positive reactivity insertion, causing a temporary rise in power. As the cold water heats and mixes with the surrounding coolant, its density decreases and the reactivity effect fades, consistent with the coolant's negative temperature coefficient. This is not a scram and it is not a permanent decrease in reactivity.

5. What is the sign of the moderator temperature coefficient in typical light-water reactors?

A. Change in reactivity with moderator temperature; typically positive.

B. Change in reactivity with moderator temperature; sign is always negative.

C. Change in reactivity with moderator temperature; typically negative.

D. Change in reactivity with moderator pressure; negligible.

The main idea is how reactivity changes as the moderator temperature changes. In a typical light-water reactor, water acts as the moderator. When the moderator heats up, its density decreases because water expands with temperature. Less dense moderator is less effective at slowing neutrons, so the population of thermal neutrons drops and the reactor's reactivity decreases. This means reactivity changes in the opposite direction to moderator temperature: as temperature goes up, reactivity goes down. That negative relationship is why the moderator temperature coefficient is described as typically negative, providing a natural, self-limiting feedback.

6. The workforce and its corrective action program constitute the first line of defense against accidents. Which statement describes this?

A. The workforce must be diligent in reducing human errors and promptly addressing issues via the corrective action program

B. The first line of defense is the built-in barriers alone

C. Only emergency systems determine safety

D. Operator actions are optional

The core idea is that people, supported by a formal process, are the first line of defense against accidents. The workforce must be diligent in reducing human errors and promptly addressing issues via the corrective action program. When issues are noticed, reported, investigated, and followed up with effective corrective actions, the likelihood of a small problem growing into an incident is greatly reduced. This proactive use of the corrective action program helps catch root causes early and prevents recurrence, which is why this description best captures the role of the first line of defense. Built-in barriers and emergency systems are crucial parts of defense in depth, but they rely on people and proper processes to be effective, and operator actions are fundamental, not optional.

7. Boron dilution in a PWR refers to which situation?

A. Water with low boron concentration injected into the primary loop

B. Water with high boron concentration injected into the primary loop

C. Boron-free water used for refueling

D. Boron is removed from the primary loop during operation

Boron dilution works by lowering the amount of neutron-absorbing boron in the primary coolant, which raises reactivity. In a PWR, soluble boron (boric acid) helps control reactivity because boron-10 captures neutrons. When you inject water with a lower boron concentration into the primary loop, you dilute the boron in the coolant. The overall neutron absorption decreases, so the reactor becomes more reactive. This approach is used during startup, refueling, or maneuvering to bring power to the desired level while keeping shutdown margins under control, and it requires careful monitoring of boron concentration, temperature, and core reactivity. The situation described—introducing water with a low boron concentration into the primary loop—fits this dilution process exactly, which is why it's the correct interpretation. Injecting water with high boron would reduce reactivity rather than increase it. Boron-free water for refueling isn't the standard mechanism of dilution, since it implies removing boron but not the deliberate, controlled lowering of boron concentration in the loop. Removing boron from the loop during operation isn't a typical defined dilution scenario.

8. Which statement correctly describes gamma decay?

A. Releases gamma rays without changing the number of neutrons or protons.

B. Changes the neutron number but not the proton number.

C. Produces alpha particles.

D. Changes the proton number.

Gamma decay is a process where the nucleus drops to a lower energy state by emitting a gamma photon, a high-energy electromagnetic wave. This emission carries away the excess energy but does not involve removing or adding any nucleons, so the numbers of protons and neutrons—the atomic number and mass number—remain the same. That's why gamma decay does not change the proton number or the neutron number. It's different from alpha decay, which ejects a helium nucleus and changes both Z and A, and from beta decay, which changes Z (and thus the element) by converting a neutron to a proton or vice versa. Gamma decay often occurs after a nucleus has been left in an excited state by a prior decay, as a final step to reach the ground state. Internal conversion is related but involves ejecting an orbital electron instead of emitting a gamma ray, while still leaving Z and A unchanged.

9. Doppler (fuel temperature) coefficient: typical sign in thermal reactors?

A. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; typically positive.

B. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; sign is unpredictable.

C. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; typically negative.

D. Reactivity change due to Doppler broadening of resonances with increasing fuel temperature; sign depends on moderator.

Raising fuel temperature causes Doppler broadening of the resonances in the fuel nuclei. With broader resonances, neutrons at energies near those resonances are more likely to be captured by the fuel without causing fission. That extra absorption removes neutrons from the fission process, lowering the neutron multiplication and reducing reactivity. So, in thermal reactors, the Doppler coefficient is typically negative: as temperature increases, reactivity decreases. This sign is a robust, stabilizing feedback in most light-water–moderated, thermal-fission systems. The idea that the sign could be positive is not consistent with the physical mechanism here, and while the exact magnitude depends on fuel composition and neutron spectrum, the direction of the effect is generally negative. The moderator influences the spectrum and thus the magnitude, but not the fundamental sign of the Doppler effect in the fuel.

10. In a BWR, reactor power is controlled by what mechanisms?

A. Turbine load only

B. Rods and recirculation flow

C. Boron concentration

D. Pressure changes

Power in a BWR is controlled mainly by changing reactivity through two levers: moving the control rods to absorb or release neutrons, and adjusting the recirculation flow to change the core's boiling and neutron economy. The control rods provide direct, rapid reactivity changes: inserting them lowers reactivity and power, withdrawing raises it. The recirculation system changes how much water is pumped through the core; increasing flow promotes more boiling and alters the voids in the core, which shifts how neutrons are moderated and thus changes reactivity to achieve the desired power level. Turbine load, boron concentration, or pressure changes aren't used as the primary means of controlling reactor power in a BWR.

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:

https://eprireactortheory.examzify.com

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