Electricity and Magnetism 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

1. **In a series RLC circuit, which parameter governs the exponential decay rate of the transient response, and what is the formula?**
   - **A. $\alpha = L/(2R)$; the decay is $e^{(-\alpha t)}$**
   - **B. $\alpha = R/(2C)$; the decay is $e^{(-\alpha t)}$**
   - **C. $\alpha = R/(2L)$; the decay is $e^{(-\alpha t)}$**
   - **D. $\alpha = 2\sqrt{(L/C)}$; the decay is $e^{(-\alpha t)}$**

2. **What is the electric field inside a conductor in electrostatic equilibrium, and why?**
   - **A. E = 0; charges rearrange to cancel the internal field**
   - **B. E = nonzero constant**
   - **C. E increases with depth**
   - **D. E proportional to distance from surface**

3. **What are the common polarization states of an electromagnetic plane wave and how are they defined?**
   - **A. Linear polarization: E remains in a fixed plane; Circular polarization: E rotates with constant magnitude; Elliptical polarization: E traces an ellipse.**
   - **B. Linear polarization: E rotates with constant magnitude; Circular polarization: E remains in a fixed plane; Elliptical polarization: E traces an ellipse.**
   - **C. Linear polarization: E remains in a fixed plane; Circular polarization: E rotates with constant magnitude; Elliptical polarization: E traces an ellipse.**
   - **D. Linear polarization: E magnitude remains constant; Circular polarization: E rotates with time while magnitude changes; Elliptical polarization: E is zero.**

4. **What is the energy density of an electric field in a dielectric with electric field E and displacement D?**
   - **A. $u_E = (1/2)\, E \cdot D$**
   - **B. $u_E = E^2/(2\varepsilon_0)$**
   - **C. $u_E = D^2/(2\varepsilon_0)$**
   - **D. $u_E = E \cdot D$**

5. **Magnetic energy density per unit volume is given by which expression?**

   A. $u_B = B^2/(2\mu_0)$

   B. $u_B = \mu_0 B^2/2$

   C. $u_B = B/(2\mu_0)$

   D. $u_B = B^2/(\mu_0)$

6. **A device that increases or decreases the voltage of alternating current?**

   A. Generator

   B. Solenoid

   C. Transformer

   D. Electric Motor

7. **Which expression correctly relates the speed of light to the vacuum permeability μ_0 and the vacuum permittivity ε_0?**

   A. $c = \mu_0 \varepsilon_0$

   B. $c = \sqrt{\mu_0 \varepsilon_0}$

   C. $c = 1/\sqrt{\mu_0 \varepsilon_0}$

   D. $c = \mu_0/\varepsilon_0$

8. **What in a circuit diagram represents a resistor?**

   A. Battery

   B. Light bulb

   C. Resistor

   D. Switch

9. **What is the magnetic flux through a surface S in a magnetic field B, and how is it defined?**

   A. $\Phi_B =$ ▯ $B \cdot dl$

   B. $\Phi_B = \int_S E \cdot dA$

   C. $\Phi_B = \int B \times dA$

   D. $\Phi_B = \int_S B \cdot dA$

10. **Which statement correctly describes circular polarization?**

   A. **The electric field vector rotates in time with a constant magnitude as the wave propagates.**

   B. **The electric field remains fixed in space and does not rotate.**

   C. **The electric field amplitude increases with time.**

   D. **The electric field is always parallel to the magnetic field.**

Answers

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

Explanations

1. **In a series RLC circuit, which parameter governs the exponential decay rate of the transient response, and what is the formula?**

   A. α = L/(2R); the decay is e^(−α t)

   B. α = R/(2C); the decay is e^(−α t)

   C. α = R/(2L); the decay is e^(−α t)

   D. α = 2√(L/C); the decay is e^(−α t)

In a series RLC circuit, the transient decay rate is set by the damping factor α that comes from the circuit's second-order equation. Writing the loop equation for charge q gives L d^2q/dt^2 + R dq/dt + q/C = 0, whose characteristic equation is L s^2 + R s + 1/C = 0. The roots are s = [-R ± sqrt(R^2 - 4L/C)]/(2L), and the real part of these roots is -R/(2L). That means the envelope of the transient decays like e^{-α t} with α = R/(2L). In the underdamped case, the full response is q(t) or i(t) = e^{-α t} [A cos(ω_d t) + B sin(ω_d t)], where ω_d = sqrt(1/(LC) - (R/(2L))^2. So the correct expression uses α = R/(2L) and the decay factor e^{-α t}.

2. **What is the electric field inside a conductor in electrostatic equilibrium, and why?**

   A. E = 0; charges rearrange to cancel the internal field

   B. E = nonzero constant

   C. E increases with depth

   D. E proportional to distance from surface

Inside a conductor in electrostatic equilibrium, the electric field is zero. Free charges rearrange themselves so that any attempt to set up a field inside would push charges to move, and they will keep moving until the interior field is canceled. The result is that all excess charge sits on the surface and the potential throughout the conductor is the same. The external field, if present, comes from the surface charges, but the interior remains field-free. (Note: in a non-static situation with currents, a small internal field can exist, but not in electrostatic equilibrium.)

3. What are the common polarization states of an electromagnetic plane wave and how are they defined?

A. Linear polarization: E remains in a fixed plane; Circular polarization: E rotates with constant magnitude; Elliptical polarization: E traces an ellipse.

B. Linear polarization: E rotates with constant magnitude; Circular polarization: E remains in a fixed plane; Elliptical polarization: E traces an ellipse.

C. Linear polarization: E remains in a fixed plane; Circular polarization: E rotates with constant magnitude; Elliptical polarization: E traces an ellipse.

D. Linear polarization: E magnitude remains constant; Circular polarization: E rotates with time while magnitude changes; Elliptical polarization: E is zero.

Polarization describes how the electric field vector at a fixed point moves in time as the wave passes. For a plane wave, the field is transverse, so its tip moves in the plane perpendicular to the direction of travel. In linear polarization, the two orthogonal components combine to give a resultant field that points along a fixed direction in that transverse plane. The tip of the electric field therefore traces a straight line as time varies. In circular polarization, the two transverse components have equal amplitudes but a 90-degree phase difference. This causes the tip of the electric field to rotate smoothly with time, maintaining a constant magnitude; it traces a circle. In elliptical polarization, the amplitudes and/or phase difference are such that the tip follows an ellipse. The instantaneous magnitude generally changes over time, and the path is not a straight line or a circle. So the best description matches linear polarization as remaining in a fixed direction (or fixed plane in the transverse context), circular polarization as rotating with constant magnitude, and elliptical polarization as tracing an ellipse.

4. What is the energy density of an electric field in a dielectric with electric field E and displacement D?

A. u_E = (1/2) E · D

B. u_E = E^2/(2ε0)

C. u_E = D^2/(2ε0)

D. u_E = E · D

The energy density in an electric field inside a dielectric is given by one half of the dot product of the electric field and the displacement: u = (1/2) E · D. This form captures how the field stores energy when both E and D are present, not just E alone. Think of building up the field from zero to its final value. The incremental work you do is dW = E · dD. Integrating from zero to the final D gives u = ∫0^D E(D') · dD'. In a linear dielectric, D and E are proportional (D = ε E), so E = D/ε and E · dD = (1/ε) D dD. The integral yields u = (1/2ε) D^2, which is the same as (1/2) E · D since D = ε E. This also reduces to the familiar vacuum result u = (1/2) ε0 E^2 when the medium is vacuum (D = ε0 E). So the correct form, (1/2) E · D, correctly accounts for the material’s response through D, whereas the other expressions either lack the dependence on D, or mix up the ε0 factor, or drop the 1/2.

5. Magnetic energy density per unit volume is given by which expression?

A. $u_B = B^2 /(2 \mu_0)$

B. $u_B = \mu_0 B^2 /2$

C. $u_B = B /(2 \mu_0)$

D. $u_B = B^2 /(\mu_0)$

Magnetic energy per unit volume in a vacuum grows with the square of the magnetic flux density and scales with $1/\mu_0$. The correct expression is $u_B = B^2/(2 \mu_0)$. This comes from the relation $u = \int H \cdot dB$; in vacuum $H = B/\mu_0$, so $u = \int (B/\mu_0)\, dB = B^2/(2 \mu_0)$. The energy density must be proportional to B^2 and inversely proportional to μ_0, and the 1/2 factor is the exact coefficient that arises from the integral. The other forms either miss the 1/2, place μ_0 in the numerator, or use the wrong dependence on B, leading to incorrect units or magnitudes.

6. A device that increases or decreases the voltage of alternating current?

A. Generator

B. Solenoid

C. Transformer

D. Electric Motor

Transformers use electromagnetic induction to change the voltage of alternating current. Two coils wrapped around a magnetic core transfer the energy: when the current in the primary coil changes, it makes the magnetic flux in the core vary, which induces a voltage in the secondary coil. The size of the output voltage depends on the turns ratio between the coils: more turns on the secondary give a higher voltage (step-up), fewer turns give a lower voltage (step-down). In an ideal transformer, power is conserved, so the output power roughly equals the input power ($V_sI_s \approx V_pI_p$), with current adjusting to keep the power balance. This only works with alternating current because a changing current is needed to produce a changing magnetic flux that induces the secondary voltage. A steady DC current would quickly produce a constant flux and then no further induction. The other devices don't perform this voltage transformation: a generator creates electrical energy from mechanical energy, a solenoid is simply a coil that can act as an inductor or electromagnet, and an electric motor converts electrical energy into mechanical energy rather than transforming voltage levels.

7. Which expression correctly relates the speed of light to the vacuum permeability μ0 and the vacuum permittivity ε0?

A. c = μ0 ε0

B. c = √(μ0 ε0)

C. c = 1/√(μ0 ε0)

D. c = μ0/ε0

In vacuum, the speed of light is set by the electromagnetic properties of empty space, μ0 and ε0. From Maxwell's equations, the electric field in free space satisfies the wave equation ∇^2E = μ0 ε0 ∂^2E/∂t^2, which describes waves with speed v = 1/√(μ0 ε0). Since all electromagnetic waves in vacuum travel at the same speed, that speed is c = 1/√(μ0 ε0). This also means μ0 ε0 = 1/c^2, so plugging in the constants gives c ≈ 3.00×10^8 m/s. The other expressions don't yield a velocity with the correct units or magnitude: μ0 ε0 by itself isn't a speed, √(μ0 ε0) has the wrong units, and μ0/ε0 also has incompatible dimensions.

8. What in a circuit diagram represents a resistor?

A. Battery

B. Light bulb

C. Resistor

D. Switch

In circuit diagrams, each component is shown with a symbol that reflects its function. A resistor is the element that limits or controls the flow of current, so its symbol is distinctive and identifies that function. In many diagrams you'll see a zigzag line (or, in some standards, a small rectangle) representing a resistor. The value next to it tells you the resistance in ohms, which determines how much current passes for a given voltage via Ohm's law. The other symbols correspond to different parts: a battery is a power source, a light bulb is a load that emits light, and a switch Opens or closes the circuit. So the symbol that represents the resistor is the one that depicts resistance—the resistor symbol.

9. What is the magnetic flux through a surface S in a magnetic field B, and how is it defined?

- A. $\Phi_B = \oint B \cdot dl$
- B. $\Phi_B = \int_S E \cdot dA$
- C. $\Phi_B = \int B \times dA$
- **D. $\Phi_B = \int_S B \cdot dA$**

Magnetic flux through a surface measures how much of the magnetic field passes through that surface. The standard definition uses the component of the field that is normal to the surface, integrated over the area: $\Phi_B = \int_S B \cdot dA$. Here dA is the vector area element, pointing perpendicular to the surface with magnitude equal to the differential area; the dot product $B \cdot dA$ picks out the part of B that crosses the surface and includes a sign depending on the chosen normal direction. If the field is uniform and the surface is flat, this reduces to $\Phi_B = B \cdot n A$, where n is the unit normal and A the surface area. This quantity is the one that changes in Faraday’s law to produce electromotive force, and Gauss’s law for magnetism tells us the total flux through a closed surface is zero in the absence of magnetic monopoles. The form with a dot product to a surface area vector is the correct way to define magnetic flux, not a line integral around a loop, not an electric flux through E, and not a cross product.

10. Which statement correctly describes circular polarization?

- **A. The electric field vector rotates in time with a constant magnitude as the wave propagates.**
- B. The electric field remains fixed in space and does not rotate.
- C. The electric field amplitude increases with time.
- D. The electric field is always parallel to the magnetic field.

Circular polarization means the electric field is always in the transverse plane and the tip of the E vector moves in a circle as time passes. This happens when the two perpendicular components of the electric field have equal amplitudes and a 90-degree phase difference. Because of that phase difference, the magnitude of the resultant E field stays constant while its direction rotates at the wave frequency, so the vector sweeps around in a circle as the wave propagates. In a plane wave, E and B remain perpendicular to the direction of travel, with E and B also perpendicular to each other, not parallel. The other descriptions describe linear polarization (fixed direction), a changing magnitude, or E being parallel to B, none of which match circular polarization.

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://electricitymagnetism.examzify.com

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