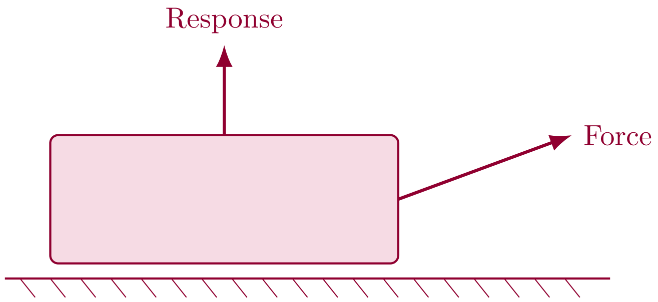
Summit PHYS 162: Physics II

Summit fully illustrated textbook edition



Original Summit-authored instructional text generated from the live course runtime, bibliography layer, and assessment structure.

March 22, 2026

@@TOKEN_0@@ Summit first edition draft @@TOKEN_1@@ college @@TOKEN_2@@ 4 @@TOKEN_3@@ 14 weeks @@TOKEN_4@@ 12.9 hours/week

Originality note

This textbook is a Summit-authored instructional text. It is informed by the course bibliography in @@TOKEN_0@@ and by open academic references used elsewhere in Summit, but it does not copy or restate any single commercial textbook.

How this textbook was built

This book was generated from the live Summit course runtime for Physics II: the syllabus, lesson sequence, reading chapters, guided practice, homework sets, quizzes, mastery exam, and workload standard. The design goal is to give a student a usable, course-complete book while preserving original Summit wording and sequencing.

An original Summit calculus-based second physics course focused on electric fields, potential, circuits, magnetism, induction, waves, optics, and modern-physics foundations for engineering systems.

Physics chapters should start from a model of the system and a picture of what is interacting. The mathematics is there to formalize that model, not replace it.

This volume is structured as a teaching book rather than a bare note pack. Every chapter contains explanation, worked examples, guided practice, chapter homework, and a rear answer key so the student can study independently and still get disciplined feedback.

Course use guide

- Read one chapter at a time in sequence; each chapter is aligned to a live lesson block in the course workspace.
- Rebuild the worked examples before attempting the graded homework or quiz material.
- Keep a scratch notebook beside the text and write down assumptions, diagrams, and the points where you usually get stuck.
- Use the course tutor, guided practice, and homework only after you can explain the chapter in your own words.

Contents

Course map

- 4 live lesson chapters
- 2 graded homework checkpoints
- 2 timed quizzes
- 1 cumulative mastery exam
- 4 declared course outcomes

Prerequisite and readiness position

Course prerequisites: physics-i, calculus-ii. Readiness clearances: calc-ii-credit, physics-mechanics-ready.

Summit Physics II begins after students can already work with calculus-based mechanics and are ready for second-course calculus ideas that support field, circuit, and wave modeling.

Semester workload standard

Summit models this course as @@TOKEN_0@@ across a 14-week term plus final assessment window. The expected distribution is:

- Contact-equivalent instruction: 56 hours
- Reading: 18 hours
- Practice and problem solving: 48 hours
- Homework: 24 hours
- Lab, design, and reporting: 14 hours
- Exam preparation: 20 hours

Expected volume:

- 140-180 problems spanning electric fields, potential, circuits, magnetism, induction, waves, and optics.
- 10 graded assignments totaling 35-45 multistep physics problems with full supporting work.
- 4-5 experiment-style analyses, modeling memos, or applied writeups tied to physical interpretation.

Reference basis

Primary synthesis anchors from the bibliography for this course (50 listed references total):

1. Electricity and Magnetism
2. Introduction to Electrodynamics
3. University Physics Volume 2
4. University Physics Volume 3
5. Fundamentals of Physics
6. University physics
7. Physics for scientists and engineers
8. Physics for scientists and engineers

Chapter 1

Chapter 1 Electric fields, potential, and electrostatic models

Chapter purpose

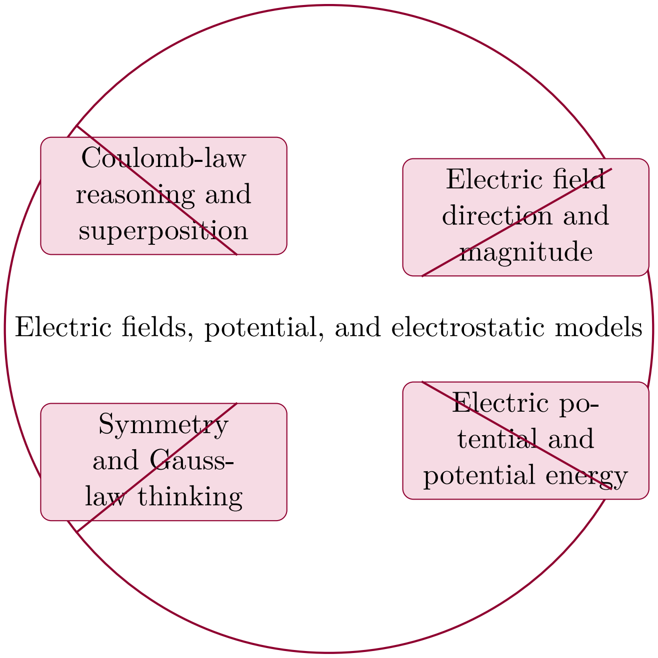
The course opens with charge interaction, electric field, potential, and field-energy ideas. Students learn to treat the field as a model that explains forces and energy changes, not just as a formula to quote after the fact.

This chapter sits at the opening of Physics II. It develops Coulomb-law reasoning and superposition, Electric field direction and magnitude, Electric potential and potential energy, and Symmetry and Gauss-law thinking so that the student can move from explanation to execution without losing the thread of the course.

This chapter should be read with a diagram-first mindset. Students need to define the system, choose coordinates, identify interactions, and decide what is being conserved or driven before they compute. The book therefore keeps physical interpretation visible in every section.

Core ideas

- Coulomb-law reasoning and superposition
- Electric field direction and magnitude
- Electric potential and potential energy
- Symmetry and Gauss-law thinking



How to think through this chapter

A strong solution in this family names assumptions, records known and unknown quantities, draws the relevant diagram, and then moves into equations. Every derived relation should still be tied to a physical story such as balance, change, accumulation, or field influence.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Physics II begins by asking students to explain how charges influence space around them. The electric field is the first serious shift from object-only thinking to distributed-model thinking.

Field language is a model of influence

Students often try to treat the electric field as a formula attached to a point charge and nothing more. The more useful viewpoint is that the field is a model of what a test charge would feel at each location in space.

That is why diagrams matter so much here. The class is learning to think about direction, strength, and symmetry before it chases numerical answers.

Superposition is disciplined vector addition

Multi-charge field problems are not about finding a clever shortcut. They are about computing one source contribution at a time and then adding those vectors honestly.

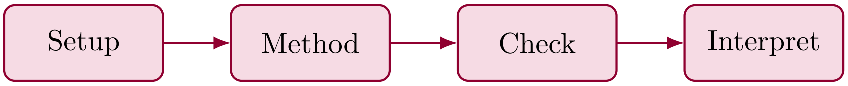
Symmetry can simplify the sum, but only after the student has identified what each contribution looks like and why certain components cancel or reinforce.

Potential changes the question from force to energy

Electric potential matters because many engineering questions care more about energy change between two locations than about the exact force vector everywhere in between.

The power of potential is that it is scalar. That simplification is not a trick. It is a different model tuned to a different kind of question.

Worked example



@@TOKEN_0@@ Two equal positive charges sit symmetrically about the origin. Explain why the horizontal electric-field components cancel on the vertical axis while the vertical components reinforce.

1. Draw the field contribution from each positive charge at the target point and resolve each contribution into components.
2. Use symmetry to show the horizontal components are equal in magnitude and opposite in direction.
3. Notice the vertical components point in the same direction, so they add.
4. Conclude that symmetry can simplify the field without replacing the need for vector reasoning.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ Two equal positive charges lie symmetrically about the origin. At a point on the vertical axis above them, what happens to the horizontal electric-field components and why?

1. Sketch the field from each charge at the target point.

2. Resolve those two field contributions into horizontal and vertical components.
3. Compare the horizontal directions and then the vertical directions.

The geometry is mirror-symmetric, so the horizontal field components have equal magnitude and opposite direction. The vertical components point the same way, so they add.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The right study pattern is draw the setup, predict the result qualitatively, solve quantitatively, and then test the answer against units, limiting cases, and physical reasonableness.

Practice while you read

Practice Set: Fields, superposition, and potential

Build electric-field vectors cleanly and decide when potential is the more efficient model.

@@TOKEN_0@@ Two equal positive charges lie symmetrically about the origin. At a point on the vertical axis above them, what happens to the horizontal electric-field components and why?

- Hint: Use symmetry only after you have identified the field direction from each charge.
- Step 1: Sketch the field from each charge at the target point.
- Step 2: Resolve those two field contributions into horizontal and vertical components.
- Step 3: Compare the horizontal directions and then the vertical directions.
- Checkpoint: The horizontal components cancel while the vertical components reinforce.

@@TOKEN_0@@ Explain why electric potential can be easier than force-by-force work when the question asks for energy change between two locations.

- Hint: Potential packages energy change per unit charge into a scalar quantity.
- Step 1: State what electric potential measures.
- Step 2: Compare a scalar potential difference to a full vector-force description.
- Step 3: Connect the potential difference back to energy change.
- Checkpoint: Potential is often easier because it gives a scalar energy-per-charge comparison between locations.

Chapter homework

@@TOKEN_0@@ Electrostatic modeling, potential interpretation, and basic circuit reduction with power reasoning.

1. Explain the steps needed to find the electric field at a point due to two perpendicular point-charge contributions.
2. Describe how electric potential can be more efficient than force integration when the engineering question is energy change between two locations.
3. Reduce a mixed simple resistor network and explain how you know whether resistors are in series or parallel.
4. A circuit dissipates power in a resistor. Explain what the power physically represents.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Separate force reasoning from field reasoning without confusing the two.
- Use superposition systematically when multiple charges contribute.
- Recognize when symmetry is strong enough to justify a Gaussian surface.

Study tips

- Sketch the field contributions before adding them.
- Use symmetry only after you know what each vector contribution is doing.
- Ask whether the problem is really about force direction or energy change.

Common traps

- Adding field magnitudes when the directions are different.
- Confusing electric field with electric potential.
- Claiming symmetry without actually checking the geometry of the point and the sources.

Family-level errors to watch for

- Writing equations before defining the system and coordinate choices.

- Ignoring units or sign conventions when translating a diagram into math.
- Failing to check whether the final answer is physically plausible.

Chapter 2

Chapter 2 Circuits, current, resistance, and energy flow

Chapter purpose

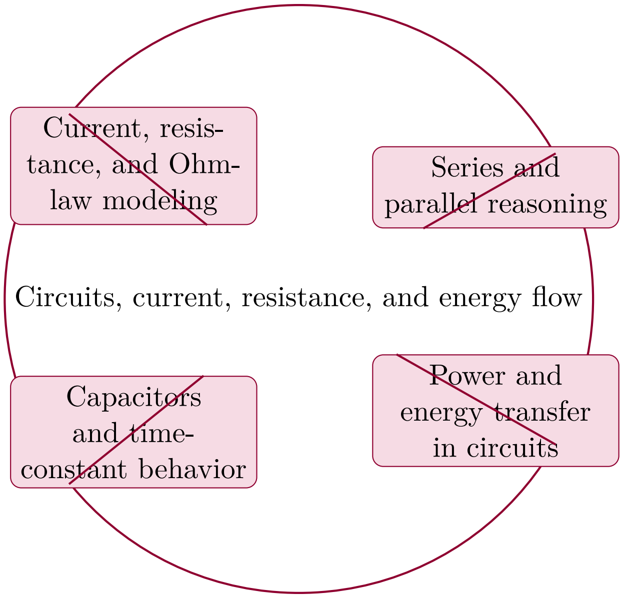
Students move from static charge to moving charge. The lesson develops current, voltage, resistance, equivalent circuits, power, and capacitor response while keeping energy transfer and physical interpretation central.

This chapter sits in the middle of Physics II. It develops Current, resistance, and Ohm-law modeling, Series and parallel reasoning, Power and energy transfer in circuits, and Capacitors and time-constant behavior so that the student can move from explanation to execution without losing the thread of the course.

This chapter should be read with a diagram-first mindset. Students need to define the system, choose coordinates, identify interactions, and decide what is being conserved or driven before they compute. The book therefore keeps physical interpretation visible in every section.

Core ideas

- Current, resistance, and Ohm-law modeling
- Series and parallel reasoning
- Power and energy transfer in circuits
- Capacitors and time-constant behavior



How to think through this chapter

A strong solution in this family names assumptions, records known and unknown quantities, draws the relevant diagram, and then moves into equations. Every derived relation should still be tied to a physical story such as balance, change, accumulation, or field influence.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Circuits teach students that electrical systems are organized by paths, nodes, and energy transfer. The formulas matter, but the real skill is to see what the loop is doing physically.

Current and voltage need a system picture

Current is the rate of charge flow through a path, while voltage records electrical energy change per unit charge between locations. Those definitions sound clean in isolation, but they become powerful only inside a full loop or network picture.

Students work faster when they keep asking where the charge is going and what energy change it experiences as it moves through the circuit.

Equivalent circuits are simplifications of the same external behavior

Equivalent resistance is not a different circuit in the physical sense. It is a simplified model that reproduces the same current-voltage behavior at the terminals being studied.

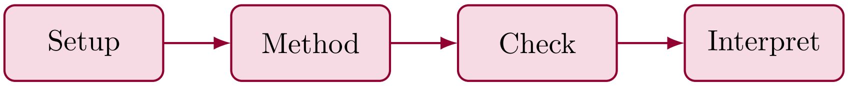
That is why reduction rules are so useful. They compress complexity without erasing the meaning of the energy-flow problem.

Power completes the interpretation

The word power should make students ask an immediate question: where is the energy going, and how fast is the transfer happening?

Once power is read that way, resistors, sources, and storage elements stop feeling like isolated symbols and start looking like participants in an energy-transfer network.

Worked example



@@TOKEN_0@@ A 12 V source drives two resistors, 4 ohms and 8 ohms, in series. Find the circuit current and the voltage drop across each resistor.

1. Add the resistances in series to get an equivalent resistance of 12 ohms.
2. Use Ohms law on the whole circuit to get I = V / R = 12 / 12 = 1 A.
3. Use V = IR for each resistor separately to get 4 V across the 4 ohm resistor and 8 V across the 8 ohm resistor.
4. Check that the individual drops add to the source voltage, confirming the circuit balance.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A 12 V source drives two resistors, 4 ohms and 8 ohms, in series. Find the circuit current.

1. Add the series resistances to get the equivalent resistance.
2. Use I = V/R for the whole circuit.
3. State the result with amperes.

The equivalent resistance is 4 + 8 = 12 ohms, so the circuit current is I = 12/12 = 1 A.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The right study pattern is draw the setup, predict the result qualitatively, solve quantitatively, and then test the answer against units, limiting cases, and physical reasonableness.

Practice while you read

Practice Set: Circuits and energy flow

Use circuit reduction, Ohm-law modeling, and power interpretation together.

@@TOKEN_0@@ A 12 V source drives two resistors, 4 ohms and 8 ohms, in series. Find the circuit current.

- Hint: Reduce the series path first before applying Ohms law to the whole loop.
- Step 1: Add the series resistances to get the equivalent resistance.
- Step 2: Use $I = V/R$ for the whole circuit.
- Step 3: State the result with amperes.
- Checkpoint: Current = 1 A

@@TOKEN_0@@ A resistor carries 2 A with a 6 V drop across it. What power is being dissipated, and what does that mean physically?

- Hint: Use $P = IV$ and then translate watts into an energy-transfer statement.
- Step 1: Compute the power using voltage and current.
- Step 2: Write the unit in watts.
- Step 3: Explain the result as an energy-transfer rate.
- Checkpoint: Power = 12 W, meaning 12 joules per second are being transferred into the resistor.

Chapter homework

@@TOKEN_0@@ Electrostatic modeling, potential interpretation, and basic circuit reduction with power reasoning.

1. Explain the steps needed to find the electric field at a point due to two perpendicular point-charge contributions.

2. Describe how electric potential can be more efficient than force integration when the engineering question is energy change between two locations.
3. Reduce a mixed simple resistor network and explain how you know whether resistors are in series or parallel.
4. A circuit dissipates power in a resistor. Explain what the power physically represents.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Reduce a simple network without losing the physical meaning of voltage and current.
- Explain what circuit power means rather than reporting watts without context.
- Use the RC time constant as a system-response idea, not just a memorized symbol pair.

Study tips

- Name the branch structure before reducing the network.
- Use Ohms law after the geometry of the circuit is already clear.
- Whenever you compute watts, say what element is sending or receiving the energy.

Common traps

- Calling elements series or parallel without checking the path or nodes carefully.
- Reducing a circuit correctly but never interpreting the current or voltage physically.
- Treating power as a number without naming the energy transfer it represents.

Family-level errors to watch for

- Writing equations before defining the system and coordinate choices.
- Ignoring units or sign conventions when translating a diagram into math.
- Failing to check whether the final answer is physically plausible.

Chapter 3

Chapter 3 Magnetism, induction, and electromagnetic coupling

Chapter purpose

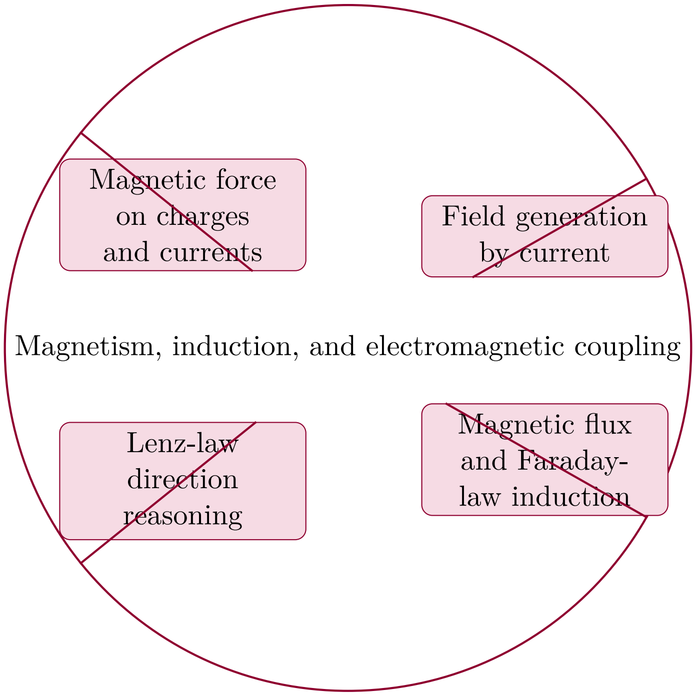
The third lesson ties moving charge to magnetic response. Students analyze magnetic force, simple field generation, changing flux, and induced emf while learning why electromagnetism is a coupled system story rather than two separate chapters.

This chapter sits in the middle of Physics II. It develops Magnetic force on charges and currents, Field generation by current, Magnetic flux and Faraday-law induction, and Lenz-law direction reasoning so that the student can move from explanation to execution without losing the thread of the course.

This chapter should be read with a diagram-first mindset. Students need to define the system, choose coordinates, identify interactions, and decide what is being conserved or driven before they compute. The book therefore keeps physical interpretation visible in every section.

Core ideas

- Magnetic force on charges and currents
- Field generation by current
- Magnetic flux and Faraday-law induction
- Lenz-law direction reasoning



How to think through this chapter

A strong solution in this family names assumptions, records known and unknown quantities, draws the relevant diagram, and then moves into equations. Every derived relation should still be tied to a physical story such as balance, change, accumulation, or field influence.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Magnetism and induction are where Physics II becomes a coupling story. Moving charge, changing flux, and induced responses all have to be read together rather than as separate rule sets.

Magnetic force bends motion instead of creating charge from nowhere

Students first need to understand what the magnetic field does to moving charge or current-carrying conductors. The magnetic force changes motion or separates charge, but it is not itself an algebraic decoration on the problem.

This is why right-hand rules should always be grounded in a sketch. Direction choices become much more reliable when the geometry is visible.

Induction starts from changing flux

Faradays law is easier when students stop searching for a memorized phrase and instead ask one clean question: is the magnetic flux through the system changing?

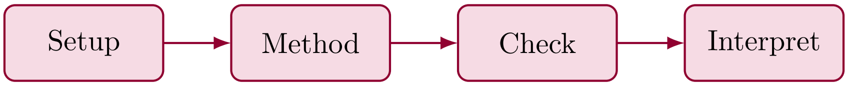
If the answer is yes, the class then asks what induced electrical response would oppose that change. That physical opposition is the heart of Lenzs law.

Physics II is teaching system response, not isolated formulas

Motional emf, loop induction, and magnetic-field generation all matter because they show how one part of an electromagnetic system reacts when another part changes.

The course is building the habit of reading the whole coupling, which is why these topics matter so much in sensors, actuators, and machines.

Worked example



@@TOKEN_0@@ A wire of length 0.5 m moves at 3 m/s perpendicular to a 2 T magnetic field. Compute the motional emf and explain the physical origin.

1. Use the motional-emf relation emf = BLv when the motion, field, and conductor are perpendicular.
2. Substitute the values to get emf = 2(0.5)(3) = 3 V.
3. Explain that charges in the moving conductor experience magnetic force, creating charge separation and a measurable voltage.
4. Separate this induction result from any later current that would depend on the external circuit.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A 0.5 m conductor moves at 3 m/s perpendicular to a 2 T magnetic field. What motional emf is induced?

1. Write the motional-emf formula.

2. Substitute B = 2, L = 0.5, and v = 3.
3. Multiply and keep volts as the unit.

For perpendicular motion, emf = BLv = 2(0.5)(3) = 3 V.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The right study pattern is draw the setup, predict the result qualitatively, solve quantitatively, and then test the answer against units, limiting cases, and physical reasonableness.

Practice while you read

Practice Set: Magnetism and induction

Separate magnetic-force questions from induction logic and handle flux-change direction carefully.

@@TOKEN_0@@ A 0.5 m conductor moves at 3 m/s perpendicular to a 2 T magnetic field. What motional emf is induced?

- Hint: Use the perpendicular-motion relation emf = BLv.
- Step 1: Write the motional-emf formula.
- Step 2: Substitute B = 2, L = 0.5, and v = 3.
- Step 3: Multiply and keep volts as the unit.
- Checkpoint: emf = 3 V

@@TOKEN_0@@ When magnetic flux through a loop is increasing, what conceptual question should you ask first to use Lenzs law correctly?

- Hint: Do not jump to clockwise or counterclockwise immediately.
- Step 1: State what is changing in the flux.
- Step 2: Ask what induced magnetic effect would oppose that change.
- Step 3: Only then decide the loop-current direction from the geometry.
- Checkpoint: Ask what induced response would oppose the increasing flux.

Chapter homework

@@TOKEN_0@@ Magnetic-force direction, induction logic, and wave or optics interpretation for engineering systems.

1. Explain the difference between magnetic force on a moving charge and induced emf in a loop with changing flux.
2. A current-carrying wire enters a uniform magnetic field. Outline how to determine the force direction with a right-hand rule.
3. Describe how to decide whether a wave-measurement point will see constructive or destructive interference.
4. Explain why waves and optics appear in engineering sensors and communication systems.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Keep right-hand-rule direction choices tied to a sketch rather than memory alone.
- Explain induced emf with changing flux, not vague motion language only.
- Distinguish clearly between a force calculation and an induction calculation.

Study tips

- Sketch the geometry before using any right-hand rule.
- Ask whether the problem is about magnetic force or induced emf before choosing a formula.
- Describe what flux is doing before deciding the induced direction.

Common traps

- Using the right-hand rule in the air without a diagram.
- Confusing force-on-charge questions with induction questions.
- Applying Lenzs law as a slogan without identifying what change is being opposed.

Family-level errors to watch for

- Writing equations before defining the system and coordinate choices.

- Ignoring units or sign conventions when translating a diagram into math.
- Failing to check whether the final answer is physically plausible.

Chapter 4

Chapter 4 Waves, optics, and modern-physics foundations

Chapter purpose

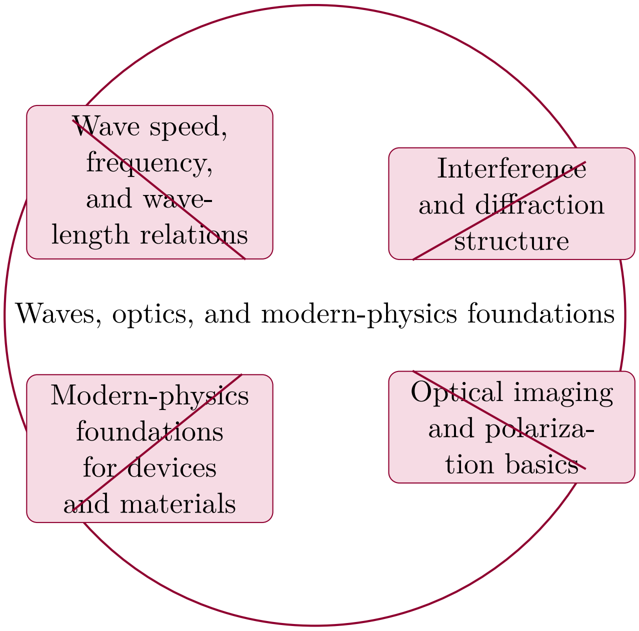
The final lesson treats waves and light as engineering carriers of information and measurement. Interference, diffraction, optical behavior, and selected modern-physics ideas are framed as foundational tools for later sensing and device work.

This chapter sits at the end of Physics II. It develops Wave speed, frequency, and wavelength relations, Interference and diffraction structure, Optical imaging and polarization basics, and Modern-physics foundations for devices and materials so that the student can move from explanation to execution without losing the thread of the course.

This chapter should be read with a diagram-first mindset. Students need to define the system, choose coordinates, identify interactions, and decide what is being conserved or driven before they compute. The book therefore keeps physical interpretation visible in every section.

Core ideas

- Wave speed, frequency, and wavelength relations
- Interference and diffraction structure
- Optical imaging and polarization basics
- Modern-physics foundations for devices and materials



How to think through this chapter

A strong solution in this family names assumptions, records known and unknown quantities, draws the relevant diagram, and then moves into equations. Every derived relation should still be tied to a physical story such as balance, change, accumulation, or field influence.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

The final lesson of Physics II treats waves and light as carriers of information, pattern, and measurement. Students need to connect geometry, phase, and observation cleanly.

Wave relations are one story told three ways

Speed, frequency, and wavelength are not three unrelated facts. They are one linked description of how quickly a disturbance travels, how often the source cycles, and how far apart repeated features appear in space.

Students should not memorize v = f lambda mechanically. They should be able to say what changing one of those quantities means for the other two.

Interference is phase made visible

Bright and dark patterns in interference setups are really phase comparisons expressed through geometry. Path difference matters only because it changes the phase relationship between the arriving waves.

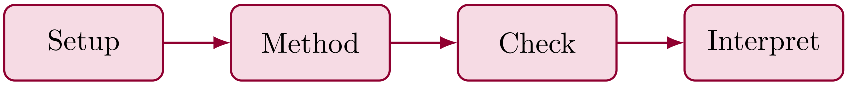
This viewpoint is what lets the student move between equations, diagrams, and actual observed patterns without losing track of what the math is describing.

Optics is measurement language

Optics belongs in an engineering physics course because light is a tool for measurement, signaling, and device behavior. The student should keep that applied frame in mind rather than treating the chapter as abstract wave theory.

That is also why modern-physics foundations appear at the end. The course is preparing students to see where these wave and light models become device-level engineering ideas.

Worked example



@@TOKEN_0@@ Light of wavelength 600 nm travels through a double-slit setup. Explain why path difference of one wavelength gives bright interference while half a wavelength gives dark interference.

1. Relate path difference to phase difference using the wavelength as the repeating distance of the wave pattern.
2. A full wavelength path difference keeps the waves in phase, so crest meets crest and reinforcement occurs.
3. A half-wavelength path difference puts crest against trough, so cancellation occurs.
4. This is the superposition idea seen in an optical measurement context.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A wave has speed 200 m/s and frequency 50 Hz. Find the wavelength.

1. Write lambda = v/f.
2. Substitute the given speed and frequency.
3. Interpret the result as the spatial size of one full cycle.

The wavelength is lambda = 200/50 = 4 m, meaning one full wave cycle occupies 4 meters in space.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The right study pattern is draw the setup, predict the result qualitatively, solve quantitatively, and then test the answer against units, limiting cases, and physical reasonableness.

Practice while you read

Practice Set: Waves, interference, and optics

Translate path difference into phase and keep the basic wave relations tied to physical meaning.

@@TOKEN_0@@ A wave has speed 200 m/s and frequency 50 Hz. Find the wavelength.

- Hint: Use the basic wave relation linking speed, frequency, and wavelength.
- Step 1: Write lambda = v/f.
- Step 2: Substitute the given speed and frequency.
- Step 3: Interpret the result as the spatial size of one full cycle.
- Checkpoint: Wavelength = 4 m

@@TOKEN_0@@ Why does a path difference of half a wavelength produce destructive interference?

- Hint: Translate the path difference into a phase relationship first.
- Step 1: Recall that one wavelength corresponds to one full cycle.
- Step 2: Interpret half a wavelength as a half-cycle phase shift.
- Step 3: State what happens when one crest meets the other waves trough.
- Checkpoint: Half a wavelength means the waves arrive out of phase and cancel.

Chapter homework

@@TOKEN_0@@ Magnetic-force direction, induction logic, and wave or optics interpretation for engineering systems.

1. Explain the difference between magnetic force on a moving charge and induced emf in a loop with changing flux.
2. A current-carrying wire enters a uniform magnetic field. Outline how to determine the force direction with a right-hand rule.
3. Describe how to decide whether a wave-measurement point will see constructive or destructive interference.
4. Explain why waves and optics appear in engineering sensors and communication systems.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Translate path difference into phase and interference conditions cleanly.
- Explain what a wave measurement says physically about a system rather than only giving a formula result.
- Connect the wave or optics model to engineering instrumentation or device behavior.

Study tips

- Translate path difference into phase before deciding bright or dark.
- Keep v, f, and lambda linked in words as well as algebra.
- Whenever possible, connect the wave pattern back to sensing, communication, or imaging behavior.

Common traps

- Memorizing bright/dark conditions without understanding phase.
- Using wavelength, frequency, and speed inconsistently.
- Treating optics as detached from measurement or signal applications.

Family-level errors to watch for

- Writing equations before defining the system and coordinate choices.
- Ignoring units or sign conventions when translating a diagram into math.
- Failing to check whether the final answer is physically plausible.

Chapter 5

Quiz review and official exam preparation

Homework structure

- Homework Set 1: Fields, potential, and circuits: 4 graded problems attached to chapter 1.
- Homework Set 2: Magnetism, induction, and waves: 4 graded problems attached to chapter 2.

Quiz structure

- Quiz 1: Electrostatics and circuits: 4 questions, timed, and single-attempt in the live course. Quiz 1 should be taken only after you can solve the chapter homework without outside prompts.
- Quiz 2: Magnetism, induction, and waves: 4 questions, timed, and single-attempt in the live course. Quiz 2 should be taken only after you can solve the chapter homework without outside prompts.

Official mastery exam

- Physics II cumulative mastery exam: 6 major questions, High rigor, first official attempt locks the course grade.

Physics II cumulative mastery exam preparation checklist

- Review how field, potential, and circuit models are chosen rather than memorizing disconnected equations.
- Practice magnetic-force direction logic and induction reasoning with sketches until the physical story is clear.

- Work wave and interference problems by translating path or circuit conditions into phase, energy, or system-response language.
- Expect the official exam to grade written justification, not only numeric answers.

How to use this book before assessment

- Read the relevant chapter and rebuild both worked examples without looking.
- Solve the guided practice in the chapter before attempting the graded homework.
- Check your chapter-homework answers only after you complete a full written attempt.
- Review the quiz answer key after each chapter block and classify your errors by concept, setup, algebra, or interpretation.
- Before the official exam, revisit the chapter purposes, homework corrections, and answer-key notes rather than rereading formulas only.

Chapter 6

Course vocabulary index

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Chapter 7

Back-of-book answers and solution outlines

Guided practice answer key

Chapter 1: Electric fields, potential, and electrostatic models

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1. Two equal positive charges lie symmetrically about the origin. At a point on the vertical axis above them, what happens to the horizontal electric-field components and why?

- Checkpoint answer: The horizontal components cancel while the vertical components reinforce. - Solution note: The geometry is mirror-symmetric, so the horizontal field components have equal magnitude and opposite direction. The vertical components point the same way, so they add.

1. Explain why electric potential can be easier than force-by-force work when the question asks for energy change between two locations.

- Checkpoint answer: Potential is often easier because it gives a scalar energy-per-charge comparison between locations. - Solution note: Electric potential is a scalar model tied directly to energy change per unit charge, so it can answer many location-comparison questions more directly than a full vector-force analysis.

Chapter 2: Circuits, current, resistance, and energy flow

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1. A 12 V source drives two resistors, 4 ohms and 8 ohms, in series. Find the circuit current.

- Checkpoint answer: Current = 1 A - Solution note: The equivalent resistance is 4 + 8 = 12 ohms, so the circuit current is I = 12/12 = 1 A.

1. A resistor carries 2 A with a 6 V drop across it. What power is being dissipated, and what does that mean physically?

- Checkpoint answer: Power = 12 W, meaning 12 joules per second are being transferred into the resistor. - Solution note: P = IV = 6(2) = 12 W. That means electrical energy is being transferred into the resistor at a rate of 12 joules per second.

Chapter 3: Magnetism, induction, and electromagnetic coupling

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1. A 0.5 m conductor moves at 3 m/s perpendicular to a 2 T magnetic field. What motional emf is induced?

- Checkpoint answer: emf = 3 V - Solution note: For perpendicular motion, emf = BLv = 2(0.5)(3) = 3 V.

1. When magnetic flux through a loop is increasing, what conceptual question should you ask first to use Lenzs law correctly?

- Checkpoint answer: Ask what induced response would oppose the increasing flux. - Solution note: Lenzs law is easiest when you first identify the changing flux and then ask what induced magnetic response would oppose that change. The direction decision comes after that physical reasoning.

Chapter 4: Waves, optics, and modern-physics foundations

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1. A wave has speed 200 m/s and frequency 50 Hz. Find the wavelength.

- Checkpoint answer: Wavelength = 4 m - Solution note: The wavelength is lambda = 200/50 = 4 m, meaning one full wave cycle occupies 4 meters in space.

1. Why does a path difference of half a wavelength produce destructive interference?

- Checkpoint answer: Half a wavelength means the waves arrive out of phase and cancel. - Solution note: A half-wavelength path difference corresponds to a half-cycle phase shift, so crest aligns with trough and the two waves cancel to produce destructive interference.

Homework answer key

Homework Set 1: Fields, potential, and circuits

1. Explain the steps needed to find the electric field at a point due to two perpendicular point-charge contributions.

- Answer / solution summary: Compute each field contribution separately, resolve each into components, add the components, and then recover the net magnitude and direction from the combined vector.

1. Describe how electric potential can be more efficient than force integration when the engineering question is energy change between two locations.

- Answer / solution summary: Potential allows the energy change of a charge to be found from a scalar difference rather than by rebuilding the force path directly in every case.

1. Reduce a mixed simple resistor network and explain how you know whether resistors are in series or parallel.

- Answer / solution summary: Series elements carry the same current sequentially, so their resistances add directly. Parallel elements connect across the same two nodes, so their reciprocal-resistance relationship applies.

1. A circuit dissipates power in a resistor. Explain what the power physically represents.

- Answer / solution summary: Electrical power is the rate at which the circuit transfers energy into the resistor, usually appearing as thermal energy through charge interaction in the material.

Homework Set 2: Magnetism, induction, and waves

1. Explain the difference between magnetic force on a moving charge and induced emf in a loop with changing flux.

- Answer / solution summary: Magnetic force describes how moving charges are pushed in a field, while induced emf describes the voltage response caused by changing magnetic flux through a conducting path or relative motion.

1. A current-carrying wire enters a uniform magnetic field. Outline how to determine the force direction with a right-hand rule.

- Answer / solution summary: Sketch the current direction and magnetic-field direction, apply the right-hand rule to the vector relation, and then interpret the resulting force relative to the geometry.

1. Describe how to decide whether a wave-measurement point will see constructive or destructive interference.

- Answer / solution summary: Compare path difference to the wavelength. Integer-multiple wavelength differences reinforce, while half-integer offset differences cancel.

1. Explain why waves and optics appear in engineering sensors and communication systems.

- Answer / solution summary: Wave behavior governs how information propagates, interferes, and is detected, so optics and waves directly support sensing, imaging, and communication hardware.

Quiz answer key

Quiz 1: Electrostatics and circuits

1. What principle allows the net electric field from multiple charges to be built from the field of each charge separately?

- Answer key: Superposition. Electric fields from multiple sources are combined by superposition.

1. Two resistors 2 ohms and 4 ohms are in series. What is the equivalent resistance?

- Answer key: Accepted answer(s): 6, 6.0, 6 ohms. Series resistances add directly, so the equivalent resistance is 6 ohms.

1. Why is electric potential often easier than force-by-force work when the question is energy change between two points?

- Answer key: Potential is a scalar energy-per-charge model. Potential is a scalar quantity tied directly to energy change per unit charge.

1. A 9 V source drives a 3 ohm resistor. What current flows?

- Answer key: Accepted answer(s): 3, 3.0, 3 A. Ohms law gives I = V / R = 9 / 3 = 3 A.

Quiz 2: Magnetism, induction, and waves

1. What quantity must change to produce induced emf through Faraday-law reasoning?

- Answer key: Magnetic flux. Induced emf is tied to changing magnetic flux.

1. A 0.4 m conductor moves at 5 m/s perpendicular to a 2 T field. What motional emf is induced?

- Answer key: Accepted answer(s): 4, 4.0, 4 V. For perpendicular motion, emf = BLv = 2(0.4)(5) = 4 V.

1. Constructive interference occurs when the path difference is:

- Answer key: An integer multiple of the wavelength. Constructive interference occurs when the path difference corresponds to an integer number of wavelengths.

1. A wave has frequency 50 Hz and speed 200 m/s. What is its wavelength?

- Answer key: Accepted answer(s): 4, 4.0, 4 m. Wavelength is speed divided by frequency, so 200 / 50 = 4 m.

Mastery exam solution outlines

Physics II cumulative mastery exam

1. Describe a complete method for finding the electric field direction and magnitude at a point caused by a small set of point charges.

- What to show: How superposition is organized; How vector direction is chosen; How the final field is interpreted - Solution outline: Compute the field contribution from each charge separately using Coulomb-law structure and the correct direction away from positive or toward negative charge. Resolve the contributions into components and add them vectorially. Interpret the magnitude and direction of the net field at the target point.

1. A long insulated system has strong symmetry. Explain how you would decide whether Gausss law is the right tool and what Gaussian surface you would choose.

- What to show: The symmetry test; How the surface aligns with the field; What quantity Gausss law solves for efficiently - Solution outline: Check whether the field has symmetry strong enough to make its magnitude constant over part of a chosen surface. Choose a Gaussian surface that aligns with that symmetry so the electric-flux integral collapses cleanly. Use enclosed charge to solve for the electric field magnitude or its dependence on radius.

1. Outline how you would analyze a resistor-capacitor charging circuit if the engineering question is how long it takes to reach a target fraction of the final voltage.

- What to show: The qualitative charging model; How the time constant enters; How the target voltage is turned into time - Solution outline: Use the exponential charging model for capacitor voltage in an RC circuit. Identify the time constant tau = RC as the system response scale. Set the capacitor voltage equal to the target fraction of the final value and solve for time.

1. Explain how magnetic force and induction reasoning differ when analyzing a conductor moving through a magnetic field.

- What to show: What magnetic force acts on directly; How motion creates induced emf; How the engineering interpretation changes - Solution outline: Magnetic force acts on moving charges or current-carrying conductors in the field. Relative motion through the field can change magnetic flux and create induced emf. The analysis must distinguish between force on charges and voltage generated by changing flux or motion.

1. You are asked to analyze an optical or wave-measurement setup. Describe how phase, path difference, and interference should be used to predict whether the sensor sees reinforcement or cancellation.

- What to show: How path difference turns into phase difference; The condition for constructive or destructive interference; What the observed signal means physically - Solution outline: Relate path difference to phase difference using the wavelength. Use integer-wavelength conditions for reinforcement and half-integer offset for cancellation. Interpret the observed amplitude in terms of the wave superposition at the sensor.

1. Explain why Physics II is still foundational for engineers who are not planning to specialize in electrical engineering.

- What to show: At least two downstream engineering applications; How fields, circuits, or waves appear in instruments or systems; Why the course matters for model selection - Solution outline: Fields, circuits, and waves show up in sensing, controls, communications, power, instrumentation, and modern materials. Even non-electrical engineers work with devices that convert physical behavior into electrical signals. Physics II teaches the field-and-circuit models needed to interpret those systems rather than treating them as black boxes.

Reference note

For the full bibliography behind this textbook, use @@TOKEN_0@@. The answer key in this book is Summit-authored and aligned to the live course runtime.