AP PHYSICS C: ELECTRICITY AND MAGNETISM

AP Pacing Guide for Flipped Classrooms: Jan.–April 2021

Overview

Due to the challenges associated with hybrid and remote learning in 2020-21, a significant amount of the content and skills colleges are requiring for credit will likely need to be assigned to students as homework or independent learning. This guide allows students who are currently behind to complete all course topics from the course and exam description by May. This guide assumes students will complete approximately 30 minutes of AP Daily videos (~10 minutes each) and topic questions each day in lieu of, or addition to, assignments the teacher would ordinarily give.

How to Implement

Here is guidance for implementing this pacing guide:

- Teachers should **assign the AP Daily videos and topic questions** listed below as student assignments each week.
- Using the reports generated by the topic questions, teachers should focus their limited, direct class time on the Learning Objectives where students need more help.
- If students are ahead of the pace indicated below, teachers will be able to incorporate additional days or weeks to spend more time on challenging topics, practicing course skills, or reviewing for the exam.

Week 1: Jan. 4–8

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.1	Electrostatics: Charge and Coulomb's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6 AP Daily Video 7	ACT-1.A: Describe behavior of charges or system of charged objects interacting with each other. ACT-1.B: Explain and/or describe the behavior of a neutral object in the presence of a charged object or a system of charges. *(continued on next page)*	Topic Questions

*Prioritize the most challenging Learning Objectives for your students for direct, synchronous instruction.

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.1	Electrostatics: Charge and Coulomb's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6 AP Daily Video 7	ACT-1.C: a. Calculate the net electrostatic force on a single point charge due to other point charges. b. Calculate unknown quantities such as the force acting on a specified charge or the distances between charges in a system of static point charges. ACT-1.D: Determine the motion of a charged object of specified charge and mass under the influence of an electrostatic force.	Topic Questions

Week 2: Jan. 11–15

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.2	Electrostatics: Electric Field and Electric Potential	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-1.A: Using the definition of electric field, unknown quantities (such as charge, force, field, and direction of field) can be calculated in an electrostatic system of a point charge or an object with a charge in a specified electric field. FIE-1.B: Describe and calculate the electric field due to a single point charge. FIE-1.C: Describe and calculate the electric field due to a dipole or a configuration of two or more static-point charges. FIE-1.D: Explain or interpret an electric field diagram of a system of charges. FIE-1.E: Sketch an electric-field diagram of a single point charge, a dipole, or a collection of static-point charges. FIE-1.F: Determine the qualitative nature of the motion of a charged particle of specified charge and mass placed in a uniform electric field. FIE-1.G: Sketch the trajectory of a known charged particle placed in a known uniform electric field.	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.2	Electrostatics: Electric Field and Electric Potential	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-1.A: Using the definition of electric field, unknown quantities (such as charge, force, field, and direction of field) can be calculated in an electrostatic system of a point charge or an object with a charge in a specified electric field. FIE-1.B: Describe and calculate the electric field due to a single point charge. FIE-1.C: Describe and calculate the electric field due to a dipole or a configuration of two or more static-point charges. FIE-1.D: Explain or interpret an electric field diagram of a system of charges. FIE-1.E: Sketch an electric-field diagram of a single point charge, a dipole, or a collection of static-point charges. FIE-1.F: Determine the qualitative nature of the motion of a charged particle of specified charge and mass placed in a uniform electric field. FIE-1.G: Sketch the trajectory of a known charged particle placed in a known uniform electric field.	Topic Questions
1.3	Electrostatics: Electric Potential Due to Point Charges and Uniform Fields	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5	CNV-1.A: Calculate the value of the electric potential in the vicinity of one or more point charges. CNV-1.B: Mathematically represent the relationships between the electric charge, the difference in electric potential, and the work done (or electrostatic potential energy lost or gained) in moving a charge between two points in a known electric field. CNV-1.C: a. Calculate the electrostatic potential energy of a collection of two or more point charges held in a static configuration. b. Calculate the amount of work needed to assemble a configuration of point charges in some known static configuration. CNV-1.D: Calculate the potential difference between two points in a uniform electric field and determine which point is at the higher potential. CNV-1.E: Calculate the work done or changes in kinetic energy (or changes in speed) of a charged particle when it is moved through some known potential difference. *(continued on next page)*	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.3	Electrostatics: Electric Potential Due to Point Charges and Uniform Fields	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5	CNV-1.F: a. Describe the relative magnitude and direction of an electrostatic field given a diagram of equipotential lines. b. Describe characteristics of a set of equipotential lines given in a diagram of an electric field. c. Describe the general relationship between electric field lines and a set of equipotential lines for an electrostatic field. CNV-1.G: a. Use the general relationship between electric field and electric potential to calculate the relationships between the magnitude of electric field or the potential difference as a function of position. b. Use integration techniques to calculate a potential difference between two points on a line, given the electric field as a function of position on that line.	Topic Questions

Week 3: Jan. 18–22

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.4	Electrostatics: Gauss's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-2.A: a. State and apply the general definition of electric flux. b. Calculate the electric flux through an arbitrary area or through a geometric shape (e.g., cylinder, sphere). c. Calculate the flux through a rectangular area when the electric field is perpendicular to the rectangle and is a function of one position coordinate only. CNV-2.B: Qualitatively apply Gauss's Law to a system of charges or charged region to determine characteristics of the electric field, flux, or charge contained in the system. CNV-2.C: State and use Gauss's Law in integral form to derive unknown electric fields for planar, spherical, or cylindrically symmetrical charge distributions. *(continued on next page)*	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.4	Electrostatics: Gauss's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-2.D: a. Using appropriate mathematics (which may involve calculus), calculate the total charge contained in lines, surfaces, or volumes when given a linear-charge density, a surface-charge density, or a volume-charge density of the charge configuration. b. Use Gauss's Law to calculate an unknown charge density or total charge on surface in terms of the electric field near the surface. CNV-2.E: a. Qualitatively describe electric fields around symmetrically (spherically, cylindrically, or planar) charged distributions. b. Describe the general features of an electric field due to symmetrically shaped charged distributions. CNV-2.F: Describe the general features of an unknown charge distribution, given other features of the system.	Topic Questions

Week 4: Jan. 25–29

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
1.5	Electrostatics: Fields and Potentials of Other Charge Distributions	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	CNV-3.A: Derive expressions for the electric field of specified charge distributions using integration and the principle of superposition. Examples of such charge distributions include a uniformly charged wire, a thin ring of charge (along the axis of the ring), and a semicircular or part of a semicircular arc. CNV-3.B: a. Identify and qualitatively describe situations in which the direction and magnitude of the electric field can be deduced from symmetry considerations and understanding the general behavior of certain charge distributions. b. Describe an electric field as a function of distance for the different types of symmetrical charge distributions. CNV-3.C: a. Derive expressions for the electric potential of a charge distribution using integration and the principle of superposition. b. Describe electric potential as a function of distance for the different types of symmetrical charge distributions. c. Identify regions of higher and lower electric potential by using a qualitative (or quantitative) argument to apply to the charged region of space.	Topic Questions Personal Progress Check

Week 5: Feb. 1–5

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
2.1	Conductors, Capacitors, Dielectrics: Electrostatics with Conductors	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	ACT-2.A: a. Recognize that the excess charge on a conductor in electrostatic equilibrium resides entirely on the surface of a conductor. b. Describe the consequence of the law of electrostatics and that it is responsible for the other law of conductors (that states there is an absence of an electric field inside of a conductor). ACT-2.B: a. Explain why a conducting surface must be an equipotential surface. b. Describe the consequences of a conductor being an equipotential surface. c. Explain how a change to a conductor's charge density due to an external electric field will not change the electric-field value inside the conductor. ACT-2.C: a. Describe the process of charging a conductor by induction. b. Describe the net charge residing on conductors during the process of inducing a charge on an electroscope/conductor. ACT-2.D: Explain how a charged object can attract a neutral conductor. ACT-2.E: Describe the concept of electrostatic shielding. ACT-3.A: a. For charged conducting spheres or spherical shells, describe the electric field with respect to position. b. For charged conducting spheres or spherical shells, describe the electric potential with respect to position. ACT-3.B: Calculate the electric potential on the surfaces of two charged conducting spheres when connected by a conducting wire.	Topic Questions

Week 6: Feb. 8–12

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
2.2	Conductors, Capacitors, Dielectrics: Capacitors	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-4.A: a. Apply the general definition of capacitance to a capacitor attached to a charging source. b. Calculate unknown quantities such as charge, potential difference, or capacitance for physical system with a charged capacitor. CNV-4.B: a. Use the relationship for stored electrical potential energy for a capacitor. b. Calculate quantities such as charge, potential difference, capacitance, and potential energy of a physical system with a charged capacitor. CNV-4.C: Explain how a charged capacitor, which has stored energy, may transfer that energy into other forms of energy. CNV-4.D: a. Derive an expression for a parallel-plate capacitor in terms of the geometry of the capacitor and fundamental constants. b. Describe the properties of a parallel-plate capacitor in terms of the electric field between the plates, the potential difference between the plates, the charge on the plates, and distance of separation between the plates. c. Calculate physical quantities such as charge, potential difference, electric field, surface area, and distance of separation for a physical system that contains a charged parallel-plate capacitor. d. Explain how a change in the geometry of a capacitor will affect the capacitance value. CNV-4.E: Apply the relationship between the electric field between the capacitor plates and the surface-charge density on the plates. CNV-4.F: Derive expressions for the energy stored in a parallel-plate capacitor or the energy per volume of the capacitor. *(continued on next page)*	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
2.2	Conductors, Capacitors, Dielectrics: Capacitors	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-4.G: a. Describe the consequences to the physical system of a charged capacitor when a conduction slab is inserted between the plates or when the conducting plates are moved closer or farther apart. b. Calculate unknown quantities such as charge, potential difference, charge density, electric field, and stored energy when a conducting slab is placed in between the plates of a charged capacitor or when the plates of a charged capacitor are moved closer or farther apart. CNV-4.H: Derive expressions for a cylindrical capacitor or a spherical capacitor in terms of the geometry of the capacitor and fundamental constants. CNV-4.I: Calculate physical quantities such as charge, potential difference, electric field, surface area, and distance of separation for a physical system that contains a charged capacitor.	Topic Questions
2.3	Conductors, Capacitors, Dielectrics: Dielectrics	AP Daily Video 1 AP Daily Video 2	FIE-2.A: Describe and/or explain the physical properties of an insulating material when the insulator is placed in an external electric field. FIE-2.B: Explain how a dielectric inserted in between the plates of a capacitor will affect the properties of the capacitor, such as potential difference, electric field between the plates, and charge on the capacitor. FIE-2.C: Use the definition of the capacitor to describe changes in the capacitance value when a dielectric is inserted between the plates. FIE-2.D: a. Calculate changes in energy, charge, or potential difference when a dielectric is inserted into an isolated charge capacitor. b. Calculate changes in energy, charge, or potential difference when a dielectric is inserted into a capacitor that is attached to a source of potential difference.	Topic Questions Personal Progress Check

CollegeBoard

Week 7: Feb. 15–19

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
3.1	Electric Circuits: Current and Resistance	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-3.A: a. Calculate unknown quantities relating to the definition of current. b. Describe the relationship between the magnitude and direction of current to the rate of flow of positive or negative charge. FIE-3.B: a. Describe the relationship between current, potential difference, and resistance of resistor using Ohm's Law. b. Apply Ohm's Law in an operating circuit with a known resistor or resistances. FIE-3.C: a. Explain how the properties of a conductor affect resistance. b. Compare resistances of conductors with different geometries or material. c. Calculate the resistance of a conductor of known resistivity and geometry. FIE-3.D: Describe the relationship between the electric field strength through a conductor and the current density within the conductor. FIE-3.E: Using the microscopic definition of current in a conductor, describe the properties of the conductor and the idea of "drift velocity." FIE-3.F: Derive the expression for resistance of a conductor of uniform cross-sectional area in terms of its dimensions and resistivity.	Topic Questions
3.2	Electric Circuits: Current, Resistance, Power	AP Daily Video 1	CNV-5.A: a. Derive expressions that relate current, voltage, and resistance to the rate at which heat is produced in a resistor. b. Calculate different rates of heat production for different resistors in a circuit. CNV-5.B: Calculate the amount of heat produced in a resistor given a known time interval and the circuit characteristics.	Topic Questions

Week 8: Feb. 22–26

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
3.3	Electric Currents: Steady-State Direct-Current Circuits with Batteries and Resistors Only	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5	CNV-6.A: a. Identify parallel or series arrangement in a circuit containing multiple resistors. b. Describe a series or a parallel arrangement of resistors. CNV-6.B: Calculate equivalent resistances for a network of resistors that can be considered a combination of series and parallel arrangement. CNV-6.C: a. Calculate voltage, current, and power dissipation for any resistor in a circuit containing a network of known resistors with a single battery or energy source. b. Calculate relationships between the potential difference, current, resistance, and power dissipation for any part of a circuit, given some of the characteristics of the circuit (i.e., battery voltage or current in the battery, or a resistor or branch of resistors). CNV-6.D: Describe a circuit diagram that will properly produce a given current and a given potential difference across a specified component in the circuit. CNV-6.E: a. Calculate the terminal voltage and the internal resistance of a battery of specified EMF and known current through the battery. b. Calculate the power distribution of a circuit with a non-ideal battery (i.e., power loss due to the battery's resistance versus the total power supplied by the battery). CNV-6.F: a. Calculate a single unknown current, potential difference, or resistance in a multi-loop circuit using Kirchhoff's Rules. b. Set up simultaneous equations to calculate at least two unknowns (currents or resistance values) in a multi-loop circuit. c. Explain why Kirchhoff's Rules are valid in terms of energy conservation and charge conservation around a circuit loop. *(continued on next page)*	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
3.3	Electric Currents: Steady-State Direct-Current Circuits with Batteries and Resistors Only	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5	d. Identify when conventional circuit-reduction methods can be used to analyze a circuit and when Kirchhoff's Rules must be used to analyze a circuit. CNV-6.G: a. Describe the proper use of an ammeter and a voltmeter in an experimental circuit and correctly demonstrate or identify these methods in a circuit diagram. b. Describe the effect on measurements made by voltmeters or ammeters that have nonideal resistances.	Topic Questions

Week 9: Mar. 1–5

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
3.4	Capacitors in Circuits	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-7.A: a. Calculate the equivalent capacitance for capacitors arranged in series or parallel, or a combination of both, in steady-state situations. b. Calculate the potential differences across specified capacitors arranged in a series in a circuit. c. Calculate the stored charge in a system of capacitors and on individual capacitors arranged in a series or in parallel. CNV-7.B: a. Calculate the potential difference across a capacitor in a circuit arrangement containing capacitors, resistors, and an energy source under steady-state conditions. b. Calculate the stored charge on a capacitor in a circuit arrangement containing capacitors, resistors, and an energy source under steady-state conditions. *(continued on next page)*	Topic Questions Personal Progress Check

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
3.4	Capacitors in Circuits	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-7.C: In transient circuit conditions (i.e., RC circuits), calculate the time constant of a circuit containing resistors and capacitors arranged in series. CNV-7.D: a. Derive expressions using calculus to describe the time dependence of the stored charge or potential difference across the capacitor, or the current or potential difference across the resistor in an RC circuit when charging or discharging a capacitor. b. Recognize the model of charging or discharging a capacitor in an RC circuit, and apply the model to a new RC circuit. CNV-7.E: a. Describe stored charge or potential difference across a capacitor or current, or potential difference of a resistor in a transient RC circuit. b. Describe the behavior of the voltage or current behavior over time for a circuit that contains resistors and capacitors in a multi-loop arrangement. CNV-7.F: Calculate expressions that determine electrical potential energy stored in a capacitor as a function of time in a transient RC circuit. CNV-7.G: a. Describe the energy transfer in charging or discharging a capacitor in an RC circuit. b. Calculate expressions that account for the energy transfer in charging or discharging a capacitor.	Topic Questions Personal Progress Check

Week 10: Mar. 8–12

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.1	Magnetic Fields: Forces on Moving Charges in Magnetic Fields	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CHG-1.A: a. Calculate the magnitude and direction of the magnetic force of interaction between a moving charged particle of specified charge and velocity moving in a region of a uniform magnetic field. b. Describe the direction of a magnetic field from the information given by a description of the motion or trajectory of a charged particle moving through a uniform magnetic field. c. Describe the conditions that are necessary for a charged particle to experience no magnetic force of interaction between the particle and the magnetic field. CHG-1.B: Describe the path of different moving charged particles (i.e., of different type of charge or mass) in a uniform magnetic field. CHG-1.C: Derive an expression for the radius of a circular path for a charged particle of specified characteristics moving in a specified magnetic field. CHG-1.D: Explain why the magnetic force acting on a moving charged particle does not work on the moving charged particle. CHG-1.E: Describe the conditions under which a moving charged particle can move through a region of crossed electric and magnetic fields with a constant velocity.	Topic Questions

Week 11: Mar. 15–19

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.2	Magnetic Fields: Forces on Current Carrying Wires in Magnetic Fields	AP Daily Video 1 AP Daily Video 2	FIE-4.A: a. Calculate the magnitude of the magnetic force acting on a straight-line segment of a conductor with current in a uniform magnetic field. b. Describe the direction of the magnetic force of interaction on a segment of a straight current-carrying conductor in a specified uniform magnetic field. FIE-4.B: a. Describe or indicate the direction of magnetic forces acting on a complete conductive loop with current in a region of uniform magnetic field. b. Describe the mechanical consequences of the magnetic forces acting on a current-carrying loop of wire. FIE-4.C: Calculate the magnitude and direction of the net torque experienced by a rectangular loop of wire carrying a current in a region of a uniform magnetic field.	Topic Questions
4.3	Magnetic Fields: Fields of Long, Current-Carrying Wires	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-5.A: a. Calculate the magnitude and direction of a magnetic field produced at a point near a long, straight, current-carrying wire. b. Apply the right-hand rule for magnetic field of a straight wire (or correctly use the Biot–Savart Law found in CNV-8.A.1) to deduce the direction of a magnetic field near a long, straight, current-carrying wire. FIE-5.B: a. Describe the direction of a magnetic-field vector at various points near multiple long, straight, current-carrying wires. b. Calculate the magnitude of a magnetic field at various points near multiple long, straight, current-carrying wires. c. Calculate an unknown current value or position value, given a specified magnetic field at a point due to multiple long, straight, current-carrying wires. *(continued on next page)*	Topic Questions

CollegeBoard

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.3	Magnetic Fields: Fields of Long, Current-Carrying Wires	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-5.C: a. Calculate the force of attraction or repulsion between two long, straight, current-carrying wires. b. Describe the consequence (attract or repel) when two long, straight, current-carrying wires have known current directions.	Topic Questions

Week 12: Mar. 22–26

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.4	Magnetic Fields: Biot–Savart Law and Ampère's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6	CNV-8.A: a. Describe the direction of the contribution to the magnetic field made by a short (differential) length of straight segment of a current-carrying conductor. b. Calculate the magnitude of the contribution to the magnetic field due to a short (differential) length of straight segment of a current-carrying conductor. CNV-8.B: a. Derive the expression for the magnitude of magnetic field on the axis of a circular loop of current or a segment of a circular loop. b. Explain how the Biot–Savart Law can be used to determine the field of a long, straight, current-carrying wire at perpendicular distances close to the wire. CNV-8.C: a. Explain Ampère's Law and justify the use of the appropriate Amperian loop for current-carrying conductors of different shapes such as straight wires, closed circular loops, conductive slabs, or solenoids. b. Derive the magnitude of the magnetic field for certain current-carrying conductors using Ampère's Law and symmetry arguments. *(continued on next page)*	Topic Questions Personal Progress Check

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.4	Magnetic Fields: Biot–Savart Law and Ampère's Law	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6	c. Derive the expression for the magnetic field of an ideal solenoid (length dimension is much larger than the radius of the solenoid) using Ampère's Law. d. Describe the conclusions that can be made about the magnetic field at a particular point in space if the line integral in Ampère's Law is equivalent to zero. CNV-8.D: Describe the relationship of the magnetic field as a function of distance for various configurations of current-carrying cylindrical conductors with either a single current or multiple currents, at points inside and outside of the conductors. CNV-8.E: a. Describe the direction of a magnetic field at a point in space due to various combinations of conductors, wires, cylindrical conductors, or loops. b. Calculate the magnitude of a magnetic field at a point in space due to various combinations of conductors, wires, cylindrical conductors, or loops.	Topic Questions Personal Progress Check

Week 13: Mar. 29–Apr. 2

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.1	Electromagnetism: Electromagnetic Induction (Including Faraday's Law and Lenz's Law)	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6	CNV-9.A: a. Calculate the magnetic flux through a loop of regular shape with an arbitrary orientation in relation to the magnetic-field direction. b. Calculate the magnetic flux of the field due to a current-carrying, long, straight wire through a rectangular-shaped area that is in the plane of the wire and oriented perpendicularly to the field. c. Calculate the magnetic flux of a non-uniform magnetic field that may have a magnitude that varies over one coordinate through a specified rectangular loop that is oriented perpendicularly to the field. FIE-6.A: a. Describe which physical situations with a changing magnetic field and a conductive loop will create an induced current in the loop. b. Describe the direction of an induced current in a conductive loop that is placed in a changing magnetic field. c. Describe the induced current magnitudes and directions for a conductive loop moving through a specified region of space containing a uniform magnetic field. d. Calculate the magnitude and direction of induced EMF and induced current in a conductive loop (or conductive bar) when the magnitude of either the field or area of loop is changing at a constant rate. e. Calculate the magnitude and direction of induced EMF and induced current in a conductive loop (or conductive bar) when a physical quantity related to magnetic field or area is changing with a specified non-linear function of time. *(continued on next page)*	Topic Questions

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.1	Electromagnetism: Electromagnetic Induction (Including Faraday's Law and Lenz's Law)	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4 AP Daily Video 5 AP Daily Video 6	f. Derive expressions for the induced EMF (or current) through a closed conductive loop with a time-varying magnetic field directed either perpendicularly through the loop or at some angle oriented relative to the magnetic-field direction. g. Describe the relative magnitude and direction of induced currents in a conductive loop with a time-varying magnetic field. ACT-4.A: a. Determine if a net force or net torque exists on a conductive loop in a region of changing magnetic field. b. Justify if a conductive loop will change its speed as it moves through different regions of a uniform magnetic field. ACT-4.B: a. Calculate an expression for the net force on a conductive bar as it is moved through a magnetic field. b. Write a differential equation and calculate the terminal velocity for the motion of a conductive bar (in a closed electrical loop) falling through a magnetic field or moving through a field due to other physical mechanisms. c. Describe the mechanical consequences of changing an electrical property (such as resistance) or a mechanical property (such as length/area) of a conductive loop as it moves through a uniform magnetic field. d. Derive an expression for the mechanical power delivered to a conductive loop as it moves through a magnetic field in terms of the electrical characteristics of the conductive loop.	Topic Questions

Week 14: Apr. 5–9

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.2	Electromagnetism: Inductance (Including LR circuits)	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3 AP Daily Video 4	CNV-10.A: a. Derive the expression for the inductance of a long solenoid. b. Calculate the magnitude and the sense of the EMF in an inductor through which a changing current is specified. c. Calculate the rate of change of current in an inductor with a transient current. CNV-10.B: Calculate the stored electrical energy in an inductor that has a steady-state current. CNV-10.C: a. Calculate initial transient currents and final steady-state currents through any part of a series or parallel circuit containing an inductor and one or more resistors. b. Calculate the maximum current in a circuit that contains only a charged capacitor and an inductor. CNV-10.D: a. Derive a differential equation for the current as a function of time in a simple LR series circuit. b. Derive a solution to the differential equation for the current through the circuit as a function of time in the cases involving the simple LR series circuit. CNV-10.E: Describe currents or potential differences with respect to time across resistors or inductors in a simple circuit containing resistors and an inductor, either in series or a parallel arrangement.	Topic Questions

Week 15: Apr. 12–16

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.3	Electromagnetism: Maxwell's Equations	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	FIE-7.A: a. Explain how a changing magnetic field can induce an electric field. b. Associate the appropriate Maxwell's equation with the appropriate physical consequence in a physical system containing a magnetic or electric field.	Topic Questions Personal Progress Check