**PhET Interactive Physics Simulations**

**Aligned to the AP Physics C Topic Outline**

Alignment is based on the topics and subtopics addressed by each sim. Sims that directly address the topic area are in the second column; sims that relate to the topic area are in the “supplemental” columns.

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| **Mechanics Topics and Sub-Topics** | **PhET Simulations** | **Supplemental PhET Simulations** |
| **Lab Work: Analyze Errors** | [Curve Fitting](http://phet.colorado.edu/en/simulation/curve-fitting)    Linear, quadratic, cubic, quartic, best fit, adjustable fit, r2, uncertainty. | [Least-Squares Regression](https://phet.colorado.edu/en/simulation/least-squares-regression)    Least-Squares Regression, correlation coefficient, error analysis. |
| **Kinematics**   * Vectors, vector algebra, vector components | [Vector Addition](http://phet.colorado.edu/en/simulation/vector-addition)    Vector algebra and components. | [Ladybug Motion 2D](http://phet.colorado.edu/en/simulation/legacy/ladybug-motion-2d)    Interpret/differentiate velocity and acceleration vectors. |
| **Kinematics in 1D**   * Displacement, velocity, acceleration | [The Moving Man](http://phet.colorado.edu/en/simulation/legacy/moving-man)    Position, displacement, velocity, acceleration, graphs. | [Maze Game](http://phet.colorado.edu/en/simulation/legacy/maze-game)    Displacement, velocity, acceleration, vectors. |
| **Kinematics in 2D**   * Displacement, velocity, acceleration, projectile motion | [Motion in 2D](http://phet.colorado.edu/en/simulation/legacy/motion-2d)    Velocity and acceleration vectors, linear, simple harmonic, circular motion.  [Projectile motion](http://phet.colorado.edu/en/simulation/legacy/projectile-motion)    Range, height, time, initial speed, mass, air resistance, diameter. | [Calculus Grapher](http://phet.colorado.edu/sims/calculus-grapher/calculus-grapher_en.html)    Integral and derivative graphs.  [Graphing Lines](http://phet.colorado.edu/en/simulation/graphing-lines)    Slope, equation of a line. |
| **Newton’s Laws of Motion**   * Static Equilibrium (1st Law) * Dynamics of a Single Particle (2nd Law) * Dynamics of two or more objects (3rd Law) | [Forces and Motion: Basics](http://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html)    Net force (sum of forces), mass, speed, applied force, friction force, acceleration (1st and 2nd laws).  [Forces and Motion](http://phet.colorado.edu/en/simulation/forces-and-motion)    1D motion, FBDs, vectors, friction, gravity, normal, spring, and applied forces, sum of forces, position, friction coefficients, force/time graphs, game “Robot Moving Company”.  [Ramp: Forces and Motion](http://phet.colorado.edu/en/simulation/ramp-forces-and-motion)    Same as Forces and motion above, but includes ramp with adjustable angle. | [Friction](http://phet.colorado.edu/sims/html/friction/latest/friction_en.html)    Molecular level, temperature.  [Forces in 1 Dimension](http://phet.colorado.edu/en/simulation/forces-1d)    1D motion; graphs: applied force, acceleration, velocity, position; free body diagram, total force, horizontal force, vectors, friction, mass, friction coefficients.  [The Ramp](http://phet.colorado.edu/en/simulation/the-ramp)    Similar to Ramp: Forces and Motion, includes energy and work graphs and bar charts.  Simulations that also fit with Newton’s Laws:  [Masses and Springs](http://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html) (spring force)  [Gravity Force Lab](http://phet.colorado.edu/en/simulation/gravity-force-lab) (3rd law vectors)  (See Oscillations and Gravity below) |
| **Work, Energy, Power**   * Work and work-energy theorem * Forces and potential energy * Conservation of energy * (Power – no simulations) | [Forces and Motion](http://phet.colorado.edu/en/simulation/forces-and-motion)  (or [Forces in 1 Dimension](http://phet.colorado.edu/en/simulation/forces-1d))  (See Newton’s Laws of Motion)  Could be used to calculate work done and compare with change in kinetic energy for work-energy theorem using force, distance, velocity measurements and graphs.  [Energy Skate Park](http://phet.colorado.edu/en/simulation/legacy/energy-skate-park)    Quantitative energy and time graph, energy and position graph; qualitative energy bar graphs, pie chart; variable friction and gravity, moveable PE reference line, mass, slow motion option, student builds ramp shapes.  Other simulations with energy bar graphs:  [Masses and Springs](http://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html)  [Pendulum Lab](http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html)  (See Oscillations & Gravity below) | [The Ramp](http://phet.colorado.edu/en/simulation/the-ramp) See above.  Quantitative energy and work graphs and qualitative bar charts. Might be able to use to show work done equals change in gravitational potential energy.  [Energy Skate Park Basics](http://phet.colorado.edu/en/simulation/energy-skate-park-basics)    Similar to Energy Skate Park, but includes speed indicator. Limitations: no quantitative graphs (bar and pie only), friction coefficient adjustable only on student build screen, no adjustable PE reference line.  [Energy Forms and Changes](http://phet.colorado.edu/en/simulations/category/physics/work-energy-and-power)    Qualitative introduction to conservation of energy principles. |
| **Systems of Particles, Linear Momentum**   * Center of mass * (Impulse and momentum – no simulations) * Conservation of linear momentum, collisions | [Collision Lab](http://phet.colorado.edu/sims/collision-lab/collision-lab_en.html)    Elastic and inelastic collisions in 1D and 2D; center of mass; velocity and momentum vectors; momentum, mass, velocity, time and kinetic energy values; path tracing in 2D; 2 or more balls. |  |
| **Circular Motion and Rotation**   * Uniform circular motion * Rotational kinematics and dynamics | [Ladybug Revolution](http://phet.colorado.edu/en/simulation/legacy/rotation)    Quantitative angular and linear position, velocity, acceleration with time graphs and values for circular motion; can vary radius, radians and degrees, vectors are very small, may be hard to see. | [Ladybug Motion 2D](http://phet.colorado.edu/en/simulation/legacy/ladybug-motion-2d) (See above)    Introductory to show velocity and acceleration vectors. May help students understand these vectors on Ladybug Revolution. |
| **Circular Motion and Rotation**   * Torque and rotational statics * Angular momentum and its conservation | [Torque](http://phet.colorado.edu/en/simulation/legacy/torque)    **Torque** (positive and negative), force, radius, braking force, mass, **moment of inertia**, angular acceleration, angular velocity, **angular momentum**. Velocity and acceleration vectors, degrees and radians, quantitative graphs. | [Balancing Act](http://phet.colorado.edu/en/simulation/balancing-act)    Balance masses at various positions on a beam. Pivot at center only. May cause a misconception that beams balance only horizontally. |
| **Oscillations and Gravitation**   * Simple harmonic motion (dynamics and energy relationships) * Mass on a spring * Pendulum and other oscillations * Newton’s Law of gravity | [Masses and Springs](http://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html)    Vary masses, spring constants, friction, gravity force; use ruler, stopwatch, for quantitative measurements. Qualitative energy bar charts.  [Pendulum Lab](http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html)    Quantitative ruler, stopwatch, photogate timer, length, mass, friction adjustments. Qualitative bar chart of kinetic, gravitational, thermal, and total energy. | [Gravity Force Lab](http://phet.colorado.edu/en/simulation/gravity-force-lab)    Two masses, force, distance, for quantitative measurements. Newton’s 3rd law vectors shown.  [Calculus Grapher](http://phet.colorado.edu/sims/calculus-grapher/calculus-grapher_en.html)  (See Kinematics in 2D) |
| **Oscillations and Gravitation**   * Orbits of planets and satellites – circular and general | [Gravity and Orbits](http://phet.colorado.edu/en/simulation/gravity-and-orbits)    Conceptual only, gravity force and velocity vectors for orbital motion. Vary initial velocity, mass of satellite, observe changes in orbit. |  |

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| **E&M Topics and Sub-Topics** | **PhET Simulations** | **Supplemental PhET Simulations** |
| **Electrostatics**   * Charge and Coulomb’s law (no simulation for Coulomb’s law) | [Balloons and Static Electricity](http://phet.colorado.edu/sims/html/balloons-and-static-electricity/latest/balloons-and-static-electricity_en.html)    Static electricity, charges, forces, polarization, charging by friction, insulators, net charge. Conceptual. | [John Travoltage](http://phet.colorado.edu/en/simulation/john-travoltage)    Charging by friction, discharge by contact, grounding, conductors. Conceptual. |
| **Electrostatics**   * Electric field and electric potential (including point charges) * Gauss’s law * Fields and potentials of other charge distributions | [Charges and Fields](http://phet.colorado.edu/en/simulation/charges-and-fields)    Electric field, field plots, voltage, equipotential lines, charge units, tape measure. Quantitative. | [Electric Field Hockey](http://phet.colorado.edu/en/simulation/electric-hockey) (Must do!)    Game with electric field plots and charges. Students love this one. Qualitative. |
| **Conductors, capacitors, dielectrics**   * Electrostatics with conductors * Capacitors (capacitance, parallel plate, spherical and cylindrical) * Dielectrics | [Capacitor Lab](http://phet.colorado.edu/en/simulation/capacitor-lab)    Quantitative. Vary area, distance, voltage, dielectrics. Measure capacitance, voltage, charge, E-field, stored energy. Connect/ disconnect battery, multiple capacitors. | [Conductivity](http://phet.colorado.edu/en/simulation/legacy/conductivity)    Conductivity in metals, plastics and photoconductors, electron energy levels. Vary applied voltage. |
| **Electric Circuits**   * Current, resistance, power * Steady state direct current circuits with batteries and resistors only | [Circuit Construction Kit (DC Only) Virtual Lab](http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab)    Quantitative. Circuits, light bulbs, resistors, voltmeter, ammeter, switches, batteries, series and parallel. |  |
| **Electric Circuits**   * Capacitors in circuits * Transients in RC circuits | [Circuit Construction Kit (AC+DC) Virtual Lab](http://phet.colorado.edu/en/simulation/legacy/circuit-construction-kit-ac-virtual-lab)    Quantitative. Similar to CCK DC only, but includes capacitors, inductors, AC, I and V graphs. | [Capacitor Lab](http://phet.colorado.edu/en/simulation/capacitor-lab)  (See above)  [Ohm’s Law Lab](http://phet.colorado.edu/en/simulation/ohms-law)  Screenshot of the simulation Ohm's Law  Quantitative. Voltage, Current, Resistance, Ohm’s Law. |
| **Magnetic Fields**   * Forces on charges in magnetic fields * Forces on current-carrying wires in magnetic fields * Fields of long current-carrying wires * Biot–Savart law and Ampere’s law | These topics are not addressed in PhET simulations. | [Faraday’s Electromagnetic Lab](http://phet.colorado.edu/en/simulation/faraday)  (See below). Introduction to magnetic field of a bar magnet (bar magnet tab). Introduction to forces on charges in magnetic fields (pick up coil tab). |
| **Electromagnetism**   * Electromagnetic induction (including Faraday’s law – Lenz’s law is not addressed in PhET simulations) | [Faraday’s Electromagnetic Lab](http://phet.colorado.edu/en/simulation/faraday)  Screenshot of the simulation Faraday's Electromagnetic Lab  Electromagnetic induction, Faraday’s law, transformer, generator. Semi-quantitative (field strength, loop area, number of loops) |  |
| **Electromagnetism**   * Inductance (including LR and LC circuits) * (Maxwell’s equations not addressed in simulations) | [Circuit Construction Kit (AC+DC) Virtual Lab](http://phet.colorado.edu/en/simulation/legacy/circuit-construction-kit-ac-virtual-lab)    Includes LR and LC circuits. |  |