

EMAP Physics Labs

| Session | Lab | Math-related things |
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| Tues 7 July 3:45-5:45 | intro / Error analysis | uncertainty, basic statistics (mean, std. dev) |
| Fri 10 July 3:45-5:45 | Coefficient of restitution | sequence & series, logarithms, power laws |
| Tues 14 July 4-6 | Atomic spectroscopy | trigonometry |
| Thu 16 July 1:30-3:30 | dc circuits | linear relationships |
| Tue 21 July 3:45-5:45 | resistive circuits (resistor networks) | systems of linear equations |
| Wed 22 July 1:30-3:30 | Planck's constant determination | trigonometry, exponential behavior, linear regression |
| Tue 28 July 1:30-3:30 | RC circuits | exponential behavior, non-linear regression, logarithms |
| Fri 31 July 1:30-3:30 | mutual inductance / wireless power | linearization, rate of change, trig functions |
| Mon 3 Aug 1:30-3:30 | homopolar motors | vector relationships (cross product) |
| Wed 5 Aug 1:30-3:30 | remote controls | time-dependent behavior, trig functions, 3D geometry in spherical coordinates |

| Lab | Things | The Idea |
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| Error analysis | meter stick, paper, calculator. Excel is optional | Students gauge their reaction time for many independent trials. How to quantify error in measurement; the care and feeding of experimental data; graphing |
| Coefficient of restitution | stopwatch (online), meter stick, paper, calculator. Excel is optional | Analysis of a bouncing ball as it comes to rest. Infinite series for height of ball after n bounces; analyze height vs. n and time to reach n bounces |
| Atomic spectroscopy | Meter stick, diffraction grating, Hg & H lamps, calculator. Excel optional, but increasingly desirable. | Observe discrete emission lines of Hg and H lamps through a diffraction grating. Use basic trig to determine the wavelengths. |
| dc circuits | Many things from the physics department ... Excel required | Measurement of current-voltage relationship for resistors. Data acquisition, Excel, plotting. Linear regression (trend line), slope, intercept. |
| resistive circuits (resistor networks) | Many things from the physics department ... Excel required | Series and parallel combination of two unknown resistors. Measure $I(V)$ relationship in both cases, extract effective resistance (slope) for each case. After processing data, they have two equations, two unknowns ... |
| Planck's constant determination | Many things from the physics department ... Excel required | Diffraction gratings to measure emission wavelength of LEDs. Analyze non-linear ("exponential") current-voltage curve to determine threshold voltage for light emission. Repeat for several LEDs, estimate Planck's constant and error in measurement. |
| RC circuits | Many things from the physics department ... Excel required | Charging and discharging of a series RC circuit with an unknown capacitor. Fit the exponential / logarithmic behavior to determine C . |
| mutual inductance / wireless power | Many things from the physics department ... Excel required | Time-varying current in one coil can wirelessly power a second coil ... determine the dependence on spatial separation of the two coils and relative angle between their axes. Linearization of annoying functions ... |

| Lab | Things | The Idea |
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| homopolar motors | wire, D battery, wood screw, small magnet, paper. No computers ... | Discovery-driven: construct a simple homopolar motor from a battery, wire, a small magnet, and a wood screw. How does the direction of rotation depend on the orientation of current and magnetic field? |
| remote controls | Many things from the physics department ... Excel required | LED and photodetector. Drive the LED with a time-varying waveform and observe the photodetector response. Even when LED is not visibly changing in intensity by eye, changes are easily observed in the photodetector voltage. Lock-in techniques, digital communications. With everything else fixed, how does the photodetector signal depend on the distance from the source? |