Physics Experiments for an Introductory Electronics Course

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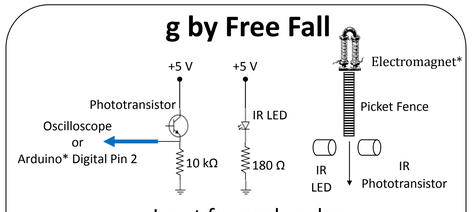
Goals

1. **Provide interesting and rewarding ways to introduce students to electronics**
2. **Review and reinforce material studied throughout the semester**
3. **Demonstrate that even an introductory-level understanding of electronics is useful in the physics laboratory**
4. **Create experiments suitable for a Physics exploration center or outreach project**

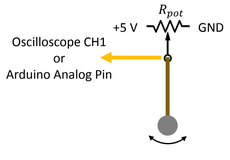
Mechanics

g by Free Fall



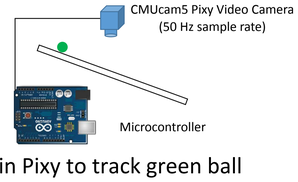
Log t for each pulse
Graph $x(t)$ to find g

g by Pendulum



Measure period and compute g

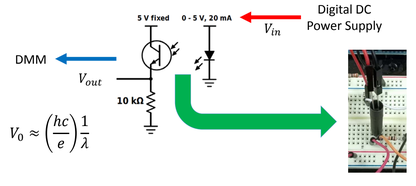
g by Image Tracking



Train Pixy to track green ball
Record $s(t)$ as ball rolls down ramp

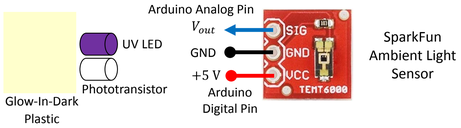
Light

Planck's Constant



Onset of LED emission at $V_{in} = V_0$
Measure V_0 for IR, red, yellow, green, violet

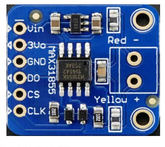
Phosphorescence Lifetime



Arduino turns LED off and records $V_{out}(t)$
Don't forget to run a blank sample
Try different sample temperatures

Heat

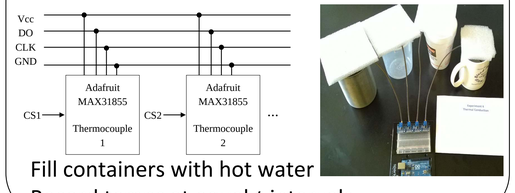
Temperature Measurement



Adafruit MAX31855 thermocouple amplifier

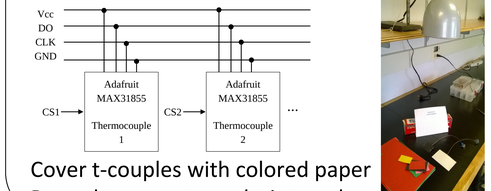
Connect to Arduino and K thermocouple

Thermal Conduction



Fill containers with hot water
Record temps at equal t intervals

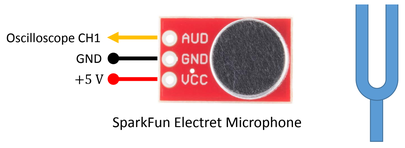
Thermal Radiation



Cover t-couples with colored paper
Record temps at equal t intervals

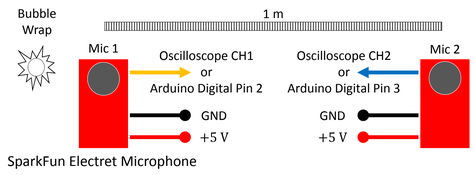
Sound

Tuning Fork



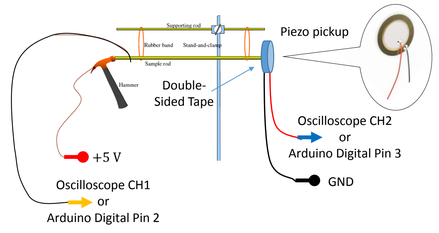
Connect sensor to oscilloscope
Measure pitch waveform and frequency

Speed of Sound in Air



Pop bubble wrap
Measure delay between pulse arrival times

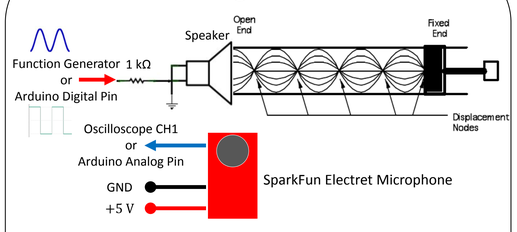
Speed of Sound in Al Rod



(Se-yuen Mak, et al., Measurement of the speed of sound in a metal rod, Physics Education 35(6), 2000)

Strike end of bar with hammer
Measure pulse delay at piezo pickup

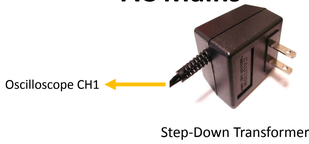
Wavelength of Sound



Generate audible tone from speaker
Measure distance piston moves between volume maxima (resonance)

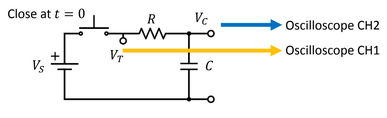
Electricity

AC Mains



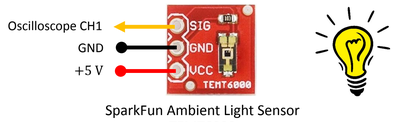
Connect step-down transformer to oscilloscope
Measure AC waveform and frequency

Capacitor Charging Curve



Trigger scope off CH1, Record $V_C(t)$ on CH2
Measure $\tau = RC$ using oscilloscope cursors

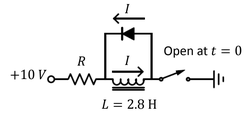
AC Lighting



SparkFun Ambient Light Sensor
TEMT6000

Connect sensor to oscilloscope
Measure AC lighting waveform and frequency

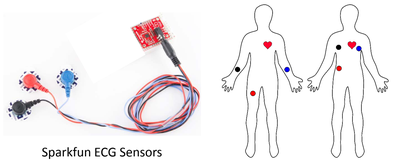
Lenz's Law



Open switch with/without diode
Look for spark at switch

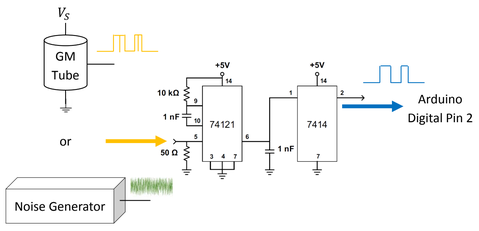
Miscellaneous

ECG Measurement



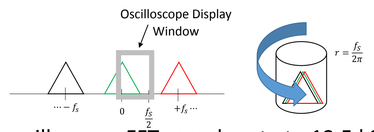
Attach sensors to subject and oscilloscope
Record ECG and identify origins of signal

Time between Random Events



Log t for each random event
Generate histogram of Δt's

FFT Spectral Wrapping



Set oscilloscope FFT sample rate to 12.5 kS/s
Set function generator to 1 kHz sine wave
Increase frequency in 1 kHz steps from 1-17 kHz
Mark spectral peaks
(Real: green, + Aliases: red, − Aliases: black)