



GK-12 Proposed Engineering Integration at RMHS

Allen Chen

Kara Quinlan

July, 2009



Presenting Cutting Edge Engineering

- Working with GK-12 enables multiple platforms for fellows to come and work in the public school classroom.
- From hands-on demonstrations to real life examples, GK-12 will allow for a wide exploration of engineering education in the classroom



Areas of Application

- Fall semester will have only one subject participating
 - 2 General Physics
- Spring semester will allow for entire curriculum to participate in the GK-12 grant
 - 2 General Physics
 - 1 AP Physics



Ideas for Growth

- In working with Physics and AP Physics, there will also be opportunities to collaborate with Anatomy and Physiology and potentially AP Biology.
- Growth areas will hopefully lead to the Technology Education department and their electronics courses



Big Picture and Scope

- Each course has been broken down into units with applicable demos, activities or lab components.
- Each of the binding parts can be directly connected back to its GK-12 research counter part



Over Arching Theme

- The goal for us is to connect all of the units back to GK-12 by one of the following themes:
 - Sensors
 - Engineering Design
 - Data Processing
 - Signal Amplification



Enter Engineer Expert...Allen

- When the classes begin, he will be able to share his background, interests in EE and what specific part of the grant he is working on.
- Myth debunking of engineering begins and Allen introduces IEEE
- IEEE and its societies



Physics- Nano, Nano

- **Understanding nano:** computer chips under microscope, then heading to nanoscale-transistors. Measurements enter the nanoscale realm.
 - **Key words:** Nano and micro scale
 - **Connections:** Avago Industry chip production, SI Units, Unit Conversion
 - **Materials:** 15 Stereo Microscopes, 15 Computer Chips, Wafer, 30m Tape Measure, 15 meter sticks



Physics- Super Newton Muscle

- Biological component by involving Action/ Reaction within muscle tissue
- Use of GK-12 video of tissue
- Possible collaboration with Marion, Carol and Cheryl???
- Still TBD



Physics- E- Mobility

- **Mobility of e-:** Semiconductor doping and how it affects e- and hole mobilities.
 - **Key words:** Mobility, doping, holes
 - **Connection:** Velocity and acceleration, chemistry
 - **Materials:** 15 Signs of Si & P, 15 tennis balls, 12 Signs of B, 4 Hole Signs



Physics- Forces of E- Mobility

- **Forces affect e- mobility:** revisit velocity and acceleration. Electric fields move e^- and holes to turn “ON” transistor.
 - **Key words:** E Field, Mobility
 - **Connection:** Forces, Vector addition
 - **Materials:** 30 batteries, 30 LEDs, 30 resistors, 30 BJTs
 - **To build simple circuit that uses transistor gain amplification**



Physics- Newton Full of Heart

- **Electrical force:** electrical forces act upon the heart to stimulate muscle and blood flow by electrical impulse
 - **Key words:** EKG, cell mobility, cell movement, impulse
 - **Connections:** Forces, Newton's 3rd Law, Newton's 2nd Law
 - **Materials:** 8 Vernier LabQuests (ADI instruments industry connection), 8 EKG Sensors



Physics- Circular Motion

- **Circular motion of hard drives:** inspect hard drives, disassemble, and analyze its rotational motion.
 - **Key words:** Arc length, angular speed, velocity, acceleration, radius, angle
 - **Connections:** Circular motion, polar coordinates
 - **Materials:** Ideally 32 broken hard drives, can work with 16 hard drives



Physics- Sound, Light & Waves

- **Laser Microphone:** simple spy gadget that uses interferometry detection. Ties sound and light waves together.
 - **Key words:** photo-"sensing"
 - **Connection:** Sound waves, optics, vibrations, light
 - **Materials:** 8 laser pointers, 8 photo cells (Cadmium sulfate), 8 laptops, 8 ear buds



Physics- Energy Inside Heating Up

- **Energy harvesting in science:** modern alternative energy on large scale and micro scale. Explore different phases of sensor energy sources.
- Use of ambient energy to power small electronics and devices
 - **Key words:** thermal gradient, power consumption μW
 - **Connections:** Alternative energy, power
 - **Materials:** Articles, YouTube, Wireless Power



Physics- Solar Power

- **Solar cells at work:** (demo or activity) solar-powered USB charger
 - **Key words:** energy consumption, power rating
 - **Connection:** alternative energy, power usage
 - **Materials:** Photovoltaic cells (outdoor garden lamps?), 15 female USB cables



AP Physics- An Electrical Household

- **Useful Electrical Knowledge:** a presentation on electricity around the house
 - Recycle batteries (useless to a digital camera, but perfect for a flashlight or clock)
 - Hack batteries (1.5V AAAA from 9V)
 - Check/change fuses in home appliances
 - Readfuse ratings for home/car
 - Fuse video clips and circuit breakers



AP Physics- An Electrical Household

- Understanding electrical outlets
- Electrical safety
- **DEMO:** Free power from phone jack.
 - **Materials:** phone line, resistors, voltage regulator, bridge rectifier



AP Physics- RC Circuits

- **Speaker Crossover:** RC filters
- Noise filtering in circuit design
- Discrete R's + C's vs. on-chip R's and C's
 - **Key words:** Noise filtering, RC filters, brain cell noise filters
 - **Connections:** Resistance, capacitance, circuitry, sound, frequency
 - **Materials:** 15 ear buds, resistors and capacitors, i-pod



AP Physics- Shocking! ESD

- **Electrostatic discharge:**
connection to chip design, frying transistors built-up charge
 - **Key words:** ESD
 - **Connection:** Electrostatics, test charge, induction, conduction
 - **Materials:** Pith lab, 8 electroscopes, 30 balloons, 30 paper clips



AP Physics- Magnetism

- **Electromagnetic induction:**
wireless power and charging, noise coupling, magnetic flux
- Still working on the “how”



AP Physics- Quantum Mechanics

- **Quantum effects in nanoscale transistors:** tunneling in transistors with gate oxide thickness of $15\text{\AA} - 50\text{\AA}$
- **GK-12: tunneling, leakage, power**
 - **Key words:** Angstrom,
 - **Connections:** Heisenberg's Uncertainty Principle, statistics
 - **Materials:** 30 marbles, 60 sheets of carbon paper