

**Purpose:** The purpose of this lesson is to integrate and summarize the electrical and electronics chapters of the Science Insights text. Additionally, this unit will give students hands-on experience with microprocessors and some basic knowledge of how microprocessor based control systems work.

**Audience:** Ninth grade, mid-level, Survey of Science (Physical Science) classes (coed, homogeneously grouped)

**Time:** Five classes of 70 minutes each.

**Synopsis:** Day 1 Review electricity and electrical circuits

Day 2 Construct two simple circuits (series and parallel using breadboard  
Diagram the simple circuits

Day 3 Following a diagram, construct a simple circuit on the BOE  
Discuss and describe more complex circuits, using I/O pins as control  
Review section in text concerning integrated circuits and computers  
Discuss role of software and programs

Day 4: Fundamentals of programming in P-Basic  
Reinforce concept of logical instruction and syntax  
Enter simple program  
Debug window  
Debug "Hello World"  
Enter complex program: "Blinker"  
Function of I/O pins in controlling circuit  
Assign I/O port to control light

Day 5: Construct circuit diagram for light circuit controlled by stamp  
Construct circuit on BOE and write P-Basic program to control the circuit  
Test and modify

**Day 1: Science Insights, Chapter 11, section 11.3 Electric Current:**

Review current electricity

produced when electrons flow through a conductor

flows through a closed, continuous path called a circuit

made to flow by voltage, a difference in the charges at each end of the circuit

Sources of current electricity include electrochemical cells, thermocouples and electrical generators

Electric current may be direct or alternating

Direct current (DC) electricity has a constant polarity, electrons flow in one direction

Alternating current (AC) has electrons which alternately move in one direction and then in the other direction (polarity changes in the wire)

Circuits carrying current electricity have measurable characteristics: flow rate,

voltage, resistance and cyclic rate (for AC circuits)

Flow rate is measured as current in units called Amperes

Voltage is the force like quantity that “pushes” the electrons through the circuit

Resistance is the opposition to electron flow, measured in units called “Ohms”

The current, voltage and resistance are related by Ohm’s Law which states that the voltage (E) in a circuit equals current (I) times resistance(R):  $(E = I \times R)$

Cyclic rate is measured as “cycles per second” or “Hertz”.

### Review Electrical Circuits

Circuits have parts: source, conductor, control and resistance (load)

The source is where the electrons flow from

The conductor carries the electrons from the source through the circuit

Control elements determine if and how electrons flow through the circuit

The resistance or “load” uses the energy of the moving electrons

Circuits may have resistances in series or in parallel or in a combination

A series circuit has only one pathway for the electrons to follow

In a series circuit each resistance gets a fraction of the voltage

In a series circuit the current through each resistance is the same

A parallel circuit has multiple pathways for the electrons to follow

In a parallel circuit the voltage is the same through each resistance

In a parallel circuit, the current through each resistance is reduced

Demonstrate with lamp board and Christmas tree lights

Day 2: Introduce the breadboard as a “wireless” means of constructing circuits

Have student (groups) construct a series and parallel circuit on a breadboard using 2 fixed resistors (750W) and a dry cell and leads; measure the voltage across each resistance with a digital multimeter (DMM) set for voltage and the amperage in the circuit with a digital multimeter set for amperage.

Discuss Circuit diagrams: Symbols used and meaning

Have students draw circuit diagrams of the circuits which they constructed

Day 3: Review “Bread-boarding Rules” (Robotics!, Appendix F, page 175)

Following the circuit diagram, below, construct a simple circuit on the BOE

Use this circuit diagram:

Construct the circuit on BOE breadboard using LED (watch polarity), micro-switch and two jumper wires. If properly constructed, pushing switch button should light up the LED.

The circuit diagram should prompt several questions; first about the LED, what is it and how does it work? Next, what about the added 470 Ohm resistor in the circuit? How is a particular resistance specified? The resistor also allows for a discussion of Ohm's law with the resistance of the LED and a voltage of 6 V at V<sub>dd</sub> requiring more resistance in the circuit.

Review text, Chapter 13, section 13.1 , Electronic Devices and section 13.3 Computers

Section 13.1 defines electronics, rectifiers, amplifiers, semiconductors, transistors and integrated circuits; discuss each term and define on board

Section 13.3 describes computers; the area of interest in computer software;

Define and differentiate between operating system and application software

Describe process of writing software -- see Skillbuilder, p. 325.

Introduce P-BASIC as a programming language to control the BASIC Stamp on the BOE

Day 4: Fundamentals of programming in P-BASIC

Using text BASIC Stamp Programming Manual 2.0b, pp 29-32

Connect BOE to serial cable of computer

Execute the Basic Stamp program and follow instructions on pp 31-2

(Enter simple program "Debug Hello World")

Enter complex program: "Blinker"

Discuss function of I/O pins in controlling circuit

Discuss the "for - next" loop and what it does

Program:

```
blinker:
LED con 8
x var byte
for x=1 to 10
high LED
pause 500
low LED
pause 500
next
```

Save the program to a floppy disk

Day 5 Control a circuit using an I/O pin

Construct a circuit using I/O #8 as the control and write a program which will turn the LED on for a specified time and then turn it off

Circuit diagram:

Discuss the program; what each line means; specifically:

What is the meaning of “for x= 1 to 10?”

In the “pause 500,” what does the 500 represent?

Is there another way to specify the LED pin I/O pin 8?

Allow students to change the “high” and “low” statements and change the x= 1 to 10 to other values and observe the result.

'can use a constant instead of pause 500, insert "delay con 500" in third line of program

Construct circuit on BOE breadboard using piezo speaker and two jumper wires.

Discuss differences in circuit diagrams (in LED circuit, source is Vss; in speaker circuit source is P2; however p2 is addressed by program)

Day 3 Review section in Ch 13 concerning integrated circuits(13.1) and computers (13.3)

Discuss role of software and programs

Fundamentals of programming in P-Basic

Introduce BASIC Stamp Editor (Basic Stamp Manual pp 34-39)

Reinforce concepts of logical instruction and syntax

Discuss “reserved words”

Introduce memory parameters (“bits,” “bytes,” “words,” etc.)

Enter simple program

Introduce “Debug window”

Enter program >Debug “Hello World” (ROBOTICS!, pp 23-25)

Frameworks Addressed: Technology Strand; Tools and Machines of Technology  
(sequence #51, 52, 53)

1. Students will describe examples of the wide range of contemporary tools that are used to process and measure materials, energy, physical phenomena, and electronic signals. Some of these include measuring instruments, computer based tools, and data capturing sensors. Choose a type of tool and investigate its use.
2. Students will use complex tools, machines, and equipment to solve problems,
3. Students will identify appropriate ways to select, operate, maintain, and dispose of technological devices.

## Chapter 13 Electronics

### 13.1 Electronic Devices

vacuum tubes produce electrons by heating an electrode

vacuum tubes are prone to failure, expensive to manufacture and consume a lot of energy

amplifiers  
 semiconductors: a substance that has a conductivity range between that of a conductor and an insulator; used to amplify currents  
 semi conductors are smaller, more durable, last longer, use less energy, give off less heat and cost less than vacuum tubes

germanium and silicon  
 transistors semi-conducting devices consisting of layered n-type and p-type crystals

semi-conducting materials three sections; emitter base and collector each treated with a different impurity  
 amplifies weak signals  
 integrated circuit consists of a silicon chip with small amounts of impurities at specific locations. impurities are used to construct transistors, resistors and diodes and other circuit elements these spots

connections between circuit elements are by copper conductors deposited on the silicon chip  
 computers

Need to understand :

Electrical circuits:

Source: batteries

resistance (load)

control computer chip

Circuit diagrams:

show conductors as lines

show source and resistance with symbols

digital information

Computers