STUDENT LOGBOOK

ARDUINO

EDUCATION STARTER KIT

SAFETY QUIZ

Answer the following questions by circling the correct answer.

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1. Which of the following is a potential hazard from dealing with electricity?

a. shock
b. burns
c. nerve damage
d. irregular heartbeat
e. all the above

2. When you are working with circuits, it is OK to do what?

a. work on a metal surface
b. have an open beverage nearby
c. work with power supplied to the circuit
d. wear metal jewelry
e. none of the above

3. If a person is being shocked by a circuit and is unable to remove himself or herself from the circuit, what is the first thing you should do?

a. tap him or her to see if he or she is OK
b. pull him or her away from the circuit
c. turn off the power to the circuit
d. go and find help

4. Supplying power to a circuit should be done when?

a. at the beginning of building the circuit
b. at any point while building the circuit
c. at the end when the circuit is complete

5. If an electronic component is damaged, what should you do?

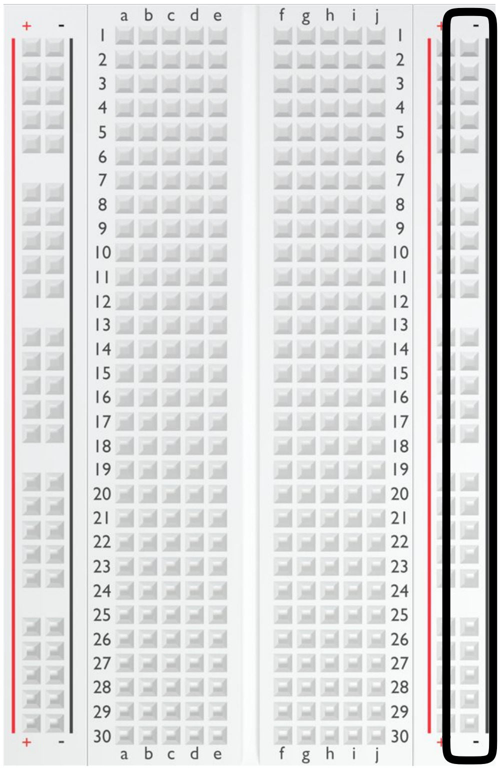
a. use it
b. repair it
c. replace it

LESSON 1

Complete this page after you have built the circuit from Lesson 1.

Remove the black wire from the breadboard and try it in other holes on the breadboard. Circle the holes on the breadboard at right that complete the circuit and light the LED.

- Why do these holes on the breadboard light the LED, but other holes don't?



Replace the 560 Ω resistor with the resistors listed in the following table. Record your observations of the LED in the table as you try each resistor.

Resistor	4-Band Color Scheme	5-Band Color Scheme	Observations
220 Ω		R,R,BL,BL,G	Brighter than 560
1 k Ω	BR,BL,R,G		Duller than 560
4.7 k Ω	Y,P,R,G		Duller than 1k
10 k Ω	BR,BL,O,G		Duller than 4.7k

Replace the resistor with a 560 Ω resistor. Then, replace the yellow LED with a red, green, and blue LED in order. Make sure the anode side of the LED is connected to the resistor and the cathode side is connected to the jumper wire. After each LED lights, swap the positions of the LED's anode and cathode and observe what happens to the circuit.

- What kind of circuit is created when the anode is connected to ground and the cathode is connected to power?

Open curcuit

With any color LED connected to the circuit and lit, swap the positions of the red and black wires from the battery.

- Does the LED light? Explain your reasoning as to why or why not.

LED only lets current travel one way. Cannot flow from negative to positive

LESSON 2

A. EXTERNAL LED ACTIVITY

Complete this part of the notebook during the External LED activity's Test and Modify section.

Circuit powered by the Arduino board

Type of Measurement	Units	Measurement When LED Is On	Observation and Notes
Voltage	Volts	4.65	
Current	Milliamps	12.5	
	Amps	0.0125	
Resistance	Ohms	4.65 / 0.0125 = 372	R = V/I

Resistance of the resistor: ___218___ ohms

Resistance of the LED: ___372 - 218 = 154___ ohms

- Assume that the total circuit resistance stays the same as what you measured and recorded in the table. Use Ohm's law to calculate the current in the circuit when a nine-volt battery is supplying the voltage.

V = 9

I = V/R = 9 / 372 = 0.0242 A

I = 0.024 A = 24 mA

- Do you think the LED would be brighter when powered by the Arduino board or when powered by the nine-volt battery? Use your current measurements and calculations to justify your answer.

The current from the battery is almost twice as high as the Arduino, so the LED would be brighter when powered by the battery.

B. SERIES CIRCUIT ACTIVITY

Complete this part of the notebook during the Series Circuit activity's Test and Modify section.

- In a series circuit, what happens when you remove one of the components? Why?

The closed circuit becomes open

Circuit	Resistor Voltage	LED 1 Voltage	LED 2 Voltage	LED 3 Voltage	Total Voltage
2 LED	0.45	1.77	1.78		4
3 LED	0.11	1.61	1.61	1.61	4.94

- What happens to the brightness of the LEDs as you add LEDs to the circuit?

They become duller.

- How is the brightness of the LED related to the voltage across the LED?

As the voltage decreases so to does the brightness of the LED. Positive relationship.

C. PARALLEL CIRCUIT ACTIVITY

Complete this part of the notebook during the Parallel Circuit activity's Test and Modify section.

- In a parallel circuit, what happens when you remove one of the components? Why?

  The circuits remain closed.

Circuit	LED 1 Voltage	LED 2 Voltage	LED 3 Voltage
2 LED	1.86	1.86	
3 LED	1.86	1.86	1.86

- What happens to the brightness of the LEDs as you add LEDs to the circuit?

  They remain the same

- How many LEDs paths do you think you could add to the circuit and have them all remain lit? Why do you think this?

If only consider voltage it may seem like the answer is infinite.

BUT, the limitation is the current that can be supplied by the power source.

Each LED requires approx. 20mA. The Arduino (5V) can provide 500mA.

So it could power 25 LEDs.

LESSON 3

Complete the following two pages as you work through Lesson 3.

A. CODE CREATION - Programming a Traffic Light

In the following space, write pseudocode for how you think the traffic light should be programmed.

B. TEST AND MODIFY

Your traffic light is a combination of series and parallel circuits. Explain which components in the circuit are wired in series and why. Then, explain which components are wired in parallel and why.

Use the multimeter to measure the voltage drop over the button and 10K-ohm resistor when the button is in both the up and down positions.

Button Position	*Pin 2 Voltage (volts)*	*Pin 2 State* *> 3 volts = HIGH* *< 1.5 volts = LOW*
Up		
Down		

In your own words, explain how the push-button circuit reads as either HIGH or LOW on pin 2 of the Arduino board.

LESSON 4

Complete this page during the Test and Modify activity in Lesson 4.

A. CODE CREATION

In the following space, write pseudocode outlining your LED indicator array. Remember that each LED should fade in one at a time based on the value of the potentiometer.

LESSON 5

Complete these pages as you work through Lesson 5.

A. PROJECT IDEAS

Brainstorm a list of possible ideas for how your holiday light circuit will be designed and programmed. Record your ideas in the following space.

B. SCHEMATIC DIAGRAM

Draw a schematic diagram of your holiday light circuit. Make sure that any changes you make to your circuit as you build are also recorded here on your diagram.

C. PSEUDOCODE

Before you begin developing your sketch in the Arduino IDE, write pseudocode that outlines the structure, functions, and commands that will be needed in your sketch to program your light circuit. Record your pseudocode in the following space.

V = 9

I = V/R = 9

E. ELECTRICAL MEASUREMENTS

Use this table to record electrical measurements and calculations of your circuit. For each component in your circuit, determine the maximum voltage, maximum current, and minimum resistance. You can assume that the minimum resistance of a component occurs when the maximum voltage is passing through it. For each entry in the table, mark whether the amount was measured (M) with the multimeter or calculated (C) with Ohm's law.

Component	*Maximum Voltage*		*Maximum Current*		*Minimum Resistance*	
	M or C	*Amount*	*M or C*	*Amount*	*M or C*	*Amount*
Total						

F. DEMONSTRATION

Use the following space to record notes, talking points, or an outline for your demonstration. Use this section as a guide as you present your project to the rest of the class.

G. PROJECT SCORING RUBRIC

Date

Team

Evaluator

Category	***3***	***2***	***1***	***0***	***Total***
Collaboration	Team worked well together to share the workload.	Team mostly worked well together to share the workload.	Team somewhat worked together, but the workload was not shared equally.	Team did not work together.	
Schematic Diagram	Diagram accurately represents the circuit developed.	Diagram mostly represents the circuit developed but has minor mistakes.	Diagram was attempted and somewhat represents the circuit developed with some mistakes.	Diagram was not attempted or does not represent the circuit developed.	
Circuit Prototype	Circuit prototype was developed, meeting all criteria and constraints	Circuit prototype was developed, meeting 75% or more of the criteria and constraints.	Circuit prototype was developed, meeting 50% or more of the criteria and constraints.	Circuit prototype was developed, meeting less than 50% of the criteria and constraints.	
Code	Code is free of errors, organized, and explained with code comments.	Code is free of errors, is mostly organized, and has some code comments.	Code has minor errors, is not organized, and lacks code comments.	Code has major errors, is not well organized, and lacks code comments.	
Electrical Measurements	All three of these quantities were measured or calculated correctly in a circuit path: • Total voltage	Two of these three quantities were measured or calculated correctly in a circuit path: • Total voltage	One of these three quantities was measured or calculated correctly in a circuit path: • Total voltage	None of these quantities were measured or calculated correctly in a circuit path: • Total voltage	

	• Total current • Total resistance	• Total current • Total resistance	• Total current • Total resistance	• Total current • Total resistance	
Demonstration	Demonstration met three of the following criteria: • Included a working prototype • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met two of the following criteria: • Included a working prototype • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met one of the following criteria: • Included a working prototype • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met none of the following criteria: • Included a working prototype • Included an explanation of the circuit design • Was well organized and delivered	
				Total:	***/18***

Notes and Comments:

LESSON 6

Complete this page during the Test the Circuit section of Lesson 6.

Potentiometer Range	Servo Angle	Distance Traveled	Observations
0 to 115	0 to 20 degrees		
230 to 285	40 to 50 degrees		
485 to 545	85 to 95 degrees		
745 to 800	130 to 140 degrees		

- What conclusions can you draw from the results of your experiment? Is there a relationship between the servo angle and the distance the balled traveled? If so, what is the relationship? Record your conclusions.

- What factors would have more of an impact on how far the robot hits, kicks, or throws the ball? Think about how you might be able to control these factors with code in a sketch. Record your ideas.

LESSON 7

Complete this section during the Test and Modify section of the Lesson 7.

Compare the effectiveness of your wiper sketch that used delays to pause the wiper versus the sketch that used the Arduino's timer and loops to pause the wiper. In your own words, explain the problem with using delays and how this problem was overcome by using the Arduino's timer and while loops.

Listed below are some pseudocode steps for adding the windshield washer mode to your wiper sketch. Arrange the steps in the most logical order based on your current sketch. To arrange the steps, number each blank from 1 to 8.

____ Declare case 3 for washer mode.

____ When the button is pressed in intermittent mode, change the wiper mode from intermittent to washer mode.

____ When the wipers are done cleaning, turn the fluid and wipers off.

____ Set the pin mode for the blue LED pin as an output.

____ Declare a constant for the blue LED pin.

____ When the button is pressed at the beginning of the main loop. If the wiper is in intermittent mode, change the wiper to washer mode.

____ Move the wipers up and down five times to wash the window.

____ Turn on the blue LED to represent squirting washer fluid on the windshield.

LESSON 8

A. SOUND EXPERIMENT

Complete this section during the Sound Experiment section of Lesson 8.

Rate Variable	***Period (s)*** *Rate • 2 / 1000*	***Frequency (Hz)*** *1 / Pitch*	***Observations***
1	***0.002***	***500***	
2			
3			

- What conclusions can you draw about the relationship between the frequency of a sound wave and how it sounds?

B. TEST AND MODIFY

Complete this section during the Test and Modify section of Lesson 8.

Note	Key	Analog Value	Voltage
0	1		
1	2		
2	3		
3	4		
4	1		
5	2		
6	3		
7	4		

Look at the data from your table. You should notice that the analog value and voltage measurements for Key 1 and Key 2 are close. This could cause a problem with your keyboard where both key buttons play the same note. Record your ideas on how you could improve the keyboard so that it is less likely to play the same note on two different keys.

NOTE FREQUENCIES

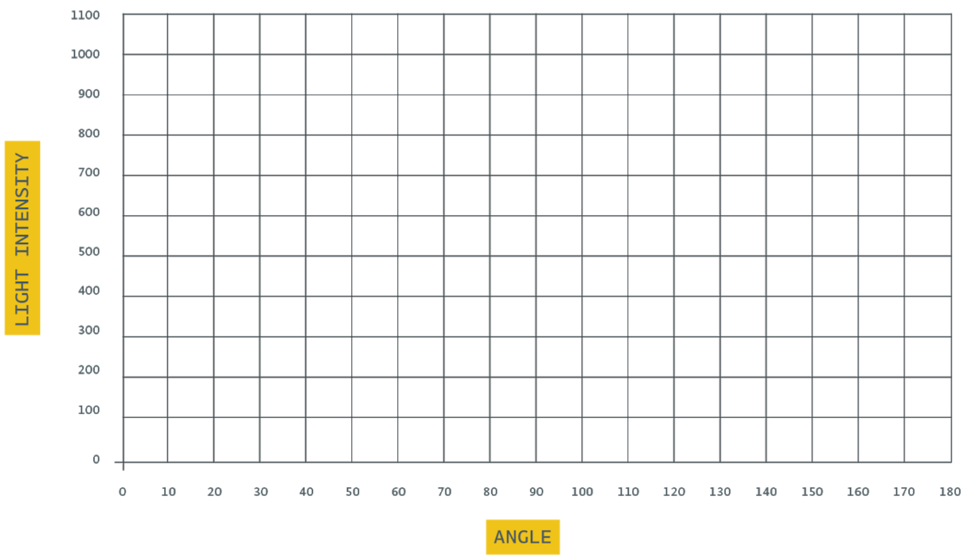
This chart shows the frequencies of common notes on a piano.

	Octave 0	Octave 1	Octave 2	Octave 3	Octave 4	Octave 5	Octave 6	Octave 7	Octave 8
C	16.35	32.70	65.41	130.81	261.63	523.25	1046.50	2093.00	4186.01
C#	17.32	34.65	69.30	138.59	277.18	554.37	1108.73	2217.46	4434.92
D	18.35	36.71	73.42	146.83	293.66	587.33	1174.66	2349.32	4698.64
D#	19.45	38.89	77.78	155.56	311.13	622.25	1244.51	2489.02	4978.03
E	20.60	41.20	82.41	164.81	329.63	659.26	1318.51	2637.02	5274.04
F	21.83	43.65	87.31	174.61	349.23	698.46	1396.91	2793.83	5587.65
F#	23.12	46.25	92.50	185.00	369.99	739.99	1479.98	2959.96	5919.91
G	24.50	49.00	98.00	196.00	392.00	783.99	1567.98	3135.96	6271.93
G#	25.96	51.91	103.83	207.65	415.30	830.61	1661.22	3322.44	6644.88
A	27.50	55.00	110.00	220.00	440.00	880.00	1760.00	3520.00	7040.00
A#	29.14	58.27	116.54	233.08	466.16	932.33	1864.66	3729.31	7458.62
B	30.87	61.74	123.47	246.94	493.88	987.77	1975.53	3951.07	7902.13

LESSON 9

A. LIGHT INTENSITY EXPERIMENT

Complete this section during the Light Intensity Experiment section of Lesson 9.



Maximum Intensity Angle:

Maximum Intensity:

Why did the maximum light intensity occur at this angle?

B. TEST AND MODIFY

Complete this section during the Test and Modify section of Lesson 9.

Maximum Intensity Angle:

Maximum Light Intensity:

Minimum Intensity Angle:

Minimum Light Intensity:

LESSON 10

Complete these pages as you work through Lesson 10.

A. PROJECT IDEAS

Brainstorm a list of possible ideas for how your greenhouse climate-control system will be designed and programmed. Record your ideas in the following space.

B. SCHEMATIC DIAGRAM

Draw a schematic diagram of your climate-control circuit. Make sure that any changes you make to your circuit as you build are also recorded here on your diagram.

C. PSEUDOCODE

Before you begin developing your sketch in the Arduino IDE, write pseudocode that outlines the structure, functions, and commands that will be needed in your sketch to program your climate-control circuit. Keep the criteria and constraints of the project in mind as you develop your pseudocode. Record your pseudocode in the following space.

E. MODEL GREENHOUSE

Use the following space to design your greenhouse model. Your design should include sketches of the greenhouse as well as how the control system will work with the model.

F. DEMONSTRATION

Use the following space to record notes, talking points, or an outline for your demonstration. Use this section as a guide as you present your project to the rest of the class.

G. PROJECT SCORING RUBRIC

Date:

Team:

Evaluator:

Category	*3*	*2*	*1*	*0*	*Total*
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Code	Code met all the following criteria: • Code functions and is free of errors and bugs. • Code includes at least one called function. • Code is clean and well organized and includes code comments.	Code met two of the following criteria: • Code functions and is free of errors and bugs. • Code includes at least one called function. • Code is clean and well organized and includes code comments.	Code met one of the following criteria: • Code functions and is free of errors and bugs. • Code includes at least one called function. • Code is clean and well organized and includes code comments.	Code met none of the following criteria: • Code functions and is free of errors and bugs. • Code includes at least one called function. • Code is clean and well organized and includes code comments.	
Model Greenhouse	Model greenhouse met all the following criteria:	Model greenhouse met two of the following criteria:	Model greenhouse met one of the following criteria:	Model greenhouse met none the following criteria:	

	• Model was constructed. • Model shows creativity and ingenuity. • Model incorporates the circuit prototype.	• Model was constructed. • Model shows creativity and ingenuity. • Model incorporates the circuit prototype.	• Model was constructed. • Model shows creativity and ingenuity. • Model incorporates the circuit prototype.	• Model was constructed. • Model shows creativity and ingenuity. • Model incorporates the circuit prototype.	
Engineering Notebook	All sections of the engineering notebook were completed with reasonable responses.	Most sections (> 66%) of the engineering notebook were completed with reasonable responses.	Some sections (> 33%) of the engineering notebook were completed with reasonable responses.	No sections of the engineering notebook were completed with reasonable responses.	
Demonstration	Demonstration met three of the following criteria: • Included a working prototype of a climate-controlled greenhouse • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met two of the following criteria: • Included a working prototype of a climate-controlled greenhouse • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met one of the following criteria: • Included a working prototype of a climate-controlled greenhouse • Included an explanation of the circuit design • Was well organized and delivered	Demonstration met none of the following criteria: • Included a working prototype of a climate-controlled greenhouse • Included an explanation of the circuit design • Was well organized and delivered	
				Total:	***/21***

Notes and Comments:

DEVELOPED BY ARDUINO