# Advanced Circuit Worksheet: Exploring Real-World Electronics

Name: _____ Date: _____

Lesson Objective:
In this activity, you'll deepen your understanding of electronic circuits by experimenting with series and parallel configurations, measuring voltages, and controlling LEDs using an Arduino microcontroller.

## Part 1: Review Questions

1. What is the main difference between a series and a parallel circuit?

2. What is Ohm's Law, and how is it used to calculate current?

3. What happens to voltage across components in a parallel circuit?

## Part 2: Hands-On Circuit Challenge

Materials:
- Breadboard
- Coin cell or AA battery pack
- 3x LEDs
- Assorted resistors
- Arduino Uno (optional for Part 3)
- Jumper wires
- Multimeter (optional)

- Build a Parallel Circuit:

1. Place two LEDs in parallel on the breadboard.

2. Use appropriate resistors to protect the LEDs.

3. Connect the power supply.

4. Sketch your circuit below:

5. Measure and record the voltage across each LED:

- LED 1 Voltage: _____

- LED 2 Voltage: _____

## Part 3: Arduino Programming (Optional Extension)

- Getting Started with the Arduino IDE:

1. Download the Arduino IDE: https://www.arduino.cc/en/software

2. Connect your Arduino using a USB cable.

3. Open the IDE and select your board and port under the Tools menu.

Sample Code to Blink an LED:

```
void setup() {
  pinMode(13, OUTPUT); // set pin 13 as output
}

void loop() {
  digitalWrite(13, HIGH); // turn LED on
  delay(500);             // wait half a second
  digitalWrite(13, LOW);  // turn LED off
  delay(500);
}
```

- Challenge:

1. Upload the code to your Arduino.

2. Modify it to make the LED blink faster.

3. Try connecting an external LED to pin 9 and make it blink instead of the onboard one.

4. Attempt to make a custom pattern of blinking, or even add multiple off-board LEDs

Pin 9 Code Snippet:

```
void setup() {
  pinMode(9, OUTPUT);
}

void loop() {
  digitalWrite(9, HIGH);
  delay(200);
  digitalWrite(9, LOW);
  delay(200);
}
```

## Reflection Questions

1.How did changing resistor values affect the brightness of your LEDs?

2. What was the hardest part of building the parallel circuit or using Arduino?

3. How do you think these basic concepts apply to real-world technology (e.g. smartwatches, car electronics)?

# Teacher Answer Sheet

## Part 1: Review Questions

1. In a series circuit, components are connected end-to-end, so the same current flows through each component. In a parallel circuit, components are connected across common points, so the voltage is the same across each branch, but the current can vary.
2. Ohm's Law is V = IR (Voltage = Current × Resistance). It is used to calculate one variable when the other two are known.
3. In a parallel circuit, the voltage across each branch/component is equal to the supply voltage.

## Part 2: Circuit Challenge

LEDs in parallel should have the same brightness (assuming identical LEDs and resistors). Voltage across each LED will be approximately equal to the supply voltage minus any drop from the resistor.

## Part 3: Arduino Programming

Sample code explanation:

`pinMode(13, OUTPUT);` sets the digital pin as output.

`digitalWrite(HIGH/LOW);` turns the pin on or off (i.e., sets voltage to 5V or 0V).

`delay(ms);` pauses the program for the specified number of milliseconds.

For the challenge, a faster blink could be achieved with a delay of 100 ms instead of 500 ms.

## Reflection Answers (will vary):

1. Lower resistance = brighter LED; higher resistance = dimmer LED (Ohm's Law in action).

2. Answers may include trouble identifying component legs, confusion in wiring, or uploading Arduino code.

3. Real-world applications include lighting systems, sensor-based devices, and any technology involving embedded electronics.