Lab 4 - Series and Parallel Resistors
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Equations:
Ohm's Law:
$\Delta V_i = I_i R_i$ **;** $I = V/R$
Power:
$P = \Delta V * I$
Series:
$R_{total} = R_1 + R_2 + R_3$
$I_{total} = I_1 = I_2 = I_3$
$\Delta V_{total} = \Delta V_1 + \Delta V_2 + \Delta V_3$
Parallel:
$\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
$\Delta V_{total} = \Delta V_1 = \Delta V_2 = \Delta V_3$
$I_{total} = I_1 + I_2 + I_3$

Calculated vs. Measured Comparisons:

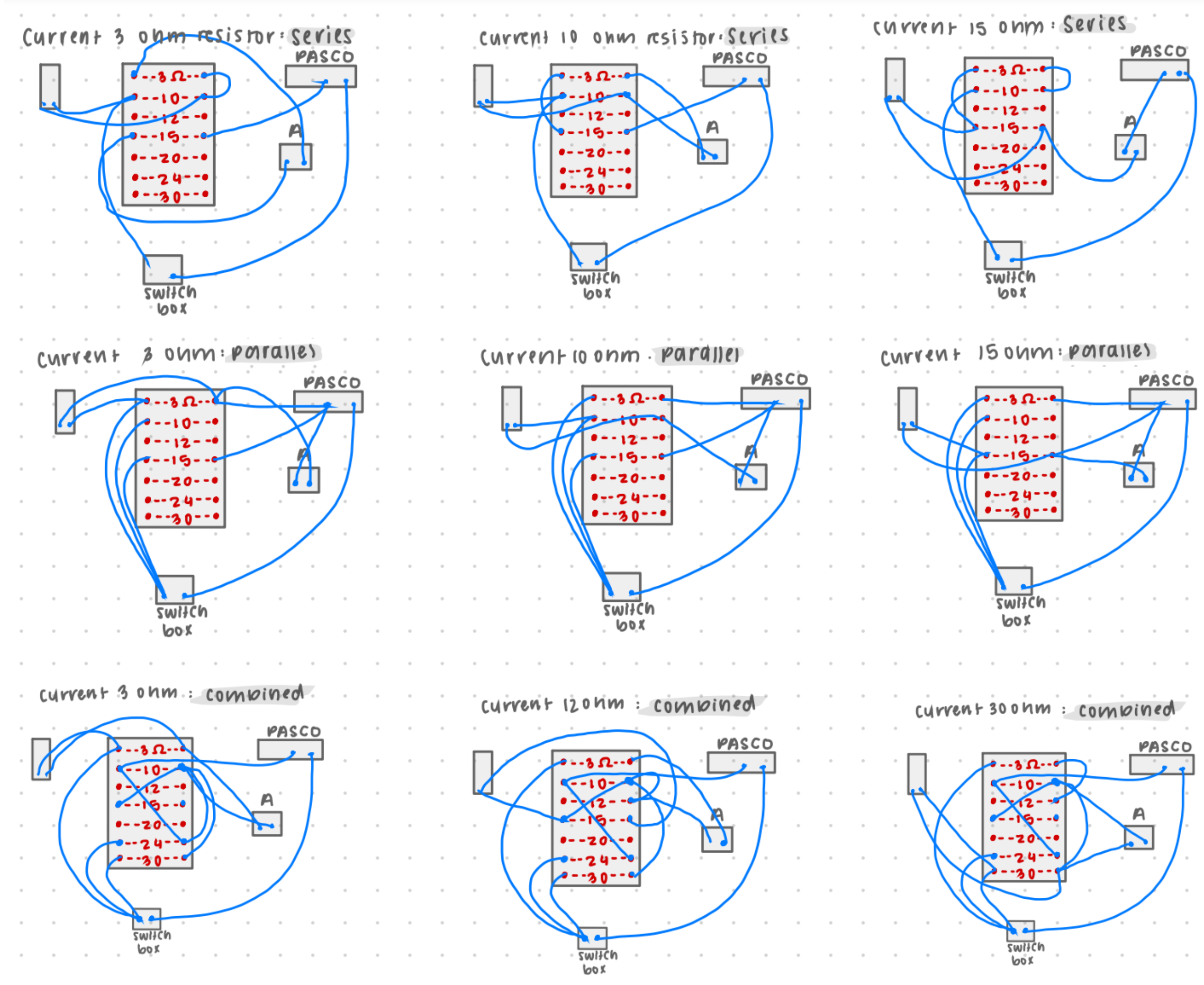
For resistors in a series circuit, each resistor carries the total current flowing from the power supply. This makes sense, since the current only has one path to follow, through each resistor sequentially through the circuit, so the current passing through any one resistor has to be the same current passing throughout the circuit. And since the current is constant, we can expect the voltage to vary with the resistance. Those varying voltages across each resistor need to sum to the total voltage in the series circuit.

Where the current was all forced to follow the same path along the series circuit, in a parallel circuit, the current has multiple branches to flow along. So, the current through each resistor will vary. The total current through a parallel circuit will be the sum of the current across each resistor

Conclusions:

Our full calculations can be found in [this spreadsheet]. We did have what feels like a fault either in our circuit wiring or some issue with the power supply cycling when measuring resistance in Circuit 2. Since the percent differences are consistently around 30%, it seems likely there was a systematic error in our setup (perhaps a loose wire/bad connection somewhere). These values are highlighted in red in our data below. Resetting our power supply gave closer to the expected 3V for the combined circuit, so the parallel circuit measurements are likely flawed by some error we were unable to track down during the lab.

Circuit Diagrams:



For the combined circuit calculations, the linked spreadsheet above shows some more detail (cells highlighted in gray) but essentially involves treating the circuit as two resistors in series with constant current, then using that constant current to find the voltage over the 10 Ohm resistor and the whole parallel branch. Since that voltage over the parallel branch will be constant for each parallel resistor, we can use Ohm's Law to find the current across each resistor. Extending these ideas also allows us to calculate for the 12 and 3 Ohm resistors in series (inside the parallel branch).

Data:

Circuit 1 - Series Resistors						
Resistance (Ohms)			**Calculated**	**Measured**	**% Difference**	**Power (W)**
R_total	28	ΔV total (V)	3	2.97	1.00	0.297
		I_total (A)	0.107	0.1	6.67	
R_1	10	ΔV1 (V)	1.071	0.98	8.53	0.098
		I1 (A)	0.107	0.1	6.67	
R_2	3	ΔV2 (V)	0.321	0.289	10.09	0.029
		I2 (A)	0.107	0.101	5.73	
R_3	15	ΔV3 (V)	1.607	1.336	16.87	0.131
		I3 (A)	0.107	0.098	8.53	

Circuit 2 - Parallel Resistors						
Resistance (Ohms)			**Calculated**	**Measured**	**% Difference**	**Power (W)**
R_total	2	ΔV total (V)	3	2.36	21.33	4.500
		I_total (A)	1.5	0.99	34.00	
R_1	10	ΔV1 (V)	3	1.69	43.67	0.287
		I1 (A)	0.3	0.17	43.33	
R_2	3	ΔV2 (V)	3	1.8	40.00	1.260
		I2 (A)	1	0.7	30.00	
R_3	15	ΔV3 (V)	3	1.8	40.00	0.216
		I3 (A)	0.2	0.12	40.00	

Circuit 3 - Combined Series and Parallel Resistors						
Resistance (Ohms)			**Calculated**	**Measured**	**% Difference**	**Power (W)**
R_total	17.06	ΔV total (V)	3.000	2.93	2.39	0.528
		I_total (A)	0.176	0.169	4.06	
R_1	10	ΔV1 (V)	1.759	1.543	14.00	0.309
		I1 (A)	0.176	0.167	5.33	
R_2	24	ΔV2 (V)	1.241	1.027	20.84	0.064
		I2 (A)	0.052	0.045	14.91	
R_3	30	ΔV3 (V)	1.241	1.048	18.42	0.051
		I3 (A)	0.041	0.036	14.91	
R_4	3	ΔV4 (V)	0.249	0.246	1.22	0.021
		I4 (A)	0.083	0.09	-7.78	
R_5	12	ΔV5 (V)	0.996	0.825	20.73	0.083
		I5 (A)	0.083	0.09	-7.78	