OHM'S LAW

Name _____

What you need to know:

- How to solve problems with Ohm's Law (V = IR)
- How to solve problems with the electric power formula (P = IV)
- How to solve a series circuit for voltage, current, resistance, and power
- How to solve a parallel circuit for voltage, current, resistance, and power

OHM'S LAW

Name _____

Part A: Ohm's Law

$$V = IR$$

Symbol	Quantity	SI Unit	
V	Voltage	Volt (V)	
I	Current	Ampere (A)	
R	Resistance	Ohm (Ω)	Ω is the Greek letter omega.

A.1 What is the name of this letter: **Ω ?** _____

What does it stand for in physics? _____

A.2 What does "I" stand for? _____

A.3 I hook up a circuit with a 10 V battery and a 5 **Ω** light bulb. What is the current?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

A.4 I hook up a circuit with a 30 V battery and a 6 **Ω** light bulb. What is the current?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

A.5 When I hook up a 12 V battery, I get 3 A of current. What is the resistance of my circuit?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

OHM'S LAW

Name _____

A.6 I have 5 A of current going through a 10 Ohm resistor. What is the voltage of my circuit?

Looking For	Formula	
Already Know		
Answer as equation *with unit*:		

A.7 I have 3 A of current going through a 5 Ohm resistor. What is the voltage of my circuit?

Looking For	Formula	
Already Know		
Answer as a complete sentence *with unit*:		

A.8 I hook up a 12 V battery to a 36 **Ω** resistor. What is the current in my circuit?

Looking For	Formula	
Already Know		
Answer as a complete sentence *with unit*:		

OHM'S LAW

Name _____

Part B: Ohm's Law table

Each row of the following table contains two numbers given and one number still unknown. Fill in the unknown number so that each row satisfies the equation
V = IR.

Voltage (Volts)	**Current (Amps)**	**Resistance (Ohms)**
24		4
15	5	
24		12
20	4	
	2	9
	3	12
10		20

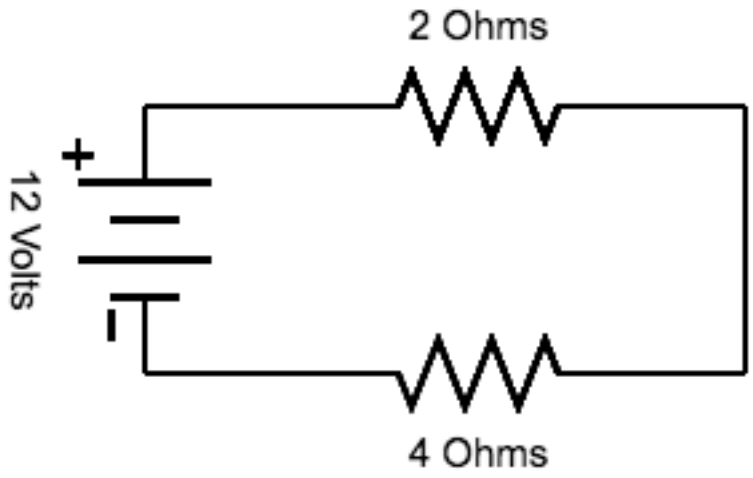
OHM'S LAW

Name _____

Part C: Solving a Series Circuit
The goal of these problems is to identify the voltage, current, and resistance of each element of a series circuit.

Series Circuit Rules:
1: For each element and the total circuit, the formula V = IR. 2: The *current* is the same for every element. 3: The *voltage* and *resistance* add up to the total for each circuit element.

C.1 A 12-volt battery, a 2-ohm resistor, and a 4-ohm resistor in series.

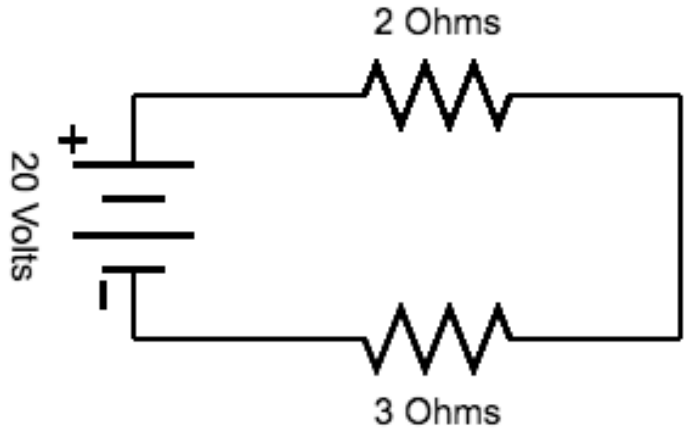


	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

OHM'S LAW

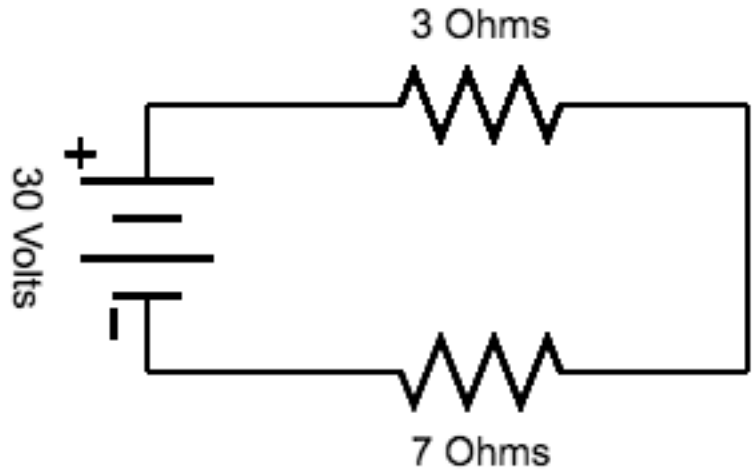
Name _____

C.2 A 20-Volt battery, a 2-ohm resistor, and a 3-ohm resistor in series.



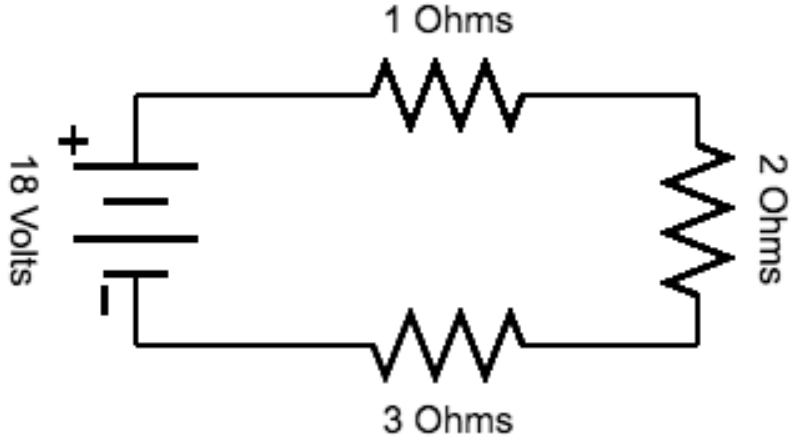
	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

C.3 A 30-volt battery, a 3-ohm resistor, and a 7-ohm resistor in series.



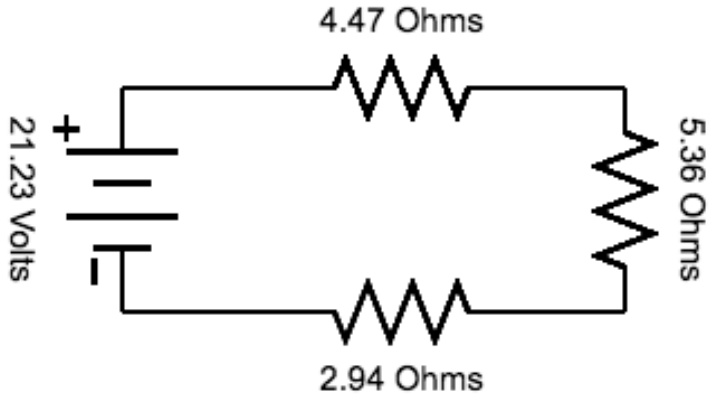
	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

C.4 An 18-volt battery, a 1-ohm resistor, a 2-ohm resistor, and a 3-ohm resistor in series.



	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)				
Current (A)				
Resistance (Ω)				

C.5 A 21.23-volt battery, a 4.47-ohm resistor, and a 5.36-ohm resistor, and a 2.94-ohm resistor in series. [use a calculator for this problem, round each cell of the table to two decimal places]



	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)				
Current (A)				
Resistance (Ω)				

OHM'S LAW

Name _____

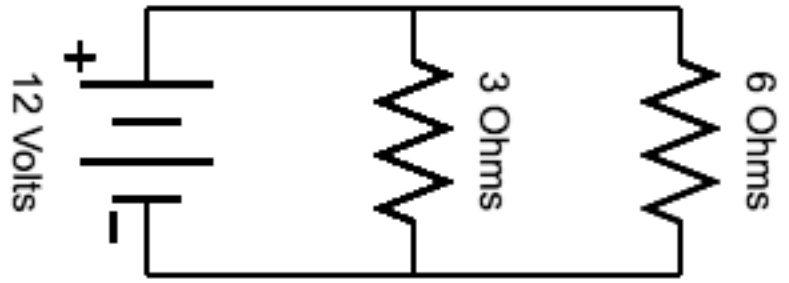
Part D: Solving Parallel circuit problems

In a parallel circuit, the rules are slightly different.

Parallel Circuit Rules:

1: For each element and the total circuit, the formula V = IR.
2: The *voltage* is the same for every element.
3: The *current* adds up to the total for each circuit element.
4: The *resistance* DOES NOT add up to the total.

D.1. A parallel circuit with a 12-Volt battery, a 3-Ohm resistor, and a 6-Ohm resistor:

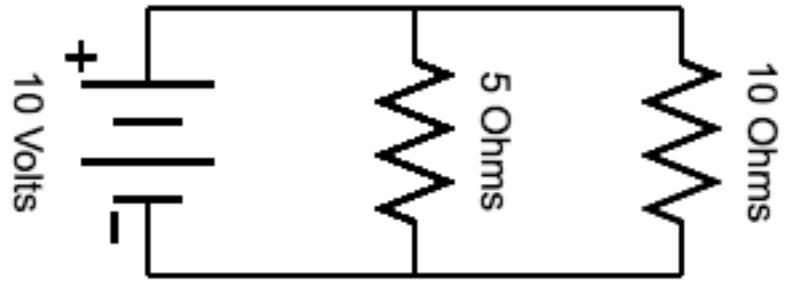


	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

OHM'S LAW

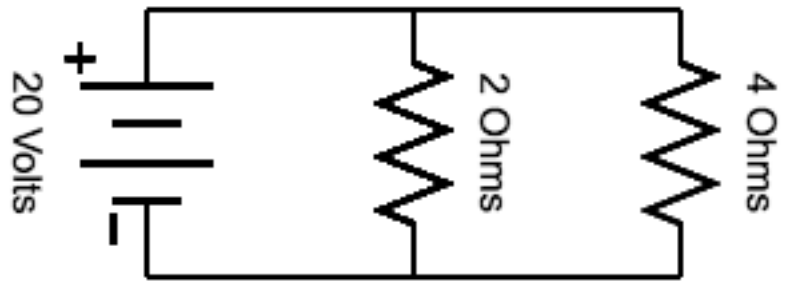
Name _____

D.2 a parallel circuit with a 10 Volt battery, a 5-Ohm resistor, and a 10-Ohm resistor:



	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

D.3 a parallel circuit with a 20 Volt battery, a 2 Ohm resistor, and a 4 Ohm resistor:

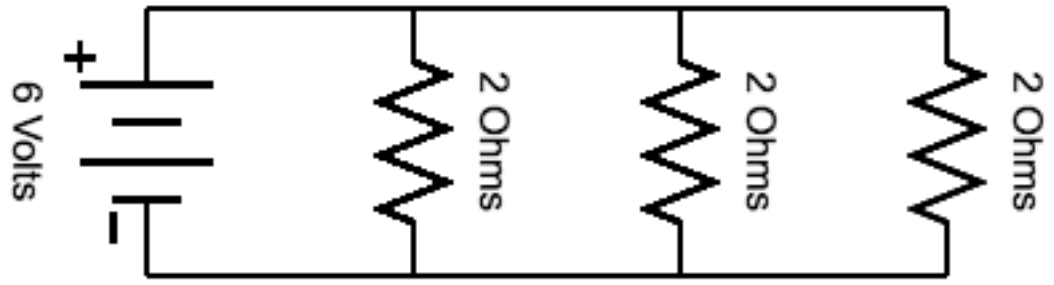


	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			

OHM'S LAW

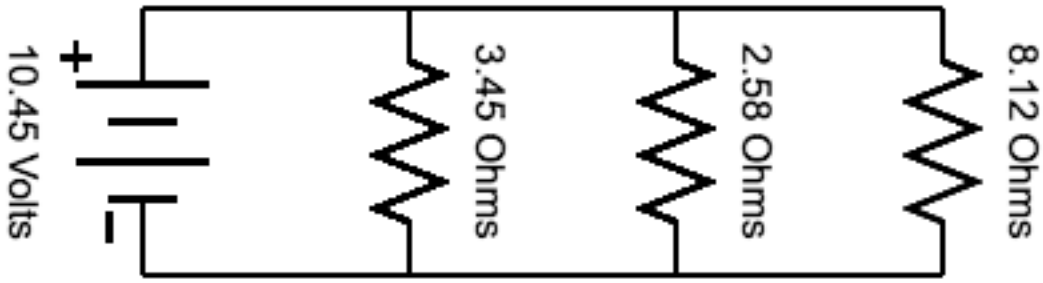
Name _____

D.4 A parallel circuit with a 6-volt battery and *three* 2-ohm resistors.



	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)				
Current (A)				
Resistance (Ω)				

D.5 A parallel circuit with a 10.45-volt battery, a 3.45-ohm resistor, a 2.58-ohm resistor, and a 8.12-ohm resistor. [use a calculator, round the answers to two decimal places]



	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)				
Current (A)				
Resistance (Ω)				

D.6 Which rule is the same for series and parallel circuits?

D.7 Which rules are different for series and parallel circuits?

OHM'S LAW

Name _____

Part E: The Power Formula

$$P = IV$$

	Quantity	SI Unit	What it means
P	Power	Watts (W)	How fast energy changes form.
I	Current	Amps (A)	Electrons per second.
V	Voltage	Volts (V)	Energy per electron.

E.1 I have a current of 5 Amps and I have a 12 Volt battery. What is my power?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

E.2 I have a current of 3 Amps and a 30 Volt battery. What is my power?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

E.3 I have a 100 Watt light bulb hooked up to an outlet, which means it has 120 Volts. What is its current?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

OHM'S LAW

Name _____

E.4 My vacuum cleaner uses 1100 Watts, and I hook it up to an outlet, which means it has 120 Volts. What is its current?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

E.5 I have a 300-Watt device, and I know there is 2 Amps of current going through it. How much voltage does it have?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

E.6 I hook up a 4-volt battery, and it produces a current of 0.3 Amps through my light bulb. How much power does the light bulb have?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

E.7 I hook up *two* 4-volt batteries, and it produces a current of 0.6 Amps through my light bulb. How much power does my light bulb have?

Looking For	Formula
Already Know	
Answer as a complete sentence *with unit*:	

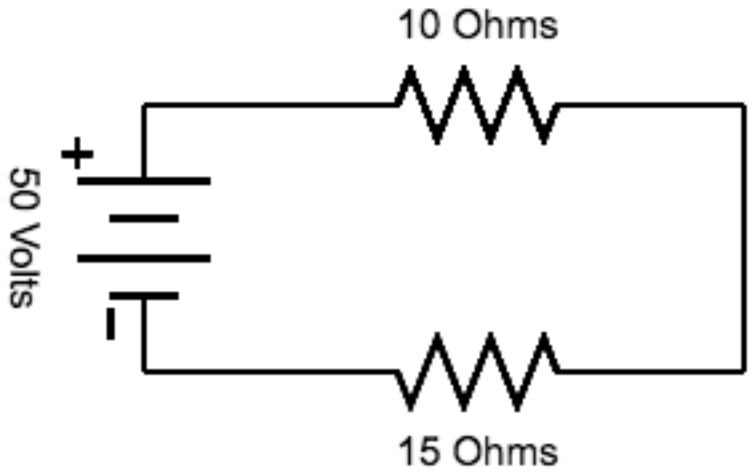
OHM'S LAW

Name _____

Part F: Solving circuit problems with power

New Rule: In both series and parallel circuits, the formula P = IV applies for each element.

F.1 A *series* circuit has a 50-volt battery, a 10-ohm resistor, and a 15-ohm resistor.

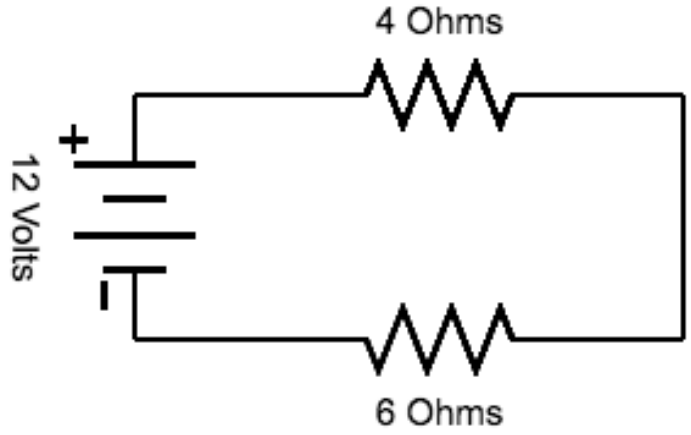


	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

OHM'S LAW

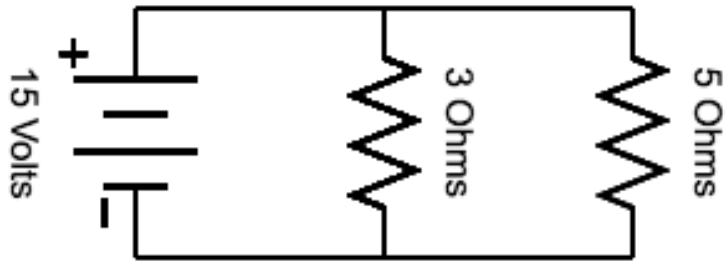
Name _____

F.2 A *series* circuit has a 12-volt battery, and four-ohm resistor, and a six-ohm resistor.



	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

F.3 A *parallel* circuit has a 15-volt battery, a 3-ohm resistor and a 5-ohm resistor.

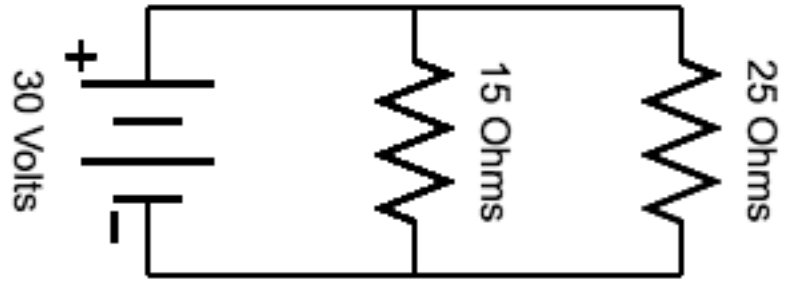


	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

OHM'S LAW

Name _____

F.4 A *parallel* circuit has a 30-volt battery, a 15-ohm resistor and a 25-ohm resistor.



	Resistor 1	Resistor 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

OHM'S LAW

Name _____

Part G: Which type of circuit has brighter light bulbs?

By now, you should have used the wire kits to build basic series and parallel circuits. Which type of circuit had brighter light bulbs?

We are going to mathematically sow *why* this rule is true:

You use two D-batteries. Each one has a voltage of 1.5 volts.
What is the total voltage of your circuit?

Assume that each light bulb has a resistance of 20 Ohms.

First, imagine you connect the light bulbs in series. Draw a circuit diagram of your circuit. Include the voltage of the batteries and resistance of the light bulbs in your circuit:

Solve the circuit:

	Light Bulb 1	Light Bulb 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

What is the power of each bulb in the series circuit?

Second, you connect the light bulbs in parallel. Draw a circuit diagram of your circuit. Include the voltage of the batteries and resistance of the light bulbs in your circuit:

	Light Bulb 1	Light Bulb 2	Total Circuit
Voltage (V)			
Current (A)			
Resistance (Ω)			
Power (W)			

What is the power of each bulb in the parallel circuit?

The *power* of a light bulb shows how much light energy each bulb generates. A light bulb with more power is a brighter light bulb. A light bulb with less power is a dimmer light bulb.

Explain how the mathematics connects with what you observe in real life:

OHM'S LAW

Name _____

Answers:

A.1 omega; it stands for Ohms
A.2 current
A.3 2 Amps
A.4 5 Amps

A.5 4 Ohms
A.6 50 Volts
A.7 15 Volts
A.8 0.33 Amps

Part B:

Voltage (Volts)	**Current (Amps)**	**Resistance (Ohms)**
24	6	4
15	5	3
24	2	12
20	4	5
18	2	9
36	3	12
10	0.5	20

C.1

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	4	8	12
Current (A)	2	2	2
Resistance (Ω)	2	4	6

OHM'S LAW

Name _____

C.2

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	8	12	20
Current (A)	4	4	4
Resistance (Ω)	2	3	5

C.3

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	9	21	30
Current (A)	3	3	3
Resistance (Ω)	3	7	10

C.4

	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)	3	6	9	18
Current (A)	3	3	3	3
Resistance (Ω)	1	2	3	6

C.5

	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)	7.43	8.91	4.89	21.23
Current (A)	1.66	1.66	1.66	1.66
Resistance (Ω)	4.47	5.36	2.94	12.77

Results are rounded to 3 significant figures.

OHM'S LAW

Name _____

D.1

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	12	12	12
Current (A)	4	2	6
Resistance (Ω)	3	6	2

D.2

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	10	10	10
Current (A)	2	1	3
Resistance (Ω)	5	10	3.33

D.3

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	20	20	20
Current (A)	10	5	15
Resistance (Ω)	2	4	1.33

D.4

	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)	6	6	6	6
Current (A)	3	3	3	9
Resistance (Ω)	2	2	2	0.667

D.5

	Resistor 1	Resistor 2	Resistor 3	Total Circuit
Voltage (V)	10.45	10.45	10.45	10.45
Current (A)	3.03	4.05	1.29	8.37
Resistance (Ω)	3.45	2.58	8.12	1.25

All results are rounded to three significant figures.

OHM'S LAW

Name _____

D.6 Ohm's Law applies to both series and parallel circuits.
D.7 In a series circuit, voltage adds and current is constant.
In a parallel circuit, current adds, and voltage is constant
In a series circuit, resistance adds up, while it does not in a parallel circuit.

E.1 60 Watts
E.2 90 Watts
E.3 0.833 Amps
E.4 9.17 Amps
E.5 150 Volts
E.6 1.2 Watts
E.7 4.8 Watts [remember there are *two* batteries]

F.1

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	20	30	50
Current (A)	2	2	2
Resistance (Ω)	10	15	25
Power (W)	40	60	100

F.2

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	4.8	7.2	12
Current (A)	1.2	1.2	1.2
Resistance (Ω)	4	6	10
Power (W)	5.76	8.64	14.4

F.3

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	15	15	15
Current (A)	5	3	8
Resistance (Ω)	3	5	1.875
Power (W)	75	45	120

OHM'S LAW

Name _____

F.4

	Resistor 1	Resistor 2	Total Circuit
Voltage (V)	30	30	30
Current (A)	2	1.2	3.2
Resistance (Ω)	15	25	9.375
Power (W)	60	36	96

Part G:

For a series circuit:

	Light Bulb 1	Light Bulb 2	Total Circuit
Voltage (V)	1.5	1.5	3.0
Current (A)	0.075	0.075	0.075
Resistance (Ω)	20	20	40
Power (W)	0.1125	0.1125	0.225

For a parallel circuit:

	Light Bulb 1	Light Bulb 2	Total Circuit
Voltage (V)	3.0	3.0	3.0
Current (A)	0.15	0.15	0.30
Resistance (Ω)	20	20	1
Power (W)	0.45	0.45	0.9

In the series circuit, each light bulb has a power of 0.1125 Watts.
In the parallel circuit, each light bulb has a power of 0.45 Watts, four times higher.
Power describes the brightness of the light bulb, which means that the bulbs in parallel should be four times brighter. This is approximately what we observe.

[Note: This calculation is slightly incorrect because light bulbs do not perfectly follow Ohm's Law, but it communicates the important point about series and parallel circuits.]