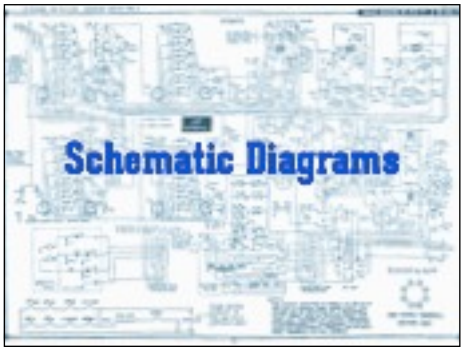
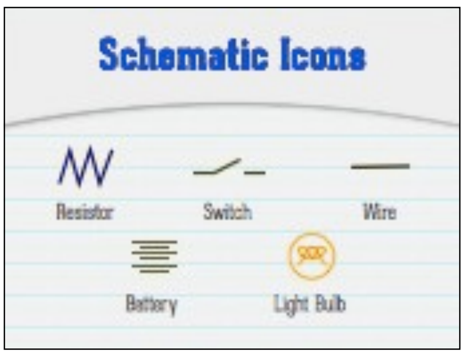

Electric Circuits

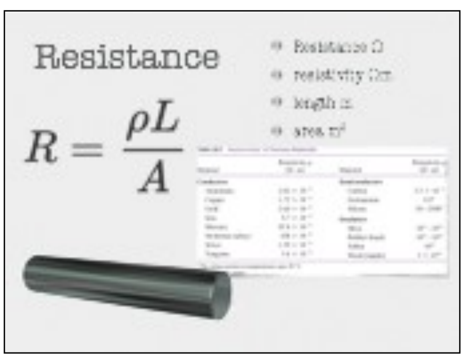
1


Schematic Diagrams

2


Schematic Icons
Resistor
Switch
Wire
Battery
Light Bulb

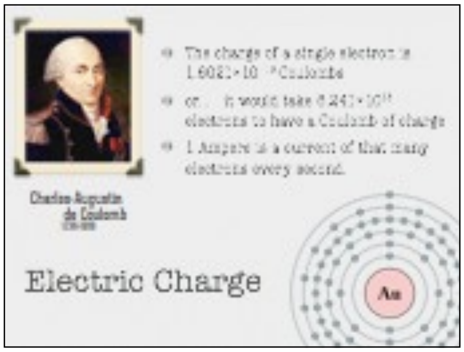
3


Resistance
$R = \frac{\rho L}{A}$
Resistance Ω
resistivity Ωm
length m
area m²

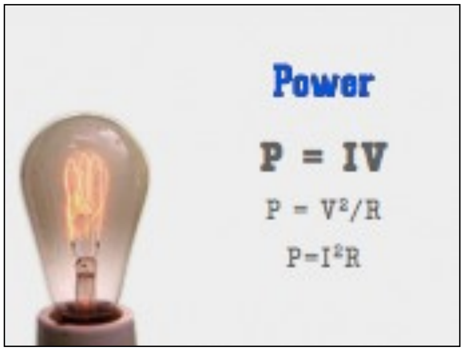
4


Ohm's Law
V = I R
ℰ = I R
Georg Simon Ohm
André-Marie Ampère
Alessandro Giuseppe Antonio Anastasio Gerolamo Umberto Volta

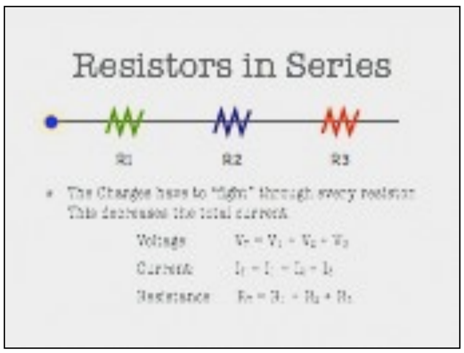
5


The charge of a single electron is
electrons to have a Coulomb of charge
1 Ampere is a current of that many electrons every second.
Charles-Augustin de Coulomb
Electric Charge
Au

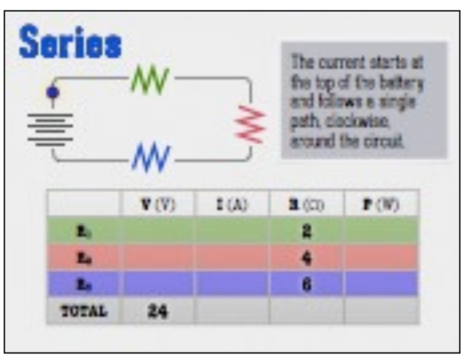
6


Power
P = IV
P = V²/R
P=I²R

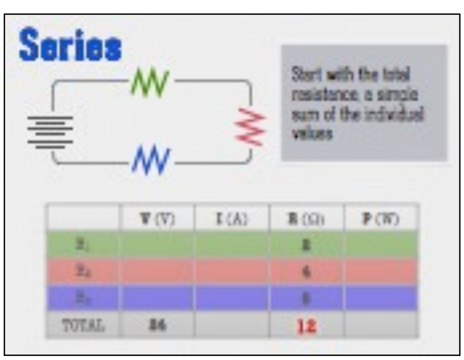
7


Resistors in Series
R1
R2
R3
The Charges have to "fight" through every resistor
This decreases the total current
Voltage
Current
Resistance

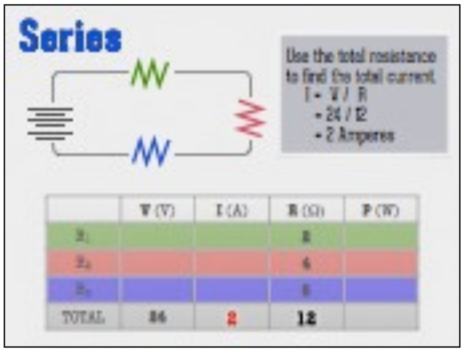
8


Series
The current starts at the top of the battery and follows a single path, clockwise, around the circuit.
V (V)
I (A)
R (Ω)
P (W)
2
4
6
TOTAL
24

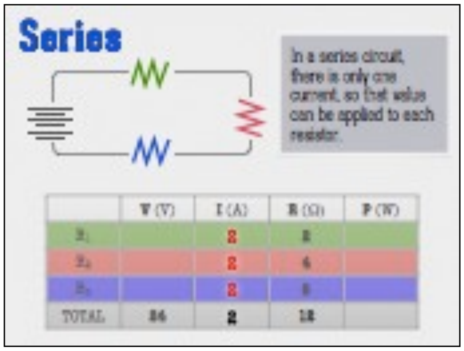
9


Series
Start with the total resistance, a simple sum of the individual values
V (V)
I (A)
R (Ω)
P (W)
2
4
6
TOTAL
24
12

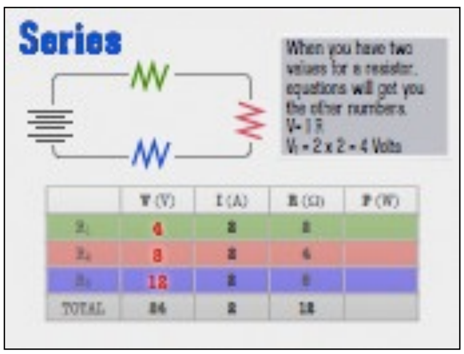
10


Series
Use the total resistance to find the total current.
I = V / R
= 24 / 12
= 2 Amperes
V (V) I (A) R (Ω) P (W)
TOTAL 24 2 12

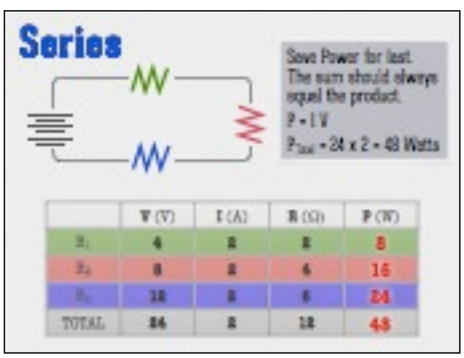
11


Series
In a series circuit, there is only one current, so that value can be applied to each resistor.
V (V) I (A) R (Ω) P (W)
TOTAL 24 2 12

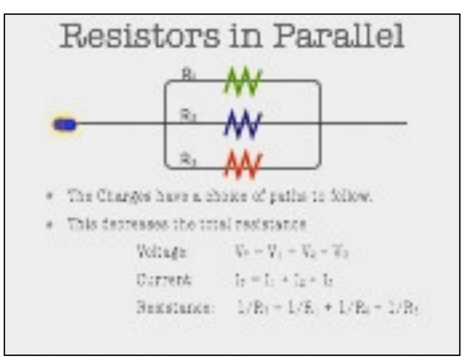
12


Series
When you have two values for a resistor, equations will get you the other numbers.
V= I R
V₁ = 2 x 2 = 4 Volts
V (V) I (A) R (Ω) P (W)
TOTAL 24 2 12

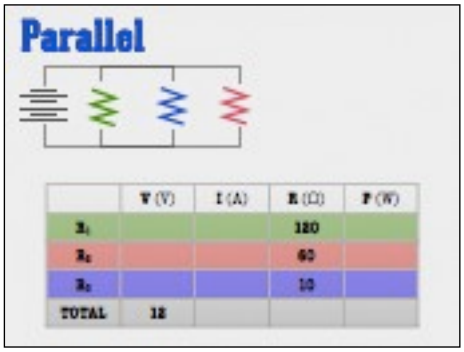
13


Series
Save Power for last. The sum should always equal the product.
P = I V
P = 24 x 2 = 48 Watts
V (V) I (A) R (Ω) P (W)
TOTAL 24 2 12 48

14

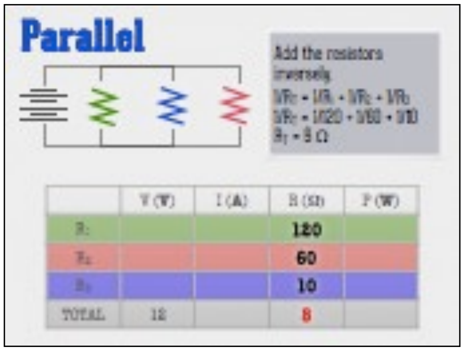

Resistors in Parallel
The Charges have a choice of paths to follow.
Voltage
Current
Resistance:

15



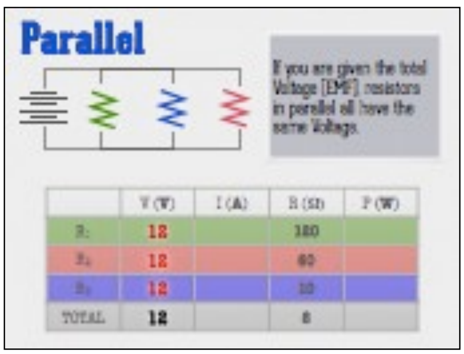
	V (V)	I (A)	R (Ω)	P (W)
R_1			120	
R_2			60	
R_3			10	
TOTAL	12			

16



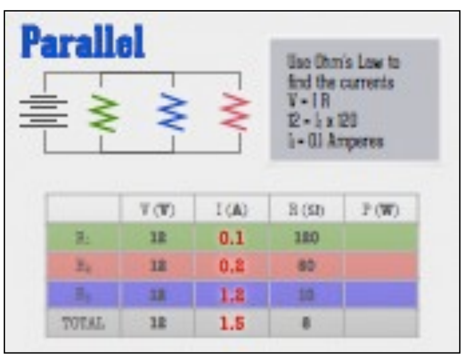
	V (V)	I (A)	R (Ω)	P (W)
R_1			120	
R_2			60	
R_3			10	
TOTAL	12		8	

17



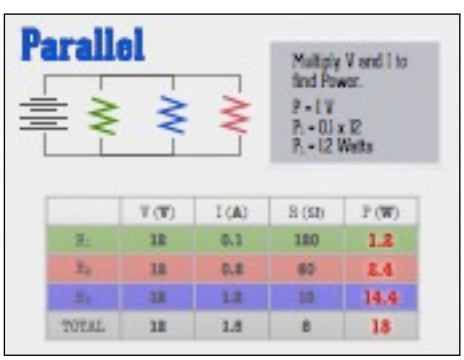
	V (V)	I (A)	R (Ω)	P (W)
R_1	12		120	
R_2	12		60	
R_3	12		10	
TOTAL	12		8	

18



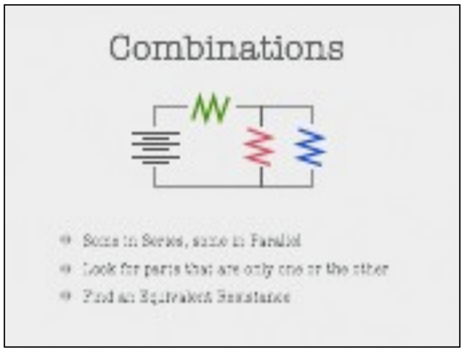
	V (V)	I (A)	R (Ω)	P (W)
R_1	12	0.1	120	
R_2	12	0.2	60	
R_3	12	1.2	10	
TOTAL	12	1.5	8	

19

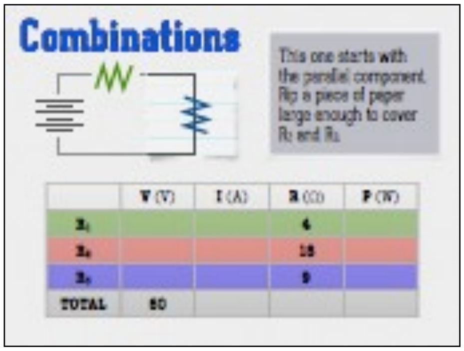


	V (V)	I (A)	R (Ω)	P (W)
R_1	12	0.1	120	1.2
R_2	12	0.2	60	2.4
R_3	12	1.2	10	14.4
TOTAL	12	1.5	8	18

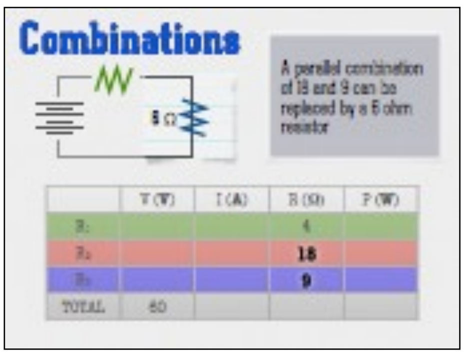
20


Combinations
Same in Series, same in Parallel
Look for parts that are only one or the other
Find an Equivalent Resistance

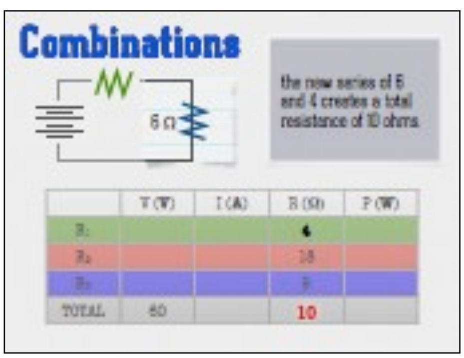
21


Combinations
This one starts with the parallel component. Flip a piece of paper large enough to cover R2 and R3
V (V)
I (A)
R (Ω)
P (W)
R1
4
R2
18
R3
9
TOTAL
60

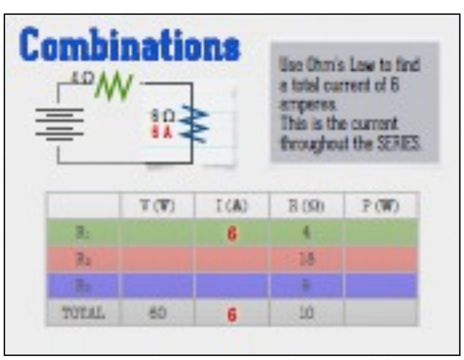
22


Combinations
6 Ω
A parallel combination of 18 and 9 can be replaced by a 6 ohm resistor
V (V)
I (A)
R (Ω)
P (W)
R1
4
R2
18
R3
9
TOTAL
60

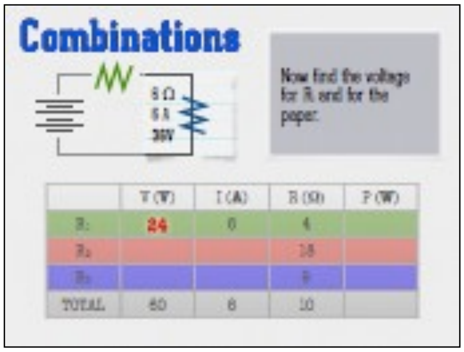
23


Combinations
6 Ω
the new series of 6 and 4 creates a total resistance of 10 ohms
V (V)
I (A)
R (Ω)
P (W)
R1
4
R2
18
R3
9
TOTAL
60
10

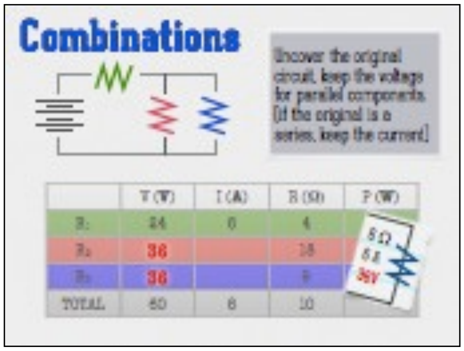
24


Combinations
4 Ω
6 Ω
6 A
Use Ohm's Law to find a total current of 6 amperes.
This is the current throughout the SERIES.
V (V)
I (A)
R (Ω)
P (W)
R1
6
4
R2
18
R3
9
TOTAL
60
6
10

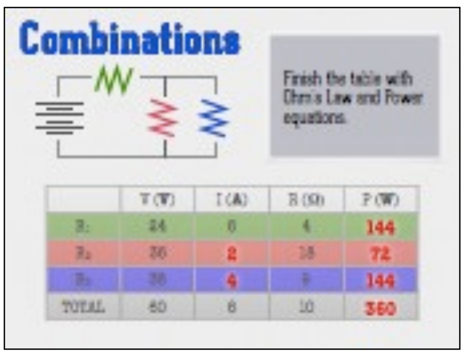
25


Combinations
6 Ω
6 A
36V
Now find the voltage for R and for the paper.
V (V) I (A) R (Ω) P (W)
R1 24 6 4
R2 18
R3 9
TOTAL 60 6 10

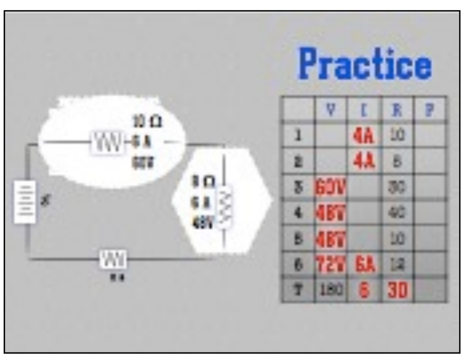
26


Combinations
Uncover the original circuit, keep the voltage for parallel components. (If the original is a series, keep the current)
V (V) I (A) R (Ω) P (W)
R1 24 6 4
R2 36 18
R3 36 9
TOTAL 60 6 10
6 Ω
6 A
36V

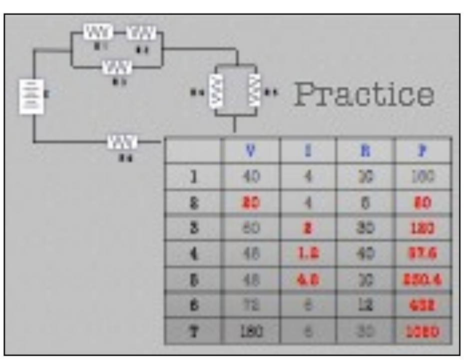
27


Combinations
Finish the table with Ohm's Law and Power equations.
V (V) I (A) R (Ω) P (W)
R1 24 6 4 144
R2 36 2 18 72
R3 36 4 9 144
TOTAL 60 6 10 360

28


Practice
10 Ω
6 A
60V
8 Ω
6 A
48V
V I R P
1 4A 10
2 4A 5
3 60V 30
4 48V 40
5 48V 10
6 72V 6A 12
T 180 6 30

29


Practice
V I R P
1 40 4 10 160
2 20 4 5 80
3 60 2 30 120
4 48 1.2 40 57.6
5 48 4.8 10 230.4
6 72 6 12 432
T 180 6 30 1080

30


Black 0
Brown 1
Red 2
Orange 3
Yellow 4
Green 5
Blue 6
Violet 7
Gray 8
White 9
Resistor Codes

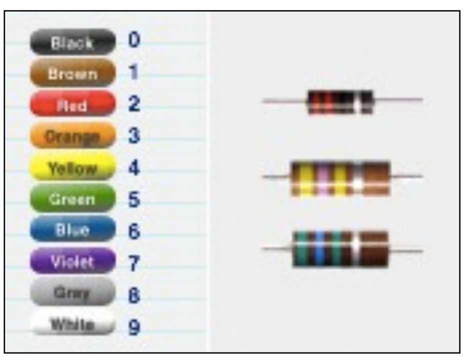
31


Black 0
Brown 1
Red 2
Orange 3
Yellow 4
Green 5
Blue 6
Violet 7
Gray 8
White 9
Orange, Orange, Green, Gold
orange 3
orange 3
green 00,000
3,300,000 Ω ± 5%
3.3 MΩ

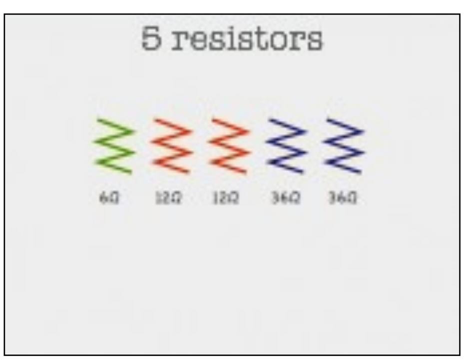
32


Black 0
Brown 1
Red 2
Orange 3
Yellow 4
Green 5
Blue 6
Violet 7
Gray 8
White 9
Gold, Yellow, Brown, Green ?
green 5
brown 1
yellow 0,000
510,000 Ω ± 5%
510 kΩ

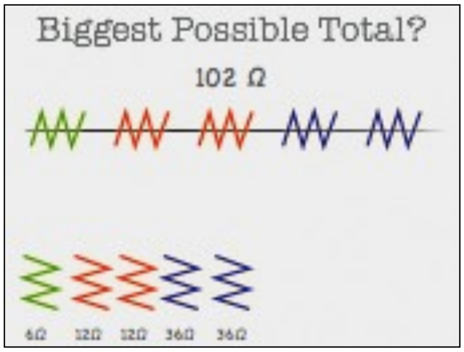
33


Black 0
Brown 1
Red 2
Orange 3
Yellow 4
Green 5
Blue 6
Violet 7
Gray 8
White 9

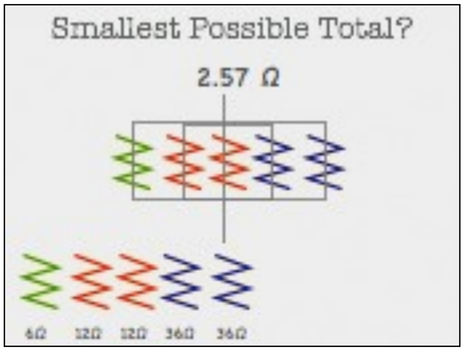
34


5 resistors
6Ω
12Ω
12Ω
36Ω
36Ω

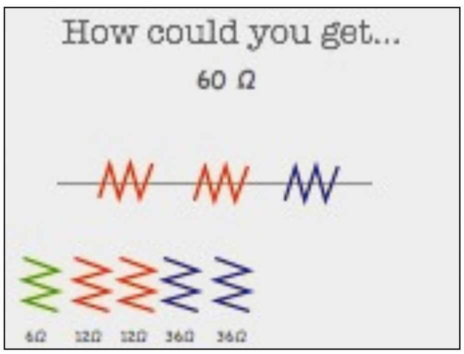
35


Biggest Possible Total?
102 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

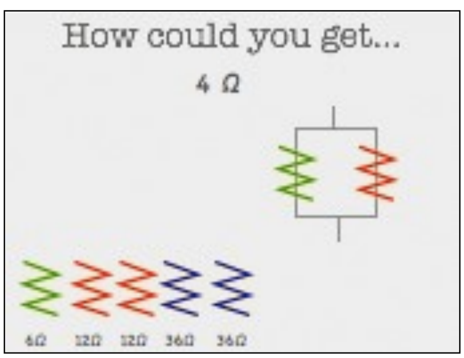
36


Smallest Possible Total?
2.57 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

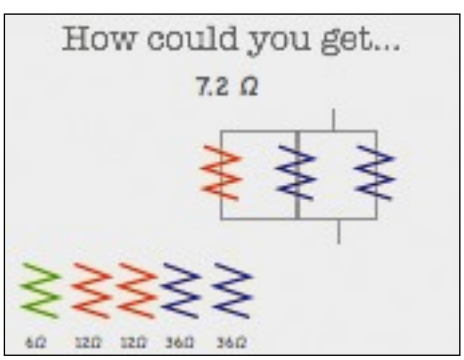
37


How could you get...
60 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

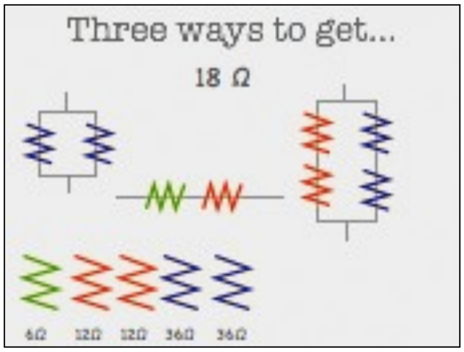
38


How could you get...
4 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

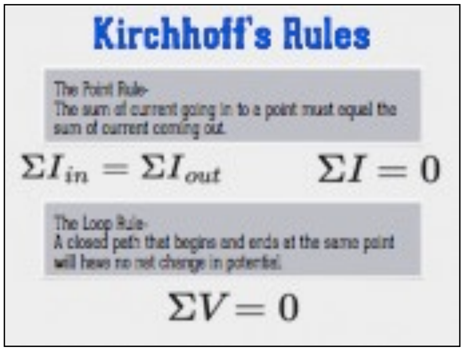
39


How could you get...
7.2 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

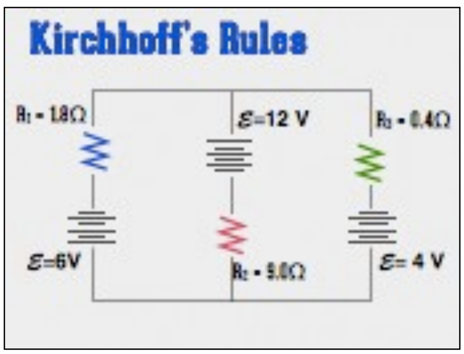
40


Three ways to get...
18 Ω
6Ω 12Ω 12Ω 36Ω 36Ω

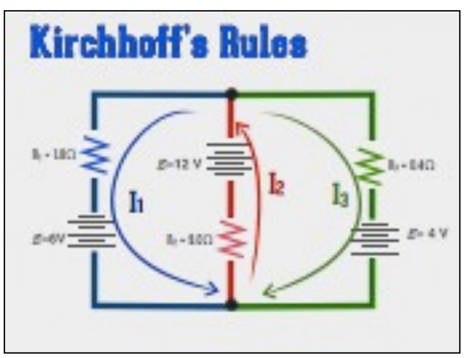
41


Kirchhoff's Rules
The Point Rule-
The sum of current going in to a point must equal the sum of current coming out
$\Sigma I_{in} = \Sigma I_{out}$
$\Sigma I = 0$
The Loop Rule-
A closed path that begins and ends at the same point will have no net change in potential
$\Sigma V = 0$

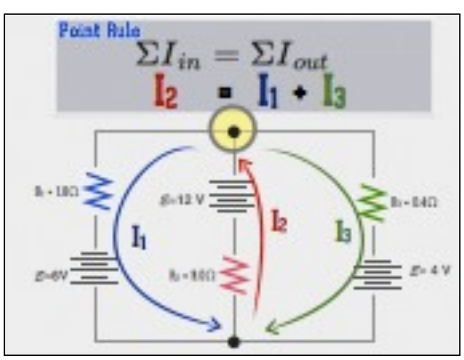
42


Kirchhoff's Rules
R1 = 1.8Ω
ℰ=12 V
R3 = 0.4Ω
ℰ=6V
R2 = 9.0Ω
ℰ= 4 V

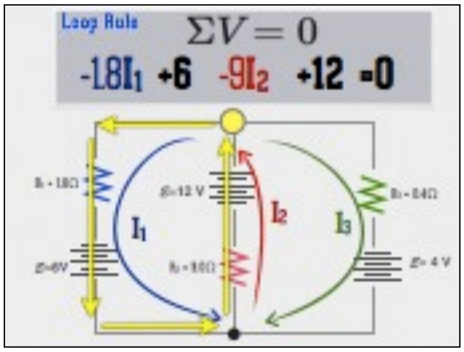
43


Kirchhoff's Rules
I1
I2
I3

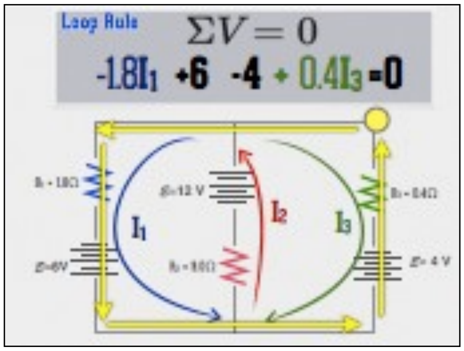
44


Point Rule
$\Sigma I_{in} = \Sigma I_{out}$
I2 = I1 + I3
I1
I2
I3

45


Loop Rule
ΣV = 0
-1.8I1 +6 -9I2 +12 =0
I1
I2
I3
ℰ=12 V
ℰ=6V
ℰ= 4 V

46


Loop Rule
ΣV = 0
-1.8I1 +6 -4 + 0.4I3 =0
I1
I2
I3
ℰ=12 V
ℰ=6V
ℰ= 4 V

47


Loop Rule -1.8I1 +6 -9I2 +12 =0
Boring Algebra
simplify to 18 - 1.8I1 = 9I2
divide by 9 to get 2 - 0.2I1 = I2
1.23 A = I1
Loop Rule -1.8I1 +6 -4 +0.4I3 =0
simplify to 2 -1.8I1 = -0.4I3
divide by -0.4 to get -5 + 4.5I1 = I3
Point Rule I2 = I1 + I3
substitute I2 2 - 0.2I1 = I1 -5 + 4.5I1 substitute I3
7 = 5.7 I1

48