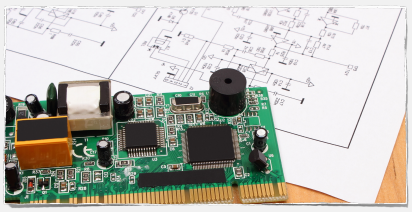
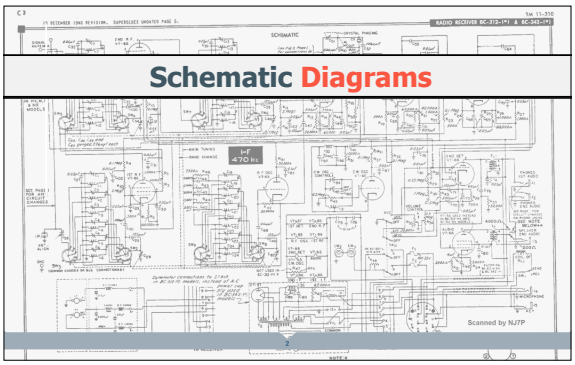
THS Physics
2018-19

Electric Circuits



1

Schematic Diagrams



2

Schematic Icons

Resistor

Switch

Wire

Battery

Cell

Light Bulb

3

Georg Simon **Ohm**
1789-1854

André-Marie **Ampère**
1775-1836

Alessandro
Giuseppe
Antonio
Anastasio
Gerolamo
Umberto
Volta
1745-1827

Ohm's Law

$$V = I R$$

$$\mathcal{E} = I R$$

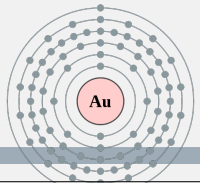
Potential or Voltage (V)	in	Volts (V)
Current (I)	in	Amperes (A)
Resistance (R)	in	Ohms (Ω)

4

Charles-Augustin
de Coulomb
1736-1806

Electric Charge

- The charge of a single electron is 1.6021×10^{-19} Coulombs
- or... it would take 6.241×10^{18} electrons to have a Coulomb of charge
- 1 Ampere is a current of that many electrons every second.



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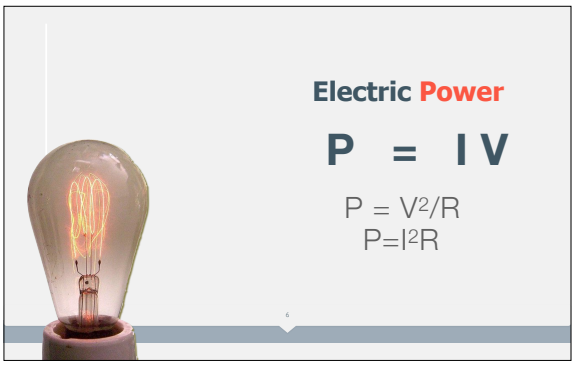
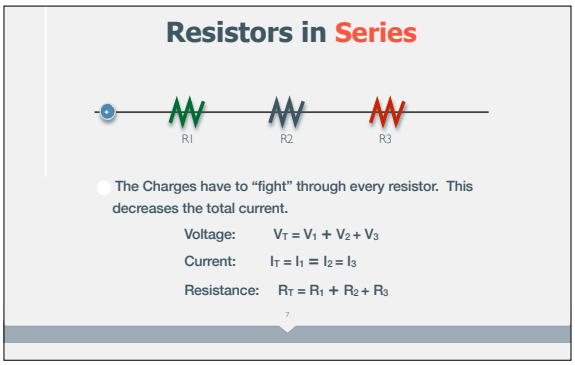
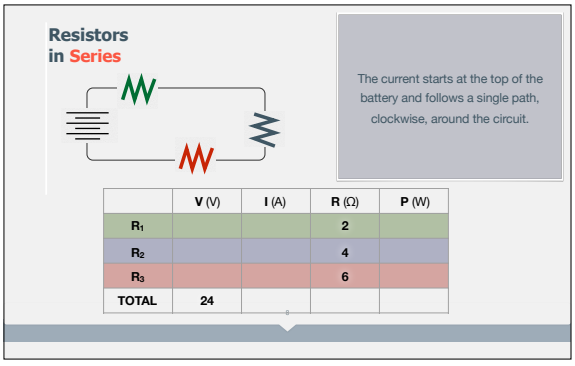

Electric Power
P = I V
P = V²/R
P=I²R

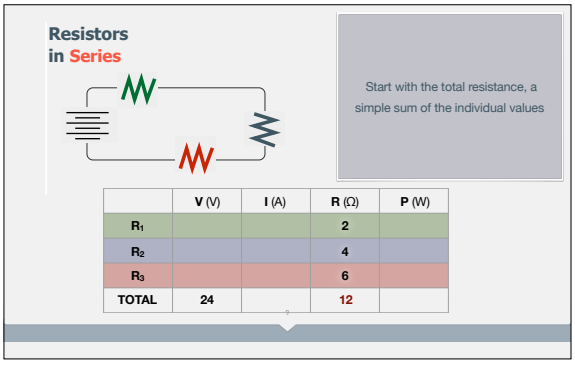
6


Resistors in Series
R1
R2
R3
The Charges have to "fight" through every resistor. This decreases the total current.
Voltage: $V_T = V_1 + V_2 + V_3$
Current: $I_T = I_1 = I_2 = I_3$
Resistance: $R_T = R_1 + R_2 + R_3$

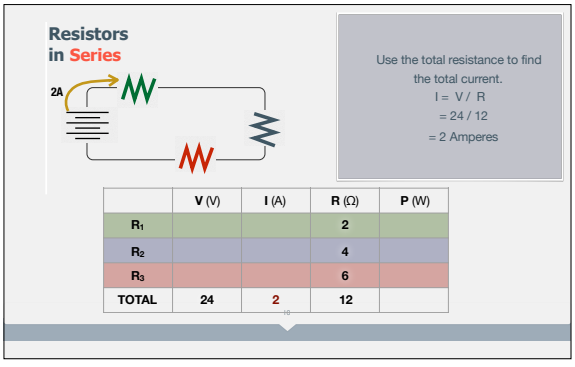
7


Resistors in 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)
R1 2
R2 4
R3 6
TOTAL 24

8


Resistors in Series
Start with the total resistance, a simple sum of the individual values
V (V) I (A) R (Ω) P (W)
R1 2
R2 4
R3 6
TOTAL 24 12

9


Resistors in Series
2A
Use the total resistance to find the total current.
I = V / R
= 24 / 12
= 2 Amperes
V (V) I (A) R (Ω) P (W)
R1 2
R2 4
R3 6
TOTAL 24 2 12

10

Resistors in Series

When you have two values for a resistor, equations will get you the other numbers.

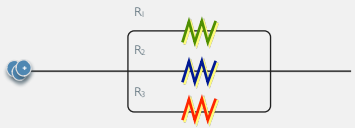
$V = I R$

$V_1 = 2 \times 2 = 4$ Volts

	V (V)	I (A)	R (Ω)	P (W)
R_1	4	2	2	
R_2	8	2	4	
R_3	12	2	6	
TOTAL	24	2	12	

12

Resistors in Parallel



- The Charges have a choice of paths to follow.
- This decreases the total resistance.

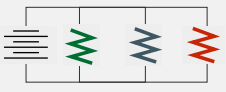
Voltage: $V_T = V_1 = V_2 = V_3$

Current: $I_T = I_1 + I_2 + I_3$

Resistance: $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$

14

Resistors in Parallel



Add the resistors inversely.

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_T = 1/120 + 1/60 + 1/10$

$R_T = 8\ \Omega$

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

16

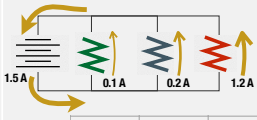
Resistors in Parallel

If you are given the total Voltage (EMF), resistors in parallel all have the same Voltage.

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

17

Resistors in Parallel



Use Ohm's Law to find the currents

$V = I R$

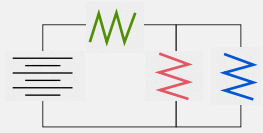
$12 = I_1 \times 120$

$I_1 = 0.1$ Amperes

	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 Ω	

18

Resistors in Combination Circuits

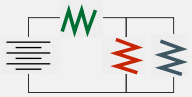


- Some in Series, some in Parallel
- Look for parts that are only one or the other
- Find an Equivalent Resistance

20

20

Resistors in Combinations



This one starts with the parallel component.

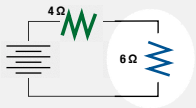
Make another resistor that will replace R_2 and R_3.

	V (V)	I (A)	R (Ω)	P (W)
R_1			4	
R_2			18	
R_3			9	
TOTAL	60			

21

21

Resistors in Combinations



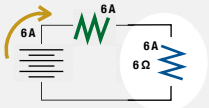
The new series of 6 and 4 creates a total resistance of 10 ohms.

	V (V)	I (A)	R (Ω)	P (W)
R_1			4	
R_2			18	
R_3			9	
TOTAL	60		10	

23

23

Resistors in Combinations



Use Ohm's Law to find a total current of 6 amperes.

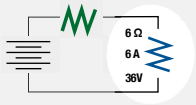
This is the current throughout each series section.

	V (V)	I (A)	R (Ω)	P (W)
R_1		6	4	
R_2			18	
R_3			9	
TOTAL	60	6	10	

24

24

Resistors in Combinations



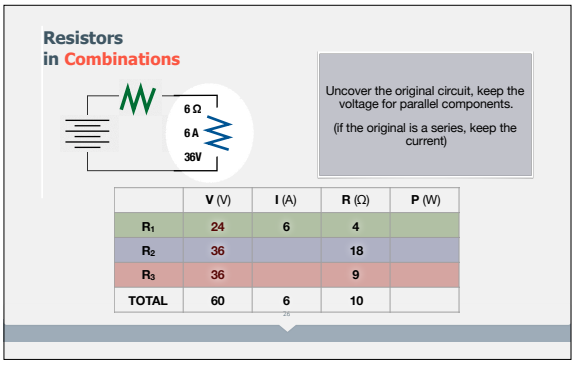
Solve for 3 values of the replacement resistor.

V, I, and R

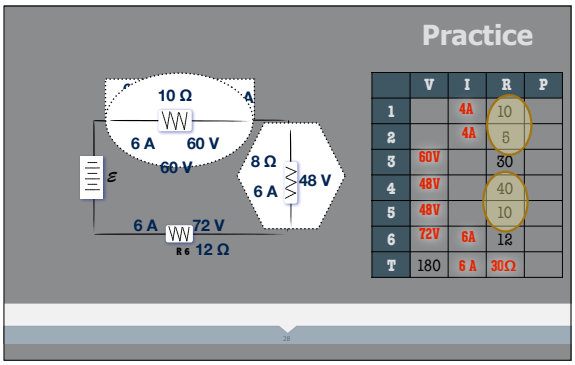
	V (V)	I (A)	R (Ω)	P (W)
R_1		6	4	
R_2			18	
R_3			9	
TOTAL	60	6	10	

25

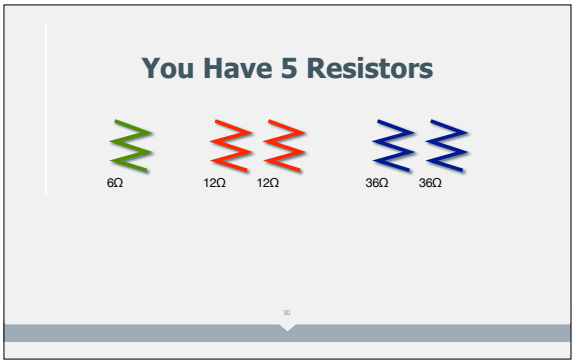
25


Resistors
in Combinations
6 Ω
6 A
36V
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

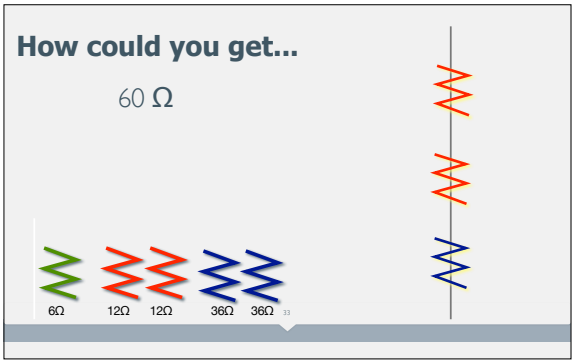
26


Practice
10 Ω
6 A
60 V
60 V
8 Ω
6 A
48 V
6 A
72 V
R6 12 Ω
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 A 30Ω

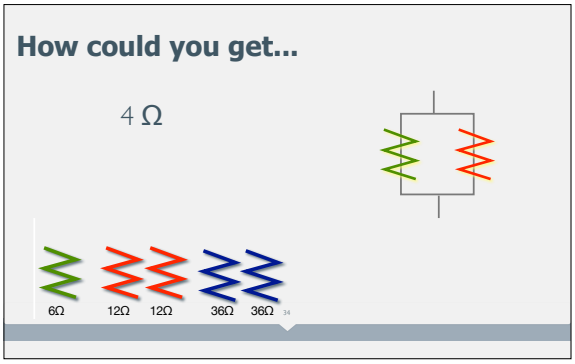
28


You Have 5 Resistors
6Ω
12Ω
12Ω
36Ω
36Ω

30


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

33


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

34

Resistor Codes

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

37

Resistor Codes

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

Green, Blue, Brown, Gold

5

6

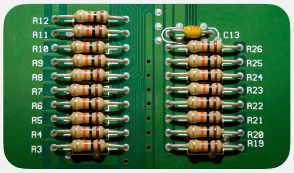
0 (1)

560 Ω ± 5%

38

Resistor Codes

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



Brown, Black, Orange, Gold

1

0

000 (3)

10,000 Ω ± 5%

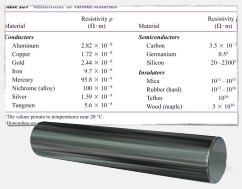
10 kΩ

39

Resistance

$$R = \frac{\rho L}{A}$$

- Resistance Ω
- resistivity Ωm
- length m
- area m^2



40