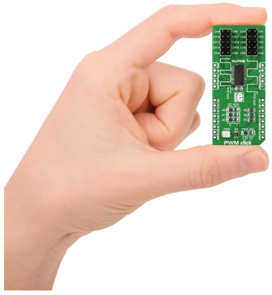
Announcements

*Get a 2-Liter bottle

PRACTICE	LABS	TESTS
Practice Problems (1-15, 21-32)	• Electrostatic Interactives • VIR Interactive	Unit 14 Test Thursday (5/9/19)

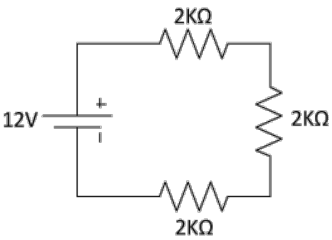
Series and Parallel Circuits



14.4	I can describe, interpret, and solve problems involving series and parallel circuits.

Resistors in Series

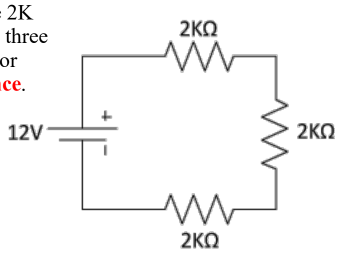
A simple circuit consists of a 12 V battery and three 2000 Ω resistors connected in series.



Resistors in Series

A simple circuit consists of a 12 V battery and three 2000 Ω resistors connected in series.

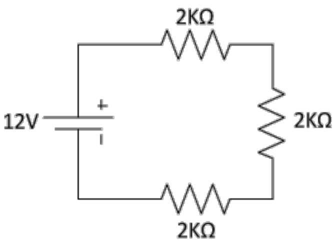
Instead of using three separate 2K resistors, we could replace the three resistors with one single resistor having an **equivalent resistance**.



Resistors in Series

Equivalent Resistance for Resistors in Series $R = R_A + R_B + \ldots$

The equivalent resistance of resistors in series equals the sum of the individual resistances of the resistors.



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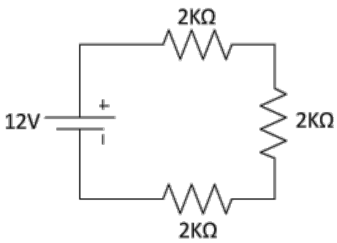
$$R_s = \sum_i R_i$$



Resistors in Series

Equivalent Resistance for Resistors in Series $R = R_A + R_B + \ldots$

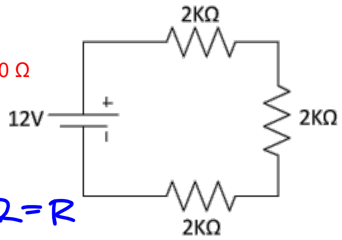
The equivalent resistance of resistors in series equals the sum of the individual resistances of the resistors.

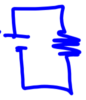
$$R_s = \sum_i R_i$$

$R_{eq} = R_1 + R_2 + R_3 + \ldots$

$R_{eq} = 2000\ \Omega + 2000\ \Omega + 2000\ \Omega$

$R_{eq} = 6000\ \Omega = 6\ k\Omega$



V = 12V  6000Ω = R

I = ?

V = IR

$I = \frac{V}{R} = \frac{12V}{6000\Omega} = 0.002A$

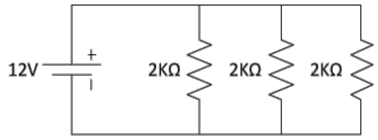
Resistors in Parallel

Equivalent Resistance for Resistors in Parallel

$\frac{1}{R} = \frac{1}{R_A} + \frac{1}{R_B} + \frac{1}{R_C} \cdots$

The reciprocal of the equivalent resistance is equal to the sum of the reciprocals of the individual resistances.

$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$



Resistors in Parallel

Equivalent Resistance for Resistors in Parallel

$\frac{1}{R} = \frac{1}{R_A} + \frac{1}{R_B} + \frac{1}{R_C} \cdots$

The reciprocal of the equivalent resistance is equal to the sum of the reciprocals of the individual resistances.

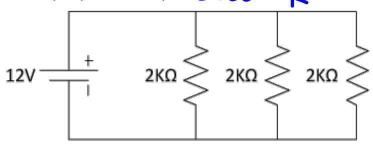
$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$

$(1 / R_{eq}) = (1 / R_1) + (1 / R_2) + (1 / R_3) + \ldots$

$(1 / R_{eq}) = (1 / 2000\ \Omega) + (1 / 2000\ \Omega) + (1 / 2000\ \Omega) = \frac{3}{2000} = \frac{1}{R}$

$(1 / R_{eq}) = 0.0015\ \Omega$

$R_{eq} = 667\ \Omega$



VIRP Tables

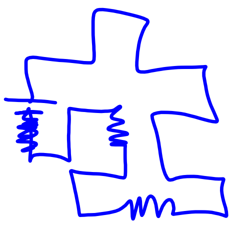
A simple and straightforward method for analyzing circuits involves creating a VIRP table for each circuit you encounter. A VIRP table describes the potential drop (V-voltage), current flow (I-current), resistance (R) and power dissipated (P-power) for each element in your circuit, as well as for the circuit as a whole.

VIRP Table

	V	I	R	P
R1				
R2				
R3				
Total				

Circuit Analysis Example

A 10-Ω, 15-Ω, and 5-Ω resistor are connected in a series circuit with a 90-V battery. Draw a schematic of the circuit and then complete a VIRP table for this circuit.



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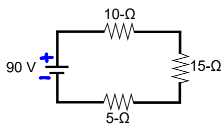


V = IR

$I = \frac{V}{R}$

VIRP Table

	V (V)	I (A)	R (Ω)	P (W)
R1	30	3	10	90
R2	45	3	15	135
R3	15	3	5	45
Total	90	3	30	270

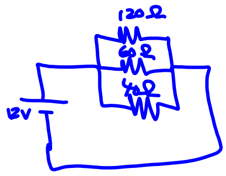
P = IV

Summary: Series and Parallel Circuits

SERIES	PARALLEL
One path for current to flow.	
$I = I_1 = I_2 = I_3 = \ldots$ $V = V_1 + V_2 + V_3 + \ldots$ $R_{eq} = R_1 + R_2 + R_3 + \ldots$	

Circuit Analysis Example

A 120.0-Ω resistor, a 60.0-Ω resistor, and a 40.0-Ω resistor are connected in parallel and placed across a 12.0-V battery. Draw a schematic and then complete a VIRP table for this circuit.



Circuit Analysis Example

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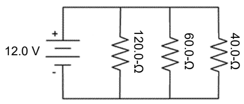


$P = IV$

VIRP Table

	V (V)	I (A)	R (Ω)	P (W)
R1	12	0.1	120	1.2
R2	12	0.2	60	2.4
R3	12	0.3	40	3.6
Total	12	0.6	20	7.2

$I = \frac{V}{R}$

$\frac{1}{120} + \frac{2}{120} + \frac{3}{120} = \frac{6}{120} = \frac{1}{20} = \frac{1}{R}$

Summary: Series and Parallel Circuits

SERIES	PARALLEL
One path for current to flow.	Multiple paths for current to flow.
$I = I_1 = I_2 = I_3 = \ldots$ $V = V_1 + V_2 + V_3 + \ldots$ $R_{eq} = R_1 + R_2 + R_3 + \ldots$	$I = I_1 + I_2 + I_3 + \ldots$ $V = V_1 = V_2 = V_3 = \ldots$ $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$

Gustav Kirchhoff

GERMAN PHYSICIST (1854)

Kirchhoff's Current Law (Junction Rule)

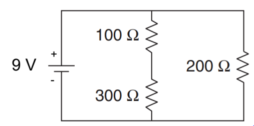
"The sum of all current entering any point in a circuit has to equal the sum of all current leaving any point in a circuit."

Kirchhoff's Voltage Law (Loop Rule)

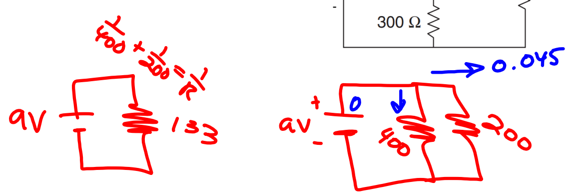
"The sum of all the potential drops in any closed loop of a circuit has to equal zero."

VIRP Tables: IN-CLASS PROBLEMS

11. Complete a VIRP table for the circuit shown here.



$\frac{1}{400} + \frac{1}{200} = \frac{1}{R}$



	V	I	R
R_1		0.025	100
R_2	9	0.045	200
R_3		0.025	300
Total	9V	0.07	133

$V = IR$

VIRP Tables: IN-CLASS PROBLEMS

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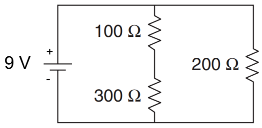


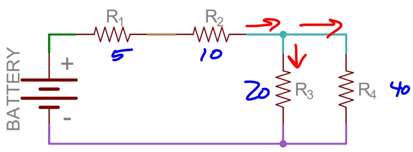
VIRP Table

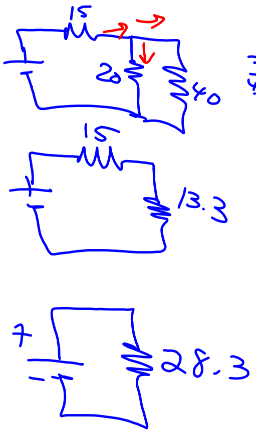
	V	I	R	P
R1	2.5 V	0.025 A	100 Ω	0.0625 W
R2	9.0 V	0.045 A	200 Ω	0.4 W
R3	7.5 V	0.025 A	300 Ω	0.19 W
Total	9.0 V	0.07 A	133 Ω	0.63 W

practice.

PROBLEMS

33-40





$\frac{3}{40} = \frac{1}{R}$

$R = \frac{40}{3}$

13.3