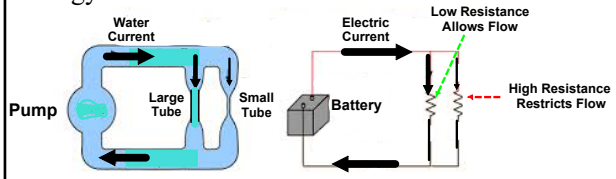
11.6 - Circuit Analysis

Water Analogue

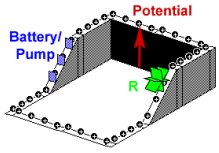
We've talked about circuits as a collection of parts, where current flows and power dissipates.

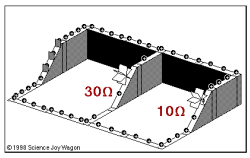
It's important to discuss what happens at each component, and to do this it is common to make an analogy with water.

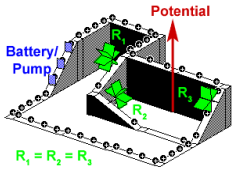


Water Analogue, Continued

A circuit is like a series of waterfalls: the loss in gravitational potential energy of water is likened to the loss of electrical potential as current flows through a resistor:



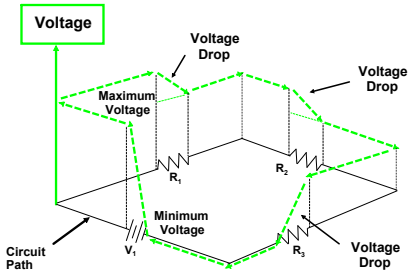




Voltage Drops

Voltage is 'electrical pressure' -highest at the positive end of a battery, and zero at the negative.

As current goes through components, voltage drops more and more, until it is zero.



Determining Voltage Drops

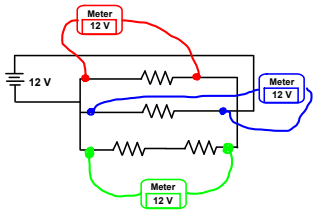
Two ways:
Direct measurement with meter. (Demo)

Ohm's Law Method: V=IR.

Parallel Voltage

Across a parallel section of circuitry, voltage drops are the same across each branch.

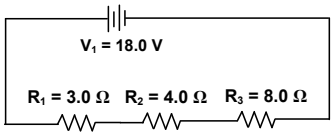
Parallel sections have a common connection point: a meter placed there shows voltage across each branch. Moving probes around doesn't alter voltage.



1. Ohm's Law Method Example

Determine circuit current, then use V = IR to calculate voltage drop over each resistor.

Use Ohm's Law to find voltage drops for the following circuit:



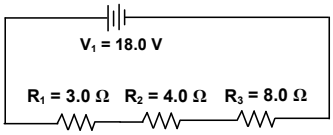
AP Phys 1 Unit 11.6 Notes - Circuit Analysis

1. Ohm's Law Method

Find total resistance,

$R_T = 3.0\Omega + 4.0\Omega + 8.0\Omega = 15.0\Omega$

then current: $I = \frac{V}{R} = \frac{18.0V}{15.0\Omega} = 1.20A$



1. Ohm's Law Method

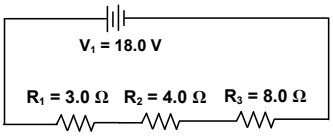
Find voltage drops:

R_1: $V_1 = IR_1 = 1.2A \bullet 3.0\Omega = 3.6V$

R_2: $V_2 = IR_2 = 1.2A \bullet 4.0\Omega = 4.8V$

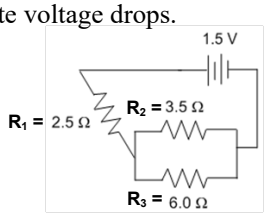
R_3: $V_3 = IR_3 = 1.2A \bullet 8.0\Omega = 9.6V$

Check: Do individual voltages add up to the total?



Mixed Circuit Example

In mixed circuits, voltage across parallel sections is the same for each resistor in that section.
Find equivalent resistance for the parallel section(s), then calculate voltage drops.



2. What is the voltage drop across each resistor?
3. What is the current through each resistor?

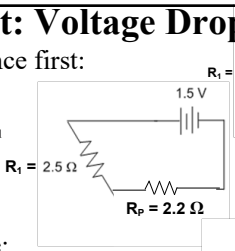
Mixed Circuit: Voltage Drops

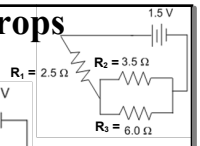
Find parallel resistance first:

$R_P = \left(R_2^{-1} + R_3^{-1}\right)^{-1}$

$= \left(3.5\Omega^{-1} + 6.0\Omega^{-1}\right)^{-1}$

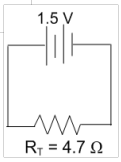
$= 2.2\Omega$





Add serial resistance:

$R_T = R_1 + R_P = 2.5\Omega + 2.2\Omega = 4.7\Omega$



Calculate circuit current:

$$I = \frac{V}{R_T} = \frac{1.5V}{4.7\Omega} = 0.32A$$

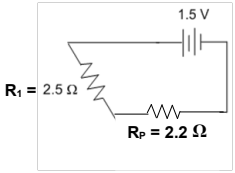
Mixed Circuit: Voltage Drops

2. Calculate voltage drop across resistor:

$R_1 = V_1 = IR_1 = 0.32A \bullet 2.5\Omega = 0.80V$

Parallel section: $V_P = IR_P = 0.32A \bullet 2.2\Omega = 0.70V$

Does the sum of individual voltages equal the total?



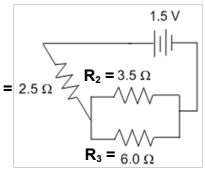
Mixed Circuit: Resistor Current

3. Use Ohm's Law to find the current through the three resistors:

R_1: $I_1 = \frac{V_1}{R_1} = \frac{0.80V}{2.5\Omega} = 0.32A$

R_2: $I_2 = \frac{V_p}{R_2} = \frac{0.70V}{3.5\Omega} = 0.20A$

R_3: $I_3 = \frac{V_p}{R_3} = \frac{0.70V}{6.0\Omega} = 0.12A$



Homework

11.6 Problems.
Due: Next Class.
Finish Unit 11 Review Problems