PROBLEM OF THE MONTH

Resistors and Resistors and Resistors, Ohm-My!

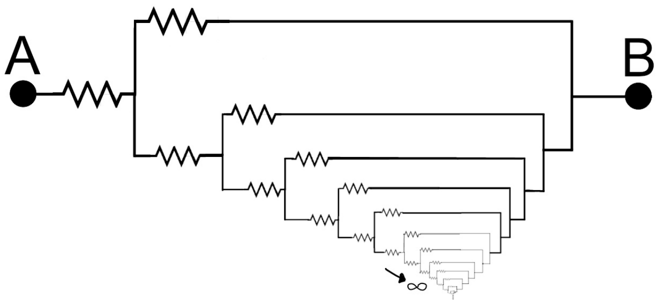
February 2023 - Langara Physics & Astronomy

0 Introduction

Could there be a better object of study for the first in our series of Problems of the Month than the unparalleled resistor? They're just so full of puzzle potential! Page 2 has a refresher on the theory you'll need. For both of this month's problems, **assume all resistors are 1Ω**. Have fun!

1 Resistors All The Way Down

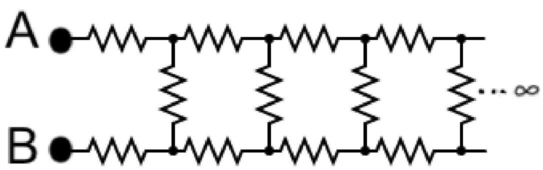
Difficulty: 3/5



Question: What is the equivalent resistance between nodes A and B?

2 Prof. Ranjbary's Relentless Resistive Rungs

Difficulty: 2.5/5



Question: What is the equivalent resistance between nodes A and B?

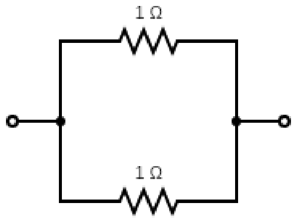
3 Submitting Your Solutions, & Prizes

Your completed solutions must be either: put in Hand-In Slot #10 outside room T340; handed to me (Alex); or emailed to achoinski@langara.ca before midnight on February 28th. Depending on how many problems you correctly solve, you will get either one or two entries into a draw for a **prize to be awarded at the end of the month!**. In addition, you will be placed on our **Display Case Leaderboard**, whose first place entry will win a **grand prize** at the end of the semester! Questions about the contest or problems can be directed to achoinski@langara.ca.

4 Background Theory: Equivalent Resistance

As a refresher - resistors in a circuit may be related to one another in one of two manners (for our purposes): in series, or parallel. A series relationship implies that current flowing through one resistor must (i.e. has no choice other than to) flow through the other resistor, as shown in Fig. 1 below.

In contrast, two resistors that are in a parallel relationship have it such that current approaching the neighbourhood of these resistors will *either* flow through one *or* through the other, but not through them both, as shown here Fig. 2.



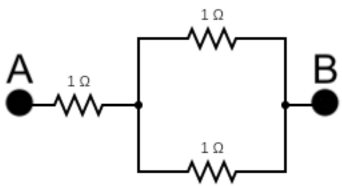
While fun to look at, complex networks of wire and resistor (such as appear in this month's problems) can make for unworkably messy circuit diagrams. We have, however, an excellent tool to untangle them - the *equivalent resistance*, R_{eq}. The equivalent resistance of an arrangement of resistors is essentially its *net* resistance, such that if we were to replace the whole arrangement with a *single* resistor R_{eq}, the current and voltage everywhere else in the circuit would remain unchanged.
We can work out the equivalent resistance of a circuit by recalling that the equivalent resistance of two resistors R_1 and R_2 in **series** is given by the following:

$$R_{eq} = R_1 + R_2 \tag{1}$$

Not so bad, eh!When two resistors are arranged in **parallel**, we have the following equation to solve for their equivalent resistance:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \tag{2}$$

Here is a short example to practice with: Show that the equivalent resistance between nodes A and B on the following circuit diagram is 1.5Ω.



This is all the physics you will need to solve this month's problems.