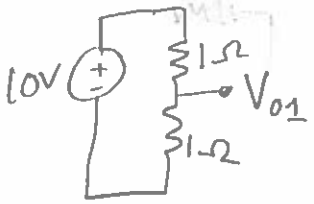
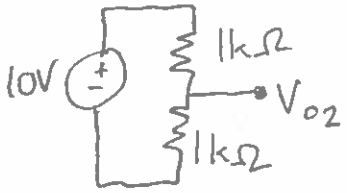
Power Hungry

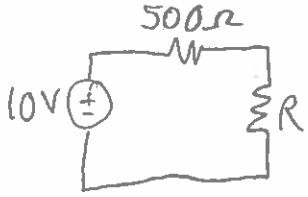
Below we have 2 voltage dividers:





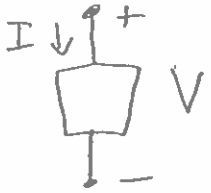
Both voltages V_{o1} and V_{o2} are equal.

In this question, we're going to explore why we would choose one circuit over another.

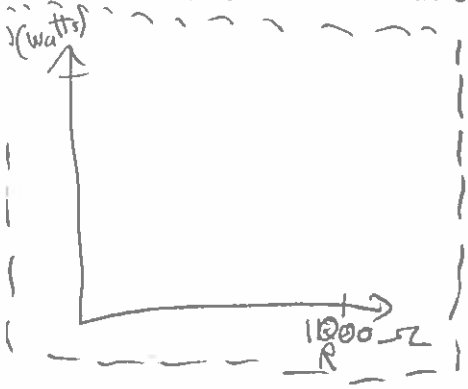


The power consumption of a circuit component is given by

$P = IV$

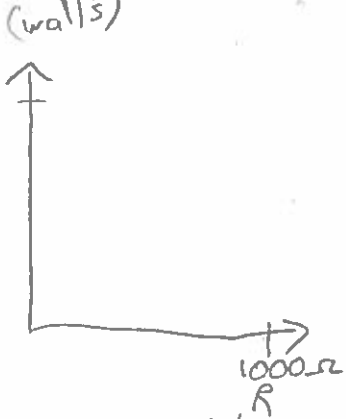


Find the equation for the power consumed by each resistors and graph the results below:



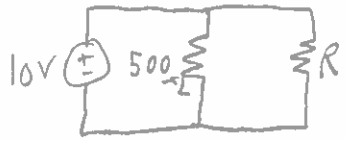
Power consumed by resistor R

Power consumed by 500Ω resistor



Check yourself! If you had a voltage source with a limited amount of energy, which circuit would run longer? A circuit with 1kΩ resistors or 1Ω resistors.

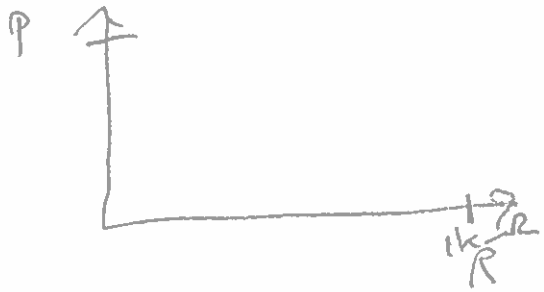
Let's look at another circuit.



Just like before, find the equation of power consumption for each resistor and graph the results below. Ignore what happens when $R = 0$

Power consumption of 500Ω resistor

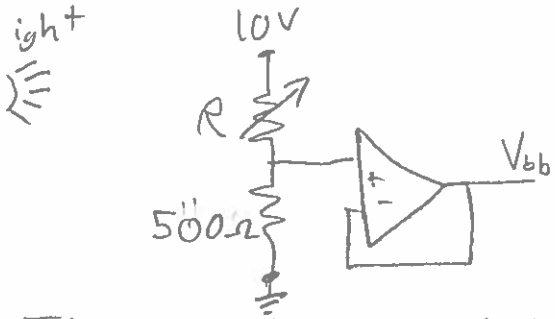
Power consumption of resistor R



Check yourself: Imagine you had a 500Ω lightbulb. Would you rather place it in the series circuit or parallel circuit? How do you think your home is wired? You can think of all the appliances you plug into the wall as resistors of different values.

Cats and Keyboards

Your cat, Nyan, keeps finding a way into your box of Tart Pops leaving you with nothing to eat for breakfast, lunch, or dinner. You know Nyan doesn't like being sprayed with water and you're able to figure out a way to automatically spray water near your Tart Pops whenever the device has a 10V drop across it. The next thing you do is build a breakbeam sensor like so:



The resistor labeled R is a photoresistor. Whenever Nyan passes between the light and photoresistor (on her way to Tart Pops) the resistance goes down to 300Ω. Otherwise it stays above 2kΩ.

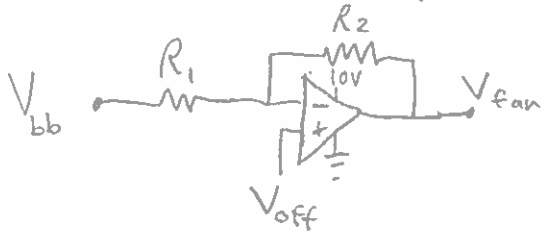
What is the voltage V_{bb} when Nyan is present?

V_{bb} Nyan =

What is the voltage V_{bb} when Nyan is not present?

V_{bb} no Nyan =

In order to spray Nyan, you choose to use a differential amplifier like below:



What is the equation of V_{fan} in terms of V_{bb}, R_1, R_2, and V_{off}?

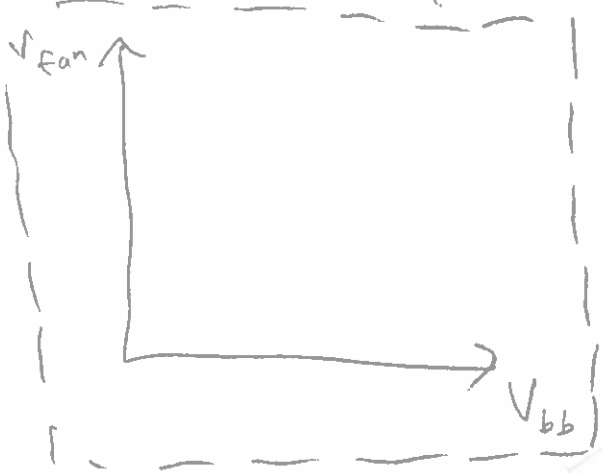
$V_{fan} =$

Let $\frac{R_2}{R_1} = k$, find the values of k and V_{off} which cause spray when Nyan is in the way (i.e. $V_{fan} = 10$) and sets V_{fan} to 0V in other situations.

$V_{off} =$

$k =$

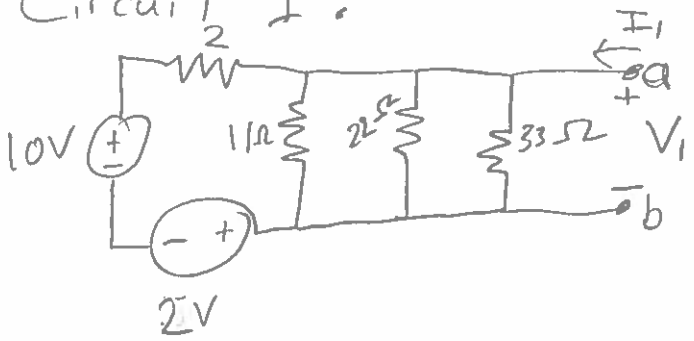
(optional) Graph what V_{fan} would look like as you increased V_{bb}



This kind of circuit behaves very similarly to an inverter as you might see in a digital electronics class. Essentially, inverters take in a high value and make it into a low value and vice-versa. Just like this circuit

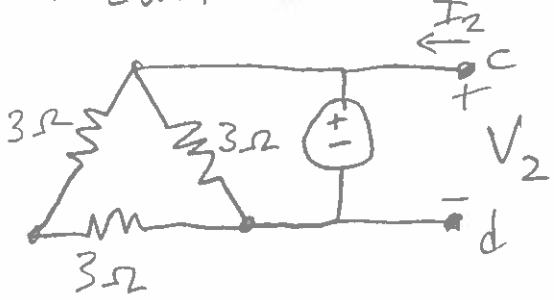
Mixing Thevenins

Circuit 1:



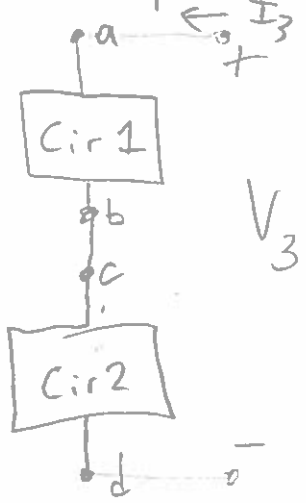
Draw the IV curve for the circuit which describes the relationship between I and V at the terminals.

Circuit 2:



Draw the IV curve for the above circuit.

Let's represent each circuit as a box:



How would the IV curve of this circuit look? Think about how the slopes, x-intercepts, and y-intercepts of the first 2 circuits should interact.