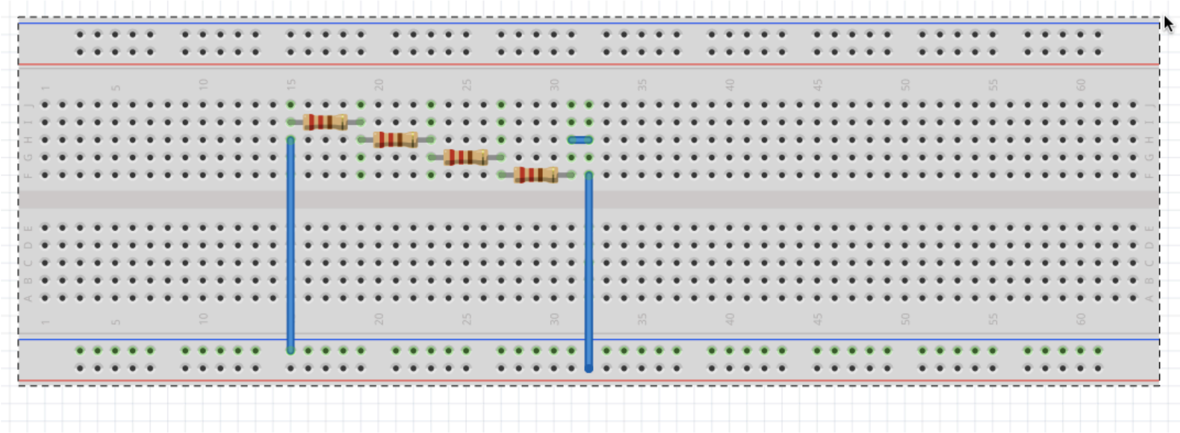
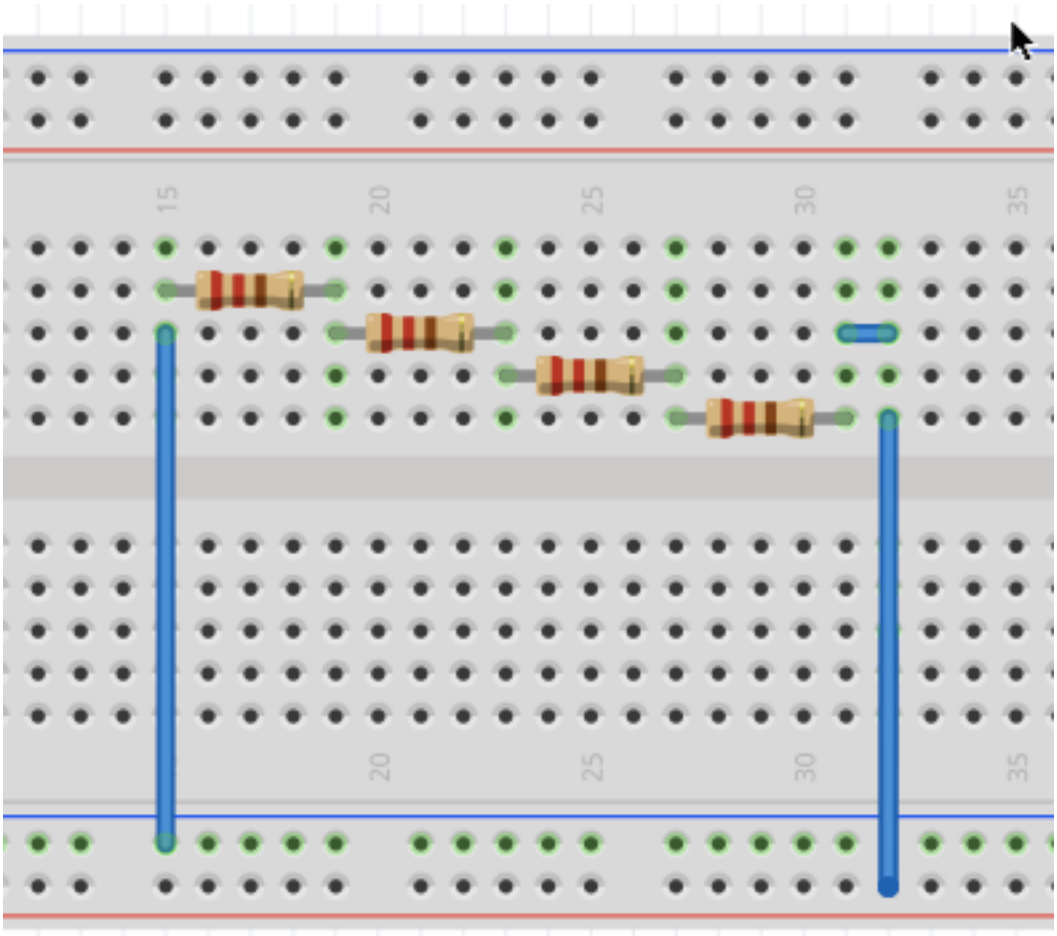
Introduce Breadboard Laboratory – Greg Moore 2014

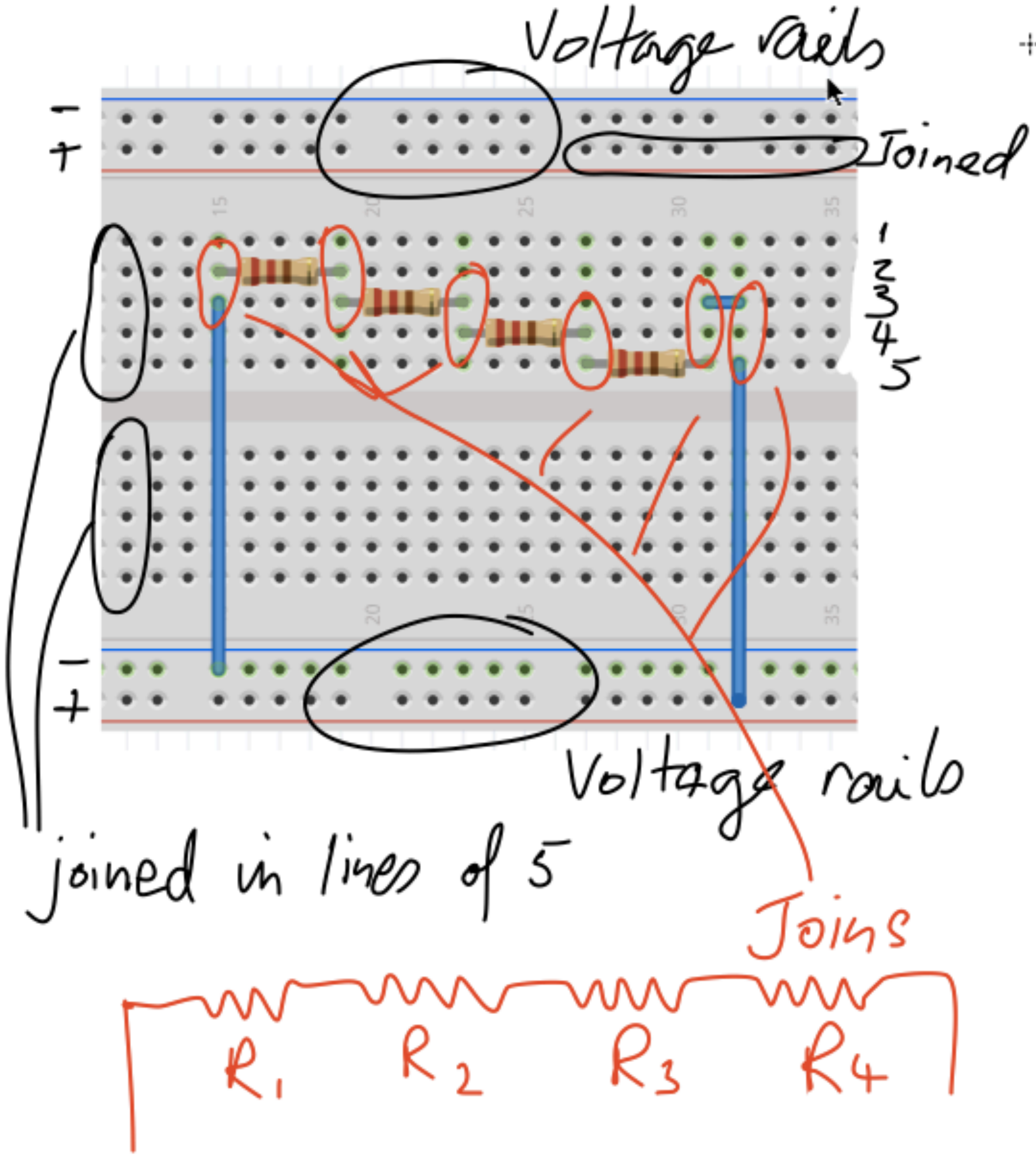


This is a breadboard. Many of the projects you build in class will use a breadboard.

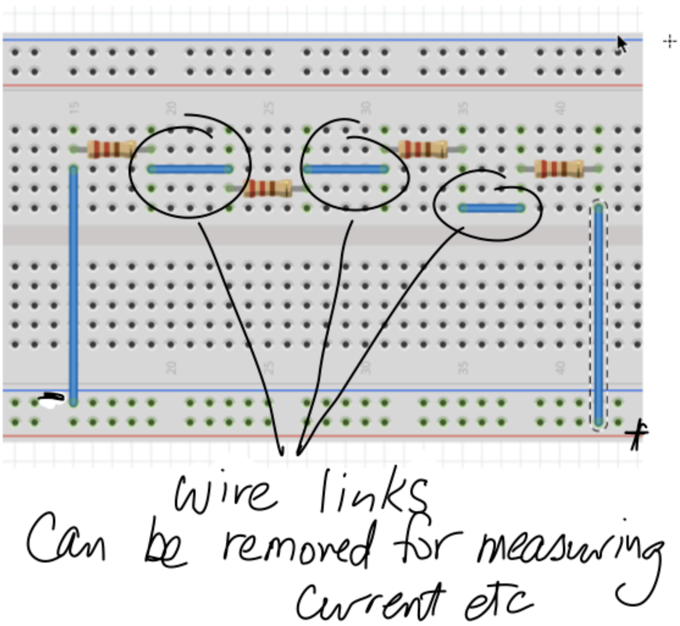


While we can populate the breadboard like shown above, very densely, this can cause some problems if we need to 'break' the circuit to add current meters etc.
Overpage you can see how the breadboard connections work. Each side of the central gutter there are 5 connections in a line which are tied together inside the board.
These are insulated from the line of connections either side.
It's generally best to space conductors apart and use wires to interconnect

each component, you can see this in the second diagram below. Practice



building the 4 resistors in series. Use 4 X 1kΩ resistors. Confirm with the use of the ohm meter (digital or analogue) that you have 4kΩ total resistance. If in trouble, call your teacher to assist you.

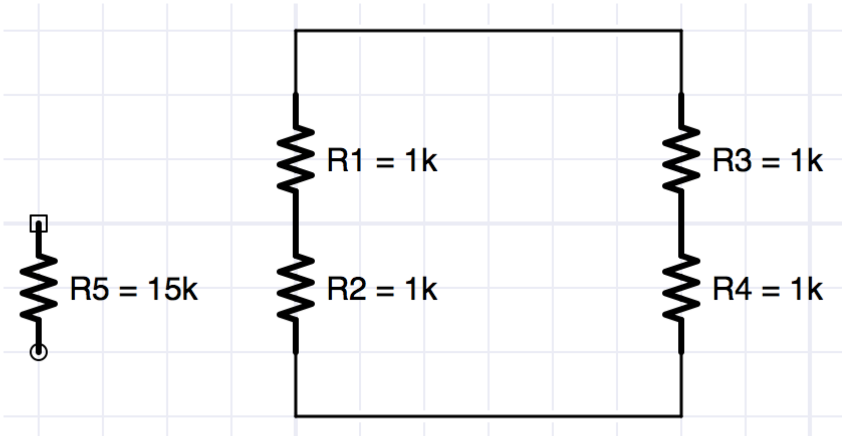


So although this gives us more work to do when we build our circuit, and even causes more possible faults due to extra connections, it's a better method when further testing and modifications are needed in a circuit.

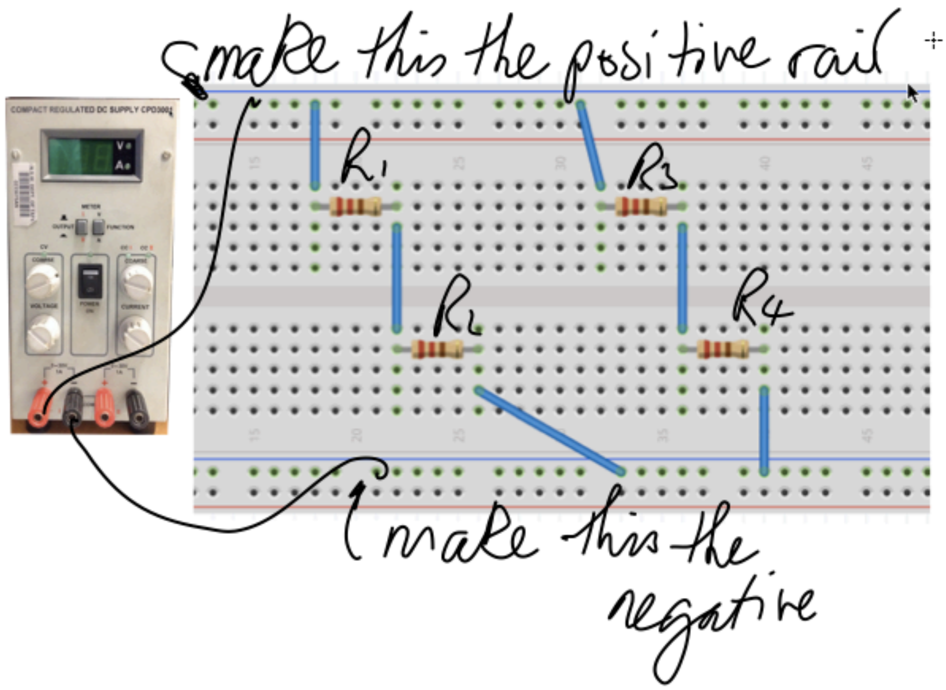
You will need to be expert in the use of the breadboard while you are studying electronics, as each class teacher will arrange for you to use this in evaluating your new circuits.
There are limitations in what you can build with the breadboarding system.
The hole size is only suitable for 1/4 watt resistors, maybe 1/2 watt.
YOU MUST NOT FORCE LARGER WIRE SIZES INTO THE SMALL HOLES! THAT WILL DAMAGE THE BREADBOARD.

Wheatstone Bridge laboratory

Study the circuit diagram below.

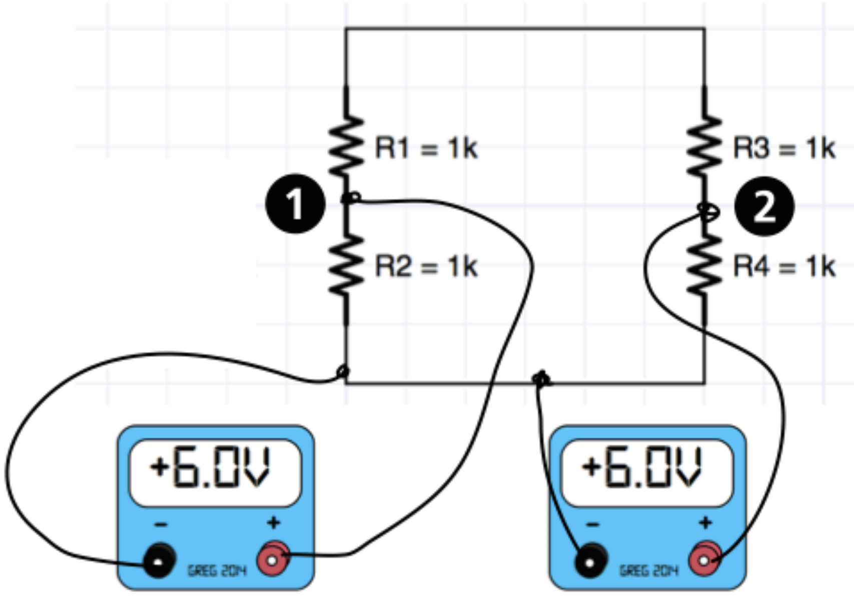


So this is a conventional matched ring of same value resistors. We will measure the voltage from the middle junctions of each leg and prove that where equal voltages exist, no voltage will be read on the voltmeter. Examine the breadboard layout below.

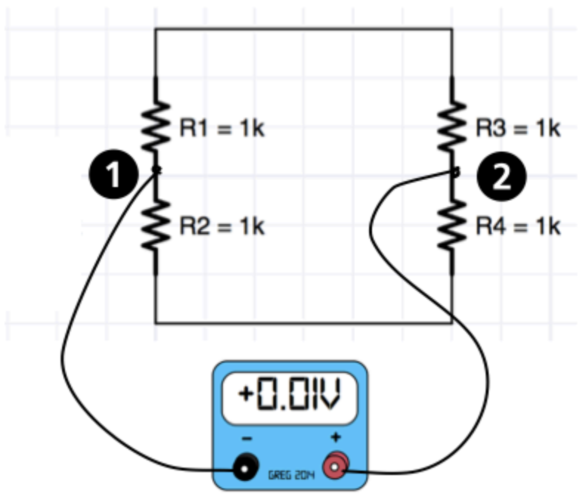


We will use the standard power supply which we have used in class before. Adjust the power supply to give 12 Volts DC output.

Notice how the breadboard layout matches our circuit diagram. It's always best practice to do this.
And after we set this part up, it's now time to think about where to insert the Voltmeter. We will do this in two stages. First, we will measure from each junction to negative and ensure that we measure +6 Volts DC.



So if you have this, all is good. If you cannot achieve this, you must fix the problem before you proceed.
As you learned in the theory part of the lesson, we have simply two voltage dividers here with +12 volts supplied at the top of each divider.
Now that you have sorted this out, and have ensured that you have +6.0 V DC at each junction 1 and 2, it's time to examine the next circuit change and implement that.



You will probably measure some small voltage here because there are small differences in each resistor.

Note that you will no doubt measure a small voltage here due to slight differences in the component tolerances. We are aiming for zero volts in the balanced conditions.

Now we will unbalance the bridge by putting a 15kΩ resistor in parallel with the R2.
15kΩ//1kΩ = 937Ω

Let's do the calculations for this imbalance. We need to run some maths on the new circuit conditions. After doing the maths, it's found that

BOTH CASES $\frac{R_2}{R_1 + R_2} \times V_s$

(1) $\frac{937\Omega}{1937\Omega} \times 12V = 5.80V$

(2) $\frac{1000\Omega}{2000\Omega} \times 12V = 6.0V$

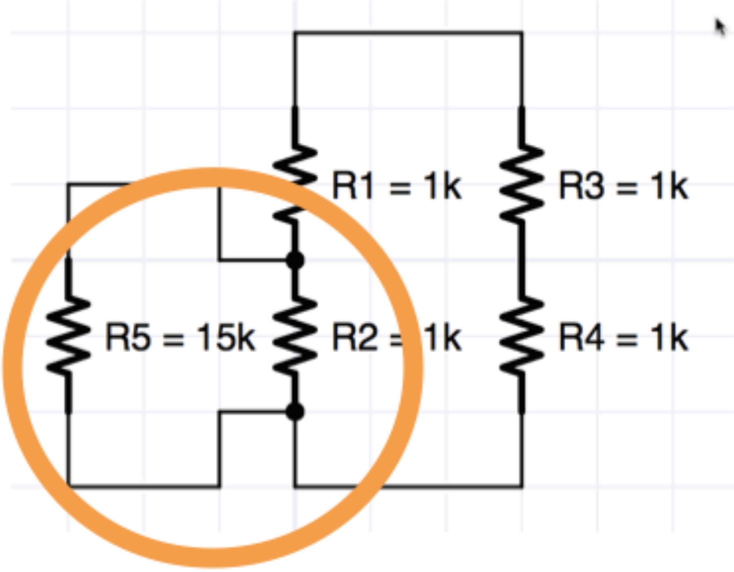
200mV

we should have 200mV of difference due to the small imbalance we have made in the first leg of our bridge.
You can now confirm that is the case with your meter. The digital meter is ideal for this as it has very good resolution at low voltages like mV levels we are now experiencing.

Now we know the new voltage at point 1 and point 2. We also know the total resistance in each leg of our voltage dividers.
From this we can calculate the current in each leg.

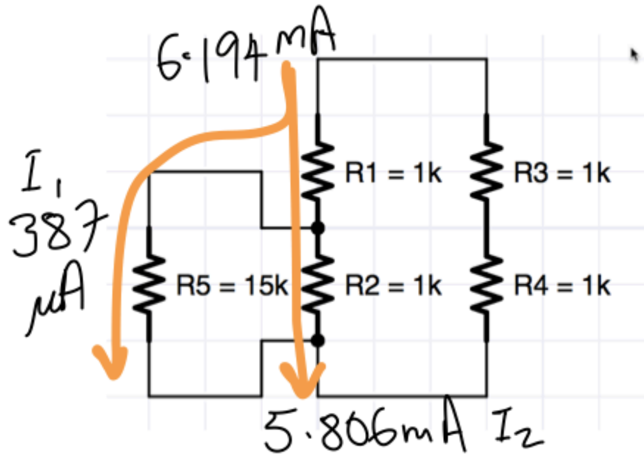
Leg 1 current =
12/1937Ω
6.20E-03A
(0.006195)

Leg 2 current =
12/2000Ω
6.0E-03A



15kΩ//1kΩ = 937Ω

So it can be seen there is 200μA extra current flowing in Leg number 1. How is this current split up with R5 and with R2? Can you calculate this mathematically?



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The current Divider rule

$$I_1 = \frac{R_2}{R_5 + R_2} \times I_{TOTAL}$$

$$= \frac{1000}{16,000} \times 6{\cdot}194\,mA$$

$$= 387\,\mu A$$

$$I_2 = \frac{R_5}{R_2 + R_5} \times I_T$$

$$= \frac{15000}{16,000} \times I_T$$

Try to follow my story to the right.
I have shown the total current in the voltage divider #1 and then I have split the current into two branch currents. Of course the sum of the two branch currents is equal to the main current feeding the two branches.
While this can be easily calculated with Ohms law and voltage drops across each resistive element in the sub branches, it's much easier if you know how to use the current divider rule. You can find this in your Phillips text book. Remember the hint... use opposite resistor to the branch you are working on. I have abbreviated the current divider rule above in my calculations. We cannot easily

measure such small currents but you may wish to try. Certainly the 5.806mA can be measured with your DMM and you could subtract that from the main current.
ie. 6.194mA – 5.806mA = 387μA

marking rubric Greg – this is for your practical assessments, it's the marking criteria I will be using. Don't forget, this unit is competency based. You must be competent to pass the unit. Anything much below the 4 points is getting into the trouble area. Below 3 points is not competent.

5 Points	4 Points	3 Points danger area maybe not competent	2 Points not competent	1 point or maybe 0 not competent
Correct circuit diagram, getting the connections right, showing step- by-step calculations and computing the answers within the expected measurement error values, right SI units, and demonstrating high level of understanding of concepts.	Taking help to complete circuit connections, showing step- by-step calculations and computing the answers within the expected measurement error values, using right SI units, and good level of understanding of concepts.	Taking help to complete circuit connections, skipping step- by-step calculations and representation of SI units. The final answer showing an error exceeding 0.10%, and demonstrating average level of understanding of concepts.	Unable to complete circuit connections, wrong calculations, answer exceeding the error limit, unable to analyze the problem, and occasional misunderstanding of concepts	Incomplete, unclear, and major misunderstandings of concepts.