Electronics

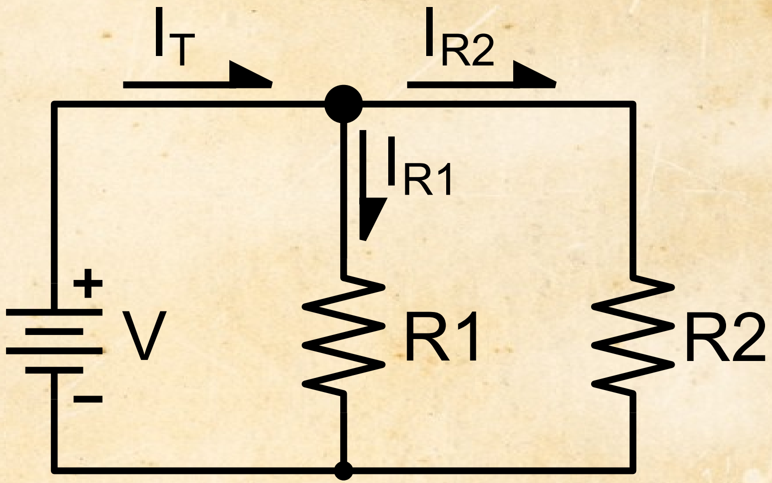
Internal Resistance

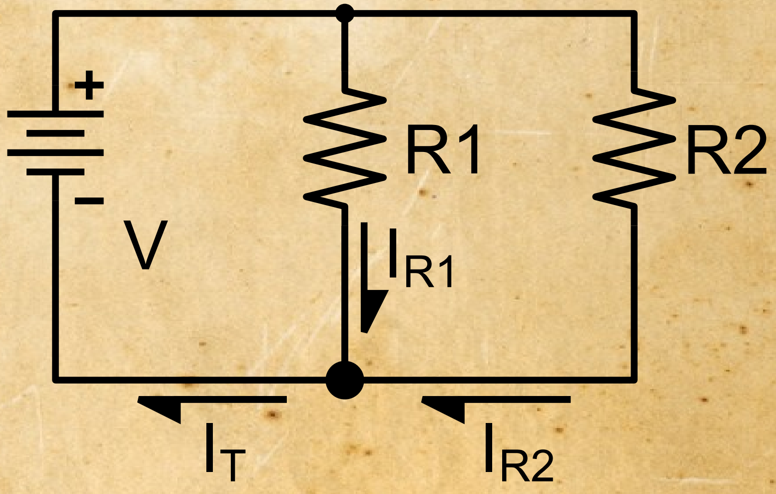
Lecture Contents

- Kirchhoff's Current and Voltage Laws
- Internal Resistance Worksheet
  - Photos to aid in understanding of the question

Kirchhoff's Current Law (Q2)

- ***the sum of all currents into a node equals the sum of all currents out of the node.***

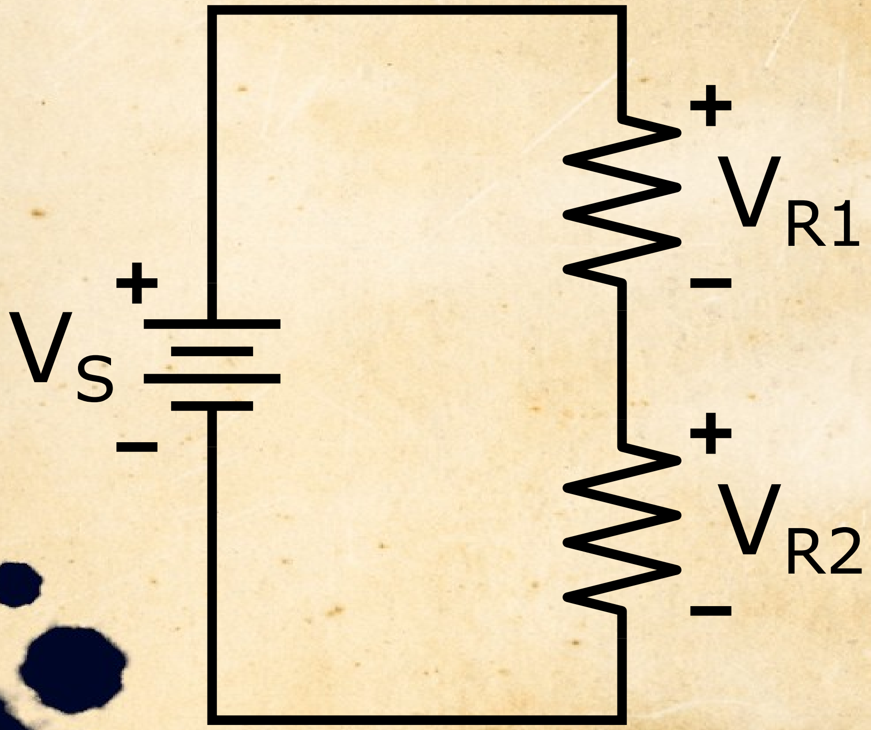




$$I_T = I_{R1} + I_{R2}$$

Kirchhoff’s Voltage Law (Q4)

- ***the algebraic sum of all voltages around any closed loop is zero.***



$$V_S + (-V_{R1}) + (-V_{R2}) = 0$$

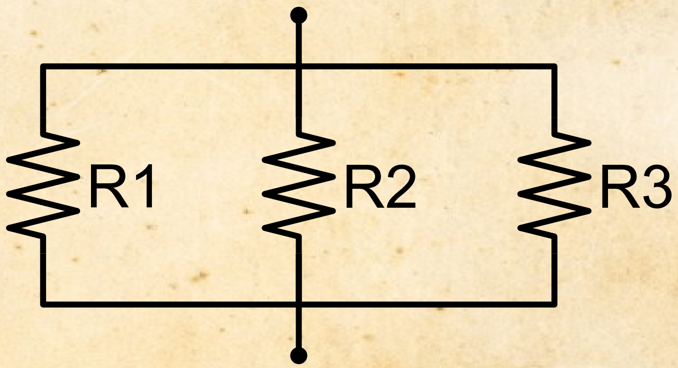
$$V_S = V_{R1} + V_{R2}$$

Equivalent Resistance (Q1a,1b)

- Series Resistance

$$R_T =$$

- Parallel Resistance



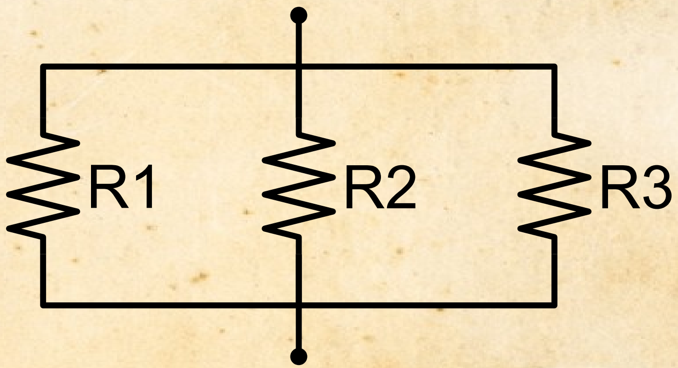
$$\frac{1}{R_T} =$$

Equivalent Resistance (Q1a,1b)

- Series Resistance

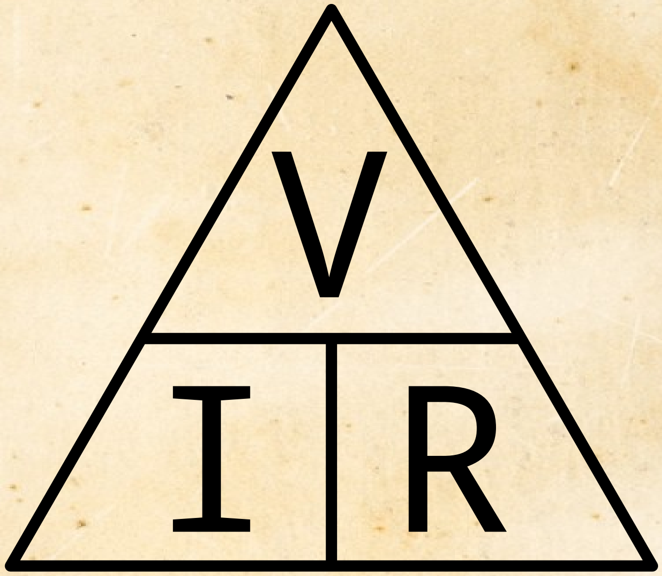
$$R_T = R1 + R2 + R3$$

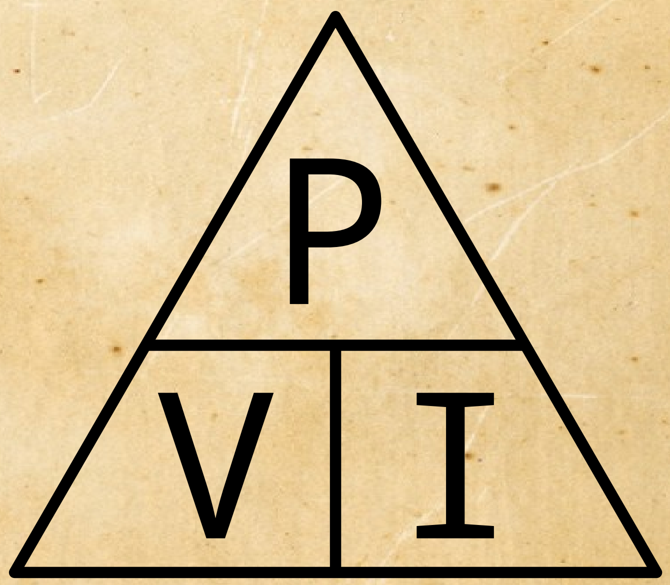
- Parallel Resistance



$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

Ohm’s Law and Power (Q1c,1d)





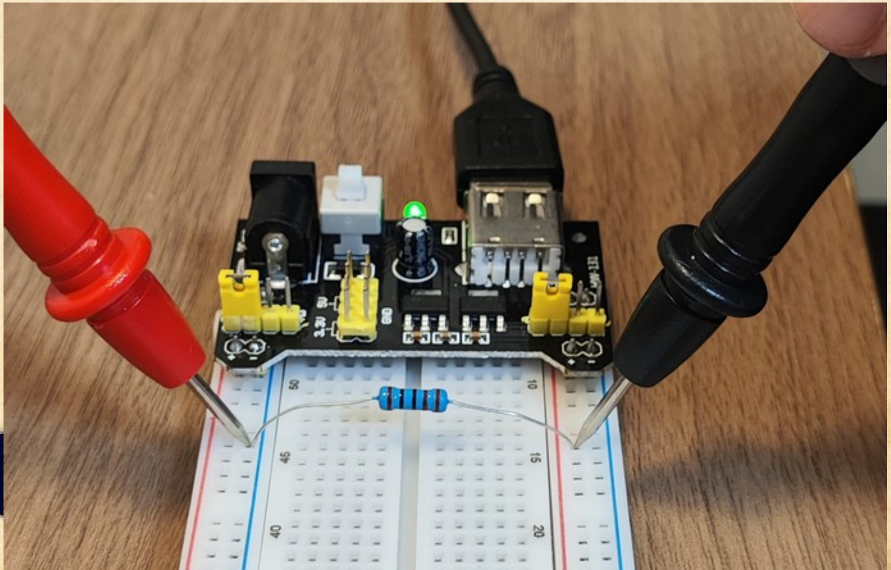
Question 3a

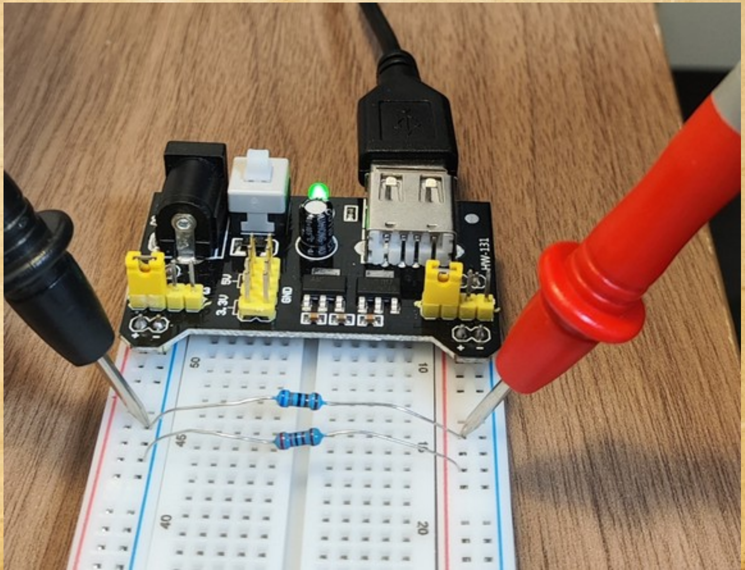
- Calculate the total resistance for one, two, three, and four resistors, using the formula:

$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}$$

Question 3b

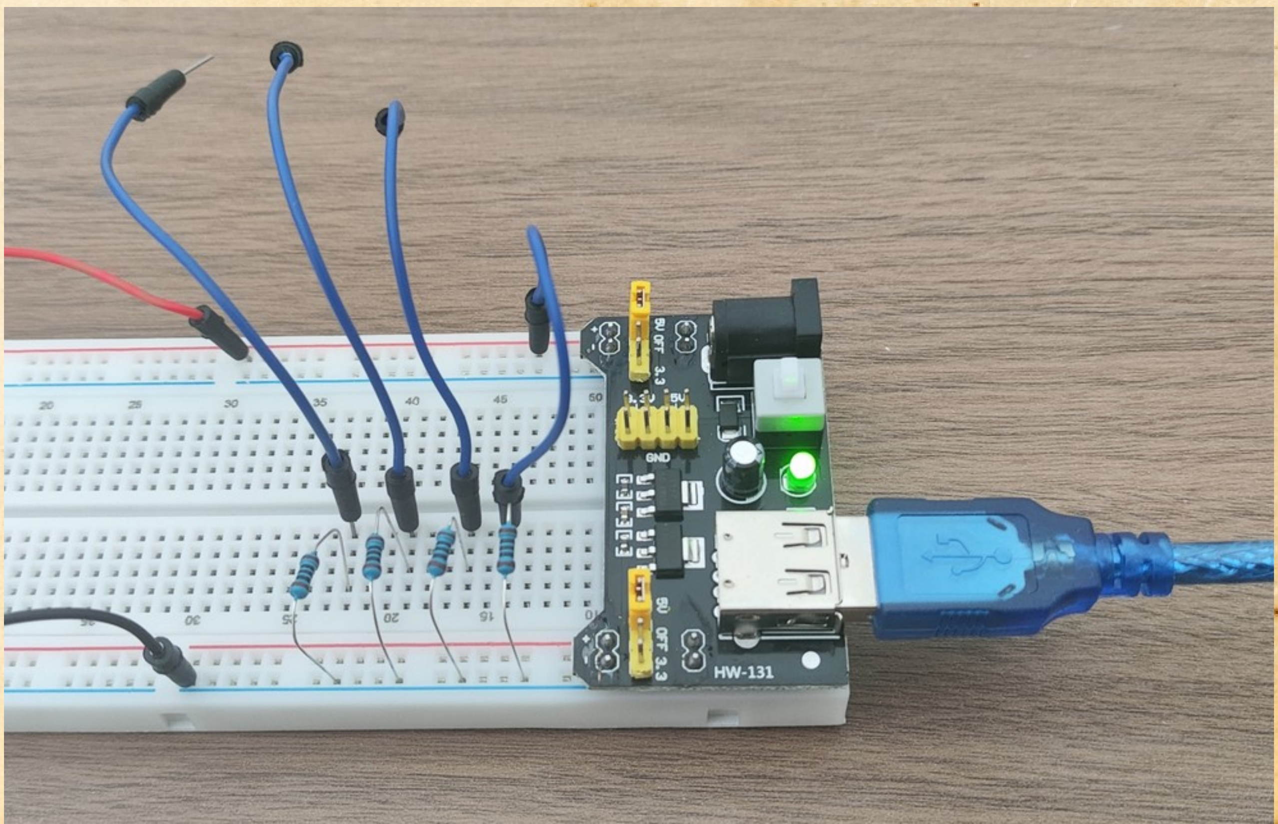
- Ensure multimeter is on voltage setting → → → → →
- Measure the voltage across zero then one resistor,
  ...then two, then three, then four.





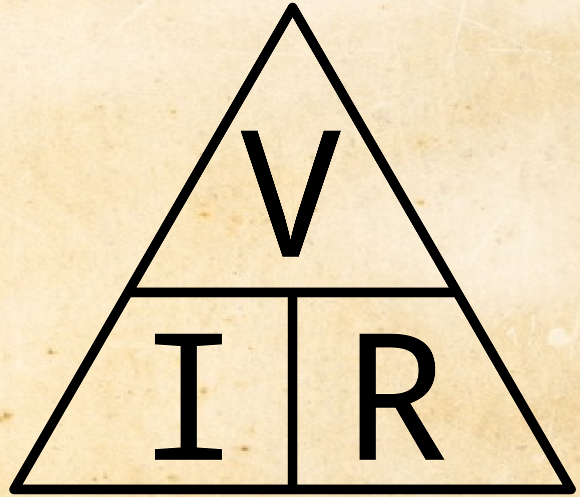
Question 3b

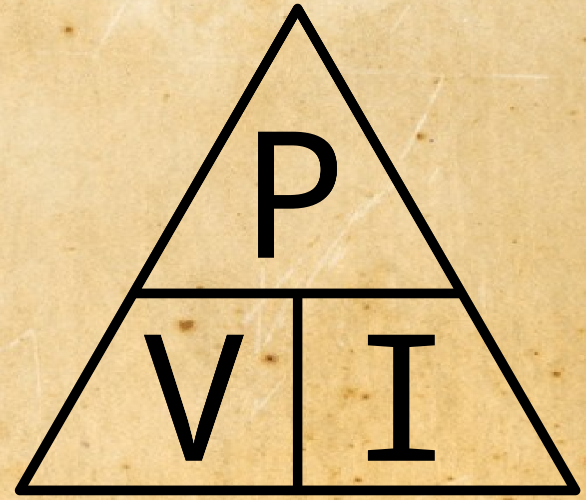
- Using wires might make things easier



Question 3c,d

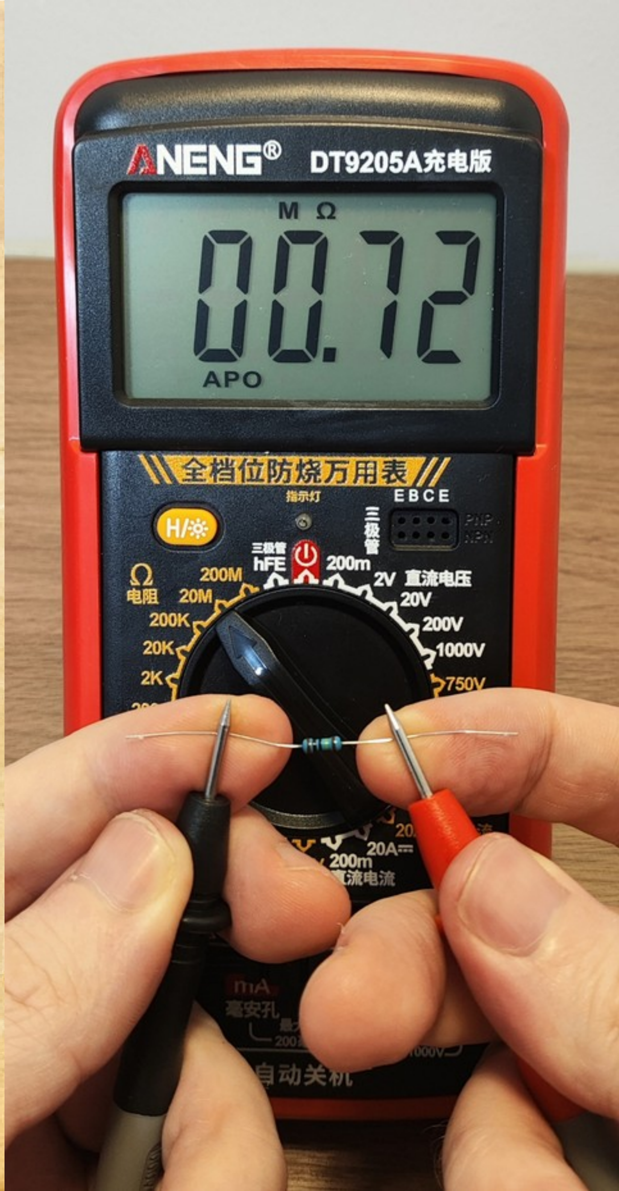
- 3c) Calculate the total current for one, two, three, and four resistors, using Ohm's law
- 3d) Calculate the total power dissipated for one, two, three, and four resistors





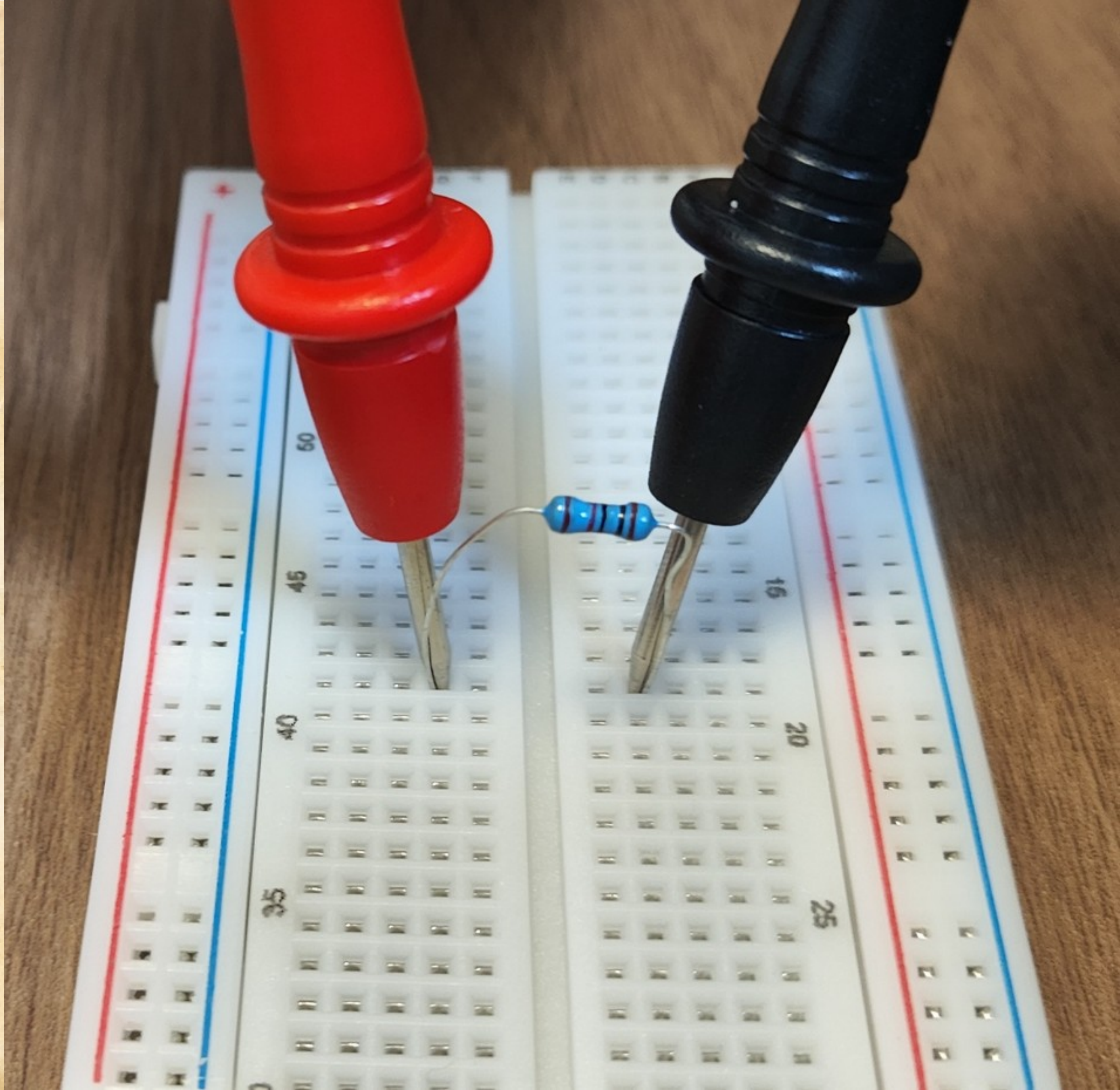
Question 2b

- Ohmmeter set to 20MΩ
- Press one lead of a 1MΩ resistor to the Ohmmeter lead using the finger of one hand
- Press the other lead of the 1MΩ resistor to the other Ohmmeter lead using the finger of the other hand
- Record the resistance value



Question 2c

- Ohmmeter set to 20MΩ
- Measure the resistance of the resistor without contact to skin or any other circuit.
- Record the resistance value



Question 2d

- Use one of these two formulas

$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \ldots \qquad R_T = \frac{R1 \cdot R2}{R1 + R2}$$

- to calculate the combined resistance of these in parallel:
  - your skin (measured in question 2a)
  - the resistor on it’s own (measured in question 2c)
- Compare this result to the measurement you recorded for question 2b.

Question 2e

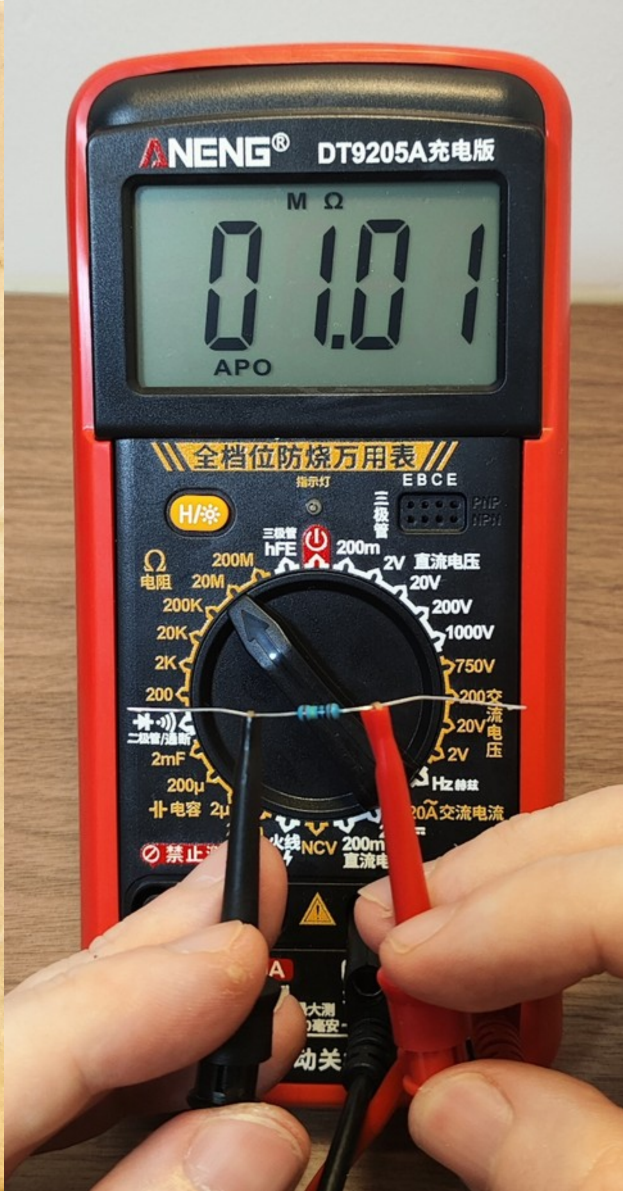
- Again use one of these two formulas

$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \cdots \qquad R_T = \frac{R1 \cdot R2}{R1 + R2}$$

- to calculate the combined resistance of these in parallel:
  - your skin (measured in question 2a)
  - a 10kΩ resistor (not measured in our activity)
- Compare how much your skin resistance affects the measurement of:
  - a very large resistor value, such as 1MΩ
  - a lower resistor value, such as 10kΩ

Conclusion

- When accuracy is important, or when measuring very large resistor values, do not contact the resistor with your skin.
- For quick estimations, especially of lower resistor values, it is fine to hold the resistor in your hand during measurements.



Question 5

- **ideal voltage** – the voltage you measured across the power supply when no resistors were connected
- **load resistance** – the calculated resistance for four parallel resistors
- **load voltage drop** – the measured voltage across four parallel resistors connected to the power supply
- **load current** – the calculated total current when four parallel resistors are connected (the current out of the power supply)
- **voltage across internal resistor** – calculated by:

ideal voltage – load voltage drop

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