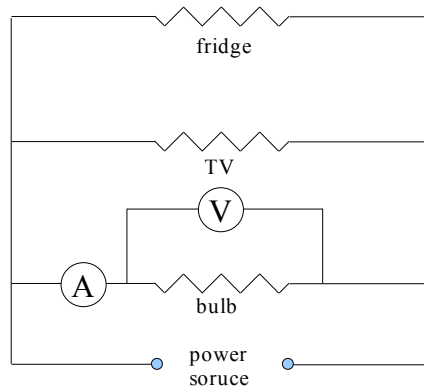


Quiz # 2
Physics 222, Section 009
Jan. 31, 2008

1. A fridge, a TV set and a light bulb are connected to power in a house. Specifications on each of the devices say that they operate at 110V. Sketch a diagram of the circuit that connects these devices to a 110V power supply, and put an ammeter and a voltmeter to measure the current and voltage for the light bulb.
(Model each of these devices as a pure resistance, and assume for simplification that this is a DC circuit, and that power outlets are connected to put out the same voltage).



2. Ammeters and voltmeters are *measurement* devices, and this means that when connected to a circuit they should be designed in a such a way as to produce as little modification as possible to the quantities they measure. If both devices are modeled as pure resistances, then one of the following should be true about how they connect to an element of a circuit:
- A voltmeter is connected parallel and an ammeter in series.
 - A voltmeter is connected series and an ammeter in parallel.
 - Both devices are connected in parallel to the element.
 - Both devices are connected in series to the element.
 - It doesn't matter whichever way they are connected because they're (ideally) designed not to disturb the circuit.
3. A power supply putting out 20 volts is connected to 20 resistors each of resistance 1Ω . All resistors are once connected to the supply in series and once in parallel. Find the current passing through each resistor in each case:

Series connection: _____ A.

Parallel connection: _____ A.

Solutions

- (2 points for recognizing the right structure of the circuit, and 2 for correct connections of meters)** Since each device needs to be operated at the same voltage, they need to be connected in parallel, which is the way things are usually connected at homes. This way, when one device malfunctions for some reason it doesn't bring down with it everything else connected to the same power source. Now, to measure voltage, we have seen in more than one context that the voltmeter needs to be connected in parallel to the element, while the ammeter needs to be connected in series.
- (2 points)** Answer is **(a)**. Both devices need to cause as little disturbance as possible to the circuit, which means that because the voltmeter is measuring voltage, it needs to draw some current to get a voltage equal to that across the element it's measuring, and to minimize current, we need to maximize its resistance. Conversely, the ammeter is trying to measure current, which means it needs to have its internal resistance in the flow of the current being measured, and in order not to disturb that, it needs to have a very small resistance.
- (2 point per correct answer)**. In series, we simply add resistance:

$$R_{eq} = \sum_{i=1} R_i \Rightarrow R_{eq} = 20 \times 1 \Omega = 20 \Omega$$

Subsequently, the current using Ohm's law is given by:

$$I = \frac{\Delta V}{R_{eq}} = \frac{20 V}{20 \Omega} = 1 A$$

In parallel, we know that the equivalent resistance R_{eq} is given in terms of the individual resistances R_i through:

$$\frac{1}{R_{eq}} = \sum_{i=1} \frac{1}{R_i}$$

and because all resistances are equal in our case, this simplifies to:

$$\frac{1}{R_{eq}} = \frac{N}{R_i} = \frac{20}{1 \Omega} \Rightarrow R_{eq} = \frac{1}{20} \Omega$$

and now we find the current:

$$I = \frac{\Delta V}{R_{eq}} = \frac{20 V}{(1/20) \Omega} = 400 A$$