

32495 Lamps in Series and Parallel

Purpose:

To provide an interesting and informative demonstration of series and parallel circuits in a three bulb arrangement that is ready to use, while offering counterintuitive elements to pique student interest and involvement. To offer some insight into the meaning of the wattage shown on a lamp.

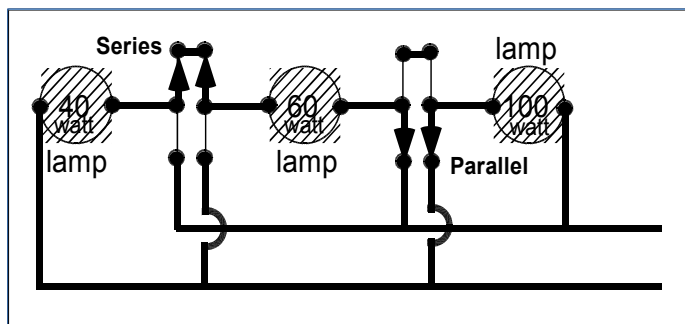
Required Accessories:

- One (1) 40 watt lamp
- One (1) 60 watt lamp
- One (1) 100 watt lamp

Assembly:

The only assembly requirement, prior to use, is inserting the 40 watt lamp into one end socket, the 60 watt lamp into the center socket, and the 100 watt lamp into the socket at the other end.

Some users might want to reassign these socket assignments during a demonstration in order to show the effect or as a response to student questions and opinions. For instance, “Is the first lamp in the series, that is the lamp closest to the outlet, necessarily going to be the brightest?” as many students want to believe. **Note: Paint dot on switches marks parallel position.**

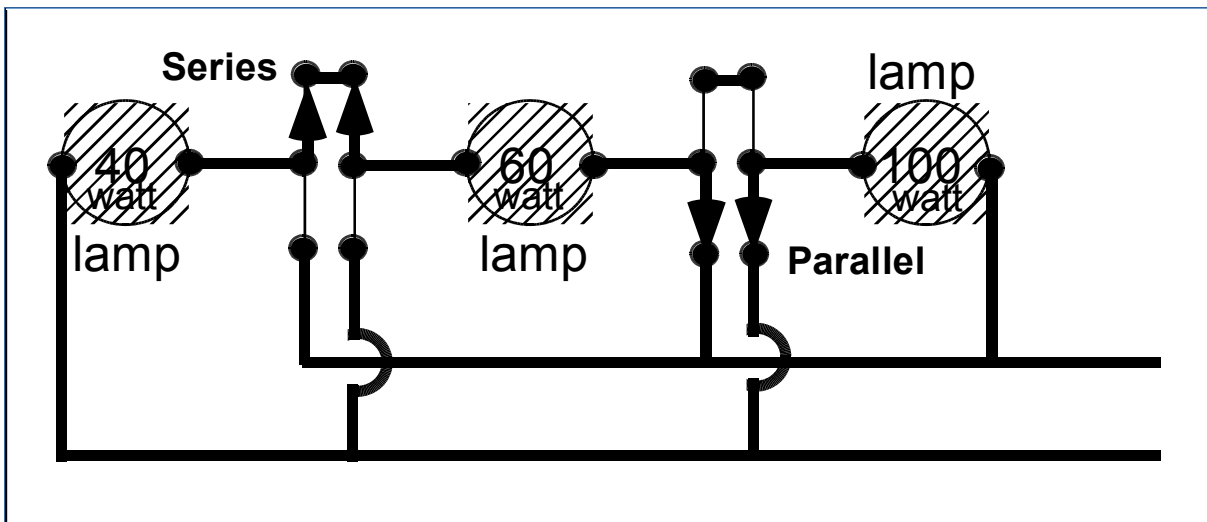


Discussion:

Are there circumstances where a 40 watt lamp will be brighter than a 100 watt lamp? Certainly, if they are connected in series. To the student just beginning to learn about circuits, this result is mysterious and perplexing. At first, it is not very convincing to make a theoretical argument based on Ohm's law: $V = IR$, and the power relationship: $P = IV$. Many students are convinced, at first, that the higher wattage lamp must have the larger resistance. Combining the two equations, we can write: $P = I^2R$, as well as: $P = V^2/R$, either before or after the actual demonstration with the apparatus.

When ordinary incandescent lamps labeled 40 watts and 100 watts are connected to a 120 volt source in the usual way (parallel position of the switches on the apparatus), it is clear that since they both have the same voltage across them then, by V^2/R , the higher wattage lamp must have the lower resistance. Now when they are connected in series, they must both carry the same current, so by I^2R , the lamp with the larger resistance is brighter. That is, a bulb with a lower power rating would actually dissipate more power. The function of the apparatus is to make the special arrangement for series, parallel, and series-parallel circuits so easy to demonstrate that it will be worth the time devoted to the exploration. Many might think this is all trivial or obvious, but students have traditionally found it difficult to fathom these mysteries with only equations to guide them. With this special purpose apparatus, it is no longer necessary to assemble generic parts for the demonstration and students can quickly be both helped and challenged in their understanding of series and parallel circuits.

The apparatus consists of three single lamp sockets wired to two switches that are both double pole and double throw. The switches are wired so that the adjacent lamps are in series, for one position of the switch, and in parallel for the other. Students might be challenged to draw a plausible diagram for this arrangement. There are two possible positions for the first switch and, for each of these, there are two possible positions of the other switch. This means there are four sets of outcomes, using the suggested order of lamps in sockets:



40 in parallel with 60 in parallel with 100
 40 in series with 60 in parallel with 100
 40 in series with 60 in series with 100
 40 in parallel with 60 in series with 100

For each of these sets, it is instructive to note the relative brightness of each lamp and then compare this with the deductions, based on the equations above, recording the results in a table such as that below:

lamp	switch	observation	lamp	switch	observation	lamp
40	parallel		60	parallel		100
40	series		60	parallel		100
40	series		60	series		100
40	parallel		60	series		100

Time Allocation:

To prepare this product for an initial experimental trial should take less than five minutes. If the lamps are stored in their respective sockets, the apparatus is, thereafter, always ready to use. Actual experiments will vary with needs of students and the method of instruction, but are easily concluded within one class period.

Feedback:

If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number.