CIRCUITS DAY 5: ELECTRIC POWER & BRIGHTNESS

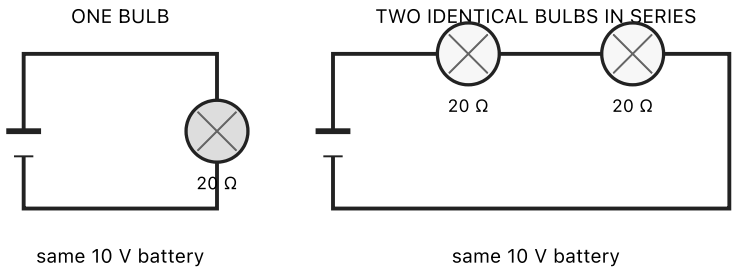
CED 11.4 · Skill 2.C · FRQ: QQT

PREDICT BEFORE OBSERVING

Connect one bulb to a battery, then connect two identical bulbs in series to the same battery. Circle one: **the single bulb is brighter / each series bulb is brighter / all are equally bright**. Be ready to defend your choice.

Observation source: matching bulbs and one low-voltage battery; projected PhET *Circuit Construction Kit: DC*; or the printed comparison below.

SAME BATTERY, DIFFERENT ARRANGEMENT



POWER IS ENERGY TRANSFER PER TIME

$$P = IV \qquad 1\ \text{W} = 1\ \text{J/s}$$

For comparable bulbs, greater dissipated power means greater brightness.

NOTES / REASONING

CHOOSE THE USEFUL POWER FORM

$$P = IV = I^2R = \frac{V^2}{R}$$

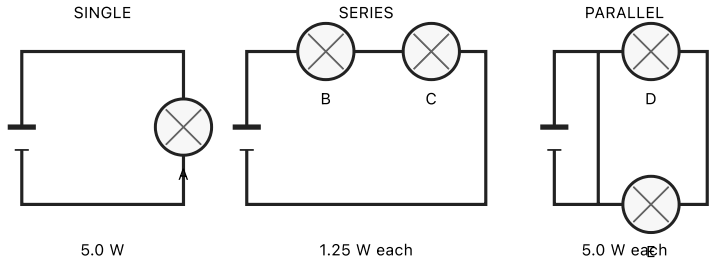
- Same current: compare with I^2R.
- Same potential difference: compare with V^2/R.
- Do not rank brightness from current alone unless the remaining quantities are controlled.

WE DO A device carries $2.4\ \text{A}$ with $9.0\ \text{V}$ across it. Find its power.

YOU DO An $18\ \text{W}$ device runs for $300\ \text{s}$. Find the transferred energy.

BRIGHTNESS IN THREE ARRANGEMENTS

IDENTICAL FIXED-20 Ω BULB MODELS ON A 10 V BATTERY



Single: $P = V^2/R = 5.0\ \text{W}$.

Series: identical elements split the 10 V evenly, so each has $P = (5.0\ \text{V})^2/(20\ \Omega) = 1.25\ \text{W}$.

Parallel: each bulb has the full 10 V, so each has $P = 5.0\ \text{W}$.

This calculation uses a stated fixed-resistance model. For real filament bulbs, compare steady-state brightness with measured $P = IV$.

REASON Explain why “current is used up” is not an acceptable explanation for the dim series bulbs.

PRACTICE

1. Find the power of a $12\ \text{V}$ device carrying $1.5\ \text{A}$.

2. Find the power of a $48\ \Omega$ resistor across $24\ \text{V}$.

3. A $30\ \text{W}$ lamp runs for $4.0\ \text{min}$. Find the energy in joules.

4. Two resistors carry the same current. Rank their powers if $R_B = 3R_A$.

5. Two resistors share the same voltage. Rank their powers if $R_B = 3R_A$.