On resistor combinations

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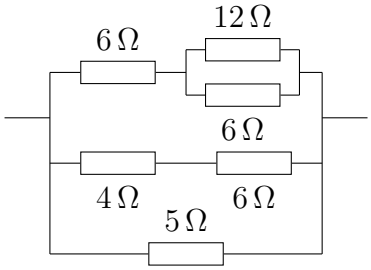
Warm-up problems

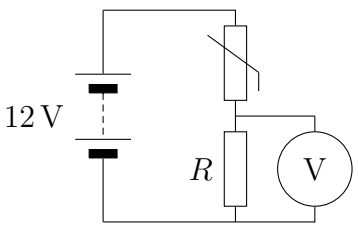
1. What are the rules for combining the resistances of resistors connected in series and parallel?
2. Draw a circuit diagram for the common configuration of resistors known as a *potential divider*, and explain how it works.
3. Find out how a potential divider is used in a sensing circuit to measure temperature, and draw a possible circuit diagram of such an arrangement.

Regular problems

4. Find the combined resistance of the following resistors, showing your step-by-step working carefully.



5. Use the rule for combinations of parallel resistors to
   (a) prove that, for two resistors with resistances R_1 and R_2 connected in parallel, their combined resistance is $\dfrac{R_1 R_2}{R_1 + R_2}$;
   (b) prove that, for N resistors of equal resistance R in parallel, their combined resistance is R/N.
6. (AQA) A thermistor is connected in series with a resistor, R, and battery of emf 6.0 V and negligible internal resistance.



When the temperature is 50 °C the resistance of the thermistor is 1.2 kΩ. The voltmeter connected across R reads 1.6 V.

(a) Calculate the p.d. across the thermistor.

(b) Calculate the current in the circuit.

(c) Calculate the resistance of R quoting your answer to an appropriate number of significant figures.

7. (AQA question, adapted) Two resistors, R_1 and R_2 are connected in series with a battery of e.m.f. 12 V and negligible internal resistance. If a voltmeter is connected across R_1, the reading on the voltmeter is 8.0 V, and the resistance of R_2 is 60 Ω.

(a) Calculate the current in the circuit.

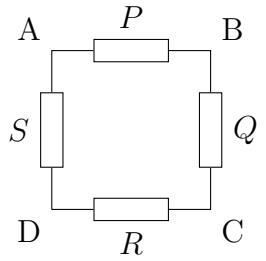
(b) Calculate the resistance of R_1.

(c) Calculate the charge passing through the battery in 2.0 minutes. Give an appropriate unit for your answer.

(d) R_2 is now replaced with a thermistor. State and explain what will happen to the reading on the voltmeter as the temperature of the thermistor increases.

Extension problems

8. (based on a CEA Advanced extension award question) Four resistors of value 1.0 Ω, 2.0 Ω, 3.0 Ω and 4.0 Ω are used to make this circuit.



The resistance is measured between pairs of terminals in turn, with the following results:

between terminals A and B	1.6 Ω
between terminals B and C	0.9 Ω
between terminals C and D	2.4 Ω
between terminals D and A	2.1 Ω

Deduce the resistance of each of the resistors P, Q, R and S. Show your reasoning clearly.