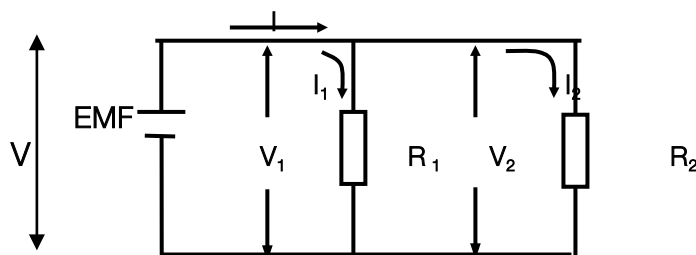


## STUDY TIPS

# PE1.3: PARALLEL CIRCUITS

When ohmic resistors are placed in parallel (side by side) with each other we can expect a greater current to flow at any particular voltage. In fact the current will be the sum of the two separate currents. We thus expect the effective resistance of two resistors in parallel to be somewhat less than either of them alone.

Consider two resistors  $R_1$  and  $R_2$  connected in parallel across a battery



If the two resistors are placed in parallel it is the sum of the two currents  $I_1$  and  $I_2$  that must add to get the total current  $I$  leaving the battery:

$$I = I_1 + I_2$$

When resistors are connected in parallel the potential difference across each resistor  $V_1$  and  $V_2$  is the same as the EMF of the battery, or

$$\text{EMF} = V = V_1 = V_2$$

For two resistors  $R_1$  and  $R_2$  in parallel:

$$\frac{1}{R_{\text{EQ}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

where  $R_{\text{EQ}}$  is one resistance equivalent to the two resistors.

### Example 1

Two pieces of nichrome wire are found to have resistances of  $10\Omega$  and  $20\Omega$ .

- If they are connected in parallel what is their effective resistance?
- What total current will flow through them and what power will be produced if the combination is placed across a 12V battery?

(a) The effective resistance is found from  $\frac{1}{R_{EQ}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10} + \frac{1}{20} = \frac{3}{20}$

Thus,  $R_{EQ} = 20/3 = 6.7\Omega$

Note how the equivalent resistance is less than the two resistances  $R_1$  and  $R_2$ .

(b) The total current is given by  $I = V/R = 12/6.7 = 1.8A$ . The power is therefore  $P = V \times I = 12 \times 1.8 = 21.6W$

### Exercise

- Two torch bulbs are placed in parallel with each other across a 3.0V battery. The current through the battery is 0.55A. The current through one of the bulbs is 0.25A.
  - What is the current through the other bulb?
  - What is the voltage across the other bulb?
- What is the effective resistance of two  $10\Omega$  resistors in (a) series, (b) parallel?
- Two equal resistors are placed in parallel and found to have a combined resistance of  $34\Omega$ . What is the resistance of each one?
- A 10V power supply is used across two separate resistors. The current through one is found to be 0.4A, and through the other 0.5A. When they are combined in parallel what current will flow through them and what is their effective resistance?
- A current of 3A is found to be flowing through two resistors of  $20\Omega$  and  $10\Omega$  in parallel.
  - What is the effective resistance of the combination?
  - What is the voltage across the pair of resistors?
  - How much current will be flowing in each resistor?
- How much power will be dissipated (used up) in each of the two resistors in Question 5?
- Three resistors of  $900\Omega$ ,  $1.5k\Omega$  and  $2.0k\Omega$  are to be used in a circuit. What is their effective resistance if they are all placed (a) in series, (b) in parallel?

### Answers

#### Exercise

1(a) 0.3A (b) 3V 2(a)  $20\Omega$  (b)  $5\Omega$  3.  $68\Omega$  4. 0.9A,  $11\Omega$  5(a)  $6.7\Omega$  (b) 20V (c) 1A (in  $20\Omega$ ) and 2A 6. 20W (in  $20\Omega$ ), 40W 7(a)  $4.4k\Omega$  (b)  $0.44k\Omega$