

# Resistance, Kirchhoff's rules and steady-state RC circuits

AP Physics 2 (algebra-based) · Test

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Class: \_\_\_\_\_ Mark: \_\_\_\_ / 20

This test covers resistivity, series and parallel networks, Kirchhoff's rules and capacitors in steady state. It lasts 45 minutes and is worth 20 points. Calculators are allowed; show every step and include units.

**Level:** AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 11

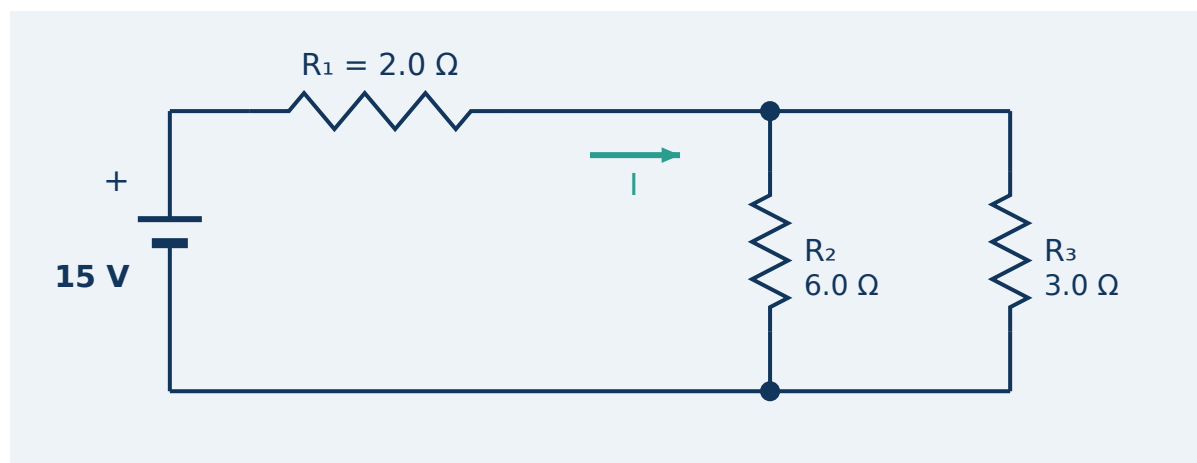
Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

## Question 1 Two wires (2 marks)

Wire Y is made of the same metal as wire X. Y is twice as long and has half the diameter. Calculate the ratio  $R_Y / R_X$ . Show your reasoning.

## Question 2 Series and parallel (3 marks)

A 15 V battery is connected as shown:  $R_1 = 2.0 \, \Omega$  in series with  $R_2 = 6.0 \, \Omega$  and  $R_3 = 3.0 \, \Omega$  in parallel.



Circuit for question 2.

- Calculate the equivalent resistance. (1 mark)
- Calculate the battery current. (1 mark)
- Calculate the current in  $R_2$ . (1 mark)

### Question 3 Kirchhoff checks (3 marks)

- At a junction, 2.5 A and 4.0 A flow in and 1.0 A flows out in one wire. Calculate the current in the only other wire. (1 mark)
- A 24 V battery drives a single loop containing a  $5.0\ \Omega$  resistor and an unknown resistor X. The current is 2.0 A. Use the loop rule to calculate X. (2 marks)

### Question 4 Capacitor after a long time (3 marks)

A 10 V battery is connected to  $R_1 = 500\ \Omega$  in series with  $R_2 = 1500\ \Omega$ . A capacitor  $C = 20\ \mu\text{F}$  is connected across  $R_2$ .

- Calculate the steady current in  $R_1$ . (1 mark)
- Calculate the charge on the capacitor after a long time. (1 mark)
- Calculate the current in  $R_1$  immediately after the circuit is closed, when the capacitor is uncharged. (1 mark)

### Question 5 Household wiring (2 marks)

Explain why the lamps in a house are connected in parallel rather than in series. Give two reasons. (2 marks)

### Question 6 Heater current (2 marks)

A heater is rated 1500 W at 230 V.

Calculate its current and its resistance. (2 marks)

### Question 7 Predicting brightness (3 marks)

Two identical bulbs, A and B, are in series across an ideal battery. A switch closes and connects a third identical bulb, C, in parallel with B.

Predict what happens to the brightness of A and of B. Justify your answer with reference to current and resistance. (3 marks)

### Question 8 Charging curve (2 marks)

Sketch a graph of the voltage across a capacitor charging through a resistor from a battery of emf  $\epsilon$ . Mark  $\epsilon$  and the time constant  $\tau$  on your graph. (2 marks)