

Series and parallel circuits

Name: _____ Class: _____ Date: _____

Start here

0-5 minutes

Today: Use circuit rules to explain currents, voltages and switches.

You need: Pen, a different-coloured pen and a calculator.

Work from memory. Write on the lines. If you are unsure, make your best attempt.

1. An ammeter in one unbranched loop reads 0.30 A before a lamp. What would it read immediately after the lamp? Explain using charge.

2. A fixed resistor has 6.0 V across it and a current of 0.20 A. Use $V = IR$ to calculate its resistance, including the unit.

Working:

Resistance = _____ Ω

3. Two components lie on separate complete branches between the same two supply terminals. Are they in series or parallel? Explain using the paths.

Stop for check 1. Wait for your teacher before moving on.

Try again A

Only if your teacher asks. Use the first 2 minutes of reading time, then turn to page 2.

Help: Use the units, equation box and circuit rules on page 2. Compare one complete loop with separate branches.

(a) In one unbranched loop, the first resistor carries 0.40 A. State the current through the second resistor and explain why.

(b) Two resistors lie on separate complete branches between the same supply terminals. Name the arrangement and give a path reason.

(c) A different fixed resistor has 3.6 V across it and 0.30 A through it. Calculate its resistance.

When your teacher says, turn to page 2.

Read the rules and models

5-15 minutes

Read this page before question 4. You can return to it during practice. Use an ideal supply with fixed voltage and fixed resistors; ignore wire resistance.

Quantity	Meaning / equation
Current, I (A)	Charge flowing per second. Charge is conserved.
Potential difference, V (V)	Energy transferred per unit charge. Also called voltage.
Resistance, R (Ω)	$V = IR$ $I = V \div R$ $R = V \div I$

Series: one complete path

The current is the same through every component. Add the resistances. The potential differences across the components add to the supply potential difference.

Worked model - series

Follow the revision note's series example: an ideal 12 V supply feeds 4 Ω and 8 Ω fixed resistors in one loop. Find the total resistance, current and potential difference across each resistor.

$R_{\text{total}} = 4 + 8 = 12 \Omega$. $I = 12/12 = 1 \text{ A}$ through both resistors. Their potential differences are $1 \times 4 = 4 \text{ V}$ and $1 \times 8 = 8 \text{ V}$. The check is $4 + 8 = 12 \text{ V}$: equal current does not mean equal potential difference.

Parallel: separate complete branches

Each branch is connected across the same supply terminals, so each has the full supply potential difference. Add the branch currents to find the total supply current.

Worked model - junction

Follow the revision note's junction example: 1.2 A enters a junction and divides between two branches. One branch carries 0.50 A. Find the other branch current.

The two branch currents must add to the entering current. The other branch current is $1.2 - 0.50 = 0.70 \text{ A}$. Check: $0.50 + 0.70 = 1.2 \text{ A}$.

What happens when a switch opens?

Trace a complete path from one supply terminal back to the other. Opening the only series path stops all current. Opening one parallel branch leaves any other complete branch connected across the same supply voltage.

Reading adapted from PhysicsUK: Series and Parallel Circuits, sections 1-3. Optional online reading.

Turn to page 3 for question 4.

Choose and explain

15-20 minutes, then begin practice

4. Two fixed resistors are on separate branches across an ideal 12 V supply. Branch P carries 0.20 A and branch Q carries 0.50 A. Which row gives the potential difference across P and the total supply current? Choose a letter, then give one reason for each value.

- A. 6 V across P; 0.70 A from the supply.
- B. 12 V across P; 0.70 A from the supply.
- C. 12 V across P; 0.50 A from the supply.
- D. 12 V across P; 0.30 A from the supply.

Stop for check 2. Wait for your teacher before moving on.

Try again B

Only if your teacher asks. Complete this instead of questions 8 and 9. Then answer questions 5-7.

Help: Use the parallel rule on page 2. Trace the same two terminals for each branch. Match the current entering a junction to the sum leaving.

An ideal 9.0 V supply feeds two parallel fixed-resistor branches. X carries 0.15 A and Y carries 0.25 A. State the potential difference across Y and calculate the total supply current. Explain both values.

Practice: explain the paths - from 20 minutes

5. Describe the difference between a series circuit and a parallel circuit.

6. A trainee says: "The second resistor in a series circuit has less current because the first resistor uses up charge." Explain why this is wrong.

Continue with questions 7-10 on page 4.

Use the rules

20-33 minutes

Questions 7-9 use two separate series-circuit tests. Both resistors are in the same loop.

Test	Supply	Resistor 1	Resistor 2
1	6.0 V	10 Ω	20 Ω
2	12 V	15 Ω	25 Ω

7. Use test 1 in the table. Calculate the total resistance and the circuit current.

Working:

Total resistance = Ω Current = A

8. Use test 2 in the table. Calculate the total resistance and the circuit current.

Working:

Total resistance = Ω Current = A

9. Use test 2. Calculate the potential difference across each resistor.

Working:

15 Ω resistor = V 25 Ω resistor = V

Pause for an independent check - about 30 minutes

10. Fixed 10 Ω and 30 Ω resistors are in parallel across an ideal 6.0 V supply. Calculate each branch current and the total current. Explain why the branch currents differ.

Working:

10 Ω branch = A 30 Ω branch = A

Total current = A

Reason:

Stop for check 3. Wait for your teacher before moving on.

Try again C

Only if your teacher asks. Complete this instead of questions 14 and 15. Then continue with the other questions.

Help: Give each branch the full supply potential difference. Use $I = V/R$ for each branch, then add the currents.

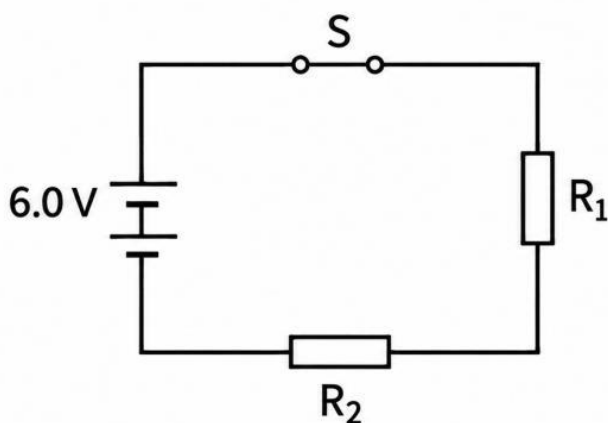
An ideal 12 V supply feeds fixed 30 Ω and 60 Ω resistors in parallel. Calculate each branch current and the supply current. Which branch carries more current, and why?

Continue with the circuit diagram on page 5.

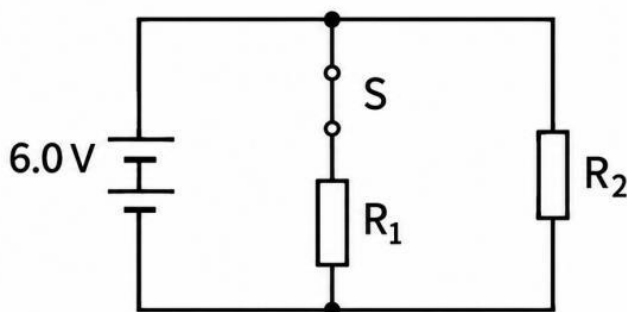
Compare the two circuits

33-45 minutes

Circuit A



Circuit B



Both supplies are 6.0 V. In each circuit $R_1 = 10\ \Omega$ and $R_2 = 20\ \Omega$. All switches are closed until a question says otherwise.

11. In circuit A, the current through R_1 is 0.20 A. State the current through R_2 .

Current through R_2 = A

12. Calculate the potential difference across each resistor in circuit A.

Working:

Across R_1 = V Across R_2 = V

13. State the potential difference across each resistor in circuit B.

Across R_1 = V Across R_2 = V

14. Calculate the current through each resistor in circuit B.

Working:

Through R_1 = A Through R_2 = A

15. Calculate the total supply current in circuit B.

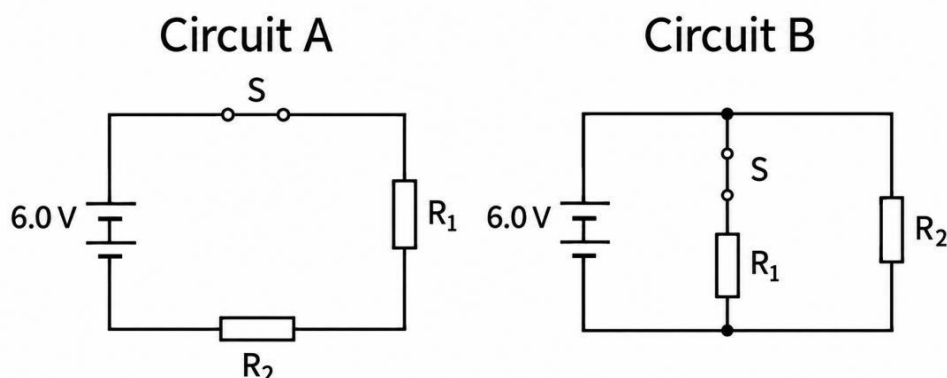
Working:

Total supply current = A

Turn to page 6. Use the same circuits for the switch questions.

Explain a switch change

Finish practice, then review at 45 minutes



Both supplies are 6.0 V. In each circuit $R_1 = 10\ \Omega$ and $R_2 = 20\ \Omega$. All switches are closed until a question says otherwise.

For each question, start again with all switches closed. Then make only the change described.

16. In circuit B, switch S is opened. State the new total supply current and explain your answer.

17. In circuit A, switch S is opened. State the current through each resistor and explain your answer.

18. Two light units each need the full 6.0 V and must operate independently. Choose layout A or B. Explain how your choice meets both requirements.

Check and improve - 45-55 minutes

19. When your teacher gives the answers, check your practice in a different colour. Improve one answer. Write what you first thought, your corrected answer and why the correction is better. If all your answers were correct, explain why unequal parallel resistors carry different currents at the same voltage.

At 55 minutes, cover the earlier pages and turn to page 7.

Show what you can do

55-60 minutes

Work independently. Keep the reading and previous answers covered.

20. An ideal 8.0 V supply powers two parallel indicator branches: P contains a fixed 20 Ω resistor and Q a fixed 40 Ω resistor. Calculate the total supply current with both connected. Q's branch switch then opens. State the new current through P and from the supply. Explain using the complete path and the potential difference across P.

Before the switch opens - working:

Current through P = A; through Q = A

Total supply current = A

After Q opens: P current = A; supply current = A

Explain using a complete path and the supply voltage:

Stop for check 4. Wait for your teacher before moving on.

Write your name on page 1. Hand in this whole booklet, including your working and corrections.

Try again D - next lesson

Leave this today. Your usual teacher may ask you to do it next lesson.

Help: Next lesson, first revisit the switch rules and parallel rule on page 2. Then cover the reading and attempt the follow-up.

Next lesson: an ideal 10 V supply feeds fixed 25 Ω and 50 Ω resistors in parallel. Find the total current with both connected. Then open the 25 Ω branch. State the current through the 50 Ω resistor and from the supply, with a reason. Finally, what current would flow if the only path in a series circuit were opened?

Hand your booklet to your teacher.