

Resistance in series and parallel circuits

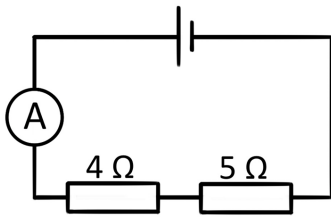
Mark Scheme



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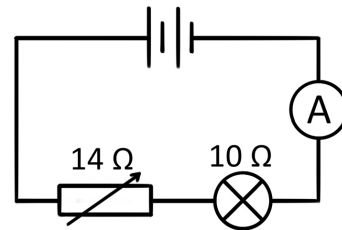
Task 1: calculating the total resistance of a series circuit

For each of the following circuits determine the total resistance of the circuit.



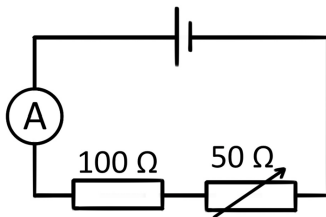
$$4\ \Omega + 5\ \Omega = 9\ \Omega$$

1 mark



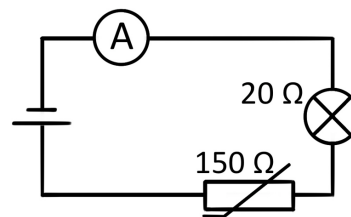
$$14\ \Omega + 10\ \Omega = 24\ \Omega$$

1 mark



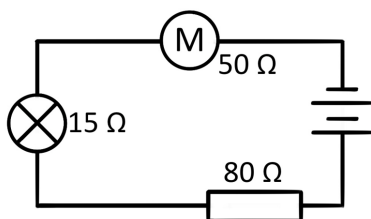
$$100\ \Omega + 50\ \Omega = 150\ \Omega$$

1 mark



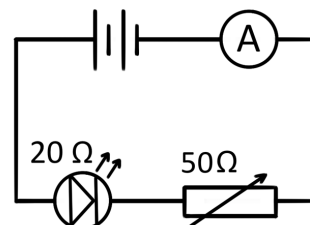
$$150\ \Omega + 20\ \Omega = 170\ \Omega$$

1 mark



$$15\ \Omega + 50\ \Omega + 80\ \Omega = 145\ \Omega$$

1 mark



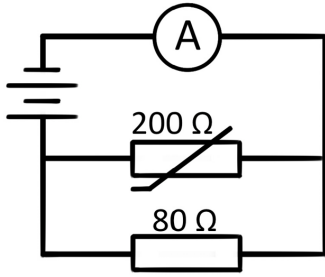
$$20\ \Omega + 50\ \Omega = 70\ \Omega$$

1 mark

(Total for Task 1 is 6 marks)

Task 2: calculating the total resistance of a parallel circuit

For each of the following circuits determine the total resistance of the circuit.



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

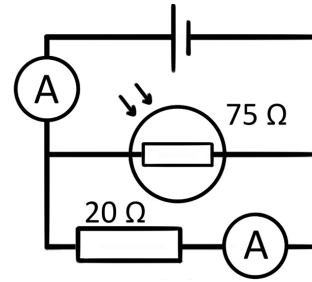
$$\frac{1}{R_T} = \frac{1}{200} + \frac{1}{80} = \frac{7}{400}$$

$$RT = 1 \div \frac{7}{400}$$

$$RT = 57.1 \Omega$$

1 mark

2 marks



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

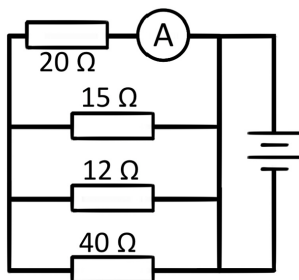
$$\frac{1}{R_T} = \frac{1}{75} + \frac{1}{20} = \frac{19}{300}$$

$$RT = 1 \div \frac{19}{300}$$

$$RT = 15.79 \Omega$$

1 mark

2 marks



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

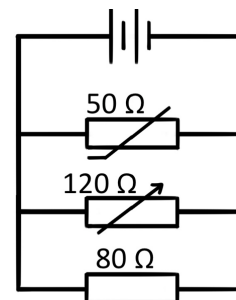
$$\frac{1}{R_T} = \frac{1}{20} + \frac{1}{15} + \frac{1}{12} + \frac{1}{40} = \frac{9}{40}$$

$$RT = 1 \div \frac{9}{40}$$

$$RT = 4.4 \Omega$$

1 mark

2 marks



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_T} = \frac{1}{50} + \frac{1}{120} + \frac{1}{80} = \frac{49}{1200}$$

$$RT = 1 \div \frac{49}{1200}$$

$$RT = 24.5 \Omega$$

1 mark

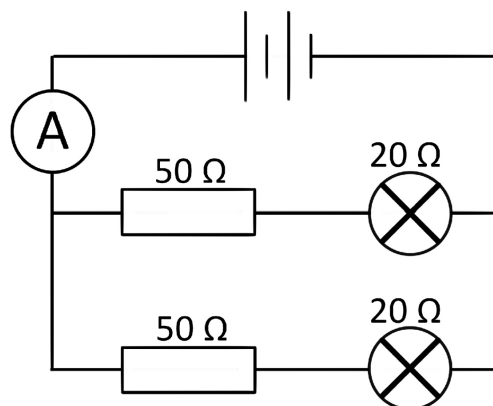
2 marks

(Total for Task 2 is 8 marks)

Task 3: Resistance in Parallel Circuits

Some extra practice for you 😊

1. A student builds the circuit shown in the figure below.



- a) Calculate the total resistance of the top branch of the circuit.

$50\ \Omega + 20\ \Omega = 70\ \Omega$	1 mark
	Total: 1 mark

- b) Calculate the total resistance of the whole circuit.
Show your working.

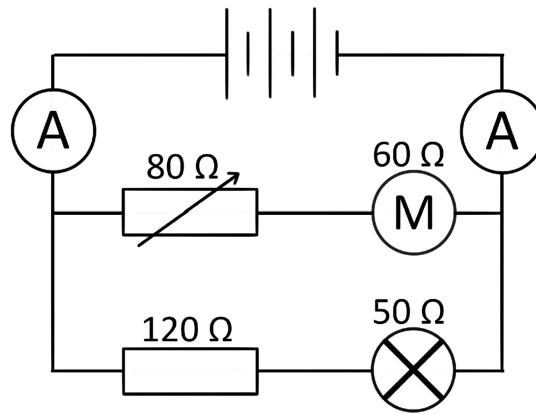
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	1 mark
$\frac{1}{R_T} = \frac{1}{70} + \frac{1}{70} = \frac{2}{70}$	1 mark
$R_T = 1 \div \frac{2}{70} = 35\ \Omega$	1 mark
	Total: 3 marks

- c) State how the current through the top bulb compares to the current through the bottom bulb.
Give a reason for your answer.

Current: <u>the same / equal</u> at all points in the circuit.	1 mark
Reason: the resistance of both branches/components is the same / equal.	1 mark
	Total: 2 marks

(Total for Question 1 is 6 marks)

2. A student builds the parallel circuit shown in the figure below.



a) Name the component in the top branch that has a resistance of 80 Ω.

A <u>variable resistor</u> .	1 mark
	Total: 1 mark

b) The circuit contains two ammeters. A student states

"The ammeter on the right will show a lower reading than the ammeter on the left because the components have used up some of the current."

Explain why the student is incorrect.

An explanation to include any two of the following:	
- Current is conserved / current is not used up (by components). (It is) energy / voltage / potential difference that is transferred / used. - Both ammeters are on the main circuit / main branch. - Current leaving the battery is the same as the current returning to it.	
	Total: 2 marks

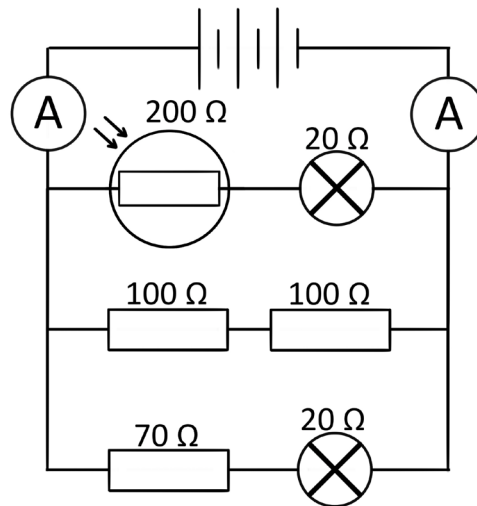
c) Determine the total resistance of the entire circuit.

Show your working. Give your answer to 1 decimal place.

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	1 mark
$\frac{1}{R_T} = \frac{1}{140} + \frac{1}{170} = \frac{31}{2380}$	1 mark
$R_T = 1 \div \frac{31}{2380} = 76.80 \Omega$	1 mark
	Total: 3 marks

(Total for Question 2 is 6 marks)

3. A student builds the parallel circuit shown below. It contains three branches.



- a) Name the component in the top branch that has a resistance of $200\ \Omega$.

LDR or light dependent resistor.	1 mark
	Total: 1 mark

- b) Calculate the total resistance of the middle branch.

$100\ \Omega + 100\ \Omega = 200\ \Omega$	1 mark
	Total: 1 mark

- c) The battery supplies a potential difference of 9 V .
Calculate the current flowing through the middle branch only.
Show your working and include the correct unit.

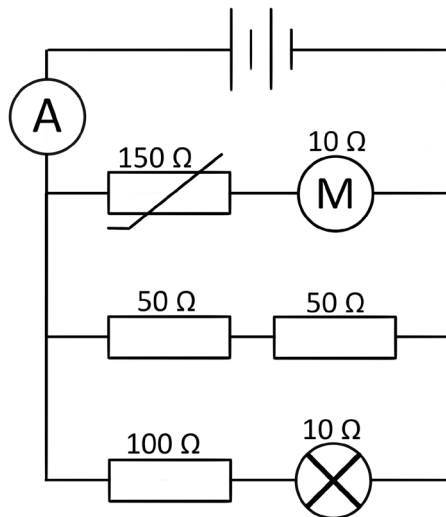
$I = V \div R$	1 mark
$I = 9 \div 200 \quad I = 0.045$	1 mark
Unit: A or Amps or Amperes	1 mark
	Total: 3 marks

- d) A bright light is shone onto the circuit. State what will happen to the reading on the ammeters.
Explain your answer.

An explanation to include the following:	
Both ammeter readings will increase.	1 mark
Because the resistance of the LDR decreases (in bright light).	1 mark
Therefore, the total resistance of the top branch / whole circuit decreases (allowing more current to flow).	1 mark
	Total: 3 marks

(Total for Question 3 is 8 marks)

4. A student is investigating the circuit shown in the figure below.



a) State the name of the component in the top branch that has a resistance of 150 Ω.

Thermistor.	1 mark
Total: 1 mark	

b) Calculate the total resistance of the middle branch.

$50\ \Omega + 50\ \Omega = 100\ \Omega$	1 mark
Total: 1 mark	

c) Calculate the total resistance of the whole circuit.
Show your working clearly. Give your answer to 1 decimal place.

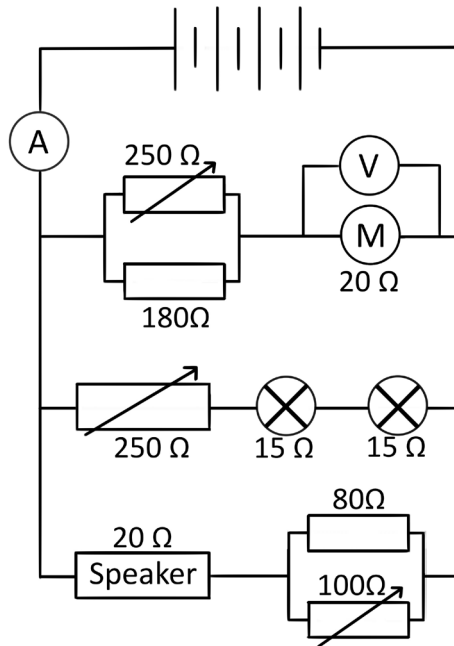
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	1 mark
$\frac{1}{R_T} = \frac{1}{160} + \frac{1}{100} + \frac{1}{110} = \frac{223}{8800}$	1 mark
$R_T = 1 \div \frac{223}{8800} = 39.461\ \Omega$	1 mark
Resistance total to 1 decimal place $R_T = 39.50\ \Omega$	1 mark
Total: 4 marks	

d) The circuit is moved into a colder room.
Explain what will happen to the amount of current flowing through the motor in the top branch.

Current: <u>will decrease</u> .	1 mark
As the resistance of the thermistor increases (in colder temperatures).	1 mark
The total resistance of the top branch increases (reducing the current).	1 mark
Total: 3 marks	

(Total for Question 4 is 9 marks)

5. A student builds the parallel circuit shown in the figure below.



- a) Calculate the total resistance of the whole circuit.
Show your working clearly. Give your answer to 1 decimal place.

Top branch resistance $= \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R_T} = \frac{1}{250} + \frac{1}{180} = \frac{43}{4500}$ $R_t = 1 \div \frac{43}{4500}$ $R_t = 104.65 + 20 \Omega$ $R_t = 124.65 \Omega$		1 mark
Middle branch resistance $= 250 + 15 + 15 = 280 \Omega$		1 mark
Bottom branch resistance $= \frac{1}{R_T} = \frac{1}{80} + \frac{1}{100} = \frac{9}{400}$ $RT = 1 \div \frac{9}{400}$ $RT = 44.44$ $44.44 + 20 = 64.4 \Omega$		1 mark
Total resistance of the circuit $\frac{1}{R_T} = \frac{1}{124.65} + \frac{1}{280} + \frac{1}{64.44} = 0.03409614169$ $RT = 1 \div 0.0271122 = 36.9 \Omega$		1 mark
		Total: 4 marks

- b) The battery supplies a total current of 1.5 A to the circuit (the ammeter reading).
The top branch draws 0.6 A and the middle branch draws 0.4 A.

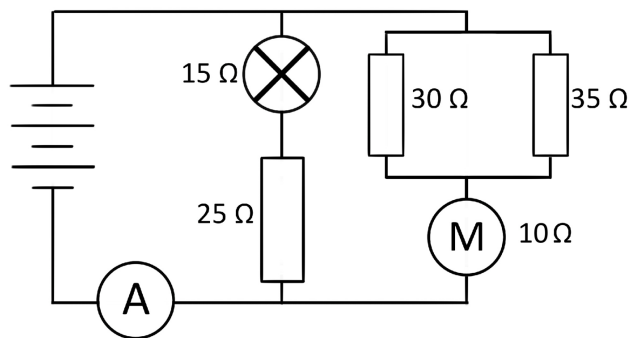
Calculate the current flowing through the speaker in the bottom branch.

$1.5 = 0.6 + 0.4 + \text{speaker}$	1 mark
$\text{Speaker} = 0.5 \text{ A}$	1 mark
	Total: 2 marks

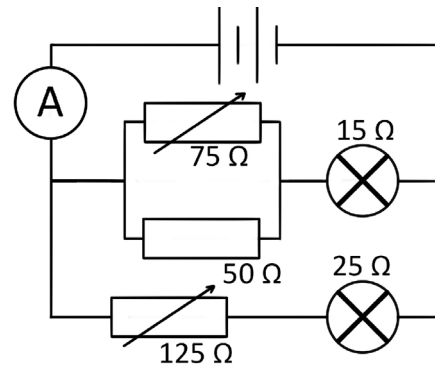
(Total for Question 5 is 6 marks)

6. A teacher set up two different parallel circuits for a practical.
These circuits, circuit A and circuit B are shown in the figure below.

Show, using calculations, which circuit has the greatest resistance.



Circuit A



Circuit B

Circuit A calculations	
- Identifies left branch resistance: $15 + 25 = 40 \Omega$ - Identifies Parallel sub-section on right branch: $\frac{1}{R_T} = \frac{1}{30} + \frac{1}{35}$ - Calculates parallel sub-section = 16.15Ω - Right branch (total): adds motor in series = $16.15 + 10 = 26.15 \Omega$ Total resistance circuit A: $\frac{1}{R_T} = \frac{1}{40} + \frac{1}{26.15}$ $\frac{1}{R_T} = \frac{1}{40} + \frac{1}{26.15} \quad \frac{1}{R_T} = \frac{1323}{20920}$ $R_T = 15.8 \Omega$	
Circuit B calculations	
- Identifies top branch resistance: $75 + 15 = 90 \Omega$ - Identifies middle branch resistance: $50 + 25 = 75 \Omega$ - Identifies bottom branch resistance: 125Ω - Sets up equation: $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \quad \frac{1}{R_T} = \frac{1}{90} + \frac{1}{75} + \frac{1}{125}$ $\frac{1}{R_T} = \frac{73}{2250}$ Total resistance circuit B: $R_T = 30.8 \Omega$	
Conclusion: circuit B has the greatest total resistance.	
Total: 6 marks	

(Total for Question 6 is 6 marks)