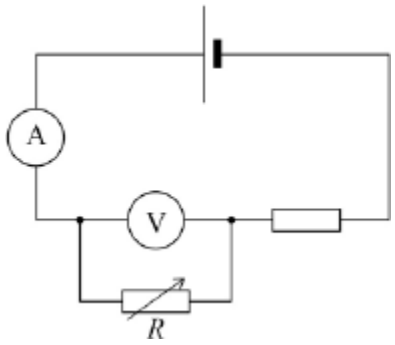
1 In the circuit shown in the diagram the cell has negligible internal resistance.

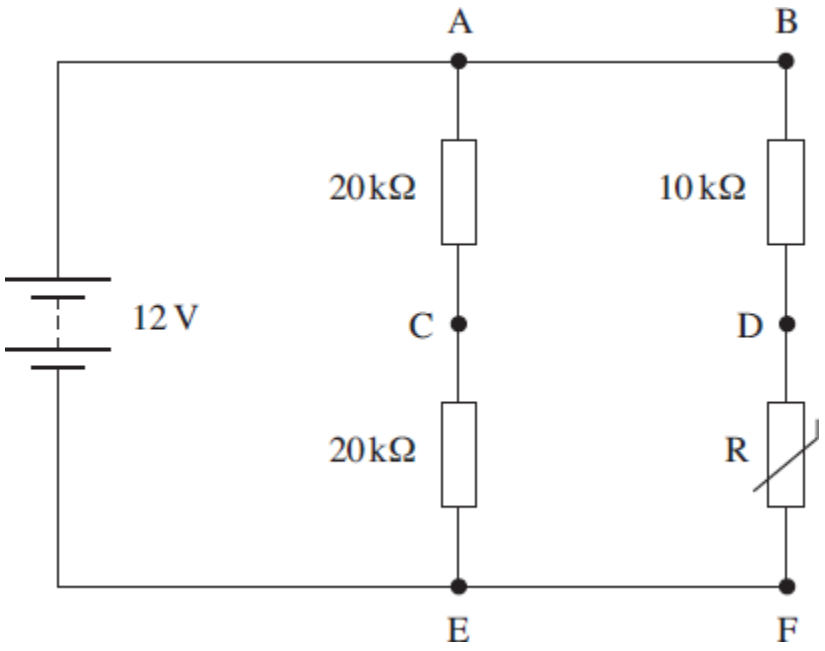


What happens to the reading of both meters when the resistance of R is decreased?

	Reading of ammeter	Reading of voltmeter	
A	increases	increases	⬭
B	increases	decreases	⬭
C	decreases	increases	⬭
D	unchanged	decreases	⬭

(Total 1 mark)

2 The circuit diagram below shows a 12 V battery of negligible internal resistance connected to a combination of three resistors and a thermistor.



(a) When the resistance of the thermistor is 5.0 kΩ

(i) calculate the total resistance of the circuit,

total resistance = ... kΩ

(3)

(ii) calculate the current in the battery.

current = ... mA

(1)

(b) A high-resistance voltmeter is used to measure the potential difference (pd) between points A-C, D-F and C-D in turn.
Complete the following table indicating the reading of the voltmeter at each of the three positions.

voltmeter position	pd / V
A-C	
D-F	
C-D	

(3)

(c) The thermistor is heated so that its resistance decreases. State and explain the effect this has on the voltmeter reading in the following positions.

(i) A–C.....

.....

.....

.....

(2)

(ii) D–F.....

.....

.....

.....

(2)
(Total 11 marks)

3 (a) Define the volt.

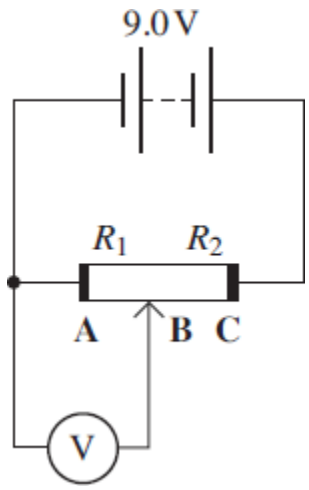
.....

.....

(1)

(b) To test the potential differences in a potential divider circuit, a student sets up the circuit of **Figure 1**. R_1 is the resistance of section **AB** and R_2 that of section **BC** of the potential divider. The battery has an emf of 9.0 V and negligible internal resistance

Figure 1



(i) Calculate the voltmeter reading when R_1 = 2.2 kΩ and R_2 = 1.8 kΩ. Assume that the voltmeter has infinite resistance.

voltmeter reading V

(2)

(ii) State the benefit of using a high value of resistance in potential divider circuits.

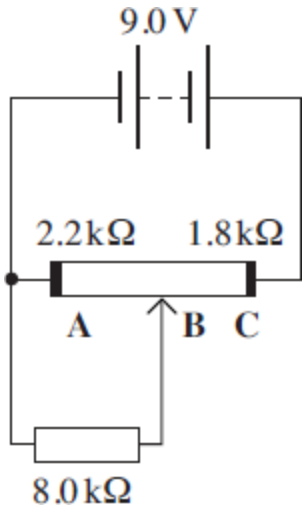
.....

.....

(1)

(iii) An 8.0 kΩ resistor is connected in the circuit to replace the voltmeter in **Figure 1**. This is shown in **Figure 2**.

Figure 2



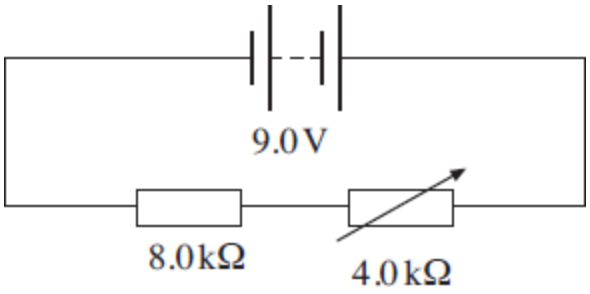
Calculate the potential difference across this resistor when the sliding contact **B** is in the position shown in **Figure 2**.

potential difference V

(3)

(iv) The 8.0 kΩ resistor is now connected in a circuit with a 4.0 kΩ variable resistor as shown in **Figure 3**.

Figure 3



Compare this arrangement for controlling the current in the 8.0 kΩ resistor with the potential divider arrangement in **Figure 2**.

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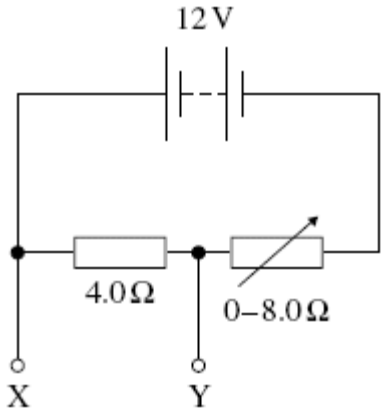
(2)
(Total 9 marks)

4 **Figure 1** shows an electrical circuit that contains a 4.0 Ω resistor, a 0 – 8.0 Ω variable resistor and a 12 V power supply with negligible internal resistance.

Figure 1



(a) State the name given to this type of circuit.

.....

(1)

(b) Calculate the minimum and maximum potential differences that can be obtained across XY. State the corresponding values of the resistance of the variable resistor.

.....

.....

.....

.....

.....

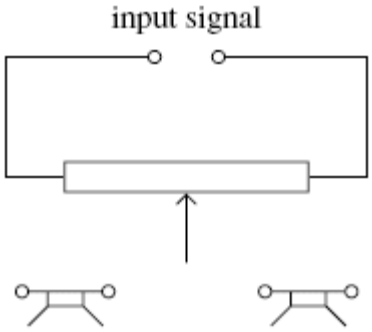
.....

minimum pd ..... V when the resistance of the variable resistor is ..... Ω

maximum pd ..... V when the resistance of the variable resistor is ..... Ω

(4)

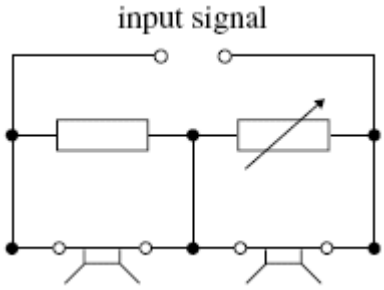
(c) (i) Complete the circuit diagram to show how a potentiometer (variable resistor) can be connected so that the relative loudness of the sound from two loudspeakers can be adjusted.



(1)

(ii) Explain the advantage of using a potentiometer over the two-resistor arrangement in **Figure 2** for this purpose.

Figure 2



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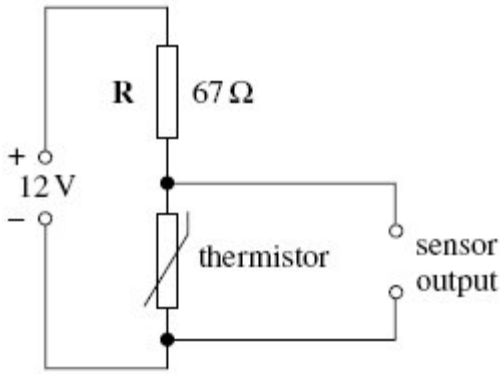
(2)
(Total 8 marks)

5 **Figure 1** shows a circuit that can be used to sense temperature changes. Sensing is possible because the potential difference across the thermistor changes as the temperature changes.

Figure 1



The power supply has a negligible internal resistance and the resistor **R** has a resistance of 67 Ω.

(a) When the thermistor is at a high temperature the potential difference across it is 4.5 V.

(i) Calculate the potential difference across **R**.

.....

.....

potential difference V

(1)

(ii) Calculate the current in the circuit.

.....

.....

.....

current ..... A

(2)

(b) (i) The temperature of the thermistor changes to 25 °C and its resistance becomes 360 Ω.
Show that the potential difference across the thermistor at 25 °C is about 10 V.

.....

.....

.....

.....

(3)

(ii) Calculate the power dissipated in the resistor **R** when the thermistor temperature is 25 °C, giving an appropriate unit for your answer.

.....

.....

.....

.....

.....

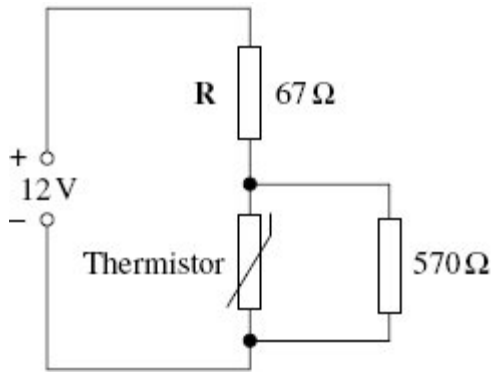
.....

power dissipated .....

(4)

(c) The circuit is modified as shown in **Figure 2**. A resistor of resistance 570 Ω is connected in parallel with the thermistor.

Figure 2



For the circuit in **Figure 2** calculate the current in the 67 Ω resistor when the thermistor temperature is 25 °C.

.....

.....

.....

.....

.....

current in 67 Ω resistor ..... A

(4)

(d) Explain, in terms of charge carriers, why the resistance of the thermistor decreases as the temperature rises.

.....

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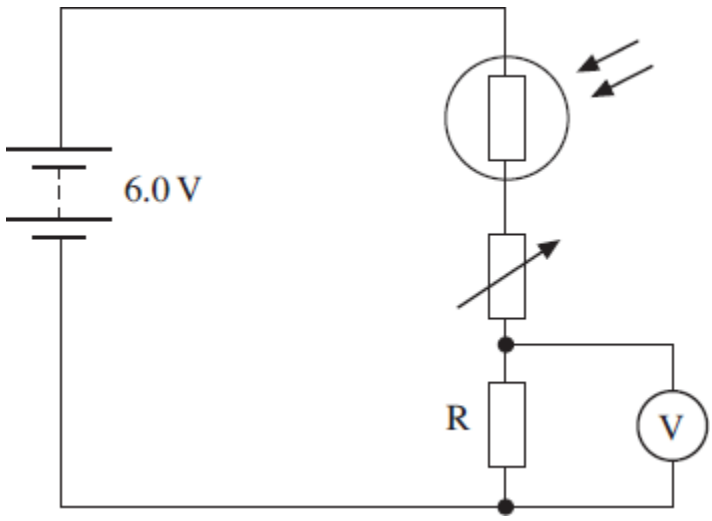
.....

.....

(3)
(Total 17 marks)

6 The circuit diagram below shows a 6.0 V battery of negligible internal resistance connected in series to a light dependent resistor (LDR), a variable resistor and a fixed resistor, R.



(a) For a particular light intensity the resistance of the LDR is 50 kΩ. The resistance of R is 5.0 kΩ and the variable resistor is set to a value of 35 kΩ.

(i) Calculate the current in the circuit.

current.....A

(2)

(ii) Calculate the reading on the voltmeter.

voltmeter reading V

(2)

(b) State and explain what happens to the reading on the voltmeter if the intensity of the light incident on the LDR increases.

.....

.....

.....

(2)

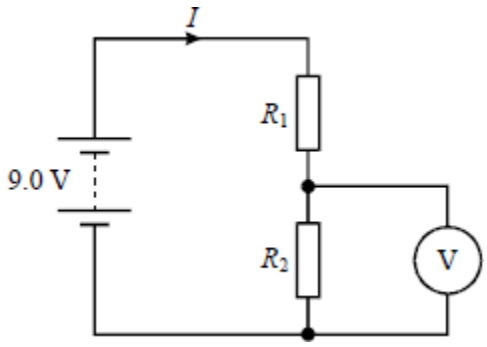
(c) For a certain application at a particular light intensity the pd across R needs to be 0.75 V. The resistance of the LDR at this intensity is 5.0 kΩ.

Calculate the required resistance of the variable resistor in this situation.

resistance ..... Ω

(3)
(Total 9 marks)

7 In the circuit shown, the battery has negligible internal resistance.



(a) (i) If the emf of the battery = 9.0 V, R_1 = 120 Ω and R_2 = 60 Ω, calculate the current I flowing in the circuit.

.....

.....

.....

.....

(ii) Calculate the voltage reading on the voltmeter.

.....

.....

(4)

(b) The circuit shown in the diagram acts as a potential divider. The circuit is now modified by replacing R_1 with a temperature sensor, whose resistance decreases as the temperature increases.

Explain whether the reading on the voltmeter increases or decreases as the temperature increases from a low value.

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.....

(3)
(Total 7 marks)

8 (a) (i) Give the equation which relates the *electrical resistivity* of a conducting material to its *resistance*. Define the symbols in the equation.

.....

.....

.....

(ii) A potential difference of 1.5 V exists across the ends of a copper wire of length 2.0 m and uniform radius 0.40 mm. Calculate the current in the wire.

resistivity of copper = 1.7×10^{-8} Ω m

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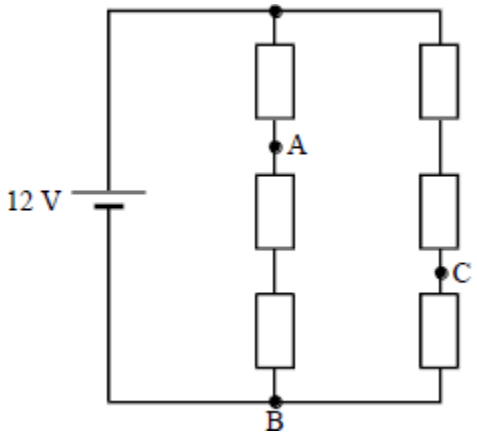
.....

.....

(5)

(b) In the circuit shown, each resistor has the same resistance. The battery has an e.m.f. of 12 V and negligible internal resistance.



(i) Calculate the potential difference between A and B.

.....

.....

(ii) Calculate the potential difference between B and C.

.....

.....

(iii) A high resistance voltmeter is connected between A and C. What is the reading on the voltmeter?

.....

(5)
(Total 10 marks)

9

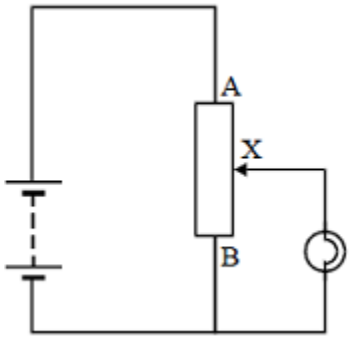


Figure 1

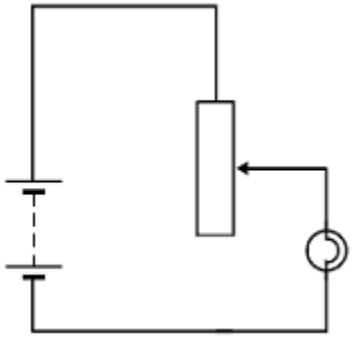


Figure 2

(a) The current flowing through a torch bulb can be controlled by a variable resistor using either of the two circuit arrangements shown above. **Figure 1** is called a potential divider arrangement and **Figure 2** may be called a rheostat arrangement. For each of these two methods explain **one** advantage and **one** disadvantage.

potential divider

advantage .....

.....

disadvantage .....

.....

rheostat

advantage .....

.....

disadvantage .....

.....

(4)

(b) In **Figure 1**, the variable resistor has a total resistance of 16 Ω. When the slider of the variable resistor is set at X, exactly mid-way along AB, the bulb works according to its specification of 2.0 V, 500 mW. Calculate

(i) the current through section XB of the variable resistance,

.....

.....

(ii) the current through section AX of the variable resistance.

.....

.....

(2)
(Total 6 marks)

10 (a) **Figure 1** and **Figure 2** show two circuits that may be used for controlling the voltage across a 3.0 Ω resistor. In each circuit the supply has an e.m.f. E of 10 V and negligible internal resistance.

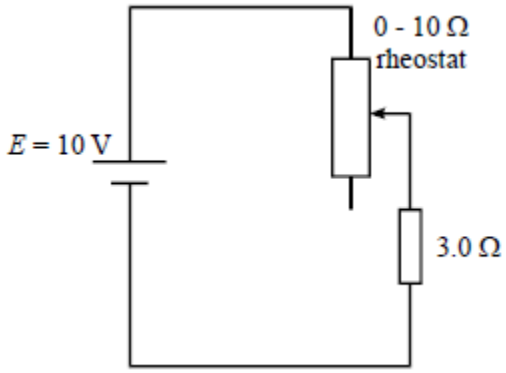


Figure 1

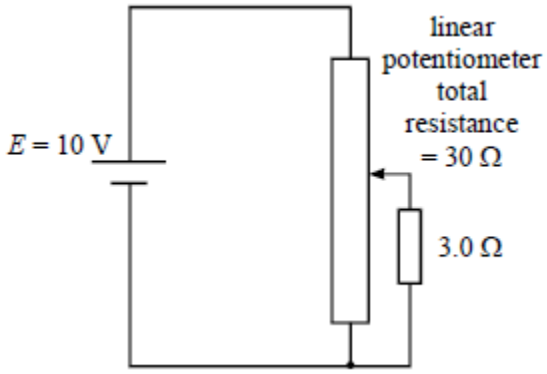


Figure 2

(i) Calculate the minimum voltage which can exist across the 3.0 Ω resistor using the circuit shown in **Figure 1**.

(3)

(ii) State **one** advantage of using the circuit shown in **Figure 2** for controlling the voltage across the 3.0 Ω resistor.

.....

.....

.....

(1)

(iii) The total resistance of the potentiometer wire in **Figure 2** is 30 Ω. Explain why the voltage across the 3.0 Ω resistor would not be half of the maximum when the slider of the potentiometer is half-way along the wire, as shown in **Figure 2**.

.....

.....

.....

(2)

(iv) Label with a letter **P** the approximate position of the slider in **Figure 2**, when the voltage across the 3.0 Ω resistor is about half the maximum possible.

(1)

(b) The circuit in **Figure 3** is used to balance the power dissipated by two components that have different resistances. This is achieved by adjusting the position of S.

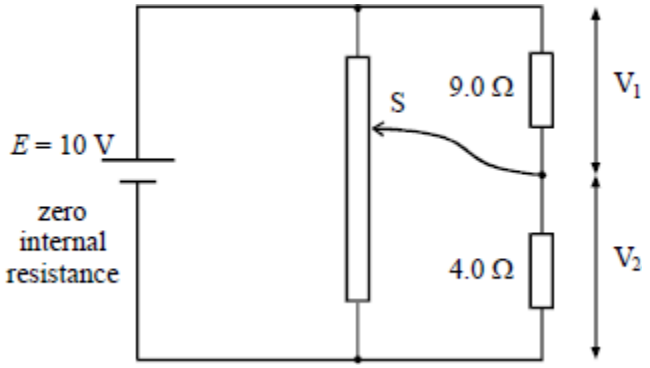


Figure 3

(i) Show that for the power dissipation to be the same, the ratio $V_1/V_2 = 3/2$.

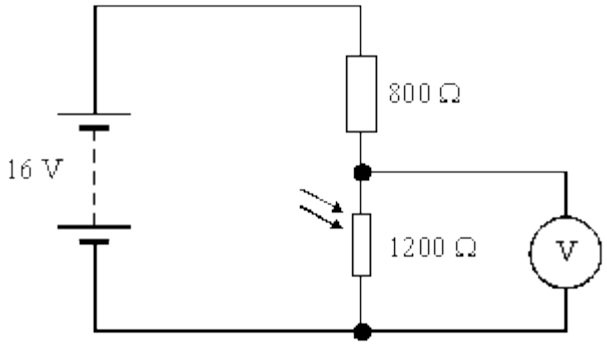
(2)

(ii) Calculate the power dissipated by **one** of the components when they are balanced.

(1)

(Total 10 marks)

11 The diagram below shows a potential divider consisting of a resistor in series with a light dependent resistor. The voltmeter connected in parallel with the light dependent resistor has an infinite resistance. The battery has an emf of 16V with a negligible internal resistance.



(a) Calculate the reading on the voltmeter when the light dependent resistor has a resistance of 1200 Ω.

Voltmeter reading .....

(2)

(b) The light intensity in the room is increased. State and explain what happens to the resistance of the LDR and the reading on the voltmeter.

.....

.....

.....

.....

.....

(3)
(Total 5 marks)