O Level Pure Physics Structured

Current and DC Circuits Test 1.0

Q1

A student decided to build a temperature probe using a thermistor. He sets up the circuit as shown in Fig. 9.1. The 9.0 V battery has negligible internal resistance.

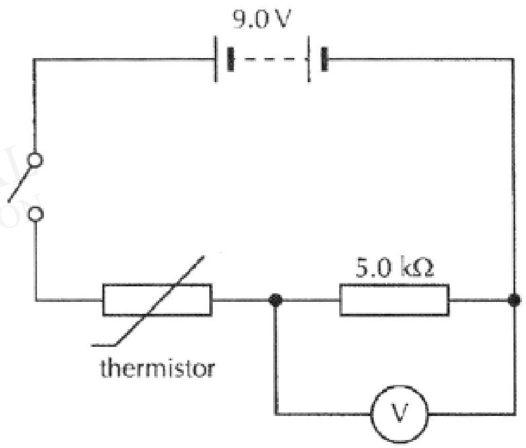

Fig. 9.1

The voltmeter connected in parallel to the 5.0 kΩ resistor has infinite resistance. The thermistor is immersed into a water bath, which is then heated. The calibration curve for the thermistor is shown in Fig. 9.2.

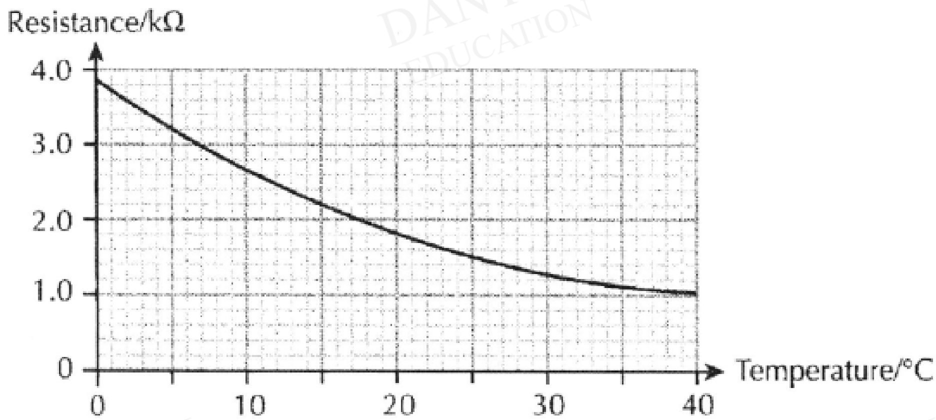

Fig. 9.2

(a) Explain why it is necessary to include a fixed resistor in the circuit as shown in Fig. 9.1.

....

....

.... [2]

(b) The probe is to be used to measure temperatures in the range of 0 °C to 35 °C.

(i) Use Fig. 9.2 to determine the resistance of the thermistor when the probe is at a temperature of 35 °C.

.... [1]

(ii) Hence, calculate the reading on the voltmeter when the temperature is 35 °C.

voltmeter reading = ... [2]

(iii) The 5.0 kΩ resistor is replaced by a light bulb. When the switch is closed, the student observes that the brightness of the light bulb increases gradually. Explain this observation.

....

....

....

.... [2]

(c) The student decides to use an ammeter and a 100 Ω resistor to replace the voltmeter and the 5 kΩ resistor as shown in Fig. 9.3.

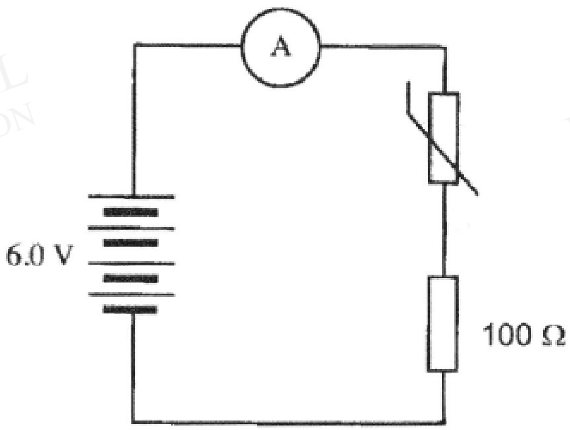

Fig. 9.3

The ammeter reading was measured across a range of temperatures and the results were plotted in a graph shown in Fig. 9.4.

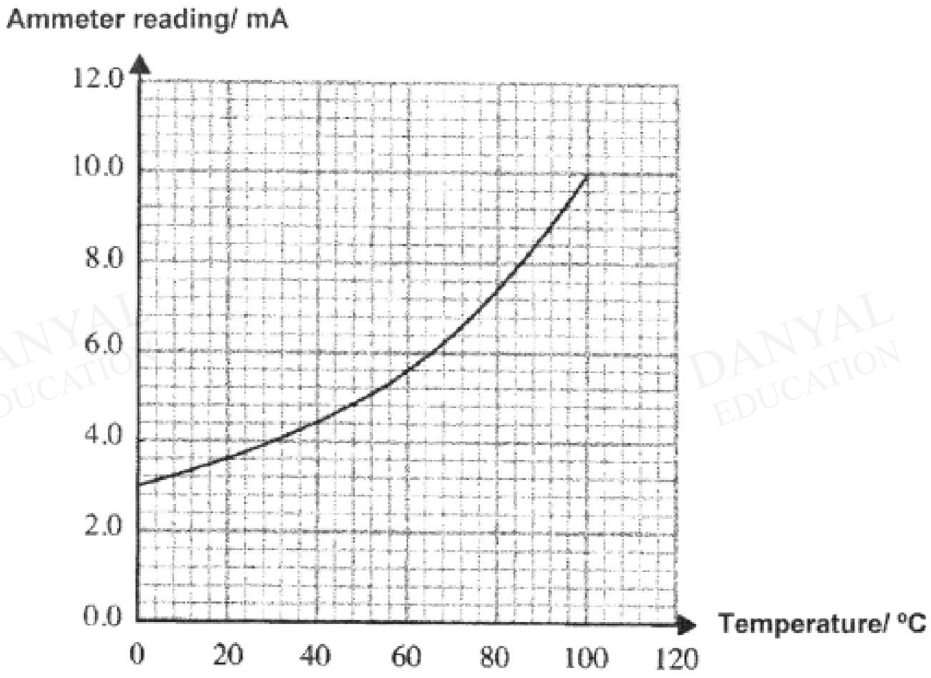

Fig. 9.4

(i) Describe how the ammeter's reading changes with temperature.

.... [1]

(ii) Calculate the thermistor's resistance at 100 °C.

resistance = ... [2]

Q2

Fig. 6.1 shows a circuit connected to a 3.0 V battery and three identical fixed resistors (2.0 Ω each). Under bright light, component X's resistance becomes 8.0 Ω.

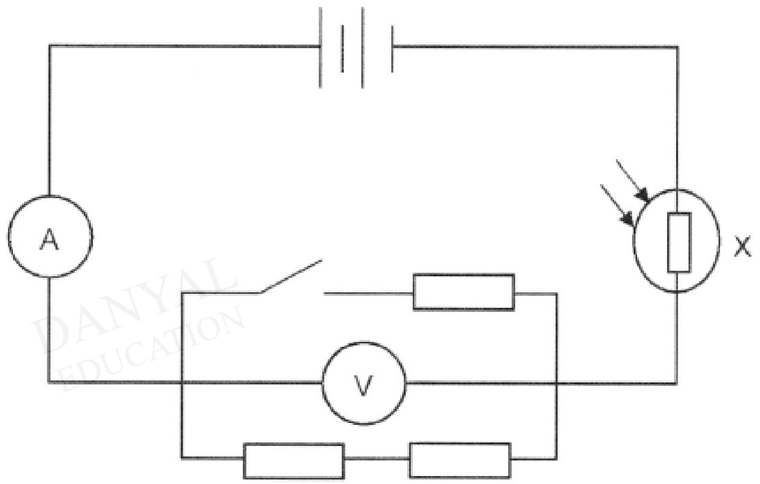

Fig. 6.1

(a) Name component X.

____ [1]

(b) Calculate the ammeter and voltmeter readings if the switch is opened in bright light condition.

ammeter reading = ________________ [1]

voltmeter reading = ________________ [2]

(c) Calculate the effective resistance of the whole circuit in bright light condition when the switch is closed.

effective resistance = ________________ [2]

(d) The light falling on the LDR is dimmed, while the switch remains open. State with reasons how the ammeter and voltmeter readings will vary compared to your answer in (b).

____

____

____

____

____ [4]

Q3

Fig. 9.1 shows a circuit with an e.m.f supply of 15.0 V. All the resistors in the circuit are identical with resistance of 10.0 Ω each.

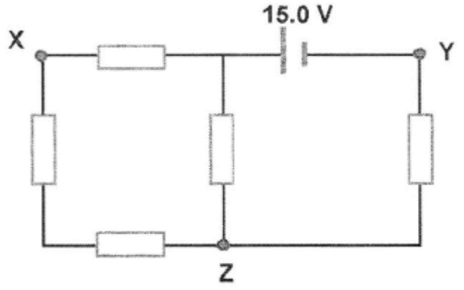

Fig. 9.1

(a) **(i)** Calculate the effective resistance of the whole circuit shown in Fig. 9.1. **[2]**

(ii) Calculate the current supplied by the battery. **[2]**

(iii) Determine the potential difference between point **X** and **Y.** **[2]**

(b) Determine the effective resistance of the whole circuit if a wire is used to connect point **X** and **Z**. **[1]**

Q4

The circuit of **Fig. 6.1** includes an ammeter, a 6.0 Ω resistor, a length of metal resistance wire and three 1.5 V cells connected in parallel.

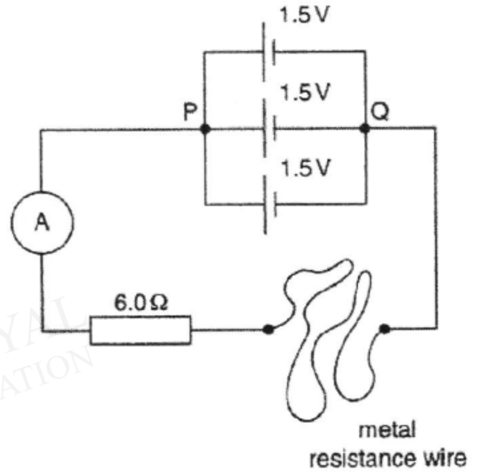

Fig. 6.1

(a) State

(i) one advantage of using cells in parallel rather than using a single cell.

....

....[1]

(ii) the potential difference (p.d.) between points P and Q in the circuit of **Fig. 6.1.**

p.d. = ... [1]

(b) **(i)** The ammeter in **Fig. 6.1** reads 0.075 A.

Calculate the resistance of the resistance wire.

resistance = ... [2]

(ii) The temperature of the metal resistance wire increases.
State and explain the effect of this temperature increase on the ammeter reading.

....

....

....[2]

Q5

A potential divider is made from a light-dependent resistor(LDR) and a 6.0 kΩ fixed resistor. The potential divider is connected in series with a 12 V d.c. power supply and a voltmeter is connected across the 6.0 kΩ resistor. **Fig. 7.1** is the circuit diagram.

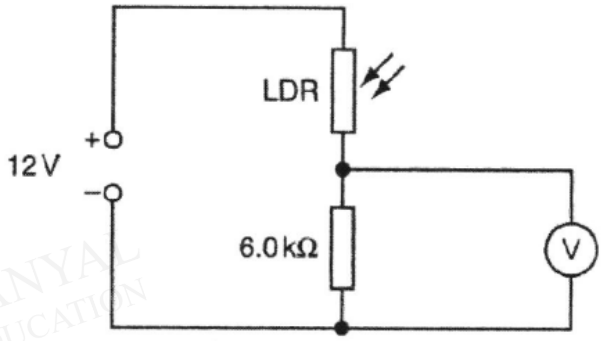

Fig. 7.1

A light shines on the LDR. The resistance of the LDR is 2.0 kΩ.

(a) Calculate

(i) the current in the LDR,

current = ... [2]

(ii) the reading of the voltmeter.

reading = ... [1]

(b) The brightness of the light on the LDR is gradually increased.

State and explain what happens to the reading on the voltmeter.

....

....

....[2]

(c) Suggest a use for a potential divider made from an LDR and a fixed resistor.

....

....[1]

Answers

Current and DC Circuits Test 1.0

Q1

a	With the fixed resistor, the total resistance of the circuit will be higher. [B1] Hence, a smaller range of current/ smaller maximum current will be present in the circuit. [B1]
bi	1.1 kΩ [A1]
bii	V = (5/(5+1.1)) x 9.0 [B1] V = 7.4 V [B1]
biii	Temperature of water bath increases, the temperature of the thermistor increases and its resistance decreases. [B1] Current passing through the light bulb (or potential difference across the light bulb) increases. [B1]
ci	The increase in current per unit temperature is increasing. [A1]
cii	Current at 100 °C = 10 mA p.d across the resistor = (10×10^{-3}) (100) = 1.0 V [B1] p.d across thermistor = 6 – 1 = 5.0 V resistance = V/I = 5/(10×10^{-3}) = 500 Ω [B1]

Q2

6(a)	Light Dependent Resistor	[1]
(b)	I = V/R = 3.0 / 12 = 0.25 A [2 sig fig]	[1]
	V = RI = 4.0 x 0.25 = 1.0 V [2 sig fig]	[1]
	[1] for working	[1]
		[1]
(c)	Effective resistance = 8.0 + $(1/2 + 1/4)^{-1}$ = 9.3 Ω [2 sig fig]	[1]
(d)	The resistance of the LDR increases drastically, thus causing the overall resistance to be largely increased.	[1]
	Hence the current flowing will be greatly reduced and the ammeter reading will be less than that in (a).	[1]
	The potential difference across the LDR will also greatly increase, thus the potential difference across the fixed resistors will be reduced,	[1]
	thus the voltmeter reading will be less than that in (a).	[1]

Q3

(a) (i)	Effective resistance = $(1/30 + 1/10)^{-1} + 10$ = 17.5 Ω	M1 A1
(ii)	V = R I 15.0 = 17.5 x I I = 0.85714 = 0.857 A	M1 A1
(iii)	Potential method Potential at Z = $\frac{10.0}{17.5} \times 15.0 = 8.5714\,V$ Potential across XY= $\frac{2}{3} \times (15.0 - 8.5714) + 8.5714 = 12.857$ = 12.9 V (note that potential at Y = 0 V) Current divider method $I_{30\Omega}$ = $\frac{10.0}{40.0} \times 0.85714 = 0.21429 = 0.214\text{ A}$ V = R I P.D across first 10 Ω resistor, between the cell and X = 10.0 X 0.21429 = 2.1429V Potential at X is 15.0 - 2.1429 = 12.857 V = 12.9 V. As potential at Y is 0 V, hence potential difference between X and Y = 12.9 - 0.0 = 12.9 V	M1 A1
(b)	Effective resistance = $(1/10 + 1/10)^{-1} + 10$ = 15.0 Ω	A1

Q4

(a)(i) MC	last longer **or** one cell can be replaced without switching off the circuit. **or** if one cell fails the rest will still work Majority of the students were able to answer this question with a few exception.	[1]
(a)(ii) MC	1.5 V Generally well-done	[1]
(b)(i) MC	Total Resistance = V/I or 1.5/0.075 =20 Ω (R) = 20 - 6 = 14 Ω Quite a number of students forgot to subtract away the 6 Ω fixed resistance.	[1] [1]
b)(ii) MC	decrease resistance of wire increase Only half the students were correct. A number of students were unsure if the resistance increase or decrease when the temperature increases.	[1] [1]

Q5

'(a)(i)	(I) = V/R = 12 / 6000 + 2000 = 12/8000 =0.0015 A or 1.5 mA	[1] [1]
MC	Quite a number of students forgot to change the resistance of the LDR of 2 kΩ to 2000 Ω and not 2Ω in their calculation and so obtained the wrong answer.	
(a)(ii)	(v) = 6000/(6000+2000) x 12 = 9 V	[1]
MC	Generally well-done as ecf is also awarded for this.	
7(b)	reading increases resistance of LDR falls	[1] [1]
MC	Generally well-done except for those who thought that the reading decreases when resistance of LDR increases.	
7(c)	light meter/sensor **or** automatic light switch **or** something sensible	[1]
MC	Only slightly more than half the students where able to give an acceptable answer.	