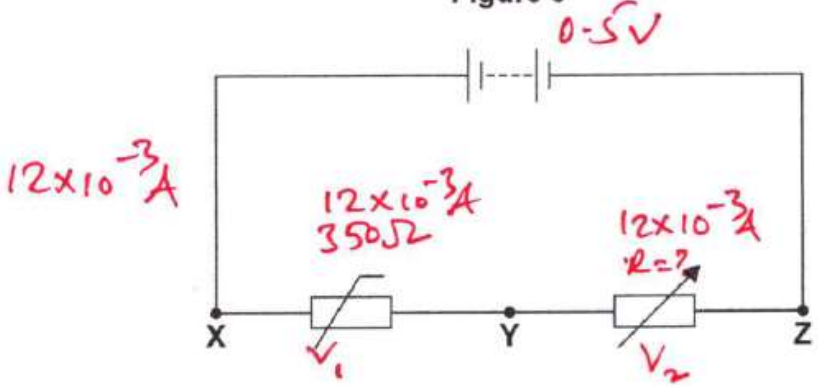
Electricity – A2 Physics P1

1. June/2024/Paper_7408/1/No.6

0 6 The circuit in **Figure 5** is used as part of a temperature sensor.
The battery has an emf of 6.5 V and negligible internal resistance.

Figure 5



The initial temperature of the thermistor is 22 °C.
At this temperature the resistance of the thermistor is 350 Ω and the circuit current is 12 mA.

0 6 . 1 Calculate the resistance of the variable resistor.

[2 marks]

So
$V_1 = IR = 12\times10^{-3} \times 350$
$= 4.2V$

And
$V_T = V_1 + V_2$ in terms
$6.5 = 4.2 + V_2$
$V_2 = 2.3V$

$R = \frac{V}{I} = \frac{2.3}{12\times10^{-3}}$
$= 191.7\Omega$

resistance = 192 Ω

0 6 . 2 The resistance R of the thermistor at temperature θ in K is given by:

$$R = R_0 e^{B\left(\frac{1}{\theta} - \frac{1}{\theta_0}\right)}$$

$R_0 = 350\Omega$

$22^\circ C + 273 = 295\,K$

where R_0 is the resistance at the initial temperature θ_0 in K, and B is a constant.

The temperature of the thermistor is increased to 318 K.
The variable resistor is adjusted so that the circuit current is again 12 mA.
The potential difference across the thermistor is now 3.2 V.

Determine B.
State an appropriate unit for your answer.

[5 marks]

Since $R = R_0 e^{B\left(\frac{1}{R} - \frac{1}{\theta_0}\right)}$

But $R_0 = 350\Omega$

$R = \frac{V}{I} = \frac{3.2}{12 \times 10^{-3}} = 266.7\Omega$

Then

$\frac{266.7}{350} = \frac{350}{350} \times e^{B\left(\frac{1}{318} - \frac{1}{295}\right)}$

$0.76 = e^{B(2.45 \times 10^{-4})}$

$\frac{\ln 0.76}{2.45 \times 10^{-4}} = \frac{B(-2.45 \times 10^{-4})}{2.45 \times 10^{-4}}$

$B = \frac{\ln 0.76}{-2.45 \times 10^{-4}}$

$B = 1102\,K$

$B =$ 1102 unit = K

0 6 . 3 Explain why the current in the thermistor needs to be controlled.

[2 marks]

Change in Current changes temperature So when temperature increases, resistance decreases and vice versa

0 6 . 4 Explain how ammeters and voltmeters can be used in the circuit in **Figure 5** to demonstrate the conservation of charge and the conservation of energy.

Refer to points **X**, **Y** and **Z** in your answer.

[2 marks]

Ammeters are in Series to show current at X = current at Y = current at Z

Voltmeters used to show that emf = p.d across XY + pd across YZ

2. June/2024/Paper_7408/1/No.27

A 12 Ω resistor is connected across the terminals of a battery of emf 2.0 V and internal resistance 4.0 Ω.

What is the pd across the resistor?

[1 mark]

A 0.25 V ○

B 0.75 V ○

C 1.30 V ○

D 1.50 V ⊗

$TR = 4 + 12 = 16\,\Omega$

$I = \frac{V}{R} = \frac{2}{16} = 0.125$

But

$V = IR$

$= 12 \times 0.125$

$= 1.5\,V$