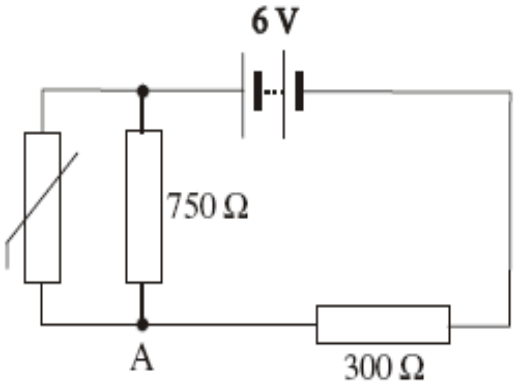
State Examination Commission – Physics Higher Level, 2005

Question 9

Define (i) potential difference, (ii) resistance. (12)
Two resistors, of resistance *R1* and *R2* respectively, are connected in parallel. Derive an expression for the effective resistance of the two resistors in terms of *R1* and *R2* . (12)

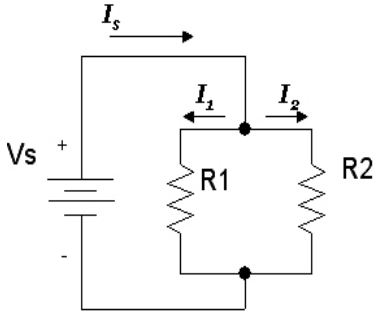


In the circuit diagram, the resistance of the thermistor at room temperature is 500 Ω. At room temperature, calculate
(i) the total resistance of the circuit;
(ii) the current flowing through the 750 Ω resistor. (18)
As the temperature of the room increases, explain why
(iii) the resistance of the thermistor decreases;
(iv) the potential at A increases. (14)

Define (i) potential difference, (ii) resistance. (6)

Standard definitions – Must know

Two resistors, of resistance R_1 and R_2 respectively, are connected in parallel. Derive an expression for the effective resistance of the two resistors in terms of R_1 and R_2 (12)



In a parallel circuit, $I = I_1 + I_2$
The pd accross each resistor in the circuit is the same, and is the same as the terminal pd of the battery, Vs.

Using Ohm's law, V = IR, and therefore, I = V/R.

Since $I = I_1 + I_2$,
$V/R = V/R_1 + V/R_2$

Dividing through by V, $1/R = 1/R_1 + 1/R_2$

In the circuit diagram, the resistance of the thermistor at room temperature is 500 Ω. At room temperature, calculate:
(i) the total resistance of the circuit. (9)

$1/R_p = 1/500 + 1/750$

$R_p = 300\ \Omega$

$R_T = 300 + 300 = 600\ \Omega$

(ii) the current flowing through the 750 Ω resistor. (9)

$I_T = (V / R)_T = 6 \div 600 = 0.01$ A

P.d. across 300 Ω resistor = (0.01)(300) = 3 V

Therefore, pd accross 750 Ω = 6 – 3 = 3 V

So, Current through 750Ω Resistor = V/R = 3 ÷ 750 = 4×10^{-3} A = 4 mA

As the temperature of the room increases, explain why (iii) the resistance of the thermistor decreases (7)

As the room temperature rises, more electrons are released into the conduction band and become available to carry charge (to conduct), i.e., the resistance drops.

(iv) the potential at A increases. (7)

Because the resistance of the thermistor drops, the resistance of the two resistors in parallel combination also drops which means the p.d. dropped accross this combination is smaller and the potential at A increases.