Answer on Question #45851 – Physics – Other

A platinum resistance thermometer has resistance of 52.5 ohms and 9.75 ohms at 0 degrees celsius and 100 degrees celsius respectively.when the resistance is 8.25 ohms, find the temperature

Solution:

$R_0 = 52.5\Omega -$ initial resistance;
$T_0 = 0°C -$ initial temperature;
$R_1 = 9.75\Omega -$ resistance at temperature $T_1 = 100°C$
$R_2 = 8.25\Omega -$ resistance at temperature T_2
$\alpha -$ temperature coefficient of resistance;

An intuitive approach to temperature dependence leads one to expect a fractional change in resistance which is proportional to the temperature change:

$$R_1 = R_0(1 + \alpha(T_1 - T_0))$$
$$R_1 = R_0 + R_0\alpha(T_1 - T_0)$$
$$\alpha = \frac{R_1 - R_0}{R_0(T_1 - T_0)} \quad (1)$$

Formula for the resistance at temperature T_2.

$$R_2 = R_0\big(1 + \alpha(T_2 - T_0)\big)$$
$$R_2 = R_0 + R_0\alpha T_2 - R_0\alpha T_0$$
$$T_2 = \frac{R_2 - R_0 + R_0\alpha T_0}{R_0\alpha} \quad (2)$$

$(1)\text{in}(2)$:

$$T_2 = \frac{R_2 - R_0 + R_0T_0 \cdot \frac{R_1 - R_0}{R_0(T_1 - T_0)}}{R_0 \cdot \frac{R_1 - R_0}{R_0(T_1 - T_0)}} = \frac{R_0(T_1 - T_0)(R_2 - R_0) + R_0T_0(R_1 - R_0)}{R_0(R_1 - R_0)} =$$
$$= \frac{52.5\Omega(100°C - 0°C)(8.25\Omega - 52.5\Omega) + 52.5\Omega \cdot 0°C \cdot (9.75\Omega - 52.5\Omega)}{52.5\Omega(9.75\Omega - 52.5\Omega)}$$
$$= 103.5\ °C$$

Answer: $103.5\ °C$