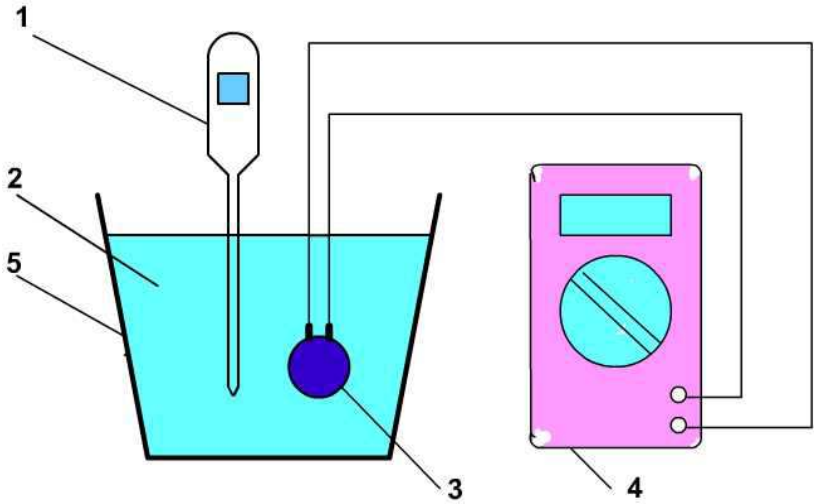
# *Solutions of the experimental task*

1. **[*1 point*]** Let's examine the relationship between resistance of the thermoresistor and temperature based on the following setup




Here: 1 – digital thermometer; 2 – distilled water; 3 – thermoresistor; 4 – digital multimeter; 5 – glass.

2. **[*3 points*]** The relationship between resistance R of the thermoresistor and temperature $t^{o}$C

Table №1

| N | t, $^{o}$C | R, Ohm |
|---|---|---|
| 1 | 80,0 ± 0,1 | 15,6 ± 0,1 |
| 2 | 75,0 ± 0,1 | 17,4 ± 0,1 |
| 3 | 70,0 ± 0,1 | 19,5 ± 0,1 |
| 4 | 65,0 ± 0,1 | 22,0 ± 0,1 |
| 5 | 60,0 ± 0,1 | 25,3 ± 0,1 |
| 6 | 55,0 ± 0,1 | 29,2 ± 0,1 |
| 7 | 50,0 ± 0,1 | 34,3 ± 0,1 |
| 8 | 45,0 ± 0,1 | 40,6 ± 0,1 |
| 9 | 40,0 ± 0,1 | 48,5 ± 0,1 |
| 10 | 35,0 ± 0,1 | 57,3 ± 0,1 |
| 11 | 30,0 ± 0,1 | 71,2 ± 0,1 |

3. **[3 *points*]** The expression

$$\sigma = \sigma_0 \exp\left\{-\frac{\Delta W}{2kT}\right\}$$

can be linearized, if we take the logarithm of both sides:

$$\ln\sigma = \ln\sigma_0 - \frac{\Delta W}{2kT}$$

Therefore

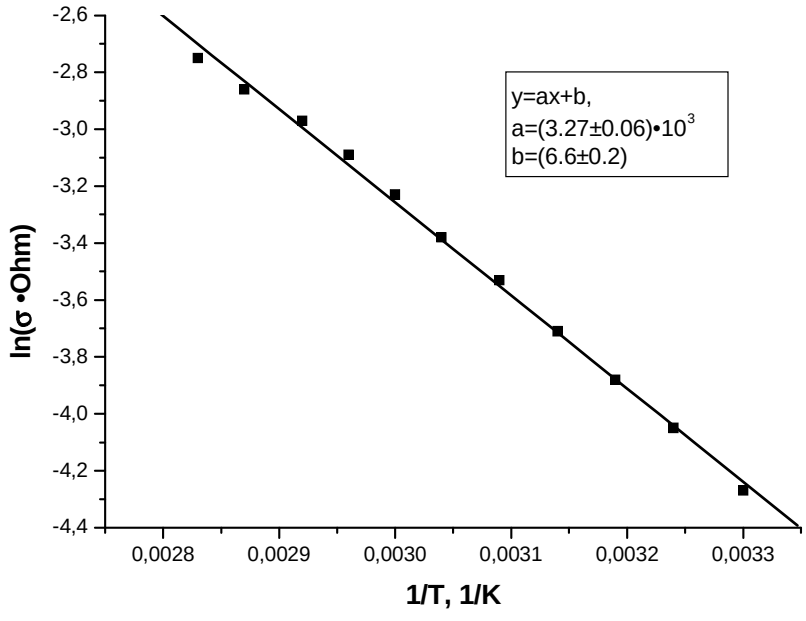
$$\ln\sigma = -\frac{\Delta W}{2k}\frac{1}{T} + \ln\sigma_0$$

4. **[*2 points*]** The values that we need are as follows:

Table №2

| N | t,°C | 1/T, $K^{-1}$ | R, Ohm | σ = 1/R, $Ohm^{-1}$ | ℓn (σ Ohm) |
|---|---|---|---|---|---|
| 1 | 80,0 | 0,00283 | 15,6 | 0,0641 | – 2,75 |
| 2 | 75,0 | 0,00287 | 17,4 | 0,0575 | – 2,86 |
| 3 | 70,0 | 0,00292 | 19,5 | 0,0513 | – 2,97 |
| 4 | 65,0 | 0,00296 | 22,0 | 0,0455 | – 3,09 |
| 5 | 60,0 | 0,00300 | 25,3 | 0,0395 | – 3,23 |
| 6 | 55,0 | 0,00304 | 29,2 | 0,0342 | – 3,38 |
| 7 | 50,0 | 0,00309 | 34,3 | 0,0292 | – 3,53 |
| 8 | 45,0 | 0,00314 | 40,6 | 0,0246 | – 3,71 |
| 9 | 40,0 | 0,00319 | 48,5 | 0,0206 | – 3,88 |
| 10 | 35,0 | 0,00324 | 57,3 | 0,0175 | – 4,05 |
| 11 | 30,0 | 0,00330 | 71,2 | 0,0140 | – 4,27 |

5. **[3 *points*]** Below is the graph of ℓn σ versus 1/T, using ordinary least squares:




6. **[3 *points*]** According to the result in 5)

a) The slope of the linear relationship is $3{,}27\cdot10^3$K. Then

$$\frac{\Delta W}{2k} = 3{,}27\cdot10^3\text{K}$$

Then the width of the forbidden zone is

$$\Delta W = 3{,}27\cdot10^{3}\cdot2\cdot k = 3{,}27\cdot10^{3}\cdot2\cdot1{,}38\cdot10^{-23}\text{J} = 0{,}90\cdot10^{-19}\text{ J} = 0{,}56\text{ eV}$$

The uncertainty is

$$(\Delta W) = 0{,}06\cdot10^{3}\cdot2\cdot k = 0{,}06\cdot10^{3}\cdot2\cdot1{,}38\cdot10^{-23} = 0{,}02\cdot10^{-19}\text{ J} = 0{,}01\text{ eV}$$

b) свободный член уравнении равняется 6,6. Тогда

$$\ln(\sigma_0 Ом) = 6{,}6$$

и значение $\sigma_0$ равняется

$$\sigma_0 = 1{,}87\text{ Ом}^{-1}$$

Соответственно погрешность

$$\Delta\sigma_0 = 0{,}37\text{ Ом}^{-1}$$

Finally

$$\Delta W = (0{,}56\pm0{,}01)\text{ eV}$$

$$\sigma_0 = (1{,}87\pm0{,}37)\text{ Ом}^{-1}$$