If you combine 280.0 mL of water at 25.00 °C and 130.0 mL of water at 95.00 °C, what is the final temperature of the mixture? Use 1.00 g/mL as the density of water.

Solution.

$$-\mathrm{Q}_{\mathrm{lost}} = \mathrm{Q}_{\mathrm{absorbed}}, \text{‘}(1)$$

Q_{lost} - heat lost by the hot water;

$\mathrm{Q}_{\mathrm{absorbed}}$- heat absorbed by the room-temperature water sample.

$$\mathrm{Q} = \mathrm{m} \cdot \mathrm{c}_{sp} \cdot \Delta\mathrm{T}, (2)$$

Q – the amount of heat;

m – the mass of the sample;

c_{sp} – the specific heat of the substance;

$\Delta\mathrm{T}$ – the difference between the final temperature and the initial temperature.

$$\mathrm{m} = \rho \cdot V,$$

m – the mass of the sample;

m – the density of water;

V – the volume of the sample.

$$\mathrm{m}_{\mathrm{sample1}} = 1.00\frac{\mathrm{g}}{\mathrm{mL}} \cdot 280.0\ \mathrm{mL} = 280.00\ \mathrm{g}.$$

$$\mathrm{m}_{\mathrm{sample2}} = 1.00\frac{\mathrm{g}}{\mathrm{mL}} \cdot 130.0\ \mathrm{mL} = 130.00\ \mathrm{g}.$$

$$\Delta\mathrm{T}_{\mathrm{sample1}} = \mathrm{T}_{\mathrm{final}} - 25.00\ °\mathrm{C}$$

$$\Delta\mathrm{T}_{\mathrm{sample2}} = \mathrm{T}_{\mathrm{final}} - 95.00\ °\mathrm{C}$$

Use equations (1) and (2) top write:

$$-\mathrm{m}_{\mathrm{sample1}} \cdot \mathrm{c}_{sp} \cdot \Delta\mathrm{T}_{\mathrm{sample1}} = \mathrm{m}_{\mathrm{sample2}} \cdot \mathrm{c}_{sp} \cdot \Delta\mathrm{T}_{\mathrm{sample2}}$$

$$-\mathrm{m}_{\mathrm{sample1}} \cdot \Delta\mathrm{T}_{\mathrm{sample1}} = \mathrm{m}_{\mathrm{sample2}} \cdot \Delta\mathrm{T}_{\mathrm{sample2}}$$

$$-280.00\ \mathrm{g} \cdot (\mathrm{T}_{\mathrm{final}} - 25.00\ °\mathrm{C}) = 130.00\ \mathrm{g} \cdot (\mathrm{T}_{\mathrm{final}} - 95.00\ °\mathrm{C})$$

$$-280.00 \cdot \mathrm{T}_{\mathrm{final}} + 7000 = 130.00 \cdot \mathrm{T}_{\mathrm{final}} - 12350$$

$$410.00 \cdot \mathrm{T}_{\mathrm{final}} = 19350$$

$$\mathrm{T}_{\mathrm{final}} = 47{,}20\ °\mathrm{C}$$

Answer.

The final temperature of the mixture

$$\mathrm{T}_{\mathrm{final}} = 47{,}20\ °\mathrm{C}$$