Problem 1

Consider two liquids A and B insoluble in each other. The pressures p_i (i = A or B) of their saturated vapors obey, to a good approximation, the formula:

$$\ln(p_i / p_o) = \frac{\alpha_i}{T} + \beta_i; \quad i = \text{A or B},$$

where p_o denotes the normal atmospheric pressure, T – the absolute temperature of the vapor, and α_i and β_i (i = A or B) – certain constants depending on the liquid. (The symbol ln denotes the natural logarithm, i.e. logarithm with base e = 2.7182818…)

The values of the ratio p_i/p_0 for the liquids A and B at the temperature 40°C and 90°C are given in Tab. 1.1.

Table 1.1

t [°C]	p_i/p_0	
	i = A	i = B
40	0.284	0.07278
90	1.476	0.6918

The errors of these values are negligible.

A. Determine the boiling temperatures of the liquids A and B under the pressure p_0.

B. The liquids A and B were poured into a vessel in which the layers shown in Fig. 1.1 were formed. The surface of the liquid B has been covered with a thin layer of a non-volatile liquid C, which is insoluble in the liquids A and B and vice versa, thereby preventing any free evaporation from the upper surface of the liquid B, The ratio of molecular masses of the liquids A and B (in the gaseous phase) is:

$$\gamma = \mu_A / \mu_B = 8.$$

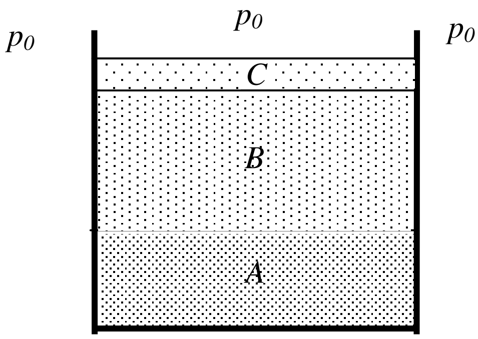

Fig. 1.1

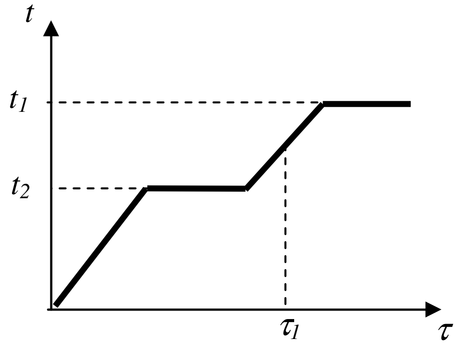

Fig. 1.2

The masses of the liquids A and B were initially the same, each equal to m = 100g. The heights of the layers of the liquids in the vessel and the densities of the liquids are small enough to make the assumption that the pressure in any point in the vessel is practically equal to the normal atmospheric pressure p_0.

The system of liquids in the vessel is slowly, but continuously and uniformly, heated. It was established that the temperature t of the liquids changed with time τ as shown schematically in the Fig. 1.2.

Determine the temperatures t_1 and t_2 corresponding to the horizontal parts of the diagram and the masses of the liquids A and B at the time τ_1. The temperatures should be rounded to the nearest degree (in °C) and the masses of the liquids should be determined to one-tenth of gram.

REMARK: Assume that the vapors of the liquids, to a good approximation,

(1) obey the Dalton law stating that the pressure of a mixture of gases is equal to the sum of the partial pressures of the gases forming the mixture and

(2) can be treated as perfect gases up to the pressures corresponding to the saturated vapors.