Subject:
Two different gaseous substances are in two containers. When connecting the containers the gases intermingle. In this process the total entropy of the compound system increases. This increase is called entropy of mixing.

Deficiencies:
The choice of the name “entropy of mixing” is inappropriate and superfluous. The term suggests that the mixture of the gases has more entropy than the gases taken separately. Such a claim would presuppose that two systems are compared with one another: the mixed gases with the unmixed gases. Such a comparison could be done in three different ways according to how one imagines the mixing to be realized.

1. We start with two gases A and B in two containers, Fig. 1a. The container with volume $V_A$ contains the amount of substance (measured in mol) $n_A$, the container with volume $V_B$ contains the amount $n_B$. We connect the containers in such a way that we get a container with the volume $V = V_A + V_B$, Fig. 1b. The gases intermingle and the entropy increases by:

$$
\Delta S = n_A \cdot R \cdot \ln \frac{V}{V_A} + n_B \cdot R \cdot \ln \frac{V}{V_B}
$$

This expression represents what is usually called the entropy of mixing. However, this increase of the entropy has nothing to do with the process of mixing of the gases. It is nothing else than an isothermal expansion of each of the two gases from its initial volume $V_A$ and $V_B$, respectively, to the same final volume $V$. The entropy increase for such an expansion is

$$
\Delta S_A = n_A \cdot R \cdot \ln \frac{V}{V_A}
$$

for gas A and

$$
\Delta S_B = n_B \cdot R \cdot \ln \frac{V}{V_B}
$$

for gas B. Thus, the total entropy increase due to this expansion is equal to $\Delta S$ in equation (1).

Abb. 1. Gas A expands from volume $V_A$ to $V$, gas B from $V_B$ to $V$. 
2. We try another interpretation of the term “mixing”. We start with two containers of the same volume $V$, Fig. 2a, containing the two gases A and B, respectively. We compare with the situation of Fig. 2b, where both gases occupy a container of volume $V$. Here the total entropy before the “mixing” is equal to the entropy after it. Nothing is left to be called entropy of mixing.

3. Finally a third tentative, Fig. 3: We compare the entropy of gases A and B (amounts of substance $n_A$ and $n_B$ as before) both within the same container of volume $V$, with the entropy of a single gas C whose amount of substance is $n_C = n_A + n_B$. We ask for the difference of the entropies. What is the effect of taking away a characteristic that distinguishes between the gases A and B? Such a difference might also be considered a candidate for the name “entropy of mixing”. In this case, however, the entropy difference depends on the chemical nature of the gases and thus cannot be equal to the value given by equation (1).

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**Origin:**
Probably, when coining the term, one had in mind the idea that entropy can be considered a measure of the disorder of a physical system. The interpretation is correct, but its handling is not always easy.

**Disposal:**
Who knows that at constant temperature entropy increases with volume (and at constant volume with temperature) no longer needs the term.

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