Рабочий лист № 2

Subject: **<u>“The Second law of thermodynamics”</u>**

Theoretical part

Vocabulary

➢ Найдите соответствие, запишите слова в словарную тетрадь.

to expend	идеальный газ	energy conversion	выделять, высвобождать
vessel	движение	to sustain	разлагать
to occupy	обратимый	investigation	взрывной, взрывчатка
suddenly	энтропия	to ingest	быть разделенным на
to combine	изолированная система	a perfect gas	объединять
explosive	достигать	for instance	происходить, случаться
to liberate	поглощать	isolated system	внезапно
to decompose	свойство	reversible	измеримый
to be divided into	исследование, изучение	motion	занимать
A spontaneous/ non-spontaneous change	подвергаться чему-либо	entropy	самопроизвольный/ несамопроизвольный процесс
to occur	поддерживать	to achieve	сосуд
measurable	например	a property	нормальные условия
normal conditions	преобразование энергии	to undergo	расширять, расширяться

➢ Составьте 3 предложения, употребляя словарные слова.

Examples: *<u>The entropy (it can be proved) is a state function, a property with a value that depends only on the present state of the system.</u>*

<u>The isothermal expansion of a perfect gas into a vacuum is spontaneous.</u>

<u>The measure of the disorderly dispersal of energy or matter used in thermodynamics is called the entropy, S.</u>

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Main laws, equations and definitions

➢ Прочитайте и запишите русские аналоги (воспользуйтесь конспектами лекций, учебником, интернетом).

The Second Law of thermodynamics: The entropy of an isolated system tends to increase.

(a) The entropy change accompanying heating

(b) The entropy change accompanying a phase transition

The Third Law of thermodynamics:

The entropies of all perfectly crystalline substances are the same at $T = 0$.

Practical part

A brief illustration

An organism inhabits a pond. In the course of its life, the organism transfers 100 kJ of heat to the pond water at 0°C (273 K). The resulting change in entropy of the water due to this transfer is

$$\Delta S = \frac{q_{\text{rev}}}{T} = \frac{100 \times 10^3 \text{ J}}{273 \text{ K}} = +366 \text{ J K}^{-1}$$

The pond is large enough to ensure that the temperature of the water does not change as heat is transferred. The same transfer at 100°C (373 K) results in

$$\Delta S = \frac{100 \times 10^3 \text{ J}}{373 \text{ K}} = +268 \text{ J K}^{-1}$$

The increase in entropy is greater at the lower temperature. Notice that the units of entropy are joules per kelvin (J K^{-1}). Entropy is an extensive property. When we deal with molar entropy, an intensive property, the units will be joules per kelvin per mole ($\text{J K}^{-1} \text{ mol}^{-1}$).

A brief illustration

The molar heat capacity of chloroform between 20°C and 37°C was found to fit the following expression:

$$C_{p,\text{m}}(T) = 91.74 \text{ J K}^{-1} \text{ mol}^{-1} + 0.075T \text{ J K}^{-2} \text{ mol}^{-1}$$

The change in entropy over this range is therefore

$$\begin{aligned}\Delta S_\text{m} &= S_\text{m}(310 \text{ K}) - S_\text{m}(293 \text{ K}) \\ &= \int_{293 \text{ K}}^{310 \text{ K}} \left(\frac{(91.74 \text{ J K}^{-1} \text{ mol}^{-1}}{T} + 0.075 \text{ J K}^{-2} \text{ mol}^{-1} \right) \mathrm{d}T \\ &= (91.74 \text{ J K}^{-1} \text{ mol}^{-1}) \ln \frac{310 \text{ K}}{293 \text{ K}} + (0.075 \text{ J K}^{-2} \text{ mol}^{-1})(310 \text{ K} - 293 \text{ K}) \\ &= +6.45 \text{ J K}^{-1} \text{ mol}^{-1}\end{aligned}$$

Home work

The standard reaction entropy (equation):____

Self-test 2.3 (a) Predict the sign of the entropy change associated with the complete oxidation of solid sucrose, $C_{12}H_{22}O_{11}(s)$, by O_2 gas to CO_2 gas and liquid H_2O. (b) Calculate the standard reaction entropy at 25°C.

Answer: (a) Positive; (b) $+512 \text{ J K}^{-1} \text{ mol}^{-1}$