[英語]　（全 4 題）

[問題 1] 次の文章（Stryer の“Biochemistry”より）を読み，熱力学におけるエネルギーとエントロピーの意味を適切に説明していると考えられるセンテンスを，それぞれ 2 つ選んでそれらを和訳せよ．

Let us review some key thermodynamic relations. In thermodynamics, a system is the matter within a defined region. The matter in the rest of the universe is called the surroundings. The first law of thermodynamics states that the total energy of a system and its surroundings is a constant. In other words, energy is conserved. The mathematical expression of the first law is

$$\Delta E = E_B - E_A = Q - W \quad (1)$$

in which E_A is the energy of a system at the start of a process and E_B at the end of the process, Q is the heat absorbed by the system, and W is the work done by the system. An important feature of equation (1) is that the change in energy of a system depends only on the initial and final states and not on the path of the transformation.

The first law of thermodynamics cannot be used to predict whether a reaction can occur spontaneously. Some reactions do occur spontaneously, although ΔE is positive (the energy of the system increases). In such cases, the system absorbs heat from its surroundings. It is evident that a function different from ΔE is required. One such function is the entropy (S), which is a measure of the degree of randomness or disorder of a system. The entropy of a system increases (ΔS is positive) when it becomes more disordered. The second law of thermodynamics states that a process can occur spontaneously only if the sum of the entropies of the system and its surroundings increases.

$$(\Delta S_{system} + \Delta S_{surroundings}) > 0 \text{ for a spontaneous process} \qquad (2)$$

Note that the entropy of a system can decrease during a spontaneous process, provided that the entropy of the surroundings increases so that their sum is positive. For example, the formation of a highly ordered biological structure is thermodynamically feasible because of the increase in the entropy of its surroundings.

One difficulty in using entropy as a criterion of whether a biochemical process can occur spontaneously is that the entropy changes of chemical reactions are not readily measured. Furthermore, the criterion of spontaneity given in equation (2) requires that both the entropy change of the surroundings and that of the system of interest be known. These difficulties are obviated by using a different thermodynamic function called the free energy, which is denoted by the symbol G. In 1878, J. W. Gibbs created the free-energy function by combining the first and second laws of thermodynamics.

[問題 2]　次の和文を英訳せよ.

一般に，固体から液体への一次相転移温度は，圧力とともに増加する．しかし，水は例外であり，その融解温度は圧力増加によって低くなる．この特筆すべき現象は，液体の水が固体の氷へ相転移する際に体積が増加することに関係している．分子レベルでは，水素結合構造の乱れによって，水分子が液体相においてより密に充填されることに対応する.

[問題 3]　以下の文章は STM と呼ばれる測定方法について述べたものである（J. McMurry & R. C. Fay の“Chemistry”より抜粋）．この文章を読んで，STM とは何をどのようにして測定する方法であるかを，内容にそって簡潔に日本語で述べよ.

We can now actually “see” individual atoms with a remarkable device called *scanning tunneling microscope*, or *STM*. Invented in 1981 by a research team at the IBM Corporation, this special microscope has achieved magnifications of up to 10 million, allowing chemists to look directly at individual atoms. STM works by moving an extremely fine probe along the surface of a sample, applying a small voltage, and measuring a tunneling current between atoms in the sample and the atom at the tip of the probe. Passing the probe across the sample while moving it up and down over individual atoms to keep current flow constant gives a two-dimensional map of the probe's path. By then moving the probe back and forth in a series of closely spaced parallel tracks and storing the data in a computer, a three-dimensional image of the surface can be constructed.

[問題 4]　以下の文章は，英国が発行する“Faraday Discussions, The Chemistry and Physics of Small Metallic Particles”に掲載された，A 博士の研究発表に対する B, C，D，E 博士の質疑の一部である．下線部(a)～(d)の和文を英訳せよ．

Dr. B opened the discussion on the paper by Dr. A:　Your technique is very promising for the preparation of bimetallic clusters at low temperatures. Have you tried to stabilize the colloids by using appropriate ligands?

Dr. A replied:　(a) 我々はコロイドを安定化させることをまだ試みていません.

Dr. C asked:　With such a small particle size how can you consider the reduced metallic product to be an alloy?

Dr. A replied:　(b) 合金という言葉は非常に小さな粒子の場合は正確ではないかもしれません.　Perhaps we should simply call them intermetallic compounds.

Dr. D commented:　We have found that uniform bimetallic colloidal clusters can be obtained from mixtures of metal salts, when (i) the two metals are miscible in the concentration range used and when (ii) one metal salt is easily reduced to the metal and can then function as a catalyst for the reduction of the second.

Dr. E said: (c)私の限られた経験では，金属混合物コロイドを作る試みは，金属塩の還元電位の違いのために，しばしば失敗しました.　Is your apparent success due to the use of a “battering ram” reagent which reduces everything rapidly?

Dr. A replied: Yes. (d) 現在の方法の潜在的な有利さの一つは，還元が非常に速いので，逐次的な還元は問題にならないと見なせることです.