平成 21 年度　理学系研究科博士前期課程　入学試験問題

（分子科学専攻・秋募集）

英語

試験時間　　：　　10:30 ～ 12:00

配点　　：　　150 点

【注意】

(1) 問題冊子（１部)、解答用紙（３枚）を配布する。
各解答用紙には、解答すべき問題番号があらかじめ記されている。
手元に上記のすべてが所定枚数配布されていることを確認すること。
過不足がある場合には速やかに申し出ること。

(2) すべての解答用紙に受験番号と氏名とを必ず記入すること。

(3) 解答は、問題番号ごとにそれぞれ指定された解答用紙に記入すること。
解答用紙は裏面を使用してもよい。

1. 次の文章を読んで、以下の問いに答えよ。

(1)If a molecule, which we represent by the general symbol A, has a tendency to decompose spontaneously into smaller molecules at a rate that is not influenced by the presence of other molecules, we expect that the number of molecules that decompose by such a unimolecular process in unit time will be proportional to the number present.

$$A \longrightarrow B + C$$

(2)If the volume of the system remains constant, the concentration of A will decrease at a rate proportional to this concentration. The symbol [A] represents the concentration of A (in moles per liter). The rate of decrease in concentration with time is $-d[A]/dt$. For a unimolecular decomposition we accordingly may write the equation

$$-\frac{d[A]}{dt} = k[A] \qquad (1)$$

as the differential equation determining the rate of the reaction. The factor k is called the first-order rate constant. A reaction of this kind is called a first-order reaction; the order of a reaction is the sum of the powers of the concentration factors in the rate expression (on the right side of the rate equation).

For example, the rate constant k may have the value 0.001, with the time t measured in seconds. The equation would then state that during each second 1/1000 of the molecules present would decompose. Suppose that at the time $t = 0$ there were 1,000,000,000 molecules per milliliter in the reaction vessel. During the first second 0.1% of these molecules would decompose, and there would remain at $t = 1$ second only (a) molecules undecomposed. During the next second (b) molecules would decompose, and there would remain (c) molecules. After some time (about 693 seconds) half of the molecules would have decomposed, and there would remain only 500,000,000 undecomposed molecules per milliliter. Of these about 500,000 would decompose during the next second, and so on. After another 693 seconds there would remain about (d) undecomposed molecules and after still another 693 seconds there would remain about (e), and so on. During each period of 693 seconds the concentration of reactant is reduced to one-half its value at the beginning of the period.

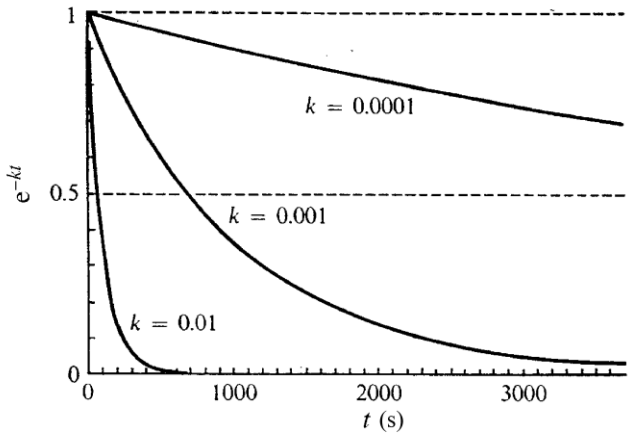

Figure 1. Curves showing decrease with time of the amount remaining of a substance decomposing by a first-order reaction, with indicated values of the reaction rate constant.

This relation between concentration of reactant and the time *t* is shown by the curves in Figure 1. The algebraic equation which expresses this relation is

$$A = [A]_0 e^{-kt} \tag{2}$$

(3)This is the equation that is obtained by integrating Equation (1); it is equivalent to Equation (1). Equation (2) is called the reaction-rate expression for a first-order reaction in the integrated form. It states that the concentration of the reactant at time *t* is equal to the concentration at time 0, $[A]_0$, multiplied by the exponential factor e^{-kt}. The nature of this function can be seen from Figure 1.

The first-order character of a reaction may be tested by observing the rate of disappearance of reactant (the amount disappearing in a short time) at various concentrations, and comparing with Equation (1), or by observing the concentration itself for a particular sample for a long time and comparing with Equation (2).

問１　下線部 (1) ～ (3) を日本語に訳せ。

問２　空欄 (　a　) ～ (　e　) にあてはまる整数を答えよ。

問３　分子 A の反応が 1 次反応であることを確かめるための方法が 2 通り述べられている。
それらを日本語に訳せ。

2. 次の英文を日本語に訳せ。

(1) The metathesis reaction allows the interchange of carbon atoms between a pair of double bonds, providing a route into alkenes and polymers that are difficult to prepare by other methods.

(2) Nuclei are known to be composed of nucleon (protons and neutrons) and to be surrounded by electrons. Because the nucleons are much more massive than the electrons, the nucleus contains most of the mass of the atom.

(3) During the last few decades, a surprising discovery has been made: the presence of almost 100 complicated molecules in the interstellar clouds.

【注】 *interstellar clouds*: Generic name given to an accumulation of gas, plasma and dust in our and other galaxies.

(4) The aldol reaction is a common method of forming new carbon-carbon bonds. In this laboratory procedure, acetone undergoes a double aldol condensation with benzaldehyde to form dibenzalacetone. The reaction is catalyzed by sodium hydroxide.

3. 次の和文をそれぞれ英訳せよ。

(1) 標的化合物を合成するためには、有用な反応を開発することと適切な合成戦略を立てることの両者が必要である。

(2) H_2 をルイス構造式で表現すると、2 個の電子が 2 個の原子核を結びつけることにより単結合を形成している。H_2 に適切な振動数（または波長）の光を当てると、電子が 1 個放出され、H_2^+ イオンが生成する。このイオンでは、2 個のプロトンがただ 1 個の電子を共有している。それゆえ、H_2^+ の結合次数は 1/2 である。