

平成17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・冬募集)

# 英語

試験時間 : 10:30 ~ 12:00

配点 : 150 点

## 【注意】

- (1) 問題冊子(1部)、問題1解答用紙(1枚)、問題2解答用紙(1枚)を配布する。  
手元に上記3種類が所定の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) 2枚の解答用紙の各々に受験番号と氏名とを必ず記入すること。
- (3) 問題1、問題2の解答をそれぞれ指定された解答用紙に記入すること。  
なお、解答用紙の表面だけで書ききれない場合には裏面を使用すること。

**1**

次の文章を読んで以下の問に答えよ。

The most important gas in the atmosphere is oxygen, which makes up around 21% volume of dry air. Without enough oxygen to breathe we die, and this might happen if we are in a confined space and the oxygen gets depleted, or if the air pressure is too low because we are very high up. (a) There the air may still contain 21% oxygen, but the pressure might be too low for our lungs to extract it. But even at the top of the highest mountain, where the air is thin, there is still enough oxygen. Early explores thought it would be otherwise, but they were later shown to be wrong. On 29 May 1953 Tenzing Norgay and Edmund Hillary became the first men to climb Mount Everest, which they did with the help of oxygen cylinders. Forty year later Harry Taylor climbed to the summit alone without extra oxygen. In 1975 the first woman to scale the peak, Junko Takei of Japan, took an oxygen cylinder. In May 1996 the late Alison Hargreaves became the first woman to achieve this feat without the aid of oxygen.

We need oxygen so our body can generate energy, and we draw upon the ready supply of this gas in the atmosphere. However, there is a lower and an upper limit to the amount of oxygen in the air if it is to be considered safe. If we are not to suffocate, the oxygen level must stay above 17%; if we are not to burst into flames it must stay below 25%.

Oxygen is attracted to the iron or hemoglobin in our blood, and thereby efficiently transported to where it is needed. (Most, but not all, species use iron as the oxygen carrier. Spiders and lobsters use copper, which is why their blood is blue.) Thanks to hemoglobin, a liter of blood can dissolve 200 ml of oxygen, fifty times as much as will dissolve in the same volume of water. (b) But if the amount of oxygen in the air decreases then so does the amount in blood, and even though our heart may be pumping as quickly as it can to make up for the deficiency, it cannot sustain this extra output of energy for long, and we die.

Molecules of oxygen gas consist of two oxygen atoms, but the bond between the atoms still puzzles chemists. It appears to be a double bond, and yet the molecule has two unpaired electrons which means that it is a so-called “free radical”. Oxygen gas will liquefy at  $-183$  Celsius and the liquid is magnetic, as Michael Faraday discovered in 1848 when he spilled some and watched it run towards the poles of a magnet; it behaves like this because of these two unpaired electrons. In theory these should make it react instantly with anything it touches, and yet we know that oxygen is a relatively unreactive molecule, otherwise it could not have built up over millions of years until it comprises a fifth of the Earth’s atmosphere. Even when it enters our body it does not immediately react chemically with its target molecules, but needs an enzyme catalyst to make it react.

- 問1 下線部 (a) を日本語に訳せ。  
問2 下線部 (b) を日本語に訳せ。  
問3 酸素分子の有する性質を要約せよ。

2

次の文章を読んで以下の問に答えよ。

There are a large number of reactions in organic chemistry but we can simplify the story by grouping these reactions into various categories. To begin with, we can classify reactions as follows:

- \* acid/base reactions
- \* functional group transformations
- \* carbon-carbon bond formations

The first category of reactions are relatively simple and involve the reaction of an acid with a base to give a salt. In the reaction of acids with bases, the acid acts as the electrophile and the base acts as the nucleophile.

There are two definitions. In the Brønsted-Lowry definition an acid is a molecule which can provide a proton, and a base is a molecule which can accept that proton. Lewis acids are electron deficient molecules which are classed as acids because they are capable of accepting a pair of electrons from another molecule to fill their valence shell. A Lewis base is a molecule which can provide those electrons.

The second category of reactions are methods by which one functional group can be converted into another (e.g. ketone to an alcohol). These reactions can be divided into the following categories:

- \* electrophilic addition
- \* electrophilic substitution
- \* nucleophilic substitution
- \* nucleophilic addition
- \* elimination
- \* reduction
- \* oxidation

The third category of reactions is extremely important to organic chemistry since they are the reactions which allow the chemist to build up big molecules from smaller ones.

問1 全文を日本語に訳せ。

問2 問題文全体の内容に適した英語の標題を提案せよ。