外国語科目（英語）　　　　　　　　　　　　　　　　　　２３大修

１４：００－１５：００

物質科学創造専攻
物質電子化学専攻
材料物理科学専攻

English Examination

Instructions
1. Please confirm that there are three answer sheets to be filled in.
2. Please write your application number on each of the three answer sheets.
3. Please answer each problem (in English) on a separate sheet on which you must write clearly the problem number (I, II, III).

Problem I.

Read the following text and answer the questions.

Scientists in Cambridge, UK, have developed a reactor that can make oxygen from Moon rock — a vital technology if plans to create a lunar base are to take off.

NASA has been looking for ways to get oxygen from Moon rock for several years. In 2005, as part of its Centennial Challenges programme, the agency offered a US$250,000 prize to the first team to come up with a piece of kit that could extract five kilograms of oxygen in eight hours from some simulated Moon rock. Despite raising the value of the prize pot to $1 million in 2008 with the help of the California Space Authority, the prize remains unclaimed.

Now, Derek Fray, a materials chemist from the University of Cambridge, UK, and his colleagues have come up with a potential solution by modifying an electrochemical process they invented in 2000 to get metals and alloys from metal oxides. The process uses the oxides – also found in Moon rocks – as a cathode, together with an anode made of carbon. To get the current flowing through the system, the electrodes sit in an electrolyte solution of molten(1) calcium chloride ($CaCl_2$), a common salt with a melting point of almost 800 °C.

The current strips the metal oxide pellets of oxygen atoms, which are ionized and dissolve in the molten salt. The negatively charged oxygen ions move through the molten salt to the anode where they give up their extra electrons and react with the carbon to produce carbon dioxide – a process that erodes(2) the anode. Meanwhile, pure metal is formed over at the cathode.

To make the system produce oxygen and not carbon dioxide, Fray had to make an unreactive anode. This was crucial: “without those anodes, it doesn't work”, says Fray. He discovered that calcium titanate, which is a poor electrical conductor on its own, became a much better conductor when he added some calcium ruthenate to it. This mixture produced an anode that barely erodes at all – after running the reactor for 150 hours, Fray calculated that the anode would wear away by roughly three centimetres a year.

In their tests, Fray and his colleagues used a simulated lunar rock called JSC-1, developed by NASA. Fray anticipates that three reactors, each a metre high, would be enough to generate a tonne of oxygen per year on the Moon. Three tonnes of rock are needed to produce each tonne of oxygen, and in tests the team saw almost 100% recovery of oxygen, he says.

To heat the reactor on the Moon would need just a small amount of power, Fray notes, and the reactor itself can be thermally insulated to lock heat in. “It won't be a problem,” he says. The three reactors would need about 4.5 kilowatts of power – not much more than that used to heat an immersion heater in a domestic boiler – which could be supplied by solar panels or even a small nuclear reactor placed on the Moon.

With an extra £10 million (US$16.5 million), Fray says he would be able to develop “a robust prototype” of a bigger reactor that could be operated remotely. He is currently working with the European Space Agency towards this goal.

An extract from “How to breathe on the Moon” written by Katharine Sanderson

http://www.nature.com/news/2009/090810

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(1) *molten:* heated to a very high temperature so that it becomes liquid

(2) *erode:* gradually wear or be worn away

Questions

I-1. Indicate whether the following claims are true (T) or false (F).

(i) In 2008, Derek Fray and his co-workers won the prize of the California Space Authority.

(ii) If a base is made on the surface of the Moon in the future, oxygen will become indispensable.

(iii) NASA developed a method for extracting oxygen from Moon rock in 2005.

(iv) In Fray's system, it was estimated that the anode made from calcium ruthenate was worn away by about three centimetres if used for one year.

(v) Fray estimated that three tonnes of Moon rock is necessary to generate one tonne of oxygen.

(vi) Fray received £10 million from NASA to develop "a robust prototype" of a bigger reactor.

(vii) Fray had to develop a new anode composed of materials other than carbon to avoid eroding the anode.

(viii) Fray's reactors would need a large amount of power to generate oxygen from Moon rock.

I-2. The title of this text is "How to breathe on the Moon". Why is Fray's system seen as making an important contribution to solving the problem of how to survive on the Moon? Answer by writing at least two complete sentences.

Problem II.

Questions

II-1. Make the following sentences logical and grammatically correct by choosing the most appropriate word or phrase in the parentheses.

(1) I agreed (for / in / of / with) my supervisor yesterday.

(2) Tom has been ill (before / since / until / when) he went to Boston last week.

(3) The theory of relativity is (much / so / too / very) abstract for me to understand.

(4) (A / It seemed / The / There was) little agreement between experimental observations and theory on this point.

(5) An eclipse of the Moon (takes place / takes place when / when / when takes place) the Earth passes directly between the Sun and the Moon.

II-2. Make the following sentences logical and grammatically correct by putting the words in the parentheses into the correct order.

(1) There was (for / no / time / to / us) visit the famous aquarium after the meeting.

(2) Last year (as / books / had / many / twice / we) as she had in the laboratory.

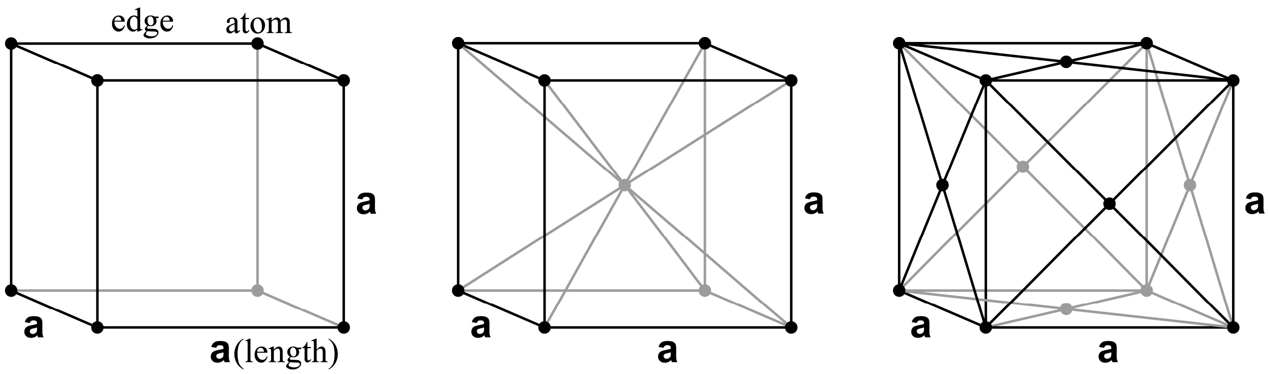
(3) Yesterday (dark / it / so / that / was / we) could not see the outline of the mountain against the sky.

(4) The invention of the microscope made (for / it / possible / scientists / to) learn more about what causes diseases.

Problem III.

Read the following text and answer the questions in English. Each answer should be a sentence consisting of at least eight words. Do not use any mathematical expressions such as algebraic terms and equations in your answers. Note that scientific accuracy is less essential than general fluency and grammatical correctness.

A crystal structure is composed of a pattern, a set of atoms arranged in a particular way, and a lattice exhibiting long-range order and symmetry. Patterns are located upon the points of a lattice, which is an array of points repeating periodically in three dimensions. The points can be thought of as forming identical tiny boxes, called unit cells, that fill the space of the lattice. The unit cell is a tiny box containing one or more atoms, a spatial arrangement of atoms. The lengths of the edges of a unit cell and the angles between them are called the lattice parameters. The unit cells of the simple cubic (SC), body-centered cubic (BCC) and face-centered cubic (FCC) structures are shown in Fig. 1 (a), (b) and (c), respectively.



(a) (b) (c)

Fig. 1

Questions

III-1. Describe similarities of the unit cells of the SC, BCC and FCC structures.

III-2. Describe differences among the unit cells of the SC, BCC and FCC structures.