令和６年度（2024 年度）
東北大学大学院理学研究科　地学専攻
博士課程前期２年の課程　入試問題

英語

令和５年８月３日　10：00 ～ 11：20 実施

注 意 事 項

1. 机の上には受験票、筆記用具、時計以外は置かないこと。
2. 携帯電話や音の出る機器などは、電源を切ってかばんの中に入れること。
3. 試験開始の合図があるまで、問題冊子を開かないこと。
4. 試験時間は 10:00 から 11:20 までである。
5. 試験中大きな地震が発生した場合、試験監督の指示に従うこと。
6. 問題は、英語 1、英語 2 の大問 2 問からなる。解答は解答用紙の指定されたところに記入すること。

英語１ 次の文章を読み、以下の問１～問４に答えよ。

Most of us know helium as the gas that makes balloons float, but the second element on the periodic table does much more than that. Helium pressurizes the fuel tanks in rockets, helps test space suits for leaks, and is important in producing components of electronic devices. Magnetic resonance imaging (MRI) machines that take images of our internal organs can't function without helium. And neither can nuclear magnetic resonance (NMR) spectrometers that researchers use to determine the structures of proteins–information that's important in the development of medications and other uses.

Although it's almost indispensable today, scientists initially wondered if helium even existed on Earth. French astronomer Pierre Janssen and English scientist Joseph Norman Lockyer first observed helium, independently, in 1868 using spectroscopes. These tools separate light into measurable wavelengths. Because every element has a unique wavelength, like a fingerprint, spectroscopes let scientists identify elements in stars. When Janssen and Lockyer used spectroscopes to look at the sun, they saw one bright yellow wavelength that didn't match any known element.

Lockyer named the mystery element after Helios, god of the sun in Greek mythology. We now know that helium is the second most abundant element in the universe (with hydrogen being the first), and most of it is in stars, like the sun. But helium wasn't spotted on Earth until 1882, when Italian physicist Luigi Palmieri reported seeing its wavelength while analyzing lava from Mount Vesuvius. Another 13 years passed before experiments on uranium-containing rock definitively proved that helium exists on our planet.

The biggest reason scientists struggled to find helium on Earth is that nearly all of it is deep underground, made when radioactive elements break down. Helium is so light that when released into the air, it quickly escapes to outer space. Because of this, scientists thought helium was very rare on Earth until 1905, when researchers at the University of Kansas discovered that it could be found in natural gas deposits and extracted in large amounts.

(a)<u>During World War II, the U.S. government used helium to lift blimps because, unlike hydrogen, it isn't flammable. U.S. Navy blimps buoyed by helium escorted thousands of ships during the war and lowered listening devices into the water to scan for submarines.</u>

The United States continued to value helium after World War II, and in 1960, Congress passed a law creating a national helium stockpile. Over the next 13 years, the U.S. government pumped 32 billion cubic feet of the gas into a natural rock chamber under a Texas field.

The stockpile has played a large role in maintaining the United States' status as the world's largest helium producer. Over the last 5 years, however, the helium in the reserve has gotten low. Due to this depletion and delays in developing other sources, the demand for helium over the last few years has exceeded the supply.

All industries that use helium are feeling the impact of the shortage, but its effect on MRI and NMR machines is especially worrisome. Both machines have large magnets that require very low temperatures to work, and they use liquid helium as a super coolant because it's about -450 degrees Fahrenheit. Turning the machines off and allowing the magnets to warm up can permanently destroy them.

(b)But due to the helium shortage, some researchers have had to take the risk of shutting down their NMR machines. Seeing this and other effects of the helium shortage, NIGMS[*1] created a supplementary grant that funds the purchase of helium recovery systems. These systems can capture 80 percent or more of helium as it evaporates, meaning that less is needed to keep machines running. Helium recovery systems also save money in the long run because they last for 30 to 40 years, and operating them costs less than buying the amount of helium they recycle.

With these recycling efforts, researchers can continue using NMR machines to create high-resolution images of proteins that help us understand their complex shapes, how they function, and how they interact. These discoveries can provide insight into diseases and assist in developing treatments, because drugs typically work by either blocking or supporting the activity of specific proteins in the body.

Not everyone uses helium to help solve scientific and medical mysteries. However, its vast range of uses makes this element an essential part of modern life and, hopefully, something we can continue to benefit from for a long time.

[*1] NIGMS: National Institute of General Medical Sciences

(National Institute of General Medical Sciences, US ウェブサイト掲載の記事 "Helium: An Abundant History and a Shortage Threatening Scientific Tools" より一部抜粋)

問１　下線部（a），（b）をそれぞれ和訳せよ。

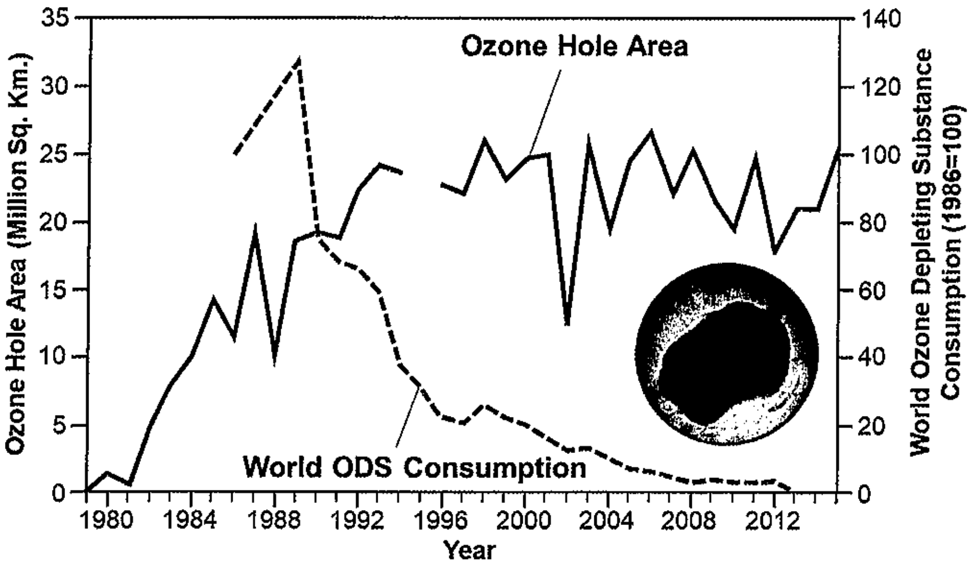
問２　自然界にヘリウムが存在する可能性は，どのような観察手法および観察事実によってはじめて明らかにされたのか。本文の内容に基づき，日本語で５行以内で説明せよ。

問３　ヘリウムが地球上に確実に存在することが証明されたのは，いつのことか。西暦で答えよ。

問４　分析装置 MRI と NMR におけるヘリウムの役割りについて，本文の内容に基づき，日本語で５行以内で説明せよ。

英語 2　以下に示す図 1、図 2 のグラフについて、それぞれ英文 10 行以内で説明せよ。ただし、データが示す変化や傾向、それがどのような科学的見解を示唆するのかを含めて説明すること。

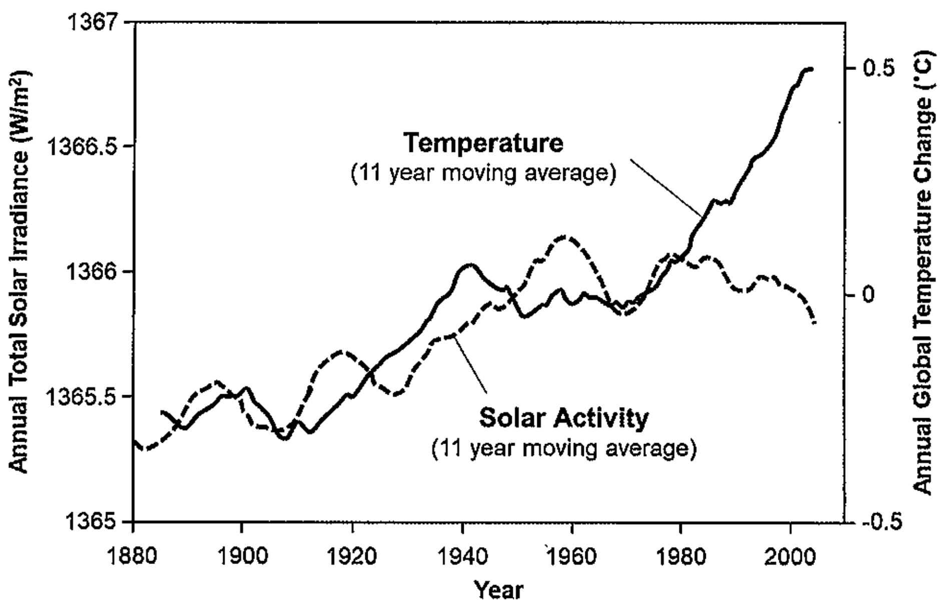
図 1



(ODS: Ozone Depleting Substances)

（Watts Up With That? ウェブサイトの記事 "Did We Really Save the Ozone Layer?!" に掲載の図を一部改変）

図 2



（Skeptical Science ウェブサイトの記事 "Sun & climate: moving in opposite directions" に掲載の図を一部改変）