※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. The following paragraphs were adopted from a Nature Geosciences article [Ohtomo et al., (2014) **Evidence for biogenic graphite in early Archaean Isua metasedimentary rocks.** http://www.nature.com/ngeo/journal/v7/n1/full/ngeo2025.html], please read carefully the text and answer the following questions.

Some graphite contained in the 3.7-billion-year-old metasedimentary rocks of the Isua Supracrustal Belt, Western Greenland, is depleted in ^{13}C and has been interpreted as evidence for early life. However, it is unclear whether this graphite is primary, or was precipitated from metamorphic or igneous fluids. Here we analyse the geochemistry and structure of the ^{13}C- depleted graphite in the Isua schists. Raman spectroscopy and geochemical analyses indicate that the schists are formed from clastic marine sediments that contained ^{13}C-depleted carbon at the time of their deposition. Transmission electron microscope observations show that graphite in the schist occurs as nanoscale polygonal and tube-like grains, in contrast to abiotic graphite in carbonate veins that exhibits a flaky morphology. Furthermore, the graphite grains in the schist contain distorted crystal structures and disordered stacking of sheets of graphene. The observed morphologies are consistent with pyrolysation and pressurization of structurally heterogeneous organic compounds during metamorphism. We thus conclude that the graphite contained in the Isua metasediments represents traces of early life that flourished in the oceans at least 3.7 billion years ago.

The suggestion that graphite in early Archaean rocks represents materials of biogenic origin has been met with a degree of scepticism. Isotopic compositions of graphite in >3.7-billion-year old (Ga) rocks from the Isua Supracrustal Belt (ISB), Western Greenland, which are believed to be of sedimentary origin, suggest that vast microbial ecosystems were present in early Archaean oceans. However, results of more recent studies suggest that most of the graphite-bearing rocks formed through interactions between crustal fluids and surrounding igneous rocks during later metasomatic events, thereby casting doubt on the existence of an extensive sedimentary sequence in the ISB and on the biogenic origin of constituents. In contrast, ^{13}C-depleted graphite globules, which are considered to form from biogenic precursors, have been reported from metamorphosed clastic sedimentary rocks in the ISB. However, these globules were found at a single locality, and it therefore remains unclear whether traces of life at other localities in the ISB were lost during metamorphism or were originally absent. The presence of additional clastic sedimentary rocks containing graphite may provide evidence for the preservation of organic constituents in early Archaean rocks, thus supporting the notion that microbes were active in early Archaean oceans.

背面仍有題目，請繼續作答

系所組別：地球科學系甲、乙組

考試科目：科學英文 考試日期：0223，節次：1

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Please answer the following questions (6% each, 30% in total).

1) Why was the graphite in the 3.7 Ga ISB sedimentary rocks interpreted as evidence of early life?

2) In what ways are graphite grains formed biotically and abiotically?

3) What evidences can be used to distinguish graphite which is primary, or was secondarily precipitated? By what tools?

4) Morphologically, what are the differences in graphite grains from biotic and abiotic sources?

5) What is the novelty and importance of this study?

2. Please translate the following English into Chinese (5% each, 40% in total, exacted from www.dhf.org.tw).

a) Because of sorrow, we can understand joy.

b) Because of loss, we can recognize gain.

c) Because of poverty, we can appreciate prosperity.

d) Because of ignorance, we can seek wisdom.

e) Because of cowardice, we can understand the real bravery.

f) Because of enemies, we can know the meaning of friends.

g) Because of betrayal, we can cherish loyalty.

h) Because of reality, dreams are more valuable.

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

3. The following paragraphs were adopted from a Nature Geosciences article [McEwen et al., (2014) **Recurring slope lineae in equatorial regions of Mars.** http://www.nature.com/ngeo/journal/v7/n1/full/ngeo2014.html]. Please read carefully the text and answer the following questions.

The presence of liquid water is a requirement of habitability on a planet. Possible indicators of liquid surface water on Mars include intermittent flow-like features observed on sloping terrains. These recurring slope lineae are narrow, dark markings on steep slopes that appear and incrementally lengthen during warm seasons on low-albedo surfaces. The lineae fade in cooler seasons and recur over multiple Mars years. Recurring slope lineae were initially reported to appear and lengthen at mid-latitudes in the late southern spring and summer and are more common on equator-facing slopes where and when the peak surface temperatures are higher. Here we report extensive activity of recurring slope lineae in equatorial regions of Mars, particularly in the deep canyons of Valles Marineris, from analysis of data acquired by the Mars Reconnaissance Orbiter. We observe the lineae to be most active in seasons when the slopes often face the sun. Expected peak temperatures suggest that activity may not depend solely on temperature. Although the origin of the recurring slope lineae remains an open question, our observations are consistent with intermittent flow of briny water. Such an origin suggests surprisingly abundant liquid water in some near-surface equatorial regions of Mars.

Pure water is highly unstable on the surface of Mars today, but the possibility of present-day habitable conditions near the surface, accessible to exploration, has been enhanced by recent results. In addition to the recurring slope lineae (RSL), there is evidence for the presence of thin films of water in the shallow subsurface, associated with ice deposits in the middle to high latitudes. However, RSL are found in the warmest areas of the planet, typically extending downslope from bedrock outcrops, and often associated with small gullies. The preferred explanation for these features is brine flow, but the source of the putative water remains unclear. Brines are far more likely than pure water because they have lower freezing temperatures and evaporation rates, and because the martian surface has been found to be highly salty at every successful landing site.

Please answer the following questions (6% each, 30% in total).

1) In searching of extraterrestrial life, this article mentioned an important searching target for scientist, and what is it?

2) What is the best season for observing RSL and why?

3) What the advantage of research in equatorial regions vs mid-latitude for RSL?

4) What patterns of RSL were found in this article?

5) Your best guess on the briny nature of the water found in Mars are similar to what kind of water? Please give an example.