1. Please translate the following sentences into English (20%)

a. 勤讀科學文章、學習實驗技巧、完成科學報告及參加研討會將會是我未來充實的碩士班生活。

b. 熬夜趕報告及用英文演講可能是未來的挑戰。

c. 你覺得我们要不要找個地方坐下來聊聊天。

d. 我從不後悔投身科學研究的工作，反而覺得這是一項有趣的工作。

e. 在台灣本島可以發現三種基本岩石：沈積岩、火成岩、變質岩。

2. Please translate the following sentences into Chinese (20%)

a) The oceans play the central role in the feedback loop via heat storage and transport around the globe. Atmospheric water vapor produces rainfall, and acts as the most important greenhouse gas. But through the formation of clouds, water vapor also leads to the reflection of sunlight back into space. And over geological time-scales, the waxing and waning of ice sheets changes the reflection of the sun's light back into space, and largely determines the sea level.

b) The planets can be divided into two groups based on their densities and closeness to the Sun. They are terrestrial planets and jovian planets.

c) Underwater sound recordings have been used to monitor transform faults in the equatorial Pacific, implicating a mechanism of foreshock generation distinct from that on most continental fault systems.

d) Mantle plumes are among the most spectacular processes that generate magmas at the surface of the Earth. They are giant upwellings of hot material from deep in the mantle, probably from below the convective mantle region that drives plate tectonics. Plumes produce long volcanic chains, such as the Hawaii-Emperor chain; and they are thought to hit the lithosphere eventually, to form large continental flood-basalts, such as the Deccan and the Ethiopian traps, over just a million years or so.

e) The noble metals provide unique clues to the early origins of our planet. But how they are distributed within the Earth — and what it all means — is the subject of intense debate. According to the most widely accepted model of the Earth's formation, the mantle received its supply of noble metals only after the Earth had already acquired about 99% of its present mass, during a final phase of bombardment by meteorites

（背面仍有題目,請繼續作答）

3. This is part of a paper recently published by Nature about the new discovery of lower mantle phase related to the issue of core-mantle boundary. Please read it and write a short summary. (30%)

The lowermost 250 km or so of Earth's mantle, known for historical reasons as D", is comparatively small in volume but potentially holds the key to understanding a host of geophysical phenomena — among them the formation of plumes in the mantle, interactions between core and mantle, and the ultimate fate of subducting slabs of crust that are driven into the interior by tectonic forces. Investigations of this region largely depend on interpreting the behaviour of seismic waves, which have shown that it is highly complex. Until recently, however, studies of the region's mineral properties at high pressures and temperatures had been unable to provide satisfying explanations for much of this complexity. Part of the problem is that the extreme conditions in D" — pressures up to 135 gigapascals and temperatures probably ranging between 2,000 K and 4,000 K — are difficult to reach in the laboratory. However, laboratory experiments and theory are finally coming together to bring this region into sharper focus.

Iitaka *et al.* and Oganov and Ono provide insights that link the calculated physical properties of a newly discovered high-pressure crystal structure with seismic observations of the deep lower mantle. Earth's mantle is composed mostly of dense silicate minerals containing magnesium, iron, calcium and aluminium. Experiments have shown that the lower mantle, extending from 660 km depth to the base of the mantle at about 2,900 km, is mainly composed of $(Mg,Fe)SiO_3$ in a crystal structure known as perovskite. Although the properties of this material are compatible with most observations for the lower mantle, the abrupt change in properties near the mantle's base defied explanation in terms of perovskite behaviour. Thus, Murakami and colleagues' experimental discovery of a 'post-perovskite phase' in $MgSiO_3$, at conditions comparable to the D" region, has stimulated considerable interest in the physical properties of the new phase. Given the difficulty of performing direct experiments under these conditions, first-principles quantum mechanical calculations of the type carried out by Iitaka *et al.* and Oganov and Ono are especially useful for studying the deep Earth. In contrast to the perovskite structure that is widely adopted by many compounds, the post-perovskite phase seems to be rather uncommon. In this structure, each silicon cation remains surrounded by six oxygen anions — producing the octahedral coordination that is characteristic of the lower mantle. But rather than forming a corner-linked, three-dimensional network as in perovskite, in the post-perovskite phase the silicon octahedra share edges and corners to form a sheet-like structure with alternating magnesium and silicon layers.

In conjunction with experimental findings, the theoretical results at 0 K indicate that the transition has a positive pressure– temperature slope. At mantle temperatures, the phase transition is then expected to occur about 200–300 km above the base of the mantle, consistent with evidence for a sudden change, or discontinuity, in the velocity of seismic waves there, possibly global in extent. The positive slope of the phase boundary is even compatible with seismic-wave evidence that the D" discontinuity is elevated in seismically fast (and presumably cold) regions and depressed in seismically slow (hot) areas. The new phase is also found to be about 1–2% denser than perovskite at D" conditions.

The proposed transition between perovskite and post-perovskite will not resolve all questions about the D" region. But it clearly provides a new framework for studying the region and is sure to stimulate further geophysical observations, laboratory experiments and computer calculations. From a mineral-physics viewpoint, studies of texture development in the new phase, as well as constraints on the behaviour of more chemically complex systems, are clearly needed. Also, the elastic anisotropy has only been calculated at 0 K, yet in some cases temperature can drastically change the magnitude and even orientation of anisotropy. The theoretical studies are in remarkably good agreement. But they all used similar techniques involving some degree of approximation, which will also necessitate further examination.

Nevertheless, a new era in the study of Earth's deepest mantle has begun. An explanation for both the D" discontinuity and the onset of seismic anisotropy in the region may finally be within our grasp.

4. Write a short essay about your motivations to be a graduate student of Earth Sciences. (30%)