Question 2

(a) T $T_e^4 = \dfrac{L}{4\pi R^2 \sigma}$

Rearrange Eq. 1 to solve for T_e:

$$T_e = \sqrt[4]{\frac{L}{4nR^2\sigma}}$$

Inserting values for L (1.19×10^{18} W), π (3.14), R ($6.30 \quad 10^6$ m) and σ ($5.67 \quad 10^{\ 8} Wm^{\ 2} K^{\ 4}$)

$$T_e = \sqrt[4]{\frac{1.19 \quad 10^{18} W}{4 \quad 3.14 \quad (6.30 \quad 10^6 m)^2 \quad 5.67 \quad 10^{\ 8} Wm^{\ 2} K^{\ 4}}}$$

Therefore,

$$T_e = \sqrt[4]{\frac{1.19 \quad 10^{11} K^4}{2.83}}$$

Therefore, T_e = 453 K or 180 °C

$T_e \quad$ 453K or 180 °C

(b) There are three competing views as to the origin of the Earth's water. p. 59-61.]

First, that the Earth accreted as a dry body and its water was subsequently added through cometary impacts.

Second, that the Earth's water was directly derived from the solar nebula.

Third, that the Earth inherited its water from water-bearing minerals in the un-degassed interiors of planetary embryos.

Although comets contain significant quantities of water, the ratio of two stable isotopes of hydrogen (deuterium/hydrogen or D/H ratio) in most comets (e.g., 1 P/Halley, Hyakutake and 67P/Churyumov-Gerasimenko) is greater than the D/H ratio in terrestrial water, although only a small, and possibly unrepresentative number of comets have been measured). Alternative phrasing along these lines would be an equally acceptable way to answer: the Earth and comets seem to have different hydrogen isotope ratios implying that the Earth did not obtain the bulk of its water by cometary impacts.

However, this is based on measurements of only a few comets, which may Table 2.1, p. 60]

It also seems unlikely that the Earth scavenged volatiles such as water directly from the solar nebula because relative concentrations of other volatiles, such as Ne, Ar, Kr, and Xe, were much higher in the solar nebula than they are now in Earth's atmosphere. [Box 2.4, p. 60]

Since we find hydrated minerals in meteorites such as carbonaceous chondrites, it is plausible that water-bearing grains became incorporated in planetesimals, planetary embryos and eventually the Earth. A major uncertainty in this model is whether water-bearing planetesimals could have formed at 1 AU or whether they could only have formed at distant parts of the solar nebula, much further away than region in which Earth was accreting. [pp. 59–61.]

(c) Plate-tectonics plays a significant role in recycling CO_2 and other atmospheric constituents between atmosphere, hydrosphere, and the Earth's interior, thereby regulating the level of greenhouse gases in the Earth's atmosphere, critical for maintaining habitability of the Earth. In the early Solar System it is estimated that there was about five times more heat being produced in the Earth's interior than there is today and, therefore, in the early Solar System when the solar luminosity was much reduced compared to the present day, plate-tectonics could have played a major role in regulating the surface temperature on Earth by bringing additional heat from the Earth's interior. [pp. 56–58.]

Question 3

This question relates mainly to Chapter 3.
(a) *can be answered mostly with reference to pp. 99–102.*

The Viking life detection instrument package consisted of three experiments which were:

1) The Pyrolitic Release experiment (PR) which tested for carbon fixation.

In this experiment Martian soil was incubated in a simulated atmosphere of CO_2 and CO (carried from Earth) labelled with radioactive ^{14}C.

A xenon arc lamp provided simulated sunlight.

After 5 days, the atmosphere was removed and the soil sample heated to 625 ^{o}C to break down any organic material and the resulting gases were passed through a ^{14}C detector to see if any organisms had ingested the radioactive CO_2.

2) The Gas Exchange experiment (GEX), which tested for metabolic production of gaseous by-products in the presence of water and nutrients as produced during respiration.