Section I: Life & Habitability

Question 1

To find the boundaries of the habitable zone—the distances where water can remain liquid—I used the equilibrium temperature formula, rearranged to solve for the distance 'a'.

$a = \sqrt{\frac{(1-A)L_{*}}{16\pi\sigma T_{eq}^4}}$

In my calculations, I used the boiling point of water, 373 K, for the inner bound and the freezing point, 273 K, for the outer bound. As a result, I found that the habitable zone in this model is located between approximately

0.47 AU and 0.87 AU.

I concluded that this model is an

underestimate. This is because Earth's position at 1 AU is outside the region I calculated. The model's shortcoming stems from the fact that it does not account for the greenhouse effect, which is caused by a planet's atmosphere and warms its surface.

Section II: Interpreting Atmospheric Absorption Spectra

Question 2

In this section, I labeled the absorption features caused by key gases in the atmosphere on the provided spectrum of Earth. The distinct dips in the graph indicate that light at those specific wavelengths is being absorbed by certain molecules. Using this understanding, I marked the spectral fingerprints of molecules like

O_3 (Ozone), O_2 (Oxygen), H_2O (Water Vapor), and CO_2 (Carbon Dioxide) on the graph.

Section III: Characterizing Atmospheric Loss

Question 3

I used the following formula to calculate the escape velocity of the super-Earth exoplanet named "Terra II".

$v_e=\sqrt{\frac{2GM}{R}}$

By taking the planet's mass as 4 times that of Earth and its radius as 2 times that of Earth, and using the provided constants, I calculated the escape velocity to be approximately

15.8 km/s.

Using this result and the information that the planet is subjected to 100 times more XUV flux than Earth, I plotted Terra II on the "Cosmic Shoreline" diagram. The planet's position fell within the region labeled "Atmosphere lost". Therefore, I concluded that it is unlikely for Terra II to have an atmosphere.