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A3_6 Gasp of the Titans

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Abstract

This paper follows the plausibility of the existence of the Greek Titan Atlas. It has previously been found that Atlas would be too large to exist on the Earth if he were to hold the atmosphere. It is further found that were Atlas to siphon the earth's atmosphere in order to breathe, he would suffocate as there would not be enough oxygen to sustain him. There would also be an associated temperature increase due to heat transfer between the atmosphere and Atlas's lungs.

Introduction

A previous paper investigated how large the Titan Atlas, from Greek mythology, would have to be to hold the atmosphere on his shoulders [1]. At a height of 63.5 × 10^6 m, Atlas would be incapable of walking the Earth as depicted in Greek mythology and would be a celestial body. This paper focuses on Atlas's means of survival in proximity of the Earth (ignoring gravitational effects) by using the earth's atmosphere as a breathing apparatus and the effect that his breathing will have on the atmosphere's temperature.

Out of Breath?

When supporting the atmosphere, one assumes that this would not be too strenuous for Atlas, such that his inhalation volume would be no greater than the tidal volume. The tidal volume is given to be the average volume of air that is inhaled/exhaled per breath [1]. For an average sized male (1.78m) [2] the tidal volume is 5 ×10^{-4} m^3 . Atlas is 35.4 × 10^6 times larger than the average male. This scale height can be used to estimate the volume of Atlas's gargantuan lungs. It is necessary to cube the value of the scale factor as a volume (three linear components) is being scaled. This gives the cubic scale factor to be 4.4 × 10^{22}. Multiplying the scale factor by the value for the average tidal volume gives an inhalation volume of 2.2 × 10^{19} m^3 which is an order of magnitude greater than the volume of the atmosphere [1]. It would appear that there is not even enough atmosphere to sustain Atlas for one breath.

Temperature Change

The temperature inside human lungs ~ 310K [3] (heat reservoir 1) is higher than the atmospheric temperature ~293K (heat reservoir 2). The temperature change at the interface between Atlas's lungs and the atmosphere can be calculated by considering the thermal resistance R_T,

$$R_T = \frac{dx}{KA}, \quad (1)$$

where *K* is the thermal conductance (0.11 and 0.026 W/(mK) for lung tissue and air [3], [4] respectively), and *A* is the area for heat transfer between reservoirs. The total gas transfer area in normal lungs [5] is ~ 75m^2 . This is scaled (by an area scale factor, i.e. the square of the linear scale factor) to give 9.38 × 10^{16} m^2 for the case of Atlas. The length of the intersection between reservoirs *dx* (the thickness of the alveoli) is normally 0.5μm [6] which is scaled to 17.7m. Equation (1) gives the thermal resistances for air ($R_{atmosphere}$) and the lungs (R_{lungs}) as 7.26 × 10^{-15} and 1.72 × 10^{-15} K/W respectively. The two reservoirs are assumed to be connected in series and so the thermal resistance is given as

$$R_S = R_{atmosphere} + R_{lungs} , \quad (2)$$

where R_S is the series total for the thermal resistance [7]. This gives a total resistance of 8.96 × 10^{-15}K/W.

The thermal current [8] between the two reservoirs (i.e. the transfer of heat per unit time) is calculated by

$$I = \frac{\Delta T}{R_S}, \quad (3)$$

where ΔT is the temperature difference between reservoir one and two and R_S is the aforementioned series resistance. Equation (3) gives a thermal current of 1.89×10^{15}W.

The temperature difference across the intersection between the two reservoirs (the thickness of the alveoli) is given by the thermal current multiplied by the thermal resistance of the atmosphere [8].

$$\Delta T_{trachea} = IR_{atmosphere}\,. \quad (4)$$

The result of equation (4) allows one to calculate the actual temperature at the interface between the reservoirs by subtracting the temperature difference (given from equation (4) as 13.77K) from the temperature *T*, within Atlas's lungs, which gives a temperature of 296K at the interface.

Conclusion

The findings of this paper demonstrate that the Titan Atlas would not be able to use the earth's atmosphere as a form of breathing apparatus, as his inhalation volume for one breath is considerably larger than the volume of the atmosphere. However, the heat transferred from Atlas's lungs is quite large and is enough to heat the interface between the lungs and the terrestrial atmosphere to a temperature of approximately 296K.

References

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