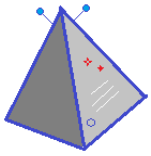
Physics I

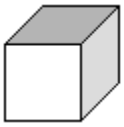
Blackbody Radiation

Radiation law: $\text{Radiation}(power) = Area \times \varepsilon\sigma T^4$, where $\sigma = 5.67\times10^{-8}\,\frac{\text{W}}{\text{m}^2\text{K}^4}$

Problem 1.- Consider a satellite with the shape of a tetrahedron and with one face directed towards the sun receiving 1350 W/m^2 of radiation. Calculate the temperature of the satellite if all 4 faces are in equilibrium.



Problem 2.- Consider that a satellite in orbit has the shape of a cube and one side is facing the sun and receiving 1,300 W/m^2 of radiation. Calculate the temperature of the satellite if it emits equally from all its 6 sides.



Problem 3.- Planet Mercury has a spherical shape. It receives radiation from the sun at a rate of 9,300 W/m^2. Estimate the temperature of the surface assuming it behaves like a black body with constant temperature.

Hint: *Consider that the sun only illuminates an area equivalent to a circle, but the planet emits in every direction.*

Problem 4.- Why is a good emitter of radiation called a black body?

Problem 5.- Consider that a satellite in orbit has the shape of a cylinder with the circular base facing the sun and receiving 1,350 W/m^2 of radiation. Calculate the temperature of the satellite if it emits equally from all parts of its surface and has a length of 20R (R being the radius of the base).

Problem 6.- The Sun, whose surface temperature is 5800K, emits 3.2×10^{26} W of radiation. Consider a brown dwarf star with the same size, but which only emits 0.2×10^{26} W. Calculate its surface temperature.

Problem 7.- Regarding the density of energy in a cavity as a function of lambda $U(\lambda)$ and as a function of frequency $U(f)$:

A) Why is the maximum given by Wien's law, $\lambda_{MAX} T = 2.9\text{mmK}$, not the same for U(f)?

B) Use the law stated above to find the wavelength at maximum intensity produced by a pizza oven whose temperature is 220ºC