Answer on Question Question #58126, Physics / Mechanics | Relativity

Task Calculate the electric power which must be supplied to the filament of of a light bulb operating at 3000K. The total surface area of the filament is 8×10−6m2 and its emissivity is 0.92.

Solution
According to black body theorem luminosity (or same, power), that going from surface, can be defined by formula:

$$L = \gamma A \sigma T^4$$

$$\gamma - emissivity, A - surface\ area, \sigma - constant, 5.67 * 10^{-8}, T - surface\ temperature$$

$$L = 0.92 \cdot 5.67 \cdot 10^{-8} \cdot 8 \cdot 10^{-6} \cdot 3000^4 = 41.7312 \cdot 10^{-14} \cdot 3^4 \cdot 10^{12} = 3380.2272 \cdot 10^{-2} \approx 33.8\ W$$

Answer L=33.8 W

Task Calculate the change in internal energy of 2kg of water at 90oC when it is changed to 3.30 m3 of steam at 100oC. The whole process occurs at atmospheric pressure. The latent heat of vaporization of water is 2.26×106J/kg.

Solution
According to thermodynamics dU=PdV-TdS, where dU is change in internal energy, P – pressure, dV – change in volume, TdS – heat, that given to system.
P is constant (according to condition) $dV=V_2-V_1$
V_1=2 liters=0.002 m^3 V_2=3.3 m^3
We can assume, that dV=3.3 m^3
TdS=Q=cm(t_2-t_1)+qm, where t_2 – 100 C (before vaporization), t_1 – initial temperature (90 C), q – latent heat of vaporization, c – heat capacity (4200 J/kg/C), m – mass of water.

$$Q = 4200 \cdot 2 \cdot 10 + 2 \cdot 2.26 \cdot 10^6 = 4.604 \cdot 10^6 = 4.6 \cdot 10^6$$

$$PdV = 100000 \cdot 3.3 = 330000$$

$$dU = PdV - Q = 0.33 \cdot 10^6 - 4.6 \cdot 10^6 = -4.27 \cdot 10^6$$

Answer

$$dU = -4.27 \cdot 10^6\ J$$