Q- The surface of the sun has a temperature of about 5800K. The radius of the Sun is 6.96 X 10^8 m. Calculate the total energy radiated by the sun each second. Assume the emissivity is 0.986.

Prevost law for heat exchange says that all bodies at all temperatures radiate heat. If the temperature of the body is more than its surrounding then the energy radiated is more than the rate at which energy absorbed and visa-versa. If the temperature of the body and surrounding is equal then the two rates are equal and the temperature remains constant.

The rate of thermal radiation from a black body is given by Stefan's law according to which the rate of thermal radiation per unit area per unit time from a black body is directly proportional to the fourth power of its absolute temperature. Hence according to the law

$$\frac{1}{A}\frac{dQ}{dt} \propto T^4$$

Or $$\frac{1}{A}\frac{dQ}{dt} = \sigma * T^4$$

Here σ is the proportionality constant called Stefan's constant. Its value is $5.67*10^{-8}$ $W/(m^2T^4)$.

As the perfect black body surface is only an ideal, for any other surface the quantity of radiation will be less and hence we introduce a quantity called emissivity (denoted by e) of the surface depending on the nature of the surface and it is the ratio of the energy radiated by the surface and blackbody surface in same situations. Hence the law can be written as

$$\frac{dQ}{dt} = Ae\sigma T^4$$

Or if the conditions remain constant we can write the rate of heat radiated as

$$\frac{\Delta Q_e}{\Delta t} = Ae\sigma T^4$$

Now in the problem T = 5800 K, e = 0.986 and R = $6.96*10^8$ m
The surface area A is given by

$$A = 4\pi R^2 = 4*3.1415*(6.96*10^8)^2 = 6.09*10^{18} \text{ m}^2$$

Thus, energy radiated away by the sun per second is given by

$$\frac{dQ}{dt} = Ae\sigma T^4$$

Substituting the values, we have

$$\frac{dQ}{dt} = Ae\sigma T^4 = 6.09*10^{18}*0.986*5.67*10^{-8}*5800^4 = 3.85*10^{26} \text{ W}$$