

Q- At high noon, the sun delivers 1000W to each square meter of a blacktop road. If the hot asphalt loses energy only by radiation, what is its steady-state temperature?

According to Prevost law of heat exchange all bodies radiates at all temperature.

If the body is in steady state the rate of heat radiated by the body is equal to the rate of the heat absorbed.

Here the rate of the heat absorbed is given by

$$\frac{dQ_a}{dt} = 1000Wm^{-2}$$

Now if the temperature of the surface is T then the power radiated per unit area is given by Stefan's law as

$$\frac{dQ_e}{dt} = Ae\sigma T^4 = 1*1*5.67*10^{-8}*T^4 = 5.67*10^{-8}*T^4$$

Now for the steady state

$$\frac{dQ_e}{dt} = \frac{dQ_a}{dt}$$

Hence  $5.67 * 10^{-8} T^4 = 1000$

$$\text{Or } T^4 = \frac{1000}{5.67 * 10^{-8}} = 1.76 * 10^{10}$$

$$\text{Or } T = (1.76 * 10^{10})^{\frac{1}{4}} = (1.76 * 10^{10})^{0.25} = 364.23 \text{ K}$$