**Ex.1**

One face of a copper plate 3 cm thick is maintained at 400◦C, and the other face is maintained at100◦C. How much heat is transferred through the plate?

**Solution:**



**Ex.2**

An aluminum pan whose thermal conductivity is 237 W/m · °C has a flat bottom with diameter 20 cm and thickness0.4 cm. Heat is transferred steadily to boiling water in the pan through its bottom at a rate of 800 W. If the inner surface of the bottom of the pan is at 105°C, determine the temperature of the outer surface of the bottom of the pan.

*A = π r²* = *π*(0.1 m)² = 0.0314 m²

Under steady conditions, the rate of heat transfer through the bottom of the

pan by conduction is



105°C

800 W

0.4 cm

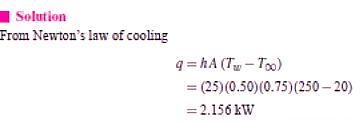
Substituting,



*T*2 = **105.43 °C**

**Ex.3**

Air at 20◦C blows over a hot plate 50 by 75 cm maintained at 250◦C. The convection heat-transfer coefficient is 25 W*/*m2 ·◦C. Calculate the heat transfer



**Ex.4**

2-m-long, 0.3-cm-diameter electrical wire extends across a room at 15°C, Heat is generated in the wire as a result of resistance heating, and the surface temperature of the wire is measured to be 152°C in steady operation. Also, the voltage drop and electric current through the wire are measured to be 60 V and 1.5 A, respectively. Disregarding any heat transfer by radiation, determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room

|  |  |
| --- | --- |
| **Ex.5** |  |



**Ex.**6

One way of measuring the thermal conductivity of a material is to sandwich an electric thermofoil heater between two identical rectangular samples of the material and to heavily insulate the four outer edges. Thermocouples attached to the inner and outer surfaces of the samples record the temperatures. During an experiment, two **0.5-cm**-thick samples **10 cm \_10** **cm** in size are used. When steady operation is reached, the heater is observed to draw **35W** of electric power, and the temperature of each sample is observed to drop from 82°C at the inner surface to **74°C** at the outer surface. Determine the thermal conductivity of the material at the average temperature.

|  |  |
| --- | --- |
| Then the thermal conductivity of the material becomes |  |

**Ex.**7

Consider a sealed 20-cm-high electronic box whose base dimensions are 40 cm \_ 40 cm placed in a vacuum chamber. The emissivity of the outer surface of the box is 0.95. If the electronic components in the box dissipate a total of 100 W of power and the outer surface temperature of the box is not to exceed

55°C, determine the temperature at which the surrounding surfaces must be kept if this box is to be cooled by radiation alone. Assume the heat transfer from the bottom surface of the box to the stand to be negligible.

***Analysis*** Disregarding the base area, the total heat transfer area of the electronic box is

100 W

ε = 0.95

*Ts* =55°C



The radiation heat transfer from the box can be expressed as



which gives *T*surr = **296.3 K = 23.3°C**. Therefore, the temperature of the

surrounding surfaces must be less than 23.3°C.

**Ex.8**

Consider a person standing in a room at 23°C. Determine the total rate of heat transfer from this person if the exposed surface area and the skin temperature of the person are1.7 m2 and 32°C, respectively, and the convection heat transfer coefficient is 5 W/m2 · °C. Take the emissivity of the skin and the clothes to be 0.9, and assume the temperature of the inner surfaces of the room to be the same as the air temperature.







*T*surr

*Q*rad

32°C

ε=0.9

23°C

*Q*conv

and



**Class work**

1.What is the thickness required of a masonry wall having thermal conductivity **0.75 W/m.k** if the heat rate is to be **80%** of the heat rate through a composite structural wall having a thermal conductivity of **0.25 W /m.k** a thickness of **100 mm** both walls are subjected to the same surface temperature difference.

**Class work**

2.One side of a plane wall is maintained at 100◦C, while the other side is exposed to a convection environment having *T* =10◦C and *h*=10 W*/*m2 · ◦C. The wall has *k* =1*.*6W*/*m· ◦C and is 40 cm thick. Calculate the heat-transfer rate through the wall.

H.W

**1–**A transistor with a height of 0.4 cm and a diameter of 0.6 cm is mounted on a circuit board. The transistor is cooled by air flowing over it with an average heat transfer coefficient of 30 W/m2 · °C. If the air temperature is 55°C and the transistor case temperature is not to exceed 70°C, determine the amount of power this transistor can dissipate safely. Disregard any heat transfer from the transistor base.

**2–**Four power transistors, each dissipating 15 W, are a mounted on a thin vertical aluminum plate 22 cm \_ 22 cm in size. The heat generated by the transistors is to be dissipated by both surfaces of the plate to the surrounding air at 25°C, which is blown over the plate by a fan. The entire plate can be assumed to be nearly isothermal, and the exposed surface area of the transistor can be taken to be equal to its base area. If the average convection heat transfer coefficient is 25 W/m2·°C, determine the temperature of the aluminum plate. Disregard any radiation effects.

**52**

**HEAT TRANSFER**

**3-**A freezer compartment consists of a cubical cavity that is 2 m on a side .Assume the bottom to be perfectly insulated. What is the minimum thickness of Styrofoam insulation(k= 0.030 W/m. k ) that must be applied to the top and side walls to ensure a heat load of less than 500W , when the inner and outer surface are -10 and 35°C .

4- A 1000-W iron is left on the iron board with its base exposed to the air at 20°C. The convection heat transfer coefficient between the base surface and the surrounding air is 35 W/m2 · °C. If the base has an emissivity of 0.6 and a surface area of 0.02 m2, determine the temperature of the base of the iron.