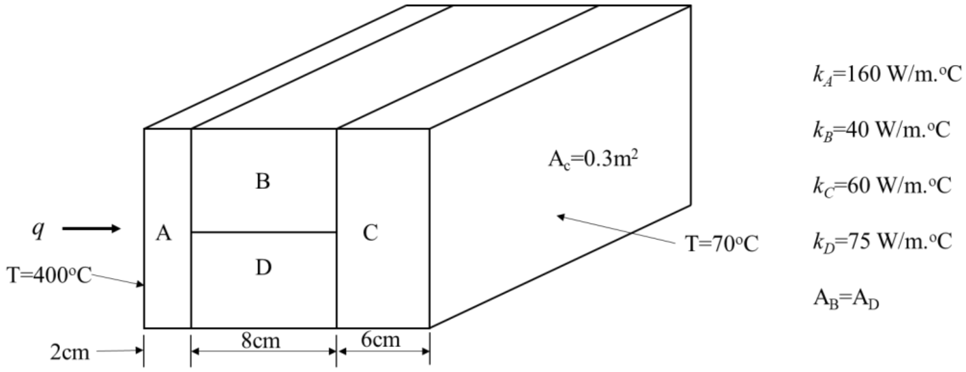
1. A 2.5cm thick solid block with a cross-sectional area of 0.2 m^2 has one side maintained at 35°C and the other at 100°C. The temperature at the center plane of the material is 66°C, and the rate of heat flow through the material is 2kW. Obtain an expression for the thermal conductivity of the material assuming a linear function of temperature.

2. Assuming one-dimensional heat flow, estimate the heat flux through the composite wall shown in Fig. 1. Is the assumption of 1d heat flow justified in this case.



3. One side of a copper block 6cm thick is maintained at 185°C. The other side is covered with a layer of fiberglass 2cm thick. The outside of the fiberglass layer is maintained at 80°C. For a heat flow rate of 250W through the composite slab, estimate the cross-sectional area of the slab normal to the direction of heat flow.

   Given: k_{copper} =386 W/m.°C and $k_{fiberglass}$ =0.035 W/m.°C.

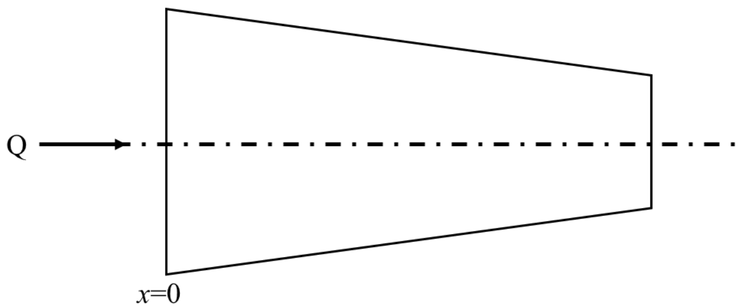
4. Heat flow occurs along the axis of a solid which has the shape of a truncated cone (see sketch) with circumferential surface insulated. The base is at 400°C and the area of the section at distance x measured from the base of the cone is given by

   $A = 1.5(1 - 1.7x)\ \mathrm{m}^2$, where x is in m.

   If the plane at x=0.3m is maintained at 150°C, determine

   a) Rate of heat flow
   b) Temperature at x=0.2m
   c) Temperature gradient at the two surfaces i.e. at x= and x=0.2m.

Given: k =2.5 W/m °C.



5. Consider a mass m of ice at the fusion temperature (T_F = 0^0C) that is enclosed in a cubical container of width (W) on a side. The container wall is of thickness L and thermal conductivity k. If the outer surface of the wall is heated to a temperature $T_1 > T_F$ to melt the ice, obtain an expression for the time needed to melt the entire mass of ice. State the assumptions.

6. A square silicon chip (k = W/m.K) is of width w = mm on a side and of thickness t = 1mm. The chip is mounted in a substrate such that its side and back surfaces are insulated while the front is exposed to a coolant. If 6W are being dissipated in circuits mounted to the back surface of the chip, what is the steady state temperature difference between back and front surfaces.

7. A thin silicon chip and an 8mm thick aluminium substrate are separated by a 0.02mm thick epoxy joint. The chip and substrate are 20mm on a side and their exposed surfaces are cooled by air which is at a temperature of 25^0C and provides a convection coefficient of 200W/(m2) K. If the chip dissipates heat at a rate 10^4 W/m^2 under normal conditions, will it operate below a maximum allowable temperature of 85^0C?
   Given: thermal conductivity of aluminium = 239W/m(K) and the contact resistance of silicon chip/epoxy joint = 0.9×10^{-4}m^{2}K/W

8. Determine the density, specific heat, and thermal conductivity of lightweight aggregate concrete that is composed of 65% stone mix concrete and 35% air by volume. Evaluate properties at T = 300K.