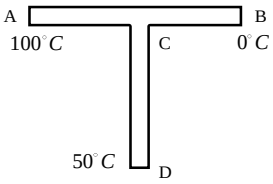
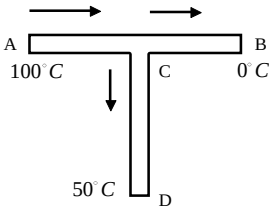
Let AB and CD be identical rods joined at the mid-point of AB forming the shape of T as shown in the figure. The ends A, B and D are maintained at 100°C, 0°C and 50°C respectively. Find the temperature of the junction C.



Solution

Consider the heat currents (power) shown by arrows in the figure below.



We have, $P_{AC} = P_{CB} + P_{CD}$

Or $\frac{\Delta Q_{AC}}{\Delta t} = \frac{\Delta Q_{CB}}{\Delta t} + \frac{\Delta Q_{CD}}{\Delta t}$

Or $\frac{T_A - T_C}{R_{AC}} = \frac{T_C - T_B}{R_{CB}} + \frac{T_C - T_D}{R_{CD}}$

Let thermal resistance of each rod be R.

$\therefore \frac{100 - T_C}{R/2} = \frac{T_C - 0}{R/2} + \frac{T_C - 50}{R}$

$\Rightarrow 200 - 2T_C = 2T_C + T_C - 50$

$\Rightarrow 250 = 5T_C$

$\Rightarrow T_C = 50^\circ C$

Note that since $T_C = T_D$, there would be no heat current through CD.