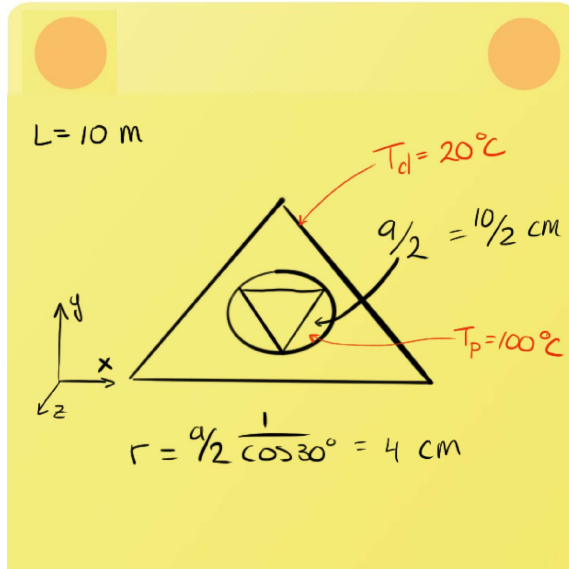


Exam Preparation - Radiation 1



Consider a circular pipe of radius $r = 4 \text{ cm}$ centered inside a triangular duct with all sides of the triangle $a = 10 \text{ cm}$. The pipe and duct have length $L = 10 \text{ m}$. The temperature of the duct is $T_d = 20^\circ\text{C}$ and the temperature of the pipe $T_p = 100^\circ\text{C}$. Both pipe and duct surfaces radiate as blackbodies.

- Determine the view factor Φ_{dp} from the duct to the pipe.
- Compute the *net* rate of heat transfer by radiation from the outside wall of the pipe to the inside wall of the duct.
- What is the maximum radius of the pipe that can fit in the duct ?

Circular pipe (p) in triangular duct (d)

$$T_p = 100^\circ\text{C}$$

$$T_d = 20^\circ\text{C}$$

$$r = 0.04 \text{ m}$$

$$a = 0.1 \text{ m}$$

$$\text{a) } \Phi_{pd} = 1$$

$$\Phi_{pp} = 0$$

$$A_d \Phi_{d \rightarrow p} = A_p \Phi_{p \rightarrow d}$$

$$\Phi_{dp} = \frac{A_p}{A_d} = \frac{\pi D L}{3 a L} = \frac{0.08 \pi}{0.03} = 0.834$$

$$\text{b) } \dot{Q} = A_p \Phi_{pd} (T_p^4 - T_d^4) = \pi D L \cdot 0.836 \cdot 5.67 \cdot 10^{-8} (373^4 - 293^4) = 567 \text{ W}$$

c) Max radius of pipe that fits in the duct: from center to middle of triangular side: $r_{max} = \frac{a}{2} \frac{1}{\cos(30^\circ)}$

$$a = 10 \text{ cm}$$

$$r_{max} = \frac{a}{\sqrt{3}} = 0.058 \text{ m}$$

