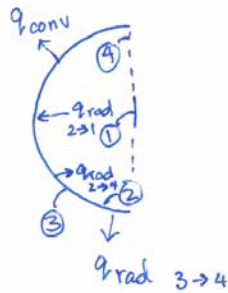
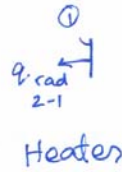


## Quiz 2 solution



Reflector

treat 4 as black body



Heater

$$\begin{aligned} \epsilon_2 = \epsilon_3 &= 0.6 \\ T_2 = T_3 &= ? \\ A_2 = A_3 &= 0.075\pi \\ A_1 &= 0.02 \\ \epsilon_1 &= 0.8 \\ F_{12} &= 1 \\ F_{24} &= 0.552 \\ F_{34} &= 1 \\ h &= 15 \text{ W/m}^2\text{K} \end{aligned}$$

① a) EB on Reflector:  $E_{in} = E_{out}$

$q_{2 \rightarrow 4}$ ,  $q_{3 \rightarrow 4} \rightarrow$  radiation to black body

$$\therefore q_{2 \rightarrow 4} = A_2 F_{24} \sigma \epsilon_2 (T_2^4 - T_4^4), \quad q_{3 \rightarrow 4} = A_3 F_{34} \sigma \epsilon_2 (T_2^4 - T_4^4)$$

$q_{rad 2 \rightarrow 1} \rightarrow$  net heat transfer between 2 gray bodies

$$E_{in} = E_{out} \quad (1 \text{ pt})$$

$$\frac{\sigma (T_1^4 - T_2^4)}{\frac{1 - \epsilon_1}{\epsilon_1 A_1} + \frac{1}{A_1 F_{12}} + \frac{1 - \epsilon_2}{\epsilon_2 A_2}} = A_2 F_{24} \sigma \epsilon_2 (T_2^4 - T_4^4) + A_3 F_{34} \sigma \epsilon_2 (T_2^4 - T_4^4) + 2A_2 h (T_2 - T_4) \quad (1 \text{ pt})$$

solve,  $T_2 = 559 \text{ K} \quad (1 \text{ pt})$

③ b) EB on heater:  $E_{gen} = E_{out} \quad (1 \text{ pt})$

$$\text{Power} = P_H = E_{gen}$$

$$P_H = \frac{\sigma (T_1^4 - T_2^4)}{\frac{1 - \epsilon_1}{\epsilon_1 A_1} + \frac{1}{A_1 F_{12}} + \frac{1 - \epsilon_2}{\epsilon_2 A_2}} = \boxed{3 \text{ kW}} \quad (1 \text{ pt})$$

(1 pt)