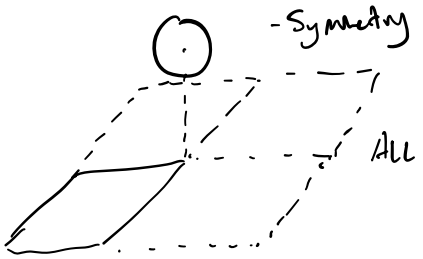
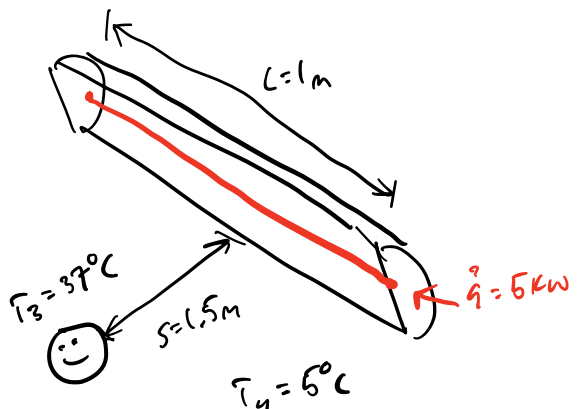
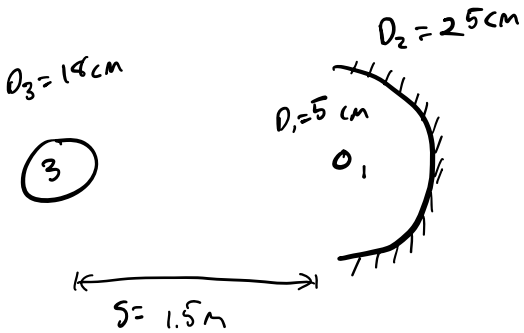


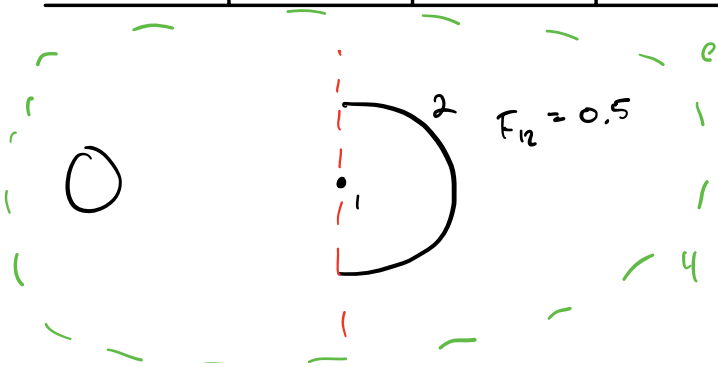




- All surfaces black bodies (ε=1)

a) Complete view factor table for surfaces + surroundings

F_{ij}	j=1	j=2	j=3	j=4
i=1	0 inspection	0.5 inspection	0.001087 reciprocity	0.4989 enclosure
i=2	0.2 reciprocity	0.3506 F20_8	0.001732 reciprocity	0.4477 enclosure
i=3	0.001677 F30_7	0.006683 F30_7	0 inspection	0.9916 enclosure
i=4	0 ← enclosure	0 → enclosure	0	1 hint



enclosure: $F_{41}+F_{42}+F_{43}+F_{44}=1$

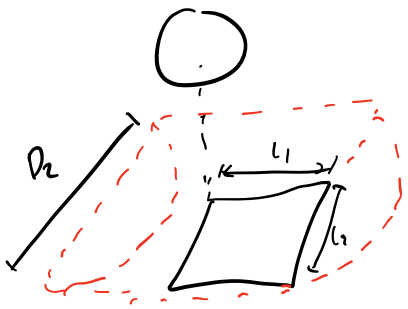
$F_{44}=1$ ∴ $F_{41}=F_{42}=F_{43}=0$

$F_{22} = F2D\_8(r_1, r_2)$ $= 0.5$

$A_2 F_{21} = A_1 F_{12} \Rightarrow F_{21} = \frac{A_1}{A_2} F_{12}$ $= 0.2$

F_{31}, F_{32}:

F_{32}:

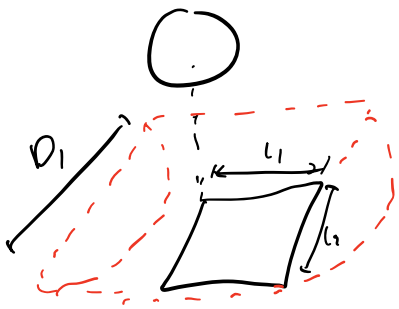


$= 4 \cdot F3D\_7(l_1, l_2, d, r) - F_{31}$

$l_1 = L/2$ $\quad d = S = 1.5m$

$l_2 = D_2/2$ $\quad r = D3/2$

F_{31}:



$= 4 \cdot F3D\_7(l_1, l_2, d, r)$

$l_1 = L/2$ $\quad d = S = 1.5m$

$l_2 = D_1/2$ $\quad r = D3/2$

$F_{13} = \frac{A_3 F_{31}}{A_1}$ $\qquad F_{23} = \frac{A_3 F_{32}}{A_2}$

b) Geometric resistances between heater & surfaces

$R^g_{12}, R^g_{13}, R^g_{23}$

$R^g_{ij} = \frac{1}{F_{ij} \cdot A_i} \left[\frac{1}{m^2}\right]$

→ ICE VALUES IN EES

c) $\dot{q}_i = \sum_{j=1}^{N} A_i F_{ij} \sigma (T_i^4 - T_j^4)$

$\dot{q}_{ij} = F_{ij} A_i \sigma (T_i^4 - T_j^4)$ → EES

d) max blackbody power @ what wavelength λ

$\lambda_{max} \cdot T_1 = 2898 \ \mu m \cdot K$

$= 3.204 \ \mu m$

e) Fraction of power visible (0.38-0.78 μm) from reactor shell

```
$Units SI K kPa J mass deg m

"part a"
L = 1[m]
S = 1.5[m]
T_3 = converttemp(C,K,37 [C])
T_4 = converttemp(C,K,5 [C])
q_dot_1 = 5 [kW]*convert(kW,W)
epsilon = 1 [-]
D_1 = 5 [cm]*convert(cm,m)
D_2 = 25 [cm]*convert(cm,m)
D_3 = 18 [cm]*convert(cm,m)
A_1 = pi#*D_1*L
A_2 = 0.5*pi#*D_2*L
A_3 = 4*pi#*(D_3/2)^2


F_1_1 = 0
F_1_2 = 0.5
F_1_3 = A_3/A_1*F_3_1
F_1_4 = 1 - F_1_1 - F_1_2 - F_1_3

F_2_1 = A_1/A_2*F_1_2
F_2_2 = f2d_8(D_1/2,D_2/2)
F_2_3 = A_3/A_2*F_3_2
F_2_4 = 1 - F_2_1 - F_2_2 - F_2_3

F_3_1 = 4*f3d_7(L/2,D_1/2,S,D_3/2)
F_3_2 = 4*f3d_7(L/2,D_2/2,S,D_3/2) - F_3_1
F_3_3 = 0
F_3_4 = 1 - F_3_1 - F_3_2 - F_3_3

F_4_1 = 0
F_4_2 = 0
F_4_3 = 0
F_4_4 = 1

"part b"
R|g_1_2 = 1/(F_1_2*A_1)
R|g_1_3 = 1/(F_1_3*A_1)
R|g_2_3 = 1/(F_2_3*A_2)


"part c"
E_b_1 = sigma#*T_1^4
E_b_2 = sigma#*T_2^4
E_b_3 = sigma#*T_3^4
E_b_4 = sigma#*T_4^4

q_dot_1 = A_1*F_1_2*(E_b_1-E_b_2) + A_1*F_1_3*(E_b_1-E_b_3) + A_1*F_1_4*(E_b_1-E_b_4)
q_dot_2 = A_2*F_2_1*(E_b_2-E_b_1) + A_2*F_2_3*(E_b_2-E_b_3) + A_2*F_2_4*(E_b_2-E_b_4)
//q_dot_3 = A_3*F_3_1*(E_b_3-E_b_1) + A_3*F_3_2*(E_b_3-E_b_2) + A_3*F_3_4*(E_b_3-E_b_4)
//q_dot_4 = A_4*F_4_1*(E_b_4-E_b_1) + A_4*F_4_2*(E_b_4-E_b_2) + A_4*F_4_3*(E_b_4-E_b_3)

q_dot_2 = 0

q_dot_spectator = A_1*F_1_3*(E_b_1-E_b_3) + A_2*F_2_3*(E_b_2-E_b_3)
```

heater_percentage = q_dot_spectator/q_dot_1

"part d"
lambda_max*T_1 = 2898 [micron-K]

"part e"
lambda_1 = 0.38 [micron]
lambda_2 = 0.78 [micron]
frac_heater = blackbody(T_1,lambda_1,lambda_2)
frac_shell = blackbody(T_2,lambda_1,lambda_2)

SOLUTION
Unit Settings: SI K kPa J mass deg

A_1 = 0.1571 [m^2]
A_2 = 0.3927 [m^2]
A_3 = 0.1018 [m^2]
D_1 = 0.05 [m]
D_2 = 0.25 [m]
D_3 = 0.18 [m]
ε = 1 [-]
$E_{b,1}$ = 37965 [W/m^2]
$E_{b,2}$ = 11928 [W/m^2]
$E_{b,3}$ = 524.7 [W/m^2]
$E_{b,4}$ = 339.4 [W/m^2]
$frac_{heater}$ = 0.000002113 [-]
$frac_{shell}$ = 5.158E-09 [-]
$F_{1,1}$ = 0
$F_{1,2}$ = 0.5
$F_{1,3}$ = 0.001087
$F_{1,4}$ = 0.4989
$F_{2,1}$ = 0.2
$F_{2,2}$ = 0.3506
$F_{2,3}$ = 0.001732
$F_{2,4}$ = 0.4477
$F_{3,1}$ = 0.001677
$F_{3,2}$ = 0.006683
$F_{3,3}$ = 0
$F_{3,4}$ = 0.9916
$F_{4,1}$ = 0
$F_{4,2}$ = 0
$F_{4,3}$ = 0
$F_{4,4}$ = 1
$heater_{percentage}$ = 0.00283 [-] {0.283 [%]}
L = 1 [m]
λ_1 = 0.38 [micron]
λ_2 = 0.78 [micron]
λ_{max} = 3.204 [micron]
$\dot{q}_1$ = 5000 [W]
$\dot{q}_2$ = 0 [W]
$\dot{q}_{spectator}$ = 14.15 [W]
$R^g_{1,2}$ = 12.73 [$1/m^2$]
$R^g_{1,3}$ = 5857 [$1/m^2$]
$R^g_{2,3}$ = 1470 [$1/m^2$]
S = 1.5 [m]
T_1 = 904.6 [K]
T_2 = 677.2 [K]
T_3 = 310.2 [K]
T_4 = 278.2 [K]

No unit problems were detected.

KEY VARIABLES

$R^g_{1,2}$ = 12.73 [$1/m^2$]	*b) geometric resistance*
$R^g_{1,3}$ = 5857 [$1/m^2$]	*b) geometric resistance*
$R^g_{2,3}$ = 1470 [$1/m^2$]	*b) geometric resistance*
$\dot{q}_{spectator}$ = 14.15 [W]	*c) q_dot_1_3 + q_dot_2_3, heat from heater to spectator and shield to spectator*
$heater_{percentage}$ = 0.00283 [-] {0.283 [%]}	*c) percentage of heater power to spectator*
λ_{max} = 3.204 [micron]	*d) wavelength for max emissive power*
$frac_{heater}$ = 0.000002113 [-]	*e) fraction of power visible for heater*
$frac_{shell}$ = 5.158E-09 [-]	*e) fraction of power visible from shell*