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ChEn 3453

HW #2

1) a) $q_x'' = \frac{-k}{L}(T_2 - T_1) = \frac{-100\ \frac{W}{mK}}{0.1\ m}(600-400)K = -200000\ \frac{W}{m^2}$

$\frac{dT}{dx} = \frac{T_2 - T_1}{x_2 - x_1} = \frac{600-400}{0.1} = 2000\ \frac{K}{m}$

b) $q_x'' = \frac{-100}{0.1}(T_1 - T_2) = \frac{-100}{0.1}(400-600) = 200000\ \frac{W}{m^2}$

$\frac{dT}{dx} = \frac{T_1 - T_2}{0.1} = \frac{400-600}{0.1} = -2000\ \frac{K}{m}$

c) $q_x'' = \frac{-100}{0.1}(600-400) = -200000\ \frac{W}{m^2}$

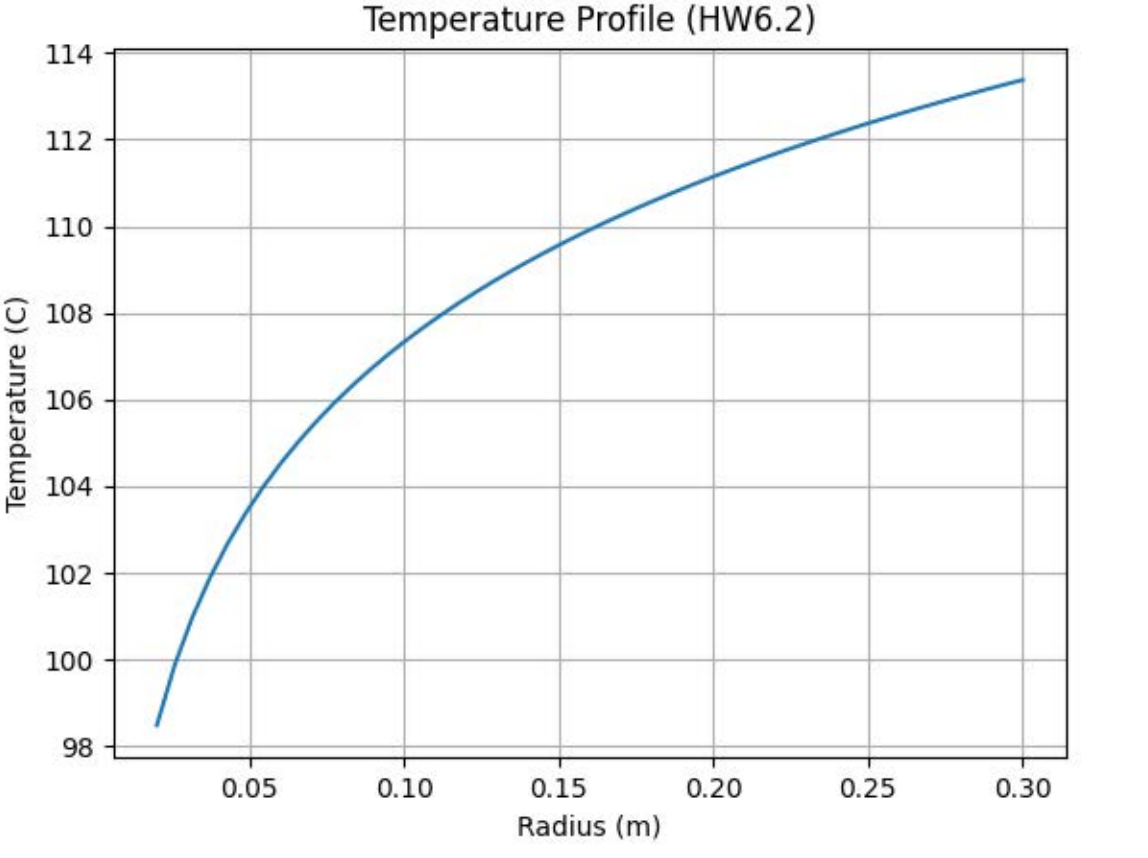
$\frac{dT}{dx} = \frac{600-400}{0.1} = 2000\ \frac{K}{m}$

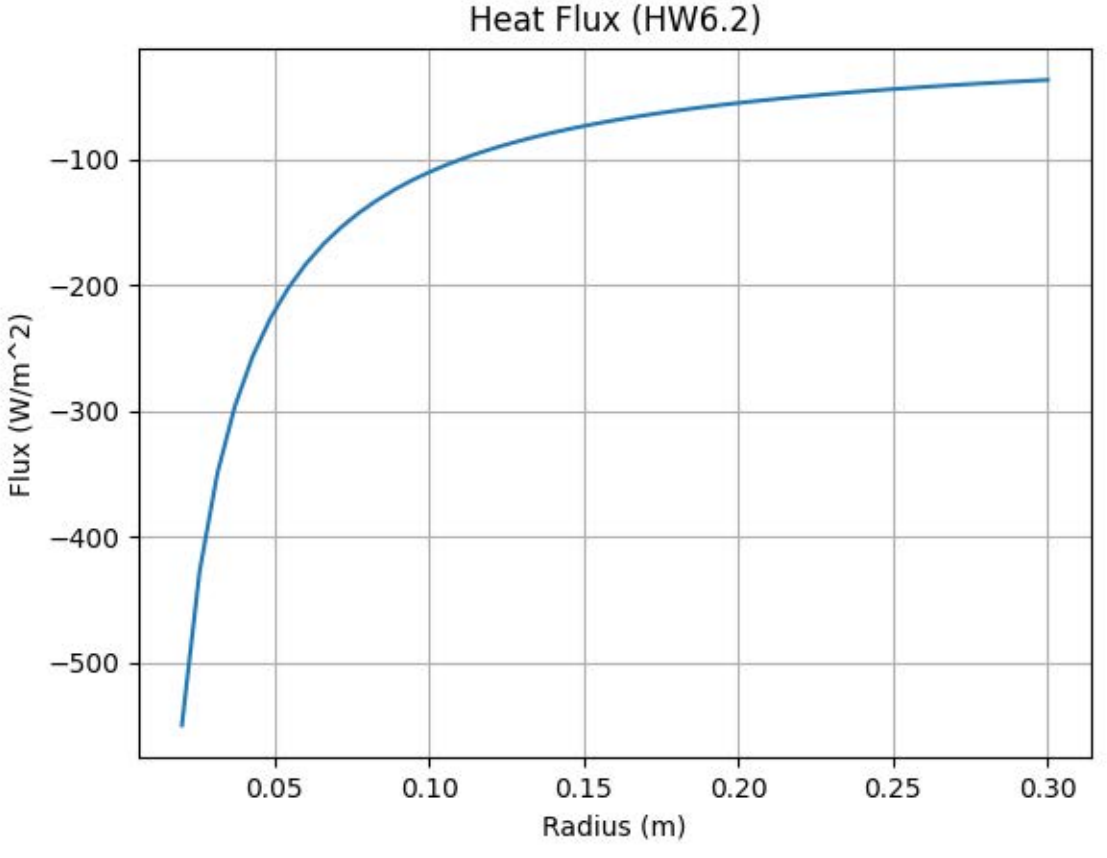
2a) $q_r'' = -k\frac{dT}{dr} = -k \cdot \frac{5.5}{r}$ @ 0.2 m

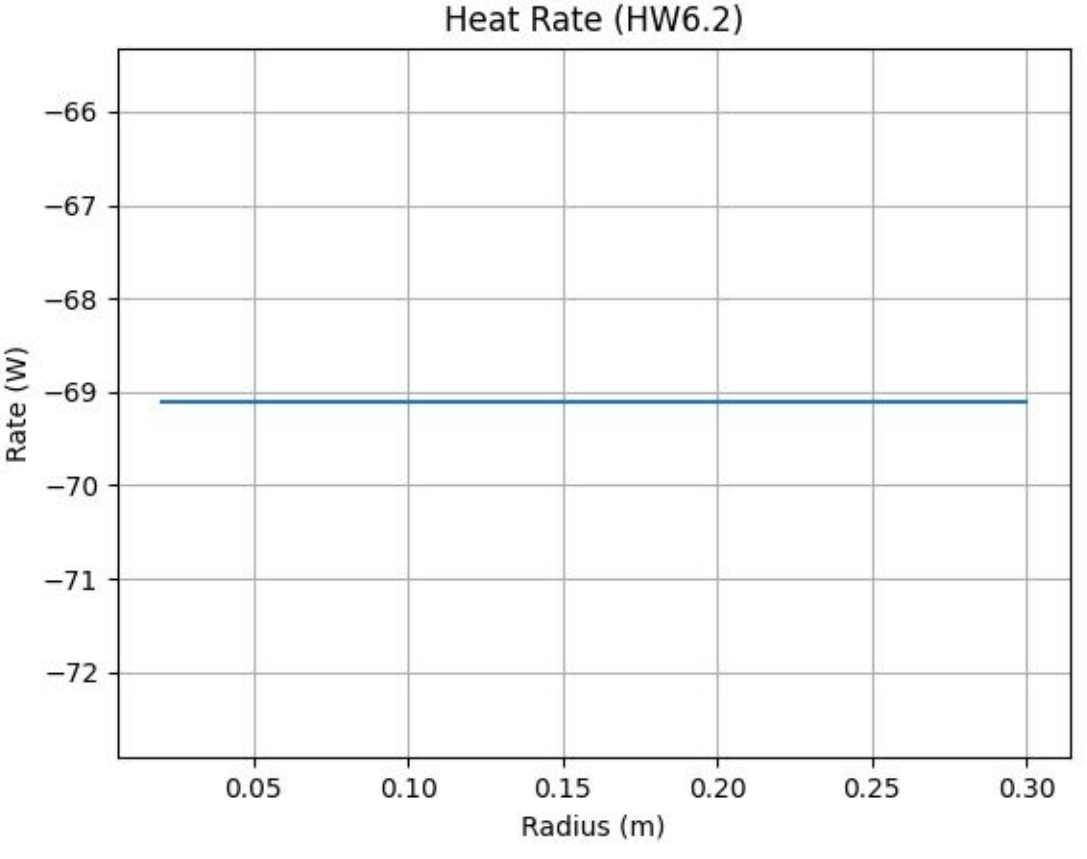
$q_r'' = -2 \cdot \frac{5.5}{0.2} = -55.0\ \frac{W}{m^2}$

b) $q_r = q_r'' A = q_r'' \cdot 2\pi r L = -55 \cdot 2\pi(0.2) \cdot 1 = -69.1\ W$

d) Heat flows towards origin


Temperature Profile (HW6.2)
Temperature (C)
Radius (m)
114
112
110
108
106
104
102
100
98
0.05
0.10
0.15
0.20
0.25
0.30


Heat Flux (HW6.2)
−100
−200
−300
−400
−500
Flux (W/m^2)
0.05
0.10
0.15
0.20
0.25
0.30
Radius (m)


Heat Rate (HW6.2)
−66
−67
−68
−69
−70
−71
−72
Rate (W)
0.05
0.10
0.15
0.20
0.25
0.30
Radius (m)

HW #2

3) $r = 0.30\ m$ $\quad k = 5\ \frac{W}{mK}$ $\quad T(r) = 500 - 100r^2 - 275r$

$\frac{dT}{dr} = -200r - 275$ $\quad q''_r = -k\frac{dT}{dr}$ $\quad q''_r A = q_r$

$q''_r = -5\frac{W}{mK}\left(-200(0.3) - 275\right) = 1675\ \frac{W}{m^2}$

$q_r = q''_r \cdot 4\pi r^2 = 1675 \cdot 4 \cdot \pi (0.3)^2 = \boxed{1.89 \times 10^3\ W}$

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4) $A = (0.3\ m)^2 = 0.09$ $\quad \Delta T = 80$ $\quad L = 0.01\ m$

Poly: $q''_x = -\frac{0.21\ \frac{W}{mK}\ (80)K}{0.01\ m} = -1680\ \frac{W}{m^2}$

$q_x = -1680 \cdot 0.09\ m^2 = -151.2\ W \rightarrow -0.1512\ kW$

$\rightarrow -0.1512\ kW \cdot 8\ hrs \cdot 130\ windows = \boxed{\$157.}$ loosing

Aerogel: $q''_x = -\frac{0.014\ \frac{W}{mK}\ (80)K}{0.01\ m} \cdot 0.09\ m^2 = -10.08\ W$

$= -0.01008\ kW \cdot 8\ hrs \cdot 130\ windows = \boxed{\$ -10.5}$

Glass: $k = 1.4$

$q_x = \frac{-1.4\ (80)}{0.01} \cdot 0.09 = -1008\ W = -1.008\ kW$

$-1.008\ kW \cdot 8\ hrs \cdot 130\ windows = \boxed{\$ -1048.}$

~~LO because loosing money~~

HW#2

5.) a) $q''_x = \frac{-50 \frac{W}{mK}}{0.25\,m}(-20-50)K = \boxed{14000 \frac{W}{m^2} = q''}$

$\frac{dT}{dx} = \frac{-20-50}{0.25} = \boxed{-280 \frac{K}{m}}$

b) $q'' = \frac{-50}{0.25}(-10+30) = \boxed{-4000 \frac{W}{m^2} q''}$ $\frac{dT}{dx} = \frac{-10+30}{0.25} = \boxed{80 \frac{K}{m}}$

c) $\frac{dT}{dx} = 160 = \frac{T_2 - 70}{0.25} \rightarrow T_2 = 0.25(160)+70 = \boxed{110°C\ T_2}$

$q'' = \frac{-50}{0.25}(110-70) = \boxed{-8000 \frac{W}{m^2} = q''}$

d) $\frac{dT}{dx} = -80 = \frac{40-T_1}{0.25} \rightarrow T_1 = -[0.25(-80)-40] = \boxed{60\ °C}$

$q'' = \frac{-50}{0.25}(-20) = \boxed{4000 \frac{W}{m^2}}$

e) $\frac{dT}{dx} = 200 = \frac{30-T_1}{0.25} \rightarrow T_1 = -[0.25(200)-30] = \boxed{20\ °C}$

$q'' = \frac{-50}{0.25}(30-20) = \boxed{-2000 \frac{W}{m^2}}$

Case	Heat flux direction
1	left → right
2	right → left
3	right → left
4	left → right
5	right → left

HW # 2

6.) b.) $q_r'' = -k \nabla T = -k \frac{dT}{dr}$

$T(r) = \frac{200 - 50}{\ln\left(\frac{0.1}{0.5}\right)} \ln\left(\frac{r}{0.5}\right) + 50$

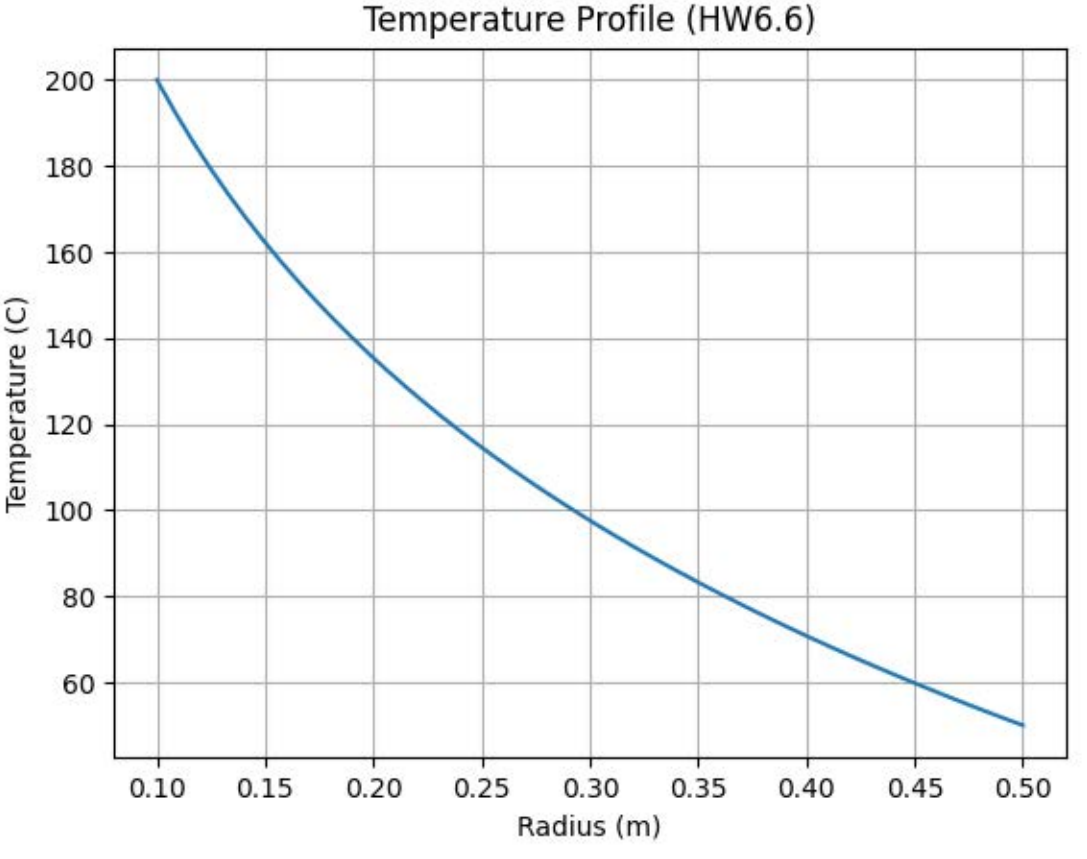
$\frac{dT}{dr} = \frac{150}{\ln(0.2)} \cdot \frac{1}{r} = \frac{-93.2}{r}$

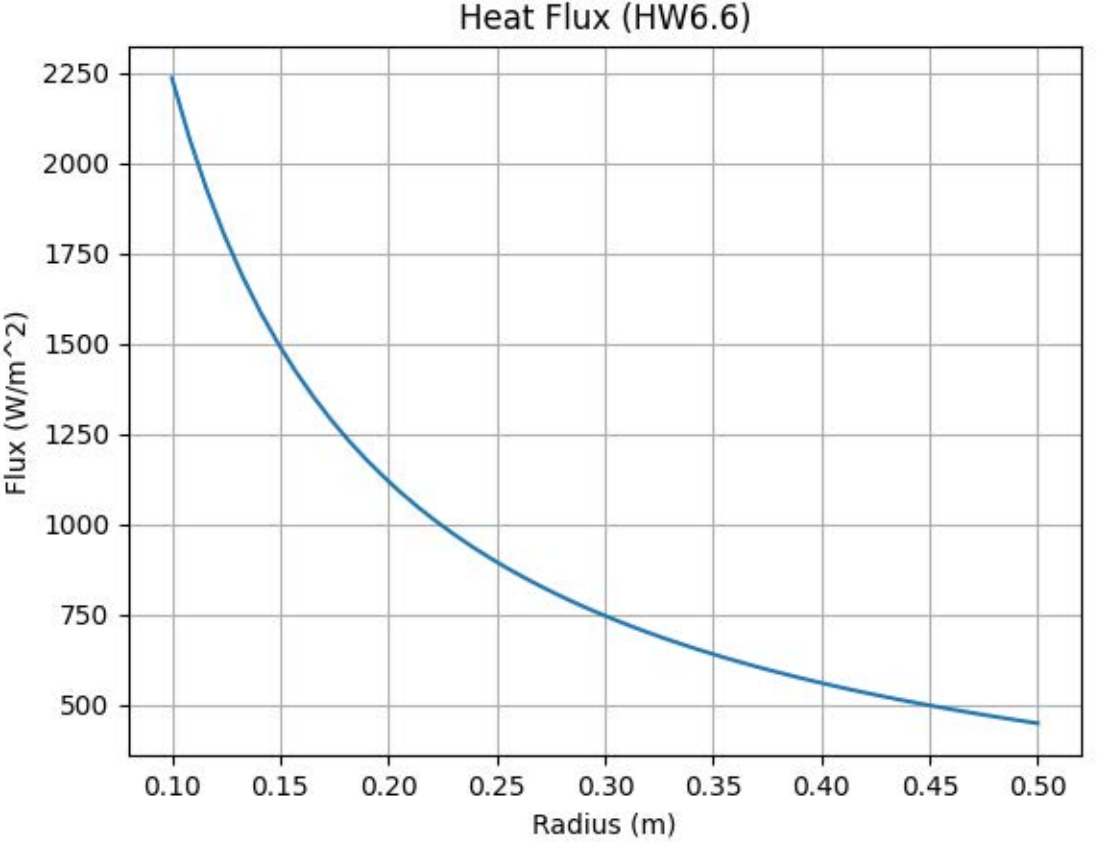
$\therefore \boxed{q_r'' = -2.4 \frac{W}{mK} \cdot \frac{-93.2}{r}}$

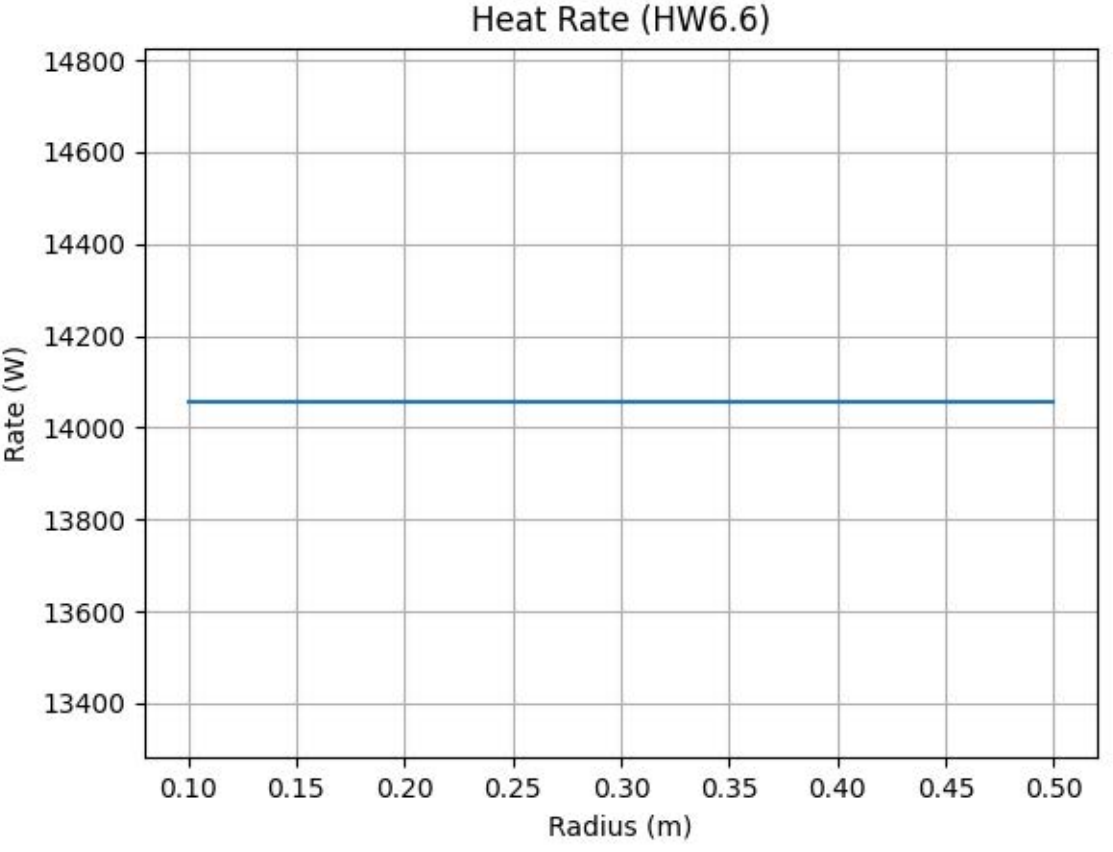
d) $q_r = q_r'' \cdot 2\pi r L = -2.4 \frac{W}{mK} \cdot \frac{-93.2}{r} \cdot 2\pi r L$

$q_r = -2.4 \frac{W}{mK} \cdot -93.2 \cdot 2\pi L$

$\boxed{q_r = 14054 \text{ W}}$


Temperature Profile (HW6.6)
Temperature (C)
200
180
160
140
120
100
80
60
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Radius (m)


Heat Flux (HW6.6)
Flux (W/m^2)
2250
2000
1750
1500
1250
1000
750
500
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Radius (m)


Heat Rate (HW6.6)
14800
14600
14400
14200
14000
13800
13600
13400
Rate (W)
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Radius (m)