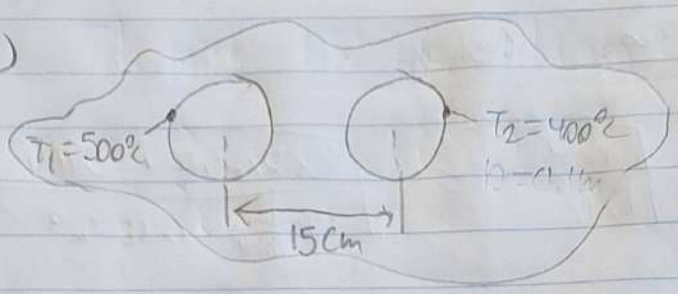
Ch4

HW1.3 - 47, 51, 54, 56

47)



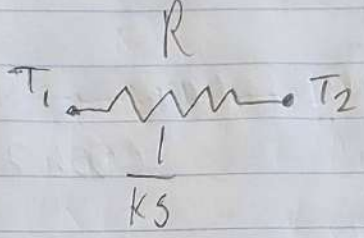
$D = 0.1m$

$L = 8m$

$K = 1 \frac{W}{m \cdot °C}$

$W = 0.15m$

$Q = ?$



$$Q = \frac{\Delta T}{R}$$

Case 4

$$S = \frac{2\pi L}{\cosh^{-1}\left(\frac{4W^2 - D_1^2 - D_2^2}{2D_1 D_2}\right)}$$

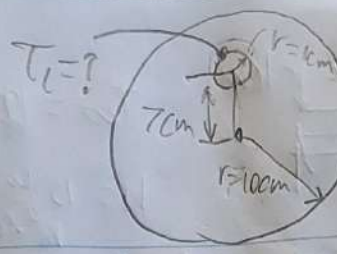
$$S = \frac{2\pi (8m)}{\cosh^{-1}\left(\frac{4 \cdot 0.15m^2 - 0.1m^2 - 0.1m^2}{2(0.1m)(0.1m)}\right)}$$

$$S = 26.11\ m$$

$$Q = KS\Delta T$$

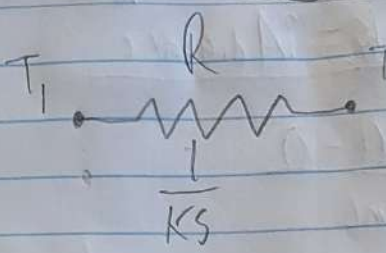
$$Q = 1 \frac{W}{m \cdot °C} \cdot 26.11m\ (500°C - 400°C)$$

$$Q = 2611\ W$$



$q = 100 \frac{W}{m}$

51.



$D = 20cm = 0.2m$

$d = 2cm = 0.02m$

$z = 7cm = 0.07m$

$$Q = \frac{\Delta T}{R}$$

$$S = \frac{2\pi L}{\cosh^{-1}\left(\frac{D^2 + d^2 - 4z^2}{2Dd}\right)}$$

$$S = \frac{2\pi \cdot 1m}{\cosh^{-1}\left(\frac{0.2m^2 + 0.02m^2 - 4 \cdot 0.07m^2}{2 \cdot 0.2m \cdot 0.02m}\right)}$$

$S = 3.9m$ Concrete $K = 0.76 \frac{W}{m \cdot °C}$

$q = 100 \frac{W}{m}$

$Q = q \cdot L$

$Q = 100 \frac{W}{m} \cdot 1m$

$Q = 100W$

$Q = KS\Delta T$

$100W = 0.76 \frac{W}{m \cdot °C} \cdot 3.9m \cdot (T_1 - 25°C)$

$100W = 2.97 \frac{W}{°C} (T_1 - 25°C)$

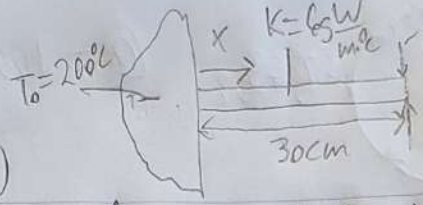
$33.7°C = T_1 - 25°C$

$T_1 = 58.7°C$

$T_{x=2cm} = ?$

$T_{x=10cm} = ?$

54)



$T_\infty = 20°C$

$h = 15 \frac{W}{m^2 \cdot °C}$

Assuming tip is Adiabatic

$\theta = T_x - T_\infty$

$\theta_0 = T_0 - T_\infty$

$$\frac{\theta}{\theta_0} = \frac{\cosh m(L-x)}{\cosh mL}$$

$$m^2 = \frac{hP}{KA} \qquad m = \sqrt{\frac{hP}{Ka}} = \sqrt{\frac{h \cdot \pi \cdot D}{K \cdot \frac{\pi}{4} \cdot D^2}}$$

$$m = \sqrt{\frac{h \cdot 4}{KD}} = \sqrt{\frac{15 \, W/m^2 \cdot °C \cdot 4}{65 \frac{W}{m \cdot °C} \cdot 0.01m}} = 9.61m$$

$$\frac{T_x - T_\infty}{T_0 - T_\infty} = \frac{\cosh m(L-x)}{\cosh mL}$$

x = 20cm

$$\frac{T_x - 20°C}{200°C - 20°C} = \frac{\cosh 9.61m\,(0.3m - 0.2m)}{\cosh 9.61m \cdot 0.3m}$$

$$\frac{T_x - 20°C}{200°C - 20°C} = 0.167$$

$$T_{x=2cm} = 50.11°C$$

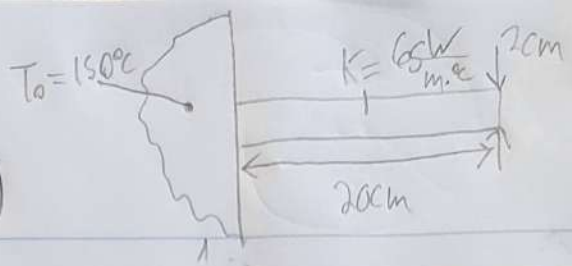
x = 10cm

$$\frac{T_x - 20°C}{200°C - 20°C} = \frac{\cosh 9.61m\,(0.3m - 0.1m)}{\cosh 9.61m \cdot 0.3m}$$

$$\frac{T_x - 20°C}{200°C - 20°C} = 0.39$$

$$T_{x=10cm} = 90.12°C$$

5(6)



$T_\infty = 20°C$

$h = 15 \frac{W}{m^2.°C}$

$Q = ?$

Assuming Tip is Adiabatic

$$Q_{fin} = M \tanh mL$$

$$M = \sqrt{hP.KA}\ \theta_0 \qquad \theta_0 = T_0 - T_\infty$$

$$M = \sqrt{h \cdot \pi \cdot D \cdot K \cdot \frac{\pi}{4} \cdot D^2}\ (T_0 - T_\infty)$$

$$M = \sqrt{h \cdot \frac{\pi^2}{4} \cdot D^3 \cdot K}\ (T_0 - T_\infty)$$

$$M = \sqrt{15 \frac{W}{m^2.°C} \cdot \frac{\pi^2}{4} \cdot 0.02m^3 \cdot 65 \frac{W}{m.°C}}\ (150°C - 20°C)$$

$$M = 18.03$$

$$m = \sqrt{\frac{hP}{KA}} = \sqrt{\frac{h.4}{KD}} = \sqrt{\frac{15 \frac{W}{m^2.°C} \cdot 4}{65 \frac{W}{m.°C} \cdot 0.02m}}$$

$$m = 6.79$$

$$Q_{fin} = 18.03 \tanh 6.79 \cdot 0.2m$$

$$Q_{fin} = 15.8\ W$$