MINI EXAM III
2NOV07
SOLN

1. $Q = m \hat{C}_p \Delta T$

$$= \left(\frac{4.9\,\text{kg}}{5}\right)\left(\frac{4.102\,\text{kJ}}{\text{kg}\,^\circ\text{C}}\right)(50-25)\,^\circ\text{C}$$

$$= 502.495\ \text{kW}$$

$$= \boxed{5.0 \times 10^2\ \text{kW} \quad (2\ \text{SIG FIGS})}$$

— or —

$$Q = U A \Delta T_{lm}$$

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

$\Delta T_1 = 45 - 25 = 20\,^\circ\text{C}$

$\Delta T_2 = 63 - 50 = 13\,^\circ\text{C}$

$$\Delta T_{lm} = \left(\frac{20 - 13}{\ln \frac{20}{13}}\right)^{\circ}C$$

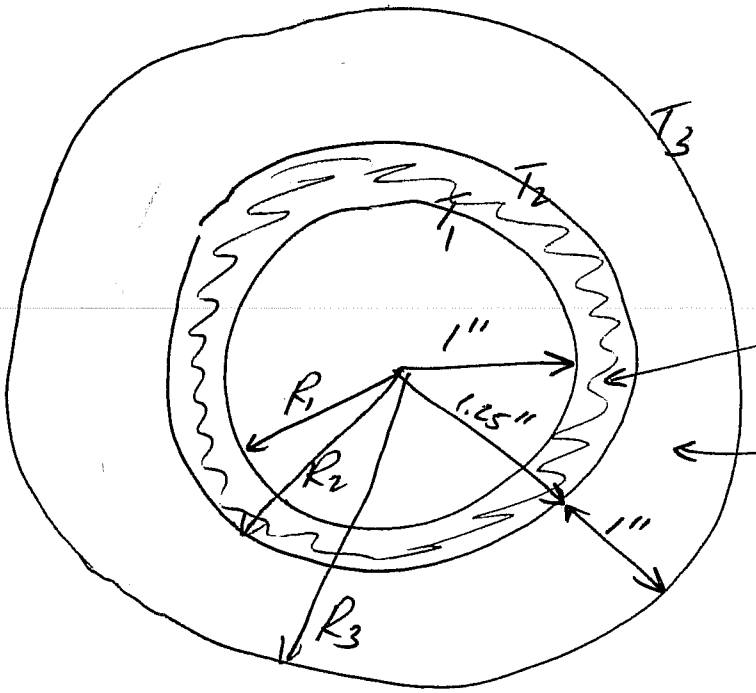
$$\boxed{\Delta T_{lm} = 16.24948\,^{\circ}C}$$

$$Q = \left(\frac{896\ W}{m^2 \cancel{K}}\right)(34.5\ m^2)(16.24948\ \cancel{K})$$

$$= 502,304\ W$$

$$= \boxed{5.0 \times 10^2\ KW} \quad \text{2 SIG FIGS}$$

2.



$k_1 = 26.0 \frac{BTU}{h\,Ft\,^oF}$

$k_2 = 0.100 \frac{BTU}{h\,Ft\,^oF}$

$R_1 = 1"$ $\quad T_1 = 212.00\,^oF$

$R_2 = 1.25"$ $\quad T_2 = 211.82\,^oF$

$R_3 = 2.25"$ $\quad T_3 = ?$ $\Leftarrow$ FIND

Heat conduction in an annulus:

$$\frac{q_r}{A} = \frac{k\left(T_{1_{inner}} - T_{2_{outer}}\right)}{\ln \frac{R_{2_{outer}}}{R_{1_{inner}}}} \frac{1}{r}$$

(from the notes)

at $r = R_2$ on the steel side:

$$\left.\frac{q_r}{A}\right|_{\substack{r=R_2 \\ \text{steel}}} = \frac{k_1 (T_1 - T_2)}{\ln\left(\frac{R_2}{R_1}\right)} \frac{1}{R_2}$$

at $r = R_2$ on the asbestos side:

equal

$$\left.\frac{q_r}{A}\right|_{\substack{r=R_2 \\ \text{asbestos}}} = \frac{k_2 (T_2 - T_3)}{\ln\left(\frac{R_3}{R_2}\right)} \frac{1}{R_2}$$

$$\frac{k_1 (T_1 - T_2)}{\ln \frac{R_2}{R_1}} \frac{1}{R_2} = \frac{k_2 (T_2 - T_3)}{\ln \frac{R_3}{R_2}} \frac{1}{R_2}$$

solve for T_3

$$\frac{\ln \frac{R_3}{R_2}}{\ln \frac{R_2}{R_1}} \frac{k_1}{k_2} (T_1 - T_2) = (T_2 - T_3)$$

$$T_2 - T_3 = \frac{\ln\left(\frac{2.25}{1.25}\right)}{\ln\left(\frac{1.25}{1}\right)} \left(\frac{24.0}{0.100}\right)\left(212 - 211.82\right)^\circ F$$

$$= \frac{0.587787}{0.223143} (240)(0.18)^\circ F$$

$$T_2 - T_3 = 123.277$$

$$T_3 = 211.82 - 123.277$$

$$T_3 = 88.54^\circ F$$

$$\boxed{T_3 = 88.5^\circ F} \quad 3 \text{ SIG FIGS}$$

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