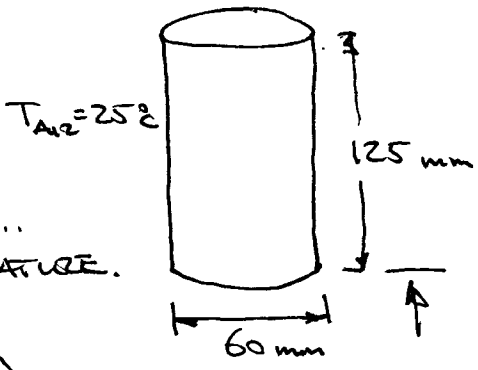
#2 - SOLUTION.

a) $T_i = 3°C$, $T_f = 10°C$

$h = 10\ W/m^2 \cdot °C$ ← ONLY INSULATION



AS ITS LIQUID ...
ASSUME WELL MIXED AND ...
UNIFORM INTERNAL TEMPERATURE.

ASSUME ITS ON A WELL INSULATED TABLE.

$$A_s = \pi DL + \frac{\pi D^2}{4}$$
$$= \pi(0.06)(0.125) + \frac{\pi(0.06)^2}{4}$$
$$= 0.0264\ m^2$$

$$V = \frac{\pi D^2}{4} L = \frac{\pi(0.06)^2}{4} \times 0.125$$
$$= 3.53 \times 10^{-4}\ m^3$$

$\rho = 999.9\ kg/m^3$

$C_p = 4205\ J/kg \cdot °C$

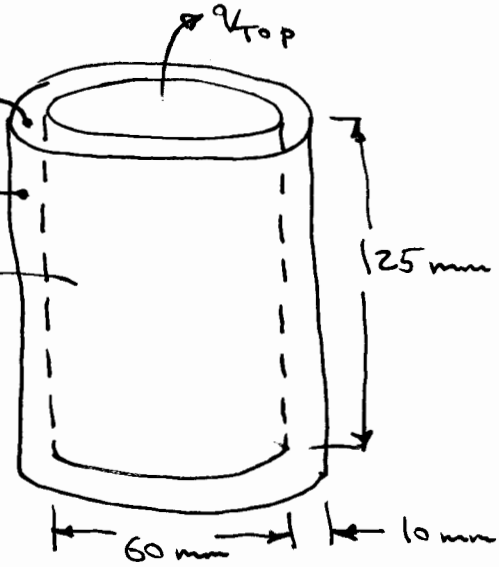
$$b = \frac{hA_s}{\rho V C_p} = \frac{(10)(0.0264)}{(999.9)(3.53\times10^{-4})(4205)}$$
$$= 1.779 \times 10^{-4}$$

So $$t = \frac{\ln\left[\frac{T(t) - T_\infty}{T_i - T_\infty}\right]}{-b} = \frac{\ln\left[\frac{10-25}{3-25}\right]}{-1.779} = \frac{-0.383}{-1.779\times10^{-4}}$$

$$= 2153.2\ s$$

$$\boxed{t = 35.9 \text{ minutes}}$$

#2 - SOLUTION (CONTINUED).



b) INSULATION: $k = 0.13\ W/m.^\circ C$

$$A_{TOP} = \frac{\pi D^2}{4} = \frac{\pi (0.06)^2}{4} = 0.00283\ m^2$$

$$A_{SIDES} = \pi DL = \pi (0.06 + 2(0.01)(0.125)$$
$$= 0.0314\ m^2$$

RECALL: $\dot{q} = \frac{\Delta T}{R_o}$ SO FIND OVERALL R_o

$$R_{TOP} = \frac{1}{hA} = \frac{1}{(10)(0.00283)} = 42.02\ \frac{^\circ C}{W}$$

$$R_{SIDES} = \frac{1}{hA} + \frac{\ln(r_2/r_1)}{2\pi k L}$$ ← ITS A CYLINDER

$r_2 = 30 + 10 = 40$ mm

$r_1 = 30$ mm.

$$= \frac{1}{(10)(0.0314)} + \frac{\ln(40/30)}{2\pi(0.13)(0.125)}$$

$$= 3.185 + 2.817$$

$$= 6.00$$

$$R_o = \frac{1}{\frac{1}{R_{TOP}} + \frac{1}{R_{SIDES}}} = \underline{5.25}\ \frac{^\circ C}{W}$$

NOW NOTE IN ... $b = \frac{hA_s}{\rho U C_p}$ ← R

IT IS ASSUMED THAT THE ONLY INSULATION IS h AND THAT $R = \frac{1}{hA}$

SO ... $\boxed{b = \frac{1}{R \times \rho U C_p}}$

IN OUR CASE THEN ... $b = \frac{1}{(5.25)(999.9)(353 \times 10^{-4})(4205)}$.

$$= 1.28 \times 10^{-4}$$

SO $t = \frac{-0.383}{-1.28 \times 10^{-4}}$ ← FROM PAGE (1).

$$= 2984.4\ s$$

$\boxed{t = 49.74\ \text{minutes.}}$