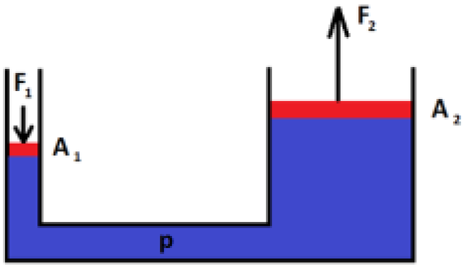
Q1.



Since we have: $F_2 = P = mg = 2000 \times 9.8 = 19600$ (N)
Pascal's principle:

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \rightarrow F_1 = \frac{F_2 A_1}{A_2} = \frac{F_2(\pi d_1^2/4)}{\pi d_2^2/4} = \frac{d_1^2 F_2}{d_2^2} = \frac{2^2 \times 19600}{24^2} = 136.11 \text{ (N)}$$

Q2.

Equation of continuity:

$$A_1 v_1 = A_2 v_2 \rightarrow v_2 = \frac{A_1 v_1}{A_2} = \frac{\pi \times 2^2 \times 0.5}{\pi \times 1^2} = 2 \text{ (m/s)}$$

Bernoulli's equation:

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

$$\leftrightarrow 3 \times 10^5 + \frac{1}{2} \times 1000 \times 0.5^2 + 0 = p_2 + \frac{1}{2} \times 1000 \times 2^2 + 1000 \times 9.8 \times 5$$

$$\rightarrow p_2 = 2.49 \times 10^5 \text{ (Pa)}$$

Q3.

Given that: $\alpha = 14.2 \times 10^{-6}$ (K^{-1}) $\rightarrow \beta = 3\alpha = 42.6 \times 10^{-6}$ (K^{-1})
We have:

$$\rho_0 = \frac{m}{V_0}$$

$$\rightarrow \rho = \frac{m}{V} = \frac{m}{V_0(1 + \beta\Delta T)} = \frac{\rho_0}{1 + \beta\Delta T} = \frac{19.3}{1 + 42.6 \times 10^{-6}(90 - 20)} = 19.24 \text{ (g/cm}^3\text{)}$$

Q4.

T_M: temperature at the point which is 20 cm from the hot end (L_1)

$$P_{cond} = kA\frac{T_H - T_L}{L} = kA\frac{T_H - T_M}{L_1}$$

$$\rightarrow \frac{100 - 40}{60} = \frac{100 - T_M}{20} \rightarrow T_M = 80 \text{ (°C)}$$

Q5.

Given that: $Q_{AB} = 150$ (J); $Q_{BD} = 600$ (J)

$$W_{ABD} = W_{AB} + W_{BD} = 0 + 80 \times (0.005 - 0.002) \times 10^3 = 240 \text{ (J)}$$

$$\rightarrow \Delta E_{ACD} = \Delta E_{ABD} = Q_{ABD} - W_{ABD} = (150 + 600) - 240 = 510 \text{ (J)}$$

$$W_{ACD} = W_{AC} + W_{CD} = 30 \times (0.005 - 0.002) \times 10^3 + 0 = 90 \text{ (J)}$$

$$\rightarrow Q_{ACD} = \Delta E_{ACD} + W_{ACD} = 510 + 90 = 600 \text{ (J)}$$