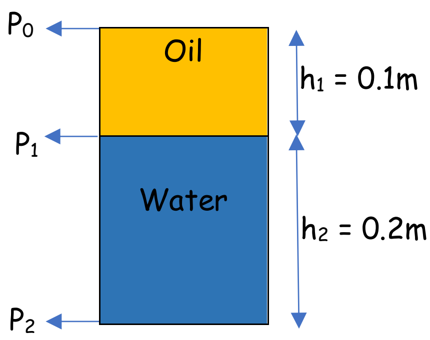
Solution 4.2019:

Problem 1:



At the interface: $P_1 = P_0 + \rho_{oil}gh_1$ (1)
At the bottom: $P_2 = P_1 + \rho_{water}gh_2$ (2)
(1) and (2)
=> $P_2 = P_1 + \rho_{water}gh_2 = P_0 + \rho_{oil}gh_1 + \rho_{water}gh_2$
=> Gauge Pressure: $P_g = \rho_{oil}gh_1 + \rho_{water}gh_2$
$\rho_{oil} = 0.6\rho_{water}$ => $P_g = (0.6h_1 + h_2)\cdot g\cdot \rho_{water}$
=> $P_g = (0.6\cdot 0.1+0.2)\cdot 9.8\cdot 1000 = 2548$ Pa
Gauge pressure at the bottom is 2548Pa

Problem 2:
d: diameter
d' = d/3 => r' = r/3 => $\pi(r')^2 = \pi(r/3)^2$ => A' = A/9 => $\frac{A}{A'} = 9$
Av = const => A'v' = Av => $v' = \frac{A}{A'}\cdot v = 9v = 9\cdot 4 = 36$ m/s
Flow speed at this section is 36 m/s

Problem 3:
Heat flow rate $P = \frac{kA\Delta T}{L}$
Steady state => $P_1 = P_2 = P_3 = P_4 = P_5 \Rightarrow \frac{k_1A_1\Delta T_1}{L_1} = \frac{k_2A_2\Delta T_2}{L_2} = \frac{k_3A_3\Delta T_3}{L_3} = \frac{k_4A_4\Delta T_4}{L_4} = \frac{k_5A_5\Delta T_5}{L_5}$

We have $L_1 = L_2 = L_3 = L_4 = L_5$ and $A_1 = A_2 = A_3 = A_4 = A_5$

=> $k_1\Delta T_1 = k_2\Delta T_2 = k_3\Delta T_3 = k_4\Delta T_4 = k_5\Delta T_5$ => $6k_1 = 5k_2 = 4k_3 = 7k_4 = 8k_5$
=> If we let $k_1 = 1$ => $k_2 = 1.2$; $k_3 = 1.5$; $k_4 = 0.86$; $k_5 = 0.75$ => k_5 is the smallest.
=> Slab 5 has the smallest thermal conductivity.

Problem 4:
Linear expansion from 7.10 m at 20°C to 7.20 m at 90°C:
$\Delta L = L_0\alpha\Delta T$ <=> $7.20-7.10 = 7.10\cdot\alpha\cdot(90-20)$
=> $\alpha = 2\times 10^{-4}$/°C
Temperature at length 7.05 after linear expansion from 7.10 m at 20°C:
$\Delta L = L_0\alpha\Delta T$ <=> $7.05-7.10 = 7.10\cdot 2\times 10^{-4}\cdot(T-20)$
=> T ≈ -15°C
Temperature at length 7.05 is about -15°C.

Problem 5:
(a) *Cyclic process => There is no change in internal energy. => ΔU = 0 J*
(b) Work is the area within the cycle: $W = \frac{1}{2}\cdot(80-20)\cdot(4-2)$ =60 J
From Figure 2:

Area under the line BC is smaller than area under the line AC => $W_{BC} < W_{CA}$
The gas expands from B to C then compresses from C to A (A to B is isobaric the volume is constant)
Therefore, the gas is compressed in one cycle.
=> Net work done by the gas is negative *=> $W_{donebygas}$ = -60 J*
(c) We have 2nd law of thermal dynamics: $\Delta U = Q - W$
Q here is heat transferred into the system, W is work done by the system.
From ***(a)*** we have $\Delta U = 0$ J
From ***(b)*** we have W done by gas is -60 J
=> $Q = \Delta U + W = 0 - 60 = -60$ J.
=> Heat transferred into the gas is -60 J. Heat
Therefore, heat transferred out of the gas is 60 J.

Answer 4.2019:

1/ 2548 Pa
2/ 36 m/s
3/ slab 5. Explain: …
4/ about -15°C
5/ (a) $\Delta U = 0$ J ***(b)*** $W_{donebygas} = -60$ J ***(c)*** $Q_{out} = 60$ J