Q1.

a)

For a floating object:

$$F_b = P \rightarrow \rho_{water} g V_{sub} = mg \rightarrow \rho_{water} g \left(\frac{1}{3}V\right) = \rho_{wood} V g$$

$$\rightarrow \rho_{wood} = \frac{1}{3}\rho_{water} = 333.33\ (\text{kg/m}^3)$$

b)

For a floating object:

$$F_b = P \rightarrow \rho_{sea} g V_{sub} = mg \rightarrow \rho_{sea} g (0.32V) = \rho_{wood} V g$$

$$\rightarrow \rho_{sea} = \frac{1}{0.32}\rho_{wood} = 1041.67\ (\text{kg/m}^3)$$

Q2.

a)

Bernoulli's equation:

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

$$\leftrightarrow 1.01 \times 10^5 + \frac{1}{2} \times 1000 \times 2^2 + 0 = p_2 + \frac{1}{2} \times 1000 \times 7^2 + 1000 \times 9.8 \times 5$$

$$\rightarrow p_2 = 49.75\ (\text{kPa})$$

b)

$$R_v = Av = \pi r^2 v \rightarrow r = \sqrt{\frac{R_v}{\pi v}}$$

For the ground:

$$r_1 = \sqrt{\frac{0.01}{\pi \times 2}} = 4\ (\text{cm})$$

For the first floor:

$$r_2 = \sqrt{\frac{0.01}{\pi \times 7}} = 2.1\ (\text{cm})$$

Q3.

Ice: 0°C (solid) $\overset{Q_1}{\rightarrow}$ 0°C (liquid) $\overset{Q_2}{\rightarrow}$ 40°C

Water: 100°C $\overset{Q_3}{\rightarrow}$ 40°C (liquid)

Thermal equilibrium equation:

$$\sum Q = 0 \leftrightarrow Q_1 + Q_2 + Q_3 = 0$$

$$\leftrightarrow L_F m_{ice} + m_{ice} c_w (40 - 0) + m_w c_w (40 - 100) = 0$$

$$\leftrightarrow 333 \times 10^3 \times 0.16 + 0.16 \times 4190 \times 40 + m_w \times 4190(-60) = 0$$

$$\leftrightarrow m_w = 0.32\ (\text{kg})$$

Q4.

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

Since, P_{cond} is equally for all slabs, therefore, the smaller of thermal conductivity, the bigger different temperature of two side of the slab we have.

Thus the fourth slab has biggest different temperature which corresponding to the smallest thermal conductivity.

Q5.

a)

For a closed cycle $\Delta E_{int} = 0$

b)

$$\Delta E_{inc} = Q_{net} - W_{net} = 0 \rightarrow Q_{net} = W_{net}$$

For a clockwise cycle:

$$W_{net} = \frac{1}{2}BC.CA = \frac{1}{2}(p_A - p_C)(V_B - V_C) = \frac{1}{2}(2-1)(3-1) = 1\text{ (kJ)}$$

Thus, $Q_{net} = W_{net} = 1$ (kJ)