Solutions

1.

a)

Layer Description	h W/m^2-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
Plywood		0.12	0.013	0.108	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	35			0.029	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**0.237**	$(W/m^2\text{-}K)^{-1}$
			U value =	**4.22**	W/m^2-K

b)

Layer Description	h W/m^2-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
XPS				0.440	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	35			0.029	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**0.569**	$(W/m^2\text{-}K)^{-1}$
			U value =	**1.76**	W/m^2-K

c)

Layer Description	h W/m^2-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
Plywood		0.12	0.013	0.108	$(W/m^2\text{-}K)^{-1}$
XPS				0.440	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	35			0.029	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**0.677**	$(W/m^2\text{-}K)^{-1}$
			U value =	**1.48**	W/m^2-K

d)

Layer Description	h W/m^2-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
XPS				1.760	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	35			0.029	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**1.889**	$(W/m^2\text{-}K)^{-1}$
			U value =	**0.53**	W/m^2-K

e)

Layer Description	h W/m^2-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
Glass		1	0.006	0.006	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	35			0.029	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**0.135**	$(W/m^2\text{-}K)^{-1}$
			U value =	**7.43**	W/m^2-K

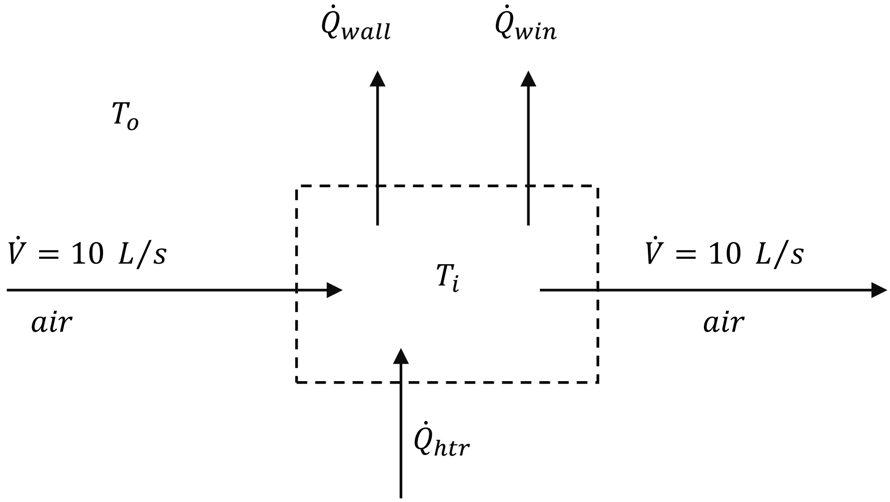
2.

$Section$	$Area$ m^2	RSI $m^2 \cdot ℃/W$	USI $W/m^2 \cdot ℃$	$U \cdot A$ $W/℃$	$\dot{Q}$ @ $\Delta T = 10℃$ W
A	60	4.58	**0.218**	**13.08**	**130.8**
B	10	1.06	**0.950**	**9.50**	**95.0**
C	30	2.82	**0.355**	**10.65**	**106.5**
Somme	100	-	-	**33.23**	**332.3**

$$U_{avg} = \frac{\sum(UA)}{\sum A} = \frac{33.23\ W/℃}{100\ m^2} = 0.332\ \frac{W}{m^2 \cdot ℃}$$

$$R_{avg} = \left(U_{avg}\right)^{-1} = 3.01\ \left(\frac{W}{m^2 \cdot ℃}\right)^{-1}$$

3.



$$\dot{Q}_{htr} = \dot{V}\rho c_p \cdot (T_i - T_o) + \dot{Q}_{wall} + \dot{Q}_{win}$$

$$= \dot{V}\rho c_p \cdot (T_i - T_o) + (UA)_{wall} \cdot (T_i - T_o) + (UA)_{win} \cdot (T_i - T_o)$$

$$= \left[\dot{V}\rho c_p + (UA)_{wall} + (UA)_{win}\right] \cdot (T_i - T_o)$$

$$\left.\begin{aligned} (UA)_{wall} &= 5.7\ W/°\mathrm{C} \\ (UA)_{win} &= 10.3\ W/°\mathrm{C} \\ \dot{V}\rho c_p &= 12.3\, W/°\mathrm{C} \end{aligned}\right\} \quad K_T = 28.3\, W/°\mathrm{C}$$

$$\dot{Q}_{htr} = K_T \cdot (T_i - T_o) = (28.3)(20) = \mathbf{566\ W}$$

$$\frac{(UA)_{wall}}{K_T} = 20.1\% \qquad \frac{(UA)_{win}}{K_T} = 36.4\% \qquad \frac{\dot{V}\rho c_p}{K_T} = 43.5\%$$

4.

Roof

Layer Description	h W/m²-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
XPS		0.028	0.075	2.679	$(W/m^2\text{-}K)^{-1}$
Concrete		0.8	0.15	0.188	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	25			0.040	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**3.006**	$(W/m^2\text{-}K)^{-1}$
			U value =	**0.33**	$W/m^2\text{-}K$

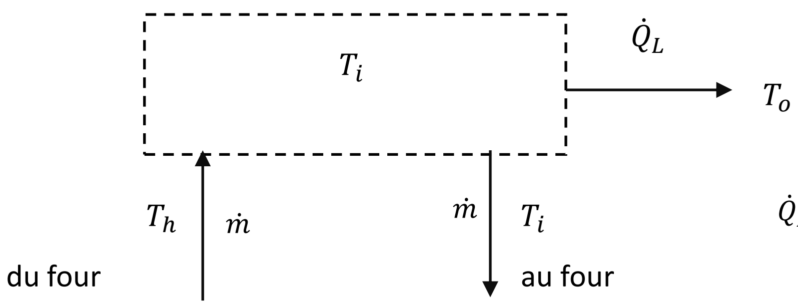
Wall

Layer Description	h W/m²-K	k W/m-K	L m	Layer R	Units
Indoor air layer	10			0.100	$(W/m^2\text{-}K)^{-1}$
XPS		0.028	0.05	1.786	$(W/m^2\text{-}K)^{-1}$
Concrete		0.8	0.1	0.125	$(W/m^2\text{-}K)^{-1}$
Outdoor air layer	25			0.040	$(W/m^2\text{-}K)^{-1}$
			Sum = R overall =	**2.051**	$(W/m^2\text{-}K)^{-1}$
			U value =	**0.49**	$W/m^2\text{-}K$

$$\dot{Q}_{wall} = (UA)_{wall} \cdot (T_i - T_o) = (0.49)(30)\big(20 - (-22)\big) = 617\ W$$

$$\dot{Q}_{roof} = (UA)_{wall} \cdot (T_i - T_o) = (0.33)(35)\big(20 - (-22)\big) = 485\ W$$

$$\dot{Q}_L = 617 + 485\ W = \mathbf{1102\ W}$$ taux de perte de chaleur totale



$$\dot{Q}_L = \dot{V}\rho c_p (T_h - T_i)$$

$$\dot{V} = \frac{\dot{Q}_L}{\rho c_p (T_h - T_i)} = \frac{1102}{(1.23)(45-20)} \approx \mathbf{36\ L/s}$$

5.

État 1 : 38 degrés C, 30% HR

du tableau : $\omega_1 \approx 12.5 \ g_v/kg_a$
$h_1 \approx 70.5 \ kJ/kg_a$

État 2 : 13 °C, 100 % HR

du tableau : $\omega_1 \approx 9.4 \ g_v/kg_a$
$h_2 \approx 37 \ kJ/kg_a$

Pour un processus de refroidissement et de déshumidification :

$\dot{m}_w = \dot{m}_a(\omega_1 - \omega_2)$ et $\dot{Q} \approx \dot{m}_a \cdot (h_1 - h_2)$

$$\frac{\dot{m}_w}{\dot{m}_a} = \omega_1 - \omega_2$$

$$= 3.1 \ g_v/kg_a$$

$$\frac{\dot{Q}}{\dot{m}_a} \approx h_1 - h_2$$

$$= 33.5 \ kJ/kg_a$$

6.

Un processus de chauffage sensible. Il s'agit du "mouvement horizontal" sur le graphique ($\omega = constant$).

État 1 : $h_1 \approx 33\ kJ/kg_a$ $\omega_1 = 5.7\ g_v/kg_a$

$$v_1 \approx 0.833\frac{m^3}{kg_a}$$

$$\dot{V}_1 = 700\ \ L/s = 0.7\ \ m^3/s$$

$$\dot{Q} = 25\ kW$$

$$\dot{Q} = \dot{m}_a(h_2 - h_1) = \frac{\dot{V}_1}{v_1}(h_2 - h_1)$$

$$h_2 = h_1 + \frac{\dot{Q}v_1}{\dot{V}_1} = 33 + \frac{(25)(0.833)}{0.7} \approx \mathbf{63}\ \frac{\boldsymbol{kJ}}{\boldsymbol{kg_a}}$$

$$\omega_2 = \omega_1 = \mathbf{5.7}\ \boldsymbol{g_v/kg_a}$$

Nous avons donc les "coordonnées" et . Sur le graphique, il s'agit de **T ≈ 48 deg C, RH ≈ 8,5%.**

7. Mélange adiabatique.

Flux 1 : 32°C, RH = 40%

$\dot{V}_1 = 20\ m^3/min = 0.333\ m^3/s$

$h_1 \approx 63\,kJ/kg_a$
$\omega_1 \approx 12\ g_v/kg_a$
$v_1 \approx 0.881\,m^3/kg_a$

$$\dot{m}_{a1} = \dot{V}_1/v_1 = (0.333\,m^3/s) \div (0.881\,m^3/kg_a) = 0.378\ kg_a/s$$

Flux 2 : 12°C, RH = 90%

$\dot{V}_2 = 25\ m^3/min = 0.417\ m^3/s$

$h_2 \approx 32\,kJ/kg_a$
$\omega_2 \approx 7.9\ g_v/kg_a$
$v_2 \approx 0.817\,m^3/kg_a$

$$\dot{m}_{a2} = \dot{V}_2/v_2 = (0.417\,m^3/s) \div (0.817\,m^3/kg_a) = 0.510\ kg_a/s$$

Flux 3 : $\dot{m}_{a3} = \dot{m}_{a1} + \dot{m}_{a2} = 0.888\,kg_a/s$

Sur le graphique, l'état 3 se trouve sur la ligne reliant les états 1 et 2.

$$h_3 = \frac{h_1\dot{m}_{a1} + h_2\dot{m}_{a2}}{\dot{m}_{a1} + \dot{m}_{a2}} = \frac{(63)(0.378) + (32)(0.51)}{0.888} = 45.2\,kJ/kg_a$$

à l'intersection : T ≈ 20.6°C, RH ≈ 64%