QUESTION 1

Determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor) of a wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400 mm. The 90-mm-wide cavity between the studs is filled with urethane rigif foam. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm plywood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent of the heat transmission area while the studs, plates, and sills constitute 21 percent. The headers constitute 4 percent of the area, and they can be treated as studs (this means 75% of area is insulation and 25% can be considered wood)

Also, determine the rate of heat loss through the walls of a house whose perimeter is 50 m and wall height is 2.5 m in Las Vegas, Nevada, whose winter design temperature is -2 C. Take the indoor design temperature to be 22 C and assume 20 percent of the wall area is occupied by glazing.

Answer:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins. (90mm)	No	3.528
Wood Studs(90mm)	0.63	No
Gypsum Borad(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$R'_{withwood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 \frac{m^2 C^\circ}{W}$

$R'_{withinsulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 \frac{m^2 C^\circ}{W}$

$\because \frac{1}{R_{total}} = \frac{1}{R_{withwood}} + \frac{1}{R_{withinsulation}}$

$R'_{withwood} = R_{withwood} \cdot A_{withwood}$, $R'_{withinsulation} = R_{withinsulation} \cdot A_{withinsulation}$

$R'_{total} = R_{total} \cdot A_{total}$

$\frac{A_{total}}{R'_{total}} = \frac{A_{withwood}}{R'_{withwood}} + \frac{A_{withinsulation}}{R'_{withinsulation}}$

$U_{withwood} = \frac{1}{R'_{withwood}}, U_{withinsulation} = \frac{1}{R'_{withinsulation}}, U_{total} = \frac{1}{R'_{total}}$

$A_{total} \cdot U_{total} = A_{withwood} \cdot U_{withwood} + A_{withinsulation} \cdot U_{withinsulation}$

Divide everything by A_{total}

$$U_{total} = \frac{A_{withwood}}{A_{total}} \cdot U_{withwood} + \frac{A_{withinsulation}}{A_{total}} \cdot U_{withinsulation}$$

$$U_{total} = 25\% \cdot U_{withwood} + 75\% \cdot U_{withinsulation}$$

$$= 25\% \cdot \frac{1}{R'_{withwood}} + 75\% \cdot \frac{1}{R'_{withinsulation}}$$

$$= 25\% \cdot \frac{1}{1.109 \frac{m^2 C^\circ}{W}} + 75\% \cdot \frac{1}{4.007 \frac{m^2 C^\circ}{W}}$$

$$= 0.4126 \frac{W}{m^2 C^\circ}$$

$$\mathrm{R-value} = \frac{1}{U_{total}} = \frac{1}{0.4126 \frac{W}{m^2 C^\circ}} = 2.4237 \frac{m^2 C^\circ}{W}$$

From the definition of U

$$\dot{Q}_{total} = U_{total} \cdot A_{total} \cdot \Delta T = 0.4126 \frac{W}{m^2 C^\circ} \cdot 50m \cdot 2.5m \cdot 80\% \cdot \left[22 C^\circ - \left(-2 C^\circ\right)\right]$$

$$= 990.24W$$

QUESTION 2

In 2 pages you should write a summary (in your own words! In your own words !!) of what you have learnt in this session about radiation and radiative heat transfer

Summary about radiation and radiative heat transfer

Radiative heat transfer and thermal transfer are commonly used to describe the science of the heat transfer caused by electromagnetic waves. Thermal transfer is transferred by electromagnetic waves, or photons, which may travel over a long distance without interacting with a medium. Radiative heat transfer becomes more important with rising temperature levels and may be totally dominant over conduction and convention at very high level. Thermal radiation is a volumetric phenomenon. However, for opaque solids such as metals, radiation is considered to be a surface phenomenon, since the radiation emitted by the interior region never reach the surface.