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 rigid foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm polywood 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).

Find the two R values, determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor)

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.

The unit thermal resistance of a plane layer of thickness L and thermal conductivity k can be determined from R = L/k.

Unit thermal resistance (the *R*-value) of common components used in buildings

Component	*R*-Value $m^2 \cdot °C/W$	*R*-Value $ft^2 \cdot h \cdot °F/Btu$
Outside surface (winter)	0.030	0.17
Outside surface (summer)	0.044	0.25
Inside surface, still air	0.12	0.68
Plane air space, vertical, ordinary surfaces (ε_{eff} = 0.82):		
13 mm ($\frac{1}{2}$ in)	0.16	0.90
20 mm ($\frac{3}{4}$ in)	0.17	0.94
40 mm (1.5 in)	0.16	0.90
90 mm (3.5 in)	0.16	0.91
Insulation, 25 mm (1 in)		
Glass fiber	0.70	4.00
Mineral fiber batt	0.66	3.73
Urethane rigid foam	0.98	5.56
Stucco, 25 mm (1 in)	0.037	0.21
Face brick, 100 mm (4 in)	0.075	0.43
Common brick, 100 mm (4 in)	0.12	0.79
Steel siding	0.00	0.00
Slag, 13 mm ($\frac{1}{2}$ in)	0.067	0.38
Wood, 25 mm (1 in)	0.22	1.25
Wood stud, nominal 2 in × 4 in (3.5 in or 90 mm wide)	0.63	3.58
Wood stud, nominal 2 in × 6 in (5.5 in or 140 mm wide)	0.98	5.56
Clay tile, 100 mm (4 in)	0.18	1.01
Acoustic tile	0.32	1.79
Asphalt shingle roofing	0.077	0.44
Building paper	0.011	0.06
Concrete block, 100 mm (4 in):		
Lightweight	0.27	1.51
Heavyweight	0.13	0.71
Plaster or gypsum board, 13 mm ($\frac{1}{2}$ in)	0.079	0.45
Wood fiberboard, 13 mm ($\frac{1}{2}$ in)	0.23	1.31
Plywood, 13 mm ($\frac{1}{2}$ in)	0.11	0.62
Concrete, 200 mm (8 in)		
Lightweight	1.17	6.67
Heavyweight	0.12	0.67
Cement mortar, 13 mm (1/2 in)	0.018	0.10
Wood bevel lapped siding, 13 mm × 200 mm (1/2 in × 8 in)	0.14	0.81

FROM OUTSIDE TO INSIDE	A/WOOD	B/INSULATION
Outside air	0.03	0.03
Wood bevel 13mm-200mm	0.14	0.14
13-mm plywood	0.11	0.11
urethane rigif foam	/	0.98*90/25=3.528
90 mm Wood studs	0.63	/
13-mm gypsum wallboard	0.079	0.079
Inside surface	0.12	0.12

R_{wood}= 1.109°C/W

$R_{insulation}$=4.007°C/W

$U_{wood} = 1/ R_{wood} = 1/1.109 = 0.9017$ ㎡°C /W

$U_{insulation} = 1/ R_{insulation} = 1/4.007 = 0.2496$ ㎡°C /W

U total =25% U wood +75% U insulation = 0.902*0.25 + 0.25*0.75 = 0.4126 W/㎡℃

Q = U total*As*detT = 0.4126*125*0.8*24 = 990.24W

In 2 pages you should write a summary of what you have learnt in this session about radiation and radiative heat transfer

Thermal radiation is electromagnetic radiation generated by the thermal motion of particles in matter. All matter with a temperature greater than absolute zero emits thermal radiation. Particle motion results in charge-acceleration or dipole oscillation which produces electromagnetic radiation.

Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium.

This phenomenon occurs when a hot object even in a vacuum chamber loses heat and reaches thermal equilibrium with its surroundings.Radiation transfer does not require the presence of a material medium to take place (unlike conduction and convection) and it can occur in solids,which in liquids or in gases.Radiation includes electromagnetic radiation which refers to the waves of the electromagnetic fields propagating through space carrying electromagnetic radiant energy as a result of the changes in the electronic configurations of the atoms or molecules.Electromagnetic waves are characterized by their frequency (v) or wavelength (c). These two properties in a medium are related by the speed of propagation of a wave in that medium (λ).

The formula is λ = c/v.Electromagnetic radiation is the propagation of elementary particle called photons. The energy of a photon is inversely proportional to its wavelength.

THERMAL RADIATION

All matter with a temperature greater than absolute zero emits thermal radiation.The rate of thermal radiation emission increases with increasing temperature.Thermal radiation is electromagnetic radiation generated by the thermal motion of particles in matter.

BLACK BODY RADIATION

Black body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment.Also it is an idealized body considered as a standard that can be compared with the radiative properties of real surfaces .It is an object that absorbs all radiation falling on it, at all wavelengths and in all direction.A blackbody emits the maximum amount of radiation by a surface at a given temperature.