Definitions

Conduction	It is the transfer of heat through a material
Radiation	It is energy transmitted directly through space
Convection	It is the transfer of heat by the movement of fluids such as air or water
Emissivity(ε)	ratio of the radiation emitted by the surface at a given temperature to the radiation emitted by a blackbody at the same temperature.
blackbody	The idealized surface that emits radiation at this maximum rate
Kirchhoff’s Law (1860)	At the thermal equilibrium, the power radiated by an object must be equal to the power absorbed.
Heat	It is the form of energy that can be transferred from one system to another as a result of temperature difference.

Definitions (cont)

Thermo dynamics	We can determine the amount of heat transferred using a Thermodynamic analysis alone. It deals with equilibrium states and changes from one to another.
Heat Transfer	It deals with systems that lack thermal equilibrium. It is the science that deals with the determination of the rates of such energy transfers is called heat transfer. Unit is Btu/hr, or Watt (1 W = 3.41 Btu/hr)
Infiltration	s the accidental heat loss/gain due to air leaking through the envelope, doors, windows etc.
Ventilation	is the deliberate, designed introduction of air into/out of a space required for healthy buildings
Heat Loss(Btu/hr)	The heat transfer through each element to outdoor in winter season.

Definitions (cont)

Peak Heating Loads(Btu/hr)	the amount of heat lost to the outdoor environment at design outdoor and indoor conditions, which must be made up by the HVAC system to maintain occupant comfort.
Annual Heating Energy(Btu)	The energy consumption during winter heating season. It will consider the heat gains from lights, human activities, appliances, etc.
When will the peak heating loads happen?	Lowest weather temperature • At night (no solar) • No internal gains • Ignore thermal mass
When will the peak cooling loads happen?	Highest weather temperature • Maximum solar gains (window orientation) • Maximum internal heat gains • Ignore thermal mass

Appropriate terms and questions

The heat (loss or gain) during a day is about #____?	B. Btu, D. Joule
The heat flow rate in this situation is # ____?	C. Btu/hr

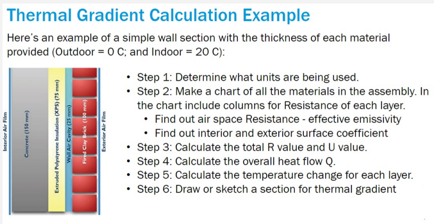
Appropriate terms and questions (cont)

#____ (heating or cooling) loads for a year will be needed	B. MBtu, D. Joule
#____ peak heating loads are documented.	B. MBtu, D. Joule
Rsubt	Total thermal resistance - Ability of a construction assembly to insulate heat, including air films
U	Overall coefficient of heat transmission - Ability of a construction assembly to transfer heat, including air films
When will the peak heating loads happen?	• Lowest weather temperature • At night (no solar) • No internal gains • Ignore thermal mass
When will the peak cooling loads happen?	• Highest weather temperature • Maximum solar gains (window orientation) • Maximum internal heat gains • Ignore thermal mass
Why do we need to calculate Peak heating/cooling loads	To size the heating/cooling equipment, ducts, etc.

Appropriate terms and questions (cont)

Why do we need to calculate these Annual heating/cooling energy	To estimate the annual energy use by a system so we can tell the building owners how much it will cost to operate a building with a proposed system.

Thermal Gradient



Calculations

U value calculation	U=1/Sum<R>=Btu/h *ft²* 0F

Calculations

U value calculation [Btu/hr *ft²* 0F]	U=1/Sum<R>
U value with frames [Btu/hr *ft²* 0F]	U=1/Sum<R> where R = Rstud *% area stud of sample + Rinsulation* % area ins of sample
Emissivity	Qemit = εδAT^4 where ε = emissivity of surface
Air Space	1/E= 1/εsub1 + 1/εsub2 - 1
Heat Flow (q) [BTU/hr]	q = u x A x deltaT
Thermal Gradient [BTU/hr]	q = u x A x deltaT

Calculations (cont)

Heat loss through slab-on-grade floors	q= F2 x P x deltaT
Heat flow through windows	$q = UA(Tin - Tout)$
Heat flow through windows pt2	q = A*SHGC* Et
Heat flow by infiltration	qv = V x 1.08 x ΔT
Latent Heat by Infiltration or Ventilation	qlatent = 4840 x V x ΔW
Simple heat loss calculation	total heat loss = Qwin + Qwalls + Qdoor + ...+ Qinfiltration
Annual Energy Estimation	E heating = UAref ×(HDD) ×(24) / k where UAref = Q heat loss / ΔT
Annual Energy Estimation pt2	Efuel = Eheating / V
F2 (this is not U-value)	heat loss coefficient from above (Btu/h-ft-F)
Eheating:	Annual heating energy in Btu

UAref : average heat loss rate from a building
HDD: the degree days at the reference temperature
k: heating system efficiency
U = U-factors of window assemblies (Btu/h ft2 F)
Q = rate of heat flow (Btu/hr)
SHGC= solar heat gain coefficient
Et= total incident irradiance
deltaW is found on the psychometric chat in-out (right side)
Efuel: Amount of fuel
V: heat value of fuel