BHSEC Name

Engineering (11/16)

Heat Transfer Problems

Recall that Q is a quantity of heat (joules)

q is the rate of heat flow (or heat flux) (joules/second or watts)

Draw a diagram. Show your work carefully with units.

1. The heat flow through a wood slab 50 mm thick, whose inner and outer surface temperatures are 40 and 20°C, respectively, has been determined to be 40 W. What is the thermal conductivity of the wood? Assume the block has an area of 1 m^2

2. The inner and outer surface temperatures of a glass window 5 mm thick are 15 and 5°C, respectively. What is the heat loss through a window that is 1 m by 3 m on a side? The thermal conductivity of glass is 1.4 W/mºC

3. The convection heat transfer coefficient between a surface at 40°C and ambient air at 20°C is 20 W/m^2K. Calculate the heat flow leaving the surface by convection. Use a unit area of $1m^2$

4.Air at 300°C flows over a flat plate of dimensions 0.50 m by 0.25 m. If the convection heat transfer coefficient is 250 W/m^2 K, determine the heat transfer rate from the air to one side of the plate when the plate is maintained at 40°C. How much heat is transferred in 10 minutes?

1.Two experiments were done to determine the molar heats of solution The data for each experiment is in the table below. Complete the calculations for the two salts.

Salt Dissolved	NaOH	NH4NO3
Total Mass of water used	100mL	100mL
Maximum change in temperature	10.2 ºC	1.41 ºC
Specific heat of water	4.18 J/gºC	4.18 J/gºC
Energy (J) absorbed or lost by water $Q = mCp\Delta T$ (eqn 1)		
Energy absorbed/lost by solute (J) (same value, but opposite sign as in the above calculation)		
Convert energy from J to kJ (Divide by 1000)		
Molar mass of solute		
Moles of solute actually used		
Molar heat of solution (eqn 2) kJ/mole		

Post Lab Questions

1. Write balanced equations for the dissociation of each ionic compound. Include the physical states (s,l,g, aq) and indicate whether energy was absorbed (endothermic) or released (exothermic) during the dissolution.

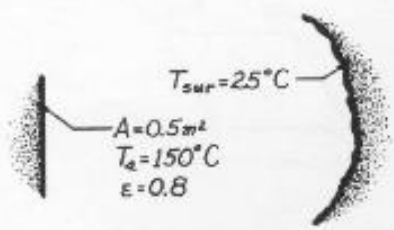
5 A surface of area 0.5 m^2, emissivity 0.8, and temperature 150°C is placed in a large, evacuated chamber whose walls are maintained at 25°C. What is the rate at which radiation is emitted by the surface? What is the net rate at which radiation is exchanged between the surface and the chamber walls?

S.5 A surface of area 0.5 m^2, emissivity 0.8, and temperature 150°C is placed in a large, evacuated chamber whose walls are maintained at 25°C. What is the rate at which radiation is emitted by the surface? What is the net rate at which radiation is exchanged between the surface and the chamber walls?

KNOWN: Area, emissivity and temperature of a surface placed in a large, evacuated chamber of prescribed temperature.

FIND: (a) Rate of surface radiation emission, (b) Net rate of radiation exchange between surface and chamber walls.

SCHEMATIC:



ASSUMPTIONS: (1) Area of the enclosed surface is much less than that of chamber walls.

ANALYSIS: (a) From Eq. 1.5, the rate at which radiation is emitted by the surface is

$$q_{emit} = q''_{emit} \cdot A = \epsilon A \sigma T_s^4$$

$$q_{emit} = 0.8(0.5\ m^2)\ 5.67 \times 10^{-8}\ W/m^2 \cdot K^4\ [(150 + 273)K]^4$$

$$q_{emit} = 726\ W. \quad \triangleleft$$

(b) From Eq. 1.7, the *net* rate at which radiation is transferred *from* the surface to the chamber walls is

$$q = \epsilon A \sigma (T_s^4 - T_{sur}^4)$$

$$q = 0.8(0.5\ m^2)\ 5.67 \times 10^{-8}\ W/m^2 \cdot K^4\ [(423K)^4 - (298K)^4]$$

$$q = 547\ W. \quad \triangleleft$$

COMMENTS: The foregoing result gives the net heat loss from the surface which occurs at the instant the surface is placed in the chamber. The surface would, of course, cool due to this heat loss and its temperature, as well as the heat loss, would decrease with increasing time. Steady-state conditions would eventually be achieved when the temperature of the surface reached that of the surroundings.