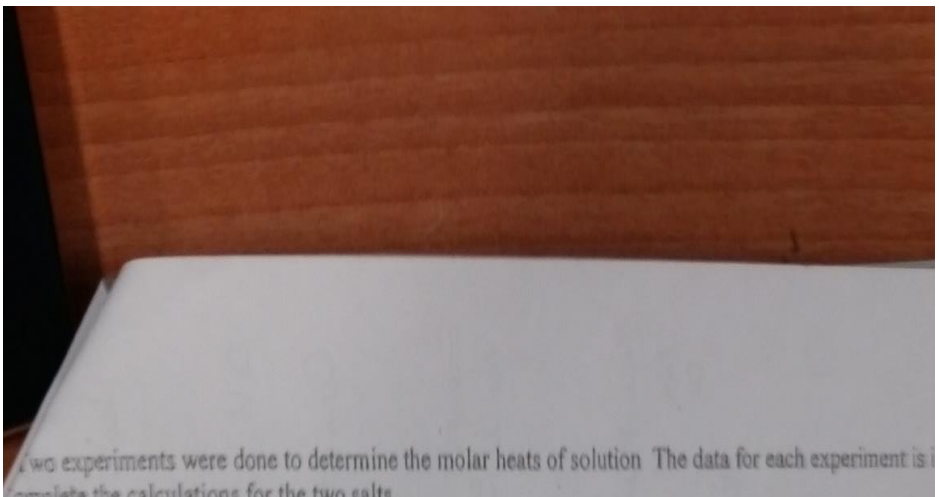
Heat Generated =	Minimum Heat Required	+ Heat Losses (Additional heat required)
J	J	J/sec · watt
ΔH_{soln} : kJ/mole	$Q = m c_p \Delta T$	Multiply by time of experiment to obtain heat loss
Convert to J/g of salt	1) Water	a) Convection (Example Pg 116)
Example: (Ionic equation)	2) Alcohol (Density is 0.79 g/mL)	(requires a fluid passing over a surface)
$NaCl \xrightarrow{aq} Na^+ + Cl^-$	3) Metal can (27.6 g)	$q = h A \Delta T$
$\Delta H_{soln} = +3.9 \frac{kJ}{mole}$	4) Outer cup (3.7 g)	h: heat transfer coefficient depends on velocity Pg 115-16
aq = water	c_p depends on material (Pg 114)	A: exposed area, top surface of cup
Molar Mass: Na 23 g, Cl 35.5 g, 58.5 g/mole	Example Pg 103	b) Conduction (Example Pg 114) (through material)
$Q: \frac{3.9 \frac{kJ}{mole}}{58.5 g/mole} \times 1000 \frac{J}{kJ}$	Answers Pg 103	$q = k A \frac{\Delta T}{L}$
$= +67$ J (endothermic)	1 +907 J	→ outer cup only
	2 − 22,751 J	c) Radiation: Estimate Pg 117
	4 + 3,400 J	



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

Salt Dissolved	NaOH 15g	NH4NO3 15g
Total Mass of water used	100mL = 100g	100mL
Maximum change in temperature	10.2 °C	1.41 °C
Specific heat of water	4.18 J/g°C	4.18 J/g°C
Energy (J) absorbed or lost by water Q = mCpΔT (eqn 1)	(100g)(4.184 J/g°C)(10.2°C) +4268 J	
Energy absorbed/lost by solute (J) (same value, but opposite sign as in the above calculation)	-4268 J (salt releases energy)	
Convert energy from J to kJ (Divide by 1000)	-4.268 kJ	
Molar mass of solute	Na 23 O 16 40g/mole H 1	
Moles of solute actually used	$\frac{15g\ NaOH}{40g/mole}$ = 0.38 moles	
Molar heat of solution (eqn 2) kJ/mole	$\frac{-4.268kJ}{.38\ moles}$ $-11.2\ \frac{kJ}{mole}$	

Post Lab Questions

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

Convection

5. The convection heat transfer coefficient between a surface at 40°C and ambient air at 20°C is 20 W/m²K. Calculate the heat flow leaving the surface by convection. The plate is 2 m² ← Note: Flow is different from laminar profiles

Newton's Law

$q = h A (T_{wall} - T_{\infty})$

$= 20 \text{ W/m}^2\text{°C} \cdot 2\text{m}^2 \cdot (40 - 20)\text{°C}$

800 watts

Convection

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/m²K, 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?

$q = h A \Delta T$

$250 \text{ W/m}^2\text{°C} \quad (0.50\text{m} \times 0.25\text{m})(300 - 40)\text{°C}$

8125 watts (joules/sec)

In 10 minutes

$Q = q \cdot t = 8125 \text{ J/sec} \times 600 \text{ sec} = 4.88 \times 10^6 \text{ joules}$

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.

Conduction

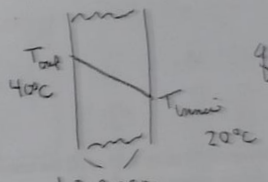
1. The heat flow through a wood slab 50 mm thick, whose inner and outer surface temperatures are 40 and 20°C, respectively, has been determined to be 40 W. What is the thermal conductivity of the wood? Assume the block has an area of 1 m^2

$A = 1 m^2$

Rearrange Fourier Law

$$q = \frac{k A (T_o - T_i)}{L}$$

$$k = q \frac{L}{A (T_o - T_i)}$$



$q = 40 W$

$$= 40W \frac{0.05m}{1m^2 (40-20)°C} = 0.10 \ W/m·°C$$

- Show units
- Watch for conversion units (mm → m)

Conduction

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/m°C

$k = 1.4 W/m·°C$

$A = 1m \times 3m = 3m^2$

$$q = \frac{k A (T_o - T_i)}{L}$$

$$= \frac{1.4W \cdot 3m^2 (15-5)°C}{0.005m}$$

$= 8400 W$