CHEM 101-080 Fall 2004

Thermodynamic Relationships, Latent and Specific Heats of Water, Sample Calculation

Thermodynamic Relationships

Equation	Parameters	Application
$Q = mC_p\Delta T$, $where\ \Delta T = T_f - T_i$	$Q = Heat\ transferred\ (J\ or\ cal)$ $C_p = Specific\ heat\ (J/g\bullet^oC\ or\ cal/g\bullet^oC)$ $m = mass\ (g)$ $T_f = Final\ temperature\ (^oC)$ $T_i = Initial\ temperature\ (^oC)$	Constant Phase
$Q = m\Delta H_{vap}$ and $Q = m\Delta H_{fus}$	$Q = Heat\ transferred\ (J\ or\ cal)$ $\Delta H_{fus} = Heat\ of\ Fusion\ (J/g\ or\ cal/g)$ $\Delta H_{vap} = Heat\ of\ Vaporization\ (J/g\ or\ cal/g)$ $m = mass\ (g)$	Change In Phase

Latent Heats of Water

Parameter	Phase Change	Latent Heat	
		J/g	cal/g
ΔH_{fus}	Solid → Liquid	334	79.8
ΔH_{vap}	Liquid → Gas	2,260	540

Specific Heats of Water

Parameter	Phase	Specific Heat	
		J/g^oC	cal/g^oC
C_p	**Solid**	2.06	0.493
	Liquid	4.18	1.00
	Gas	0.458	0.110

Sample Calculation: Heating Curve

(See also Example 10-3 on p. 312 of the textbook)

1. How much is required to convert 500 grams of ice initially at -25 ^{o}C to steam at 125 ^{o}C?

Step 1: Heat ice: $500\,g\,ice \times \frac{2.06 J}{g \cdot {}^{o}C} \times \left(0\,{}^{o}C - \left(-25\,{}^{o}C\right)\right) = 25,750\,J$

Step 2: Melt ice: $500\,g\,ice \times \frac{334 J}{g} = 167,000\,J$

Step 3: Heat water: $500\,g\,water \times \frac{4.18 J}{g \cdot {}^{o}C} \times \left(100\,{}^{o}C - 0\,{}^{o}C\right) = 209,000\,J$

Step 4: Vaporize water: $500\,g\,water \times \frac{2260 J}{g} = 1,130,000\,J$

Step 5: Heat steam: $500\,g\,steam \times \frac{0.458 J}{g \cdot {}^{o}C} \times \left(120\,{}^{o}C - 100\,{}^{o}C\right) = 4,580 J$

Total: $1,535,330\,J$