CHEM 1210
Optional Quiz version 3
Thermodynamics and solutions

Name: ANSWERS

1) The enthalpy of vapourization of water is 44.0 kJ/mol, determine q, w, ΔH, ΔS, ΔG, and ΔE for the vapourization of 1 mole of water at 100.°C and 1.00 bar.

$q = \Delta H = 44.0\ kJ$

assume small V_{liquid}.

$V_{gas} = \frac{1 \times 0.083144621 \times 373.15}{1} = 31.0\ L$

$w = -1\ bar \times (31.0 - \text{"0"}) \times \frac{100\ J}{1\ L\cdot bar}$

$= -3.1\ kJ$

$\Delta E = 44.0 - 3.1 = 40.9\ kJ$

$\Delta S = \frac{44000\ J}{373.15\ K} = 117.9\ \frac{J}{K}$

$\Delta G = 0$

2) The energy of combustion of octane was determined by combusting 0.850 g of octane in a bomb calorimeter. The heat capacity of the calorimeter had previously been determined to be 6.25 kJ/°C, and the observed temperature change was 6.55°C. Determine the energy of combustion of octane in kJ/mol

$q_{cal} = 6.25 \times 6.55 = 40.9375\ kJ \quad \therefore q_{rxn} = -40.9375\ kJ$

octane is C_8H_{18} → molar mass is 114.2285 g

$$\frac{-40.9375\ kJ}{0.850\,g \times \frac{1\ mol}{114.2285\,g}} = \boxed{\Delta E^\circ = -5501.4\ \frac{kJ}{mol}}$$

turn over

3) Hard candy is made from very hot solutions of sugar in water. In a typical preparation the boiling point of the sugar-water solution reached 145°C. If the boiling point elevation constant of water is 0.512 °C kg/mol, determine the mass of sugar ($C_{12}H_{22}O_{11}$, molar mass 342.3 g/mol) that would be required for 500. mL of water.

$45 = 1 \cdot 0.512 \times m$

$\Rightarrow m = 87.9 \frac{mol}{kg}$

$87.9 \frac{mol}{kg} \times 0.5\,kg \times 342.3 \frac{g}{mol} = $ **15,042 g or ~15 kg**

4) At 24°C the vapour pressure of pure liquid C is 328.0 mmHg, and the vapour pressure of pure liquid D is 174.6 mmHg. A solution is prepared in which the mole fraction of C is 0.048. The vapour pressure of the solution is 184.8 mmHg,

a) Does this solution obey Raoult's law? Show all calculations necessary to answer the question.

$P_{Raoult} = 0.048 \times 328 + 0.952 \times 174.6 = 182$ (mmHg)

Since $P > P_{Raoult}$, then no, sol'n does not obey Raoult's Law.

b) Would you predict ΔH for the solution process to be positive, negative or equal to zero?

Positive deviations from Raoult's Law indicate a positive ΔH_{soln}.

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