**Dougherty Valley HS AP Chemistry**

**WORKSHEET #2**

**Thermodynamics – Entropy and Gibbs I**

**Name: Date: Period: Seat #:**

Show all work

$$∆G°= Σ∆G\_{f}^{°} products-Σ∆G\_{f}^{°} reactants$$

[1] Calculate G° in kJ for the following reactions, using the appropriate data tables.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| (a) SO3 (g) + H2O(*l*) → H2SO4 (*l*) |  | $$∆H\_{f}^{°} (\frac{kJ}{mol})$$ | $$∆G\_{f}^{°} \left(\frac{kJ}{mol}\right)$$ | $$∆S^{°} (\frac{J}{mol∙K})$$ |
| (b) 2 NH4Cl(s) + CaO(s) → CaCl2 (s) + H2O(*l*) + 2 NH3 (g) | CaCl2 | -795 | -750.2 | 114 |
| (c) CaSO4 (s) + 2 HCl(g) → CaCl2 (s) + H2SO4 (*l*) | CH3Cl | -83.7 | -60.2 | 234 |
| (d) C2H4 (g) + H2O(*l*) → C2H5OH(l) | KCl | -436.69 | -408.8 | 82.55 |
| (e) Ca(s) + 2 H2SO4 (*l*) → CaSO4 (s) + SO2 (g) + 2 H2O(*l*) | K2SO4 | -1437.8 | -1321.4 | 175.6 |

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| [2] When solid potassium iodide is dissolved in water, a cooling of the mixture occurs because the solution process is endothermic for these substances. Explain, in terms of what happens to the molecules and ions, why this mixing occurs spontaneously? |

[3] Predict the algebraic sign of the entropy change for the following reactions?

|  |  |
| --- | --- |
| (a) PCl3(g) + Cl2(g) → PCl5(g) | (b) SO2(g) + CaO(s) → CaSO3(s) |
| (c) CO2(g) + H2O(*l*) → H2CO3(aq) | (d) Ni(s) + 2 HCl(aq) → H2(g) + NiCl(aq) |
| (e) I2(s) → I2(g) | (f) Cl2(g) + Br2(g) → 2 BrCl(g) |
| (g) NH3(g) + HCl(g) → NH4Cl(s) | (h) CaO(s) + H2O(*l*) → Ca(OH)2(s) |

[4] Show that ΔS for the melting of ice is positive

|  |  |
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| Conceptually | Quantitatively |

[5] Calculate the entropy change in J/mol⋅K for each of the following reactions. [$∆S°= Σ∆S^{°}products-Σ∆S^{°}reactants$]

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| --- | --- |
| (a) CaO(s) + 2 HCl(g) → CaCl2(s) + H2O(*l*) | (b) C2H4(g) + H2(g) → C2H6(g) |

[7] Predict the probability of the following reactions by approximating the sign of ΔG. Classify each reaction as exothermic or endothermic.

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| a) H2O(*l*) → H2(g) + ½ O2(g) | ΔH= +285 kJTΔS = -245 kJ |  |
| b) C6H14(g) → 6 C(s) + 7 H2(g) | ΔH = +167 kJTΔS = +168 kJ |  |
| c) 2 Fe(s) + ½ N2(g) → Fe2N(s) | ΔH = -3.8 kJTΔS = -14.6 kJ |  |
| d) HCl(g) + H2O(*l*) → H3O+(aq) + Cl−(aq) | ΔH = -75.3 kJTΔS = -39.3 kJ |  |

[8] Calculate ΔGo in kJ/mole for the following reactions, using the appropriate data tables from your textbook appendix.

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| (a) SO3(g) + H2O(*l*) → H2SO4(*l*) |
| (b) 2 NH4Cl(s) + CaO(s) → CaCl2(s) + H2O(*l*) + 2 NH3(g) |
| (c) CaSO4(s) + 2 HCl(g) → CaCl(s) + H2SO4(*l*) |

[9] For the reaction at 298.2 K >>> **2 NO2(g) → N2O4(g)**

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| a) The values of ΔHo and ΔSo are -58.03 kJ mol-1 and -176.61 J K-1mol-1 respectively. What is the value of ΔGo at 298.2 K? |
| b) At what temperature is ΔGo = 0? |
| c) Is ΔG negative above, or below, this temperature? |