**AP Unit 6 Jeopardy Questions and Study Guide**

**Important equations and things to remember:**

q = mcΔT

ΔG = ΔH – TΔS

ΔH = ΣHf products – ΣHf reactants

ΔS = ΣSf products – ΣSf reactants

**Predicting spontaneity:** Reactions are spontaneous when ΔSuniverse is positive, or more specifically, when ΔG is negative.

**Enthalpy: (answer key at the end of the document)**

**100:** What is the symbol for change in enthalpy?

**200:** Which of the following is an endothermic process?

1. Ice melting
2. Water freezing
3. HCl and BaOH are mixed and react, causing a drop in temperature
4. Condensation of water vapor

**300:** The temperature of a 35.2 g sample of iron increases  from 23.7 °C to 29.5 °C. If the specific heat of iron is  0.450 J/g-K, how many joules of heat are absorbed?

**400:** The value of ΔH° for the reaction below is -126 kJ.  \_\_\_\_\_\_\_\_\_\_ kj are released when 2.00 mol of NaOH is formed in the reaction?

            2 Na2O2 (s)  +  2 H2O (l)  →  4NaOH (s)  +  O2(g

**500:** Given the following reactions,

            CaCO3 (s)  →  CaO (s)  +  CO2 (g)               ΔH = 178.1 kJ

            C (s, graphite)  +  O2 (g)  →  CO2 (g)            ΔH = -393.5 kJ

the enthalpy of the reaction

            CaCO3 (s)  →  CaO (s)  +  C (s, graphite)  +  O2 (g)

is \_\_\_\_\_\_\_\_\_\_ kJ.

**Section 2: Entropy and Gibbs free energy**

**100:** What does it mean to say a reaction or process is “spontaneous”?

**200:**     Which one of the following is always positive when a spontaneous process occurs?

A) ΔSsystem

B) ΔSsurroundings

C) ΔSuniverse

D) ΔHuniverse

E) ΔHsurroundings

**300:** For the reaction below, ΔH° is -125 kJ/mol and ΔS° is +253 J/K ∙ mol. This reaction is:

            2C4H10 (g)  +  13O2 (g) →  8CO2 (g)  +  10H2O (g)

A) spontaneous at all temperatures

B) spontaneous only at high temperature

C) spontaneous only at low temperature

D) nonspontaneous at all temperatures

E) unable to determine without more information

**400:** For a reaction to be spontaneous under standard conditions at all temperatures, the signs of ΔH° and ΔS° must be \_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_, respectively.

A) +, +

B) +, -

C) -, +

D) -, -

E) +, 0

**500:** Given the following table of thermodynamic data, the vaporization of TiCl4 is:



A) spontaneous at all temperatures

B) spontaneous at low temperature and nonspontaneous at high temperature

C) nonspontaneous at low temperature and spontaneous at high temperature

D) nonspontaneous at all temperatures

E) not enough information given to draw a conclusion

**JEOPARDY ANSWERS:**

**ENTHALPY:**

**100:** ΔH

**200:** A. Ice melting is the correct answer. Ice must take in energy to melt, so it is endothermic.

**300:** 92 J. Use q = mcΔT to solve this problem. m = mass, c = specific heat, ΔT = change in temp.

**400:** 63 kJ are released

**500:** 571.6 kJ

**ENTROPY:**

**100:** Spontaneous means something occurs without outside intervention (in other words, a reaction or process that happens on its own). Any reaction/process that requires adding heat, electricity, or energy in ANY form is NOT spontaneous.

**200:** C. The entropy of the universe must be positive in order for a reaction to be spontaneous.

**300:** A is the correct answer.

**Justification:** Reactions are spontaneous when ΔG is negative. Using the equation ΔG = ΔH – TΔS, we can predict the sign of ΔG if we know values for ΔH and ΔS. (See table below)

|  |  |  |
| --- | --- | --- |
| **ΔH** | **ΔS** | **ΔG** |
| **+** | **+** | Depends on temperature (high temps are spontaneous, low temps are not) |
| **–** | **–** | Depends on temperature (low temps are spontaneous, high temps are not) |
| **–** | **+** | **–**  |
| **+** | **–** | **+** |

**400:** C(see justification above)

**500: C**

ΔH = ΣHf products – ΣHf reactants, so ΔH = (-763.2) – (-804.2) = 41 kJ/mol

ΔS = ΣSf products – ΣSf reactants, so ΔS = (354.9) – (221.9) = 133 kJ/mol

Since both ΔH and ΔS are both positive, spontaneity depends on temperature. The process would be nonspontaneous at low temperatures and spontaneous at high temperatures (see chart above)