Thermochemistry Christmas Break Assignment

Watch the following video podcasts and answer each question below:

Thermochemistry – Part 1: **https://www.youtube.com/watch?v=PlO35TryV2Q&list=UUwcko-upj4mgQNKM-x6Y74Q&index=3&feature=plcp**

PART 1

Questions 1-3 refer to the following reaction and table of heats of formation.

$$2\ KClO_3\ (s) \rightarrow 2\ KCl\ (s) + 3\ O_2\ (g)$$

Substance	Heats of Formation (kJ/mol)
$KClO_3$	-391 kJ/mol
KCl	-436 kJ/mol
O_2	0 kJ/mol

1) Using the heats of formation given above, calculate the enthaply for the reaction, ΔH rxn.
   (A) +90 kJ/mol
   (B) -90 kJ/mol
   (C) +1654 kJ/mol
   (D) -1654 kJ/mol

2) What is the sign of delta S and what is the reason for this sign?
   (A) + due to the fact that the reaction releases heat.
   (B) – due to the fact that the reaction absorbs heat.
   (C) + due to the fact that the reaction goes from a solid to a solid and a gas.
   (D) – due to the fact that the reaction goes from a solid to a solid and a gas.

3) If the delta G is negative which means the reaction is spontaneous or thermodynamically favorable, what would be a reason why the reaction would not readily occur?
   (A) The reaction does not readily occur because of the coulombic forces of attraction of $KClO_3$ (s).
   (B) The reaction does not readily occur because oxygen gas has a heat of formation of 0 kJ/mol.
   (C) The reaction does not readily occur because of the magnitude of the enthalpy for the reaction.
   (D) The reaction does not readily occur because the activation energy must first be reached to have a reaction occur.

Part 1 (continued)

$$C_6H_6\ (g) \rightarrow 3\ C_2H_2\ (g)$$

4) Calculate the standard enthalpy change, $\Delta H°$, for the reaction represented above?
(ΔH_f of C_6H_6 is 83 kJ mol^{-1}; ΔH_f of C_2H_2 (g) is 230 kJ mol^{-1})

(A) -607 kJ
(B) -211 kJ
(C) +211 kJ
(D) +607 kJ

5) For which of the following processes does entropy decrease?
(A) CO_2 (s) $\rightarrow CO_2$ (g)
(B) Br_2 (l) $\rightarrow$ Br_2 (g)
(C) Precipitation of AgCl (s) by solutions of $AgNO_3$ and NaCl
(D) Dissolving solid NaOH into water

6) When solid NH_4OH is dissolved completely in water in a closed container, the temperature drops. Which of the following indicates the correct signs for ΔG, ΔH, and ΔS for the process?

	ΔG	ΔH	ΔS
(A)	-	-	-
(B)	-	+	-
(C)	-	+	+
(D)	+	-	+

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Watch the following video podcasts and answer each question below:

Thermochemistry – Part 2: **https://www.youtube.com/watch?v=Cemdq_O8Plg&list=UUwcko-upj4mgQNKM-x6Y74Q&index=2&feature=plcp**

PART 2

Questions 7-8 refer to the following three combustion reactions.

$CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H2O\ (l)$ $\Delta H = -890$ kJ/mol

$H_2\ (g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (l)$ $\Delta H = -286$ kJ/mol

$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$ $\Delta H = -394$ kJ/mol

7) Calculate the enthalpy of reaction, ΔHrxn, based on the information above for the reaction:

$C\ (s) + 2\ H_2\ (g) \rightarrow CH_4\ (g)$

(A) +76 kJ/mol
(B) -76 kJ/mol
(C) -210 kJ/mol
(D) +210 kJ/mol

8) If 36 grams of carbon were used in the reaction in question #7, how much heat was absorbed or released?

(A) +25.3 kJ
(B) -25.3 kJ
(C) +228 kJ
(D) -228 kJ

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For Questions 9-13 refer to the reaction and table of information below

$$Na\ (s) + \tfrac{1}{2}\ Cl_2\ (g) \rightarrow NaCl\ (s) \qquad \Delta H° = -\ 411\ kJ/mol$$

The elements Na and Cl react directly to form the compound NaCl according to the reaction above. Refer to the table below and reaction information above to answer the questions that follow.

Process	**ΔH° (kJ/mol)**
$Na\ (s) \rightarrow Na\ (g)$	A
$Na\ (g) \rightarrow Na^+\ (g) + e^-$	B
$Cl_2\ (g) \rightarrow 2\ Cl\ (g)$	C
$Cl\ (g) + e^- \rightarrow Cl^-\ (g)$	D
$Na^+\ (g) + Cl^-\ (g) \rightarrow NaCl\ (s)$	E

9) How much heat is released or absorbed when 0.100 mol of Cl_2 is used to form NaCl (s)?
   (A) 41.1 kJ released
   (B) 41.1 kJ absorbed
   (C) 82.2 kJ released
   (D) 82.2 kJ absorbed

10) What remains in the vessel after equal masses of Na (s) and Cl_2 (g) have reacted until either one or both of the reactants have been completely consumed?
   (A) NaCl and Na only
   (B) NaCl and Cl_2 only
   (C) NaCl only
   (D) NaCl, Na, and Cl_2

11) Which of the ΔH° values for a process in the table are less than zero or indicate an exothermic process?
   (A) E only
   (B) D and E only
   (C) C, D, and E only
   (D) A, B, C, D, and E

12) It is observed that the reaction above producing NaCl (s) is a reaction in which the reactants essentially go to completion. Which of the following is a true statement about the thermodynamic favorability of the reaction?
   (A) The reaction is thermodynamically favorable and driven by the enthalpy change only.
   (B) The reaction is thermodynamically favorable and is driven by the entropy change only.
   (C) The reaction is thermodynamically favorable and is driven by both the enthalpy and entropy changes.
   (D) The reaction is thermodynamically unfavorable and is driven by both the enthalpy change only.

$$Cl_2\ (g) + 2\ e^- \rightarrow 2\ Cl^-\ (g)$$

13) Which of the following expressions is equivalent to the ΔH° for the reaction represented above?
   (A) C + 2 D (B) C + D (C) C – D (D) C – 2D

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Watch the following video podcasts and answer each question below:

Thermochemistry – Part 3: **https://www.youtube.com/watch?v=4jAnZlAeRSk&list=UUwcko-upj4mgQNKM-x6Y74Q&index=1&feature=plcp**

PART 3

Bond	Bond Dissociation Energy (kJ/mol)
C-H	415 kJ/mol
O=O	495 kJ/mol
C=O	799 kJ/mol
O-H	463 kJ/mol

14) Calculate the enthapy of reaction, ΔHrxn, based on the information above for the reaction:

CH_4 (g) + 2 O_2 (g) → CO_2 (g) + 2 H_2O (g)

(A) +320 kJ/mol
(B) -320 kJ/mol
(C) +800 kJ/mol
(D) -800 kJ/mol

15) The particulate diagram above shows an ionic compound being separated into ions during step 1. It then shows those ions being dissolved in a polar solvent such as water during step 2. Which of the following best describes the enthalpy change, ΔH, for each step using your knowledge of bond enthalpies?
(A) Step 1 is endothermic and Step 2 is exothermic.
(B) Step 1 is exothermic and Step 2 is endothermic.
(C) Step 1 and 2 are both endothermic.
(D) Step 1 and 2 are both exothermic.

H_2O	Enthalpy of Formation	-242 kJ/mol
H_2O	Enthalpy of Vaporization	+44 kJ/mol

16) Above is a table that shows the enthalpy of formation and enthalpy of vaporization of water. Which of the following best accounts for the differences in enthalpy values?
   (A) Uneven repulsions among nonbonding electron pairs
   (B) Different amount of water tested
   (C) Accommodation of the necessary bond angles in the formation of the liquid water
   (D) Difference in strength between intramolecular and intermolecular attractions

17) An exothermic reaction that goes towards more disorder will always be thermodynamically favored. If this reaction does not occur at any measurable extent or when it does occur it is found to occur at extremely slow rates, what is the best reason for this observation?
   (A) The reaction detailed above has multiple pathways.
   (B) The reaction detailed above has multiple intermediates.
   (C) The reaction detailed above has a very small Gibbs Free Energy value.
   (D) The reaction detailed above is said to be under "kinetic control," which means there is a high activation energy.

18) A student is asked to determine the enthalpy of the dissolution of NaOH (s) with water. The student measures the mass of the NaOH (s) to be 10.0 grams and placed it in 100.0 mL of water that the students measured with a graduated cylinder in a Styrofoam cup. Before adding the NaOH (s) to the cup, the student measured the water in the cup to be an initial temperature of 22.8°C. The student covered the cup, stirred to ensure full dissolution with the thermometer, and measured the maximum temperature to be 33.4°C. When the student used the information above to calculate the enthalpy of the reaction, the enthalpy was found to be less than the standard value found in a handbook of thermodynamic values. What could be the cause for this difference?
   (A) The student applied too much energy in stirring the dissolution process.
   (B) The student should have used a beaker to measure out the volume of water.
   (C) The student had heat transfer to the thermometer or to the Styrofoam cup.
   (D) The student performed a miscalculation in their enthalpy determination.