Name: ___________________________________

Chemistry 30

Unit 1: Energy Changes in Chemical Reactions

21 max

Assignment 4: Section 3-1

1. Predict (do not calculate) whether ΔS will be positive or negative, **and explain** your answer:

   a) $6\ CO_{2(g)} + 6\ H_2O_{(\ell)} \rightarrow C_6H_{12}O_{6(s)} + 6\ O_{2(g)}$

      Predict a negative ΔS (entropy is decreasing; system becomes more ordered/less random)

      Provide at least one explanation

      1. gases and liquids produce a solid
      2. 12 moles produces 7 moles – fewer moles is a more ordered state

6

   b) $PCl_{3(\ell)} + Cl_{2(g)} \rightarrow PCl_{5(s)}$

      Predict –ΔS (entropy decreases; the system becomes more ordered / less random)

      Provide at least one explanation:

      1. 2 moles on the reactant side produce 1 mole; fewer moles is a more ordered state
      2. a liquid and gas produce a more ordered (less random) solid

(2 marks each)

   c) $H_2O_{(g)} \rightarrow H_{2(g)} + ½\ O_{2(g)}$

      Predict +ΔS (entropy increases; the system becomes more random / less ordered)

      Provide at least one explanation:

      1. 1 moles produces 1½ moles (not much difference)
      2. this is a decomposition reaction, generally producing a more random product

2. Calculate ΔS using values from the *Thermochemical Data* handout.

   a) $4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2\ Fe_2O_{3(s)}$

      $\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

a.	4Fe (s)	+	3 O_2 (g)	→	2 Fe_2O_3 (s)
	4(27.8)	+	3 (205.1)		2(87.4)
	111.2	+	615.3		
		726.5			174.8

3

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

ΔS = 174.8 – (726.5) = <u>- 551.7 J/K·mol</u>

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b) $C_2H_{4(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 2\ H_2O_{(\ell)}$

3	C_2H_4 (g)	+	3 O_2 (g)	→	2 CO_2(g)	+	2 H_2O (l)
	219.6	+	3 (205.1)		2(213.7)	+	2 (69.9)
	219.6	+	615.3		427.4	+	139.8
		834.0				567.2	

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

$\Delta S =$ 567.2 – (834.0) = <u>- 267.7 J/K·mol</u>

c) $H_{2(g)} + Br_{2(\ell)} \rightarrow 2\ HBr_{(g)}$

H_2 (g)	+	Br_2 (g)	→	2 HBr(g)
130.7	+	151.6		2(198.7)
	282.3			397.4

3

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

$\Delta S =$ 397.4 – (282.3) = 115.1 <u>J/K·mol</u>

d) $Na_{(s)} + ½\ Cl_{2(g)} \rightarrow NaCl_{(s)}$

Na (s)	+	½ $Cl_{2(g)}$	→	$NaCl_{(s)}$
57.2	+	½ (223.1)		
	162.75			72.1

3

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

$\Delta S =$ 72.1 – (162.8) = <u>- 90.7 J/K·mol</u>

e) $C_2H_{6(g)} + \frac{7}{2}\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 3\ H_2O_{(\ell)}$

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

C_2H_6 (g)	+	7/2 O_2 (g)	→	2 CO_2(g)	+	3 H_2O (l)
229.6	+	7/2 (205.1)		2(213.7)	+	3 (69.9)
	947.5				637.6	

3

$\Delta S = \Sigma\Delta S_{products} - \Sigma\Delta S_{reactants}$

$\Delta S =$ 637.6 – (947.5) = <u>- 310.4 J/K·mol</u>