Chapter 13 Worksheet 2 (Entropy)

Name: _____ UGA ID: _____

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname).
- Your UGA myID is a combination of letters and numbers (example: mine is sre13137). **Do not use your 81x number.**
- If you do not have a printer, type your answers in the then upload the worksheet template to Gradescope by Monday, September 21 at 11:59 p.m. Write your work on separate sheets of paper, convert to a PDF and upload to eLC.
- If you have a printer download the worksheet, convert it to a PDF and upload to Gradescope by Monday, September 21 at 11:59 p.m. You do not need to upload anything to eLC.

1. Calculate ΔS^o for the formation of 1 mole of water from its elements given $S^o[H_2(g)] = 131$ J/K·mole, $S^o[O_2(g)] = 205$ J/K·mole, $S^o[H_2O\ (l)] = 69.9$ J/K·mole

A. 327.2 J/K

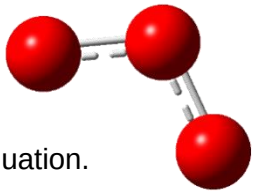
B. - 327.2 J/K

C. 163.6 J/K

D. -163.6 J/K

2. The entropy change for the decomposition of ozone forming diatomic oxygen,

$$2\ O_3(g) \rightarrow 3\ O_{2(g)} \qquad \Delta H = -285\ kJ/mol$$



A. is positive because two moles of gas are forming three moles of gas.

B. is close to zero because there are the same number of atoms on each side of the equation.

C. is negative because energy is released as the reaction proceeds.

D. is close to zero because both ozone and oxygen are in the gas phase.

E. None of the above answers makes sense.

3. Which of the following reactions, occurring when propane is burned, would you expect to be the most entropically favored (most positive change in entropy)?

A. $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$

B. $C_3H_8(g) + \frac{7}{2}\ O_2(g) \rightarrow 3\ CO(g) + 4\ H_2O(g)$

C. $C_3H_8(g) + 2\ O_2(g) \rightarrow 3\ C(graphite) + 4\ H_2O(g)$

4. For the formation reaction of methane,

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

the ΔH_f is -74.87 kJ/mol and the ΔS_{rxn} is -80.7 J/mol. At what temperature, in Celsius, does the reaction flip from being spontaneous to not spontaneous?

5. At room temperature, ~290 K, the reaction of H_2 and O_2 to form water:

$2H_2\ (g) + O_2(g) \rightleftharpoons 2H_2O(l)$ $\Delta H = -285.8\ kJ\ mol^{-1}$ $\Delta S = -327\ J\ K^{-1}\ mol^{-1}$

A. is spontaneous because it is exothermic.

B. is non-spontaneous because ΔS is negative.

C. is spontaneous because ΔS is negative.

D. is spontaneous because ΔG is negative.

E. is spontaneous because ΔG is positive.

6. A mixture of H_2 and O_2 can sit in a flask almost indefinitely at 298 K without reacting.

$2H_2\ (g) + O_2(g) \rightleftharpoons 2H_2O(l)$ $\Delta H = -285.8\ kJ\ mol^{-1}$ $\Delta S = -327\ J\ K^{-1}\ mol^{-1}$

What is the best explanation for the absence of observable reaction?

A. A significant energy barrier hinders the start of the reaction.

B. The reaction is not spontaneous at this temperature.

C. The reaction is entropically unfavorable.

D. All three of these factors contribute.

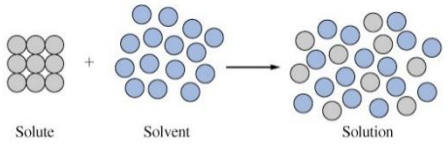
E. None of the above answers is correct.

7. Which of these processes would you expect to be spontaneous at all temperatures?

A. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $\Delta H = -200$ kJ mol^{-1}

B. 

$\Delta H = 6$ kJ mol^{-1}

C. 

$\Delta H = -5$ kJ mol^{-1}

D. None are spontaneous at all temperatures.

E. All are spontaneous irrespective of the temperature.

8. Carbon monoxide and oxygen gas react to form carbon dioxide.

$CO(g) + ½ O_2(g) \rightarrow CO_2(g)$

Calculate the standard free energy change for this reaction at 25 °C from ΔH^o_{rxn} and ΔS^o_{rxn}.

CO(g) $\Delta H^o_f = -110.5$ kJ/mol, $\Delta S^o = 197.7$ J/mol·K

$O_2(g)$ $\Delta S^o = 205.1$ J/mol·K

$CO_2(g)$ $\Delta H^o_f = -393.5$ kJ/mol, $\Delta S^o = 213.7$ J/mol·K

9. Determine the change in entropy when 10.00 grams of solid ethanol is converted into a liquid at -114.0°C.

Boiling Point: 78.3°C

Melting Point: -114.0°C

$\Delta H_{vap} = 38.56$ kJ/mol

$\Delta H_{fus} = 4.90$ kJ/mol

$C_{liquid} = 112.4$ J/(mol·K)

$C_{gas} = 78.28$ J/(mol·K)

$C_{solid} = 111.46$ J/(mol·K)

10. How many microstates are possible in a collection of four particles that are present, with two particles each in two connected flasks? (It may be helpful to draw a diagram).

11. For a particular reaction, the value of ΔH is -38.6 kJ/mol and ΔS is +154 J/mol K. When is this reaction spontaneous (assuming that ΔH and ΔS do not vary as the temperature changes).

A. At $T < 251K$

B. At $T > 251K$

C. At $T < 524$ K

D. This reaction is spontaneous at all temperatures

E. This reaction is not spontaneous at all temperatures