

## AP CHEM Thermo Review

- A reaction determined to be spontaneous only at very high temperatures. Which of the following is true regarding this reaction?
  - $\Delta H$  and  $\Delta S$  are both positive.
  - $\Delta H$  and  $\Delta S$  are both negative.
  - $\Delta H$  is negative, but  $\Delta S$  is positive.
  - $\Delta H$  is positive, but  $\Delta S$  is negative.
  - The reaction will proceed at a very slow rate.
- For which of the following processes would  $\Delta S^\circ$  be expected to be most positive?
  - $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{s})$
  - $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
  - $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6 \text{O}_2(\text{g}) \rightarrow 6 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$
  - $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{NaCl}(\text{s})$
  - $\text{Cl}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2 \text{HCl}(\text{g})$
- Which of the following statements are true for the reaction:  $\text{I}_2(\text{g}) \rightarrow 2 \text{I}(\text{g})$  (Multiple Answers)
  - $\Delta H$  is positive.
  - $\Delta H$  is negative.
  - $\Delta S$  is positive.
  - $\Delta S$  is negative.
  - The reaction is spontaneous at any temperature.
- At  $25^\circ$ , the free energy of formation of gaseous water is  $-229 \text{ kJ/mol}$ . Calculate  $\Delta G$  for the following reaction if the hydrogen is supplied at  $4.00 \text{ atm}$  and the oxygen is supplied at  $3.00 \text{ atm}$ , while the water produced is at  $1.00 \text{ atm}$  pressure.
$$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$$
  - $-568 \text{ kJ}$
  - $453 \text{ kJ}$
  - $-239 \text{ kJ}$
  - $-10148 \text{ kJ}$
  - $-9819 \text{ kJ}$
- It is determined that for a particular process,  $\Delta H = +185 \text{ kJ}$  and  $\Delta S = +1.80 \text{ J/K}$ . At what temperature does the reaction become spontaneous?
  - $0.00973 \text{ K}$
  - $376 \text{ K}$
  - $1.03 \times 10^5 \text{ K}$
  - $333 \text{ K}$
  - $187 \text{ K}$

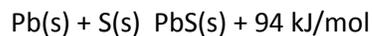
6. Determine  $\Delta G^\circ$  for the weak acid  $\text{HC}_2\text{H}_3\text{O}_2$  (acetic acid,  $K_a = 1.8 \times 10^{-5}$ ) at  $25^\circ\text{C}$ .
- 11 kJ/mol
  - 356 kJ/mol
  - 14.1 kJ/mol
  - 27 kJ/mol
  - 211 kJ/mol
7. Which of the following liquids is likely to have the highest value for  $S^\circ$ ?
- Hg
  - $\text{H}_2\text{O}$
  - $\text{CH}_3\text{OH}$
  - $\text{N}_2\text{H}_4$
  - $\text{C}_2\text{H}_5\text{OH}$
8. Which of the following statements is true?
- In a spontaneous process,  $\Delta G$  has a positive value.
  - Exothermic reactions are always spontaneous.
  - The entropy of the universe is increasing.
  - A system at constant temperature cannot experience entropy changes.
  - For a process to be spontaneous, the number of moles of product must exceed the number of moles of reactant.
9. Which of the following samples of oxygen has the greatest positional entropy?
- 1 mole of  $\text{O}_2(\text{g})$  at 2.0 atm and 200 K
  - 1 mole of  $\text{O}_2(\text{s})$  at 15 K
  - 1 mole of  $\text{O}_2(\text{g})$  at 1.0 atm and 273 K
  - 1 mole of  $\text{O}_2(\text{g})$  at 2.0 atm and 273 K
  - 1 mole of  $\text{O}_2(\text{g})$  at 0.5 atm and 273 K
10. Calculate  $\Delta S^\circ$  for the following reaction:  $2 \text{NH}_3 \rightarrow 3 \text{H}_2 + \text{N}_2$

Substance	$S^\circ$ J/(K mol)
$\text{NH}_3(\text{g})$	193
$\text{H}_2(\text{g})$	131
$\text{N}_2(\text{g})$	192

- 199 J/mol \* K
- 971 J/mol \* K
- 130 J/mol \* K
- 212 J/mol \* K
- 54 J/mol \* K

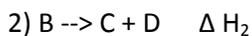
11. The standard free energy of formation of NaBr(s) is -347 kJ/mol. Calculate  $\Delta G^\circ$  for the reaction:  
 $2\text{NaBr}(s) \rightarrow 2\text{Na}(s) + \text{Br}_2(g)$
- 347 kJ
  - 694 kJ
  - 694 kJ
  - 347 kJ
  - 112 kJ
12. If the reaction  $A + B \rightleftharpoons C$  has an equilibrium constant,  $K$ , greater than 1. Which of the following statements is true?
- The reaction is nonspontaneous and favors the reactants.
  - The reaction is spontaneous and favors the reactants.
  - The reaction is nonspontaneous and favors the products.
  - The reaction is spontaneous and favors the products.
13. Which of the following is true when a gas condenses into a liquid?
- $\Delta H$  and  $\Delta S$  are both positive.
  - $\Delta H$  and  $\Delta S$  are both negative.
  - $\Delta H$  is negative, but  $\Delta S$  is positive.
  - $\Delta H$  is positive, but  $\Delta S$  is negative.
14. What is the value of  $\Delta G$  during a phase change?  $\Delta G = 0$
15. Which of the following is true for any substance undergoing a phase change?
- $\Delta S < 0$
  - $\Delta H = 0$
  - $\Delta H = T\Delta G$
  - $\Delta H = T\Delta S$
  - $T\Delta S = 0$
16. A bomb calorimeter has a heat capacity of 3.18 kJ/K. When 0.0038 mol of a gas is burned in the calorimeter, the temperature increased from 25.0°C to 27.3°C. Calculate the energy released by the combustion of one mole of the gas.
- $-1.9 \times 10^3$  kJ
  - $2.8 \times 10^{-2}$  kJ
  - $-2.8 \times 10^{-2}$  kJ
  - $-3.6 \times 10^{-2}$  kJ
  - 7.3 kJ

17. Calculate the heat evolved in the formation of 1 mole of  $\text{PbSO}_4(\text{s})$  from its elements, given the following:



- a. 730 kJ/mol
- b. -730 kJ/mol
- c. 918 kJ/mol
- d. -918 kJ/mol

18. Consider the following numbered processes:



$\Delta H$  for the process  $\text{A} \rightarrow 2\text{C} + \text{E}$  is

- a.  $2 \Delta H_1 + 2 \Delta H_2 - \Delta H_3$
- b.  $\Delta H_1 - 2 \Delta H_3$
- c.  $2 \Delta H_1 + \Delta H_2 - \Delta H_3$
- d.  $\Delta H_1 + 2 \Delta H_2 - \Delta H_3$
- e.  $\Delta H_1 + \Delta H_2 + \Delta H_3$

19. A sample of wood has a heat of combustion of 3.29 kJ/g. What quantity of the wood must be burned to heat 250. g of water from  $18^\circ\text{C}$  to  $85^\circ\text{C}$ ? Once again, the specific heat capacity of water is  $4.18 \text{ J}/^\circ\text{C}\cdot\text{g}$ .

- a.  $2.13 \times 10^4 \text{ g}$
- b. 0.45 g
- c. 85.1 g
- d. 12.4 g
- e. 21.3 g

20. As a result of an exothermic reaction,

- a. the energy of the system is increased and the energy of the surroundings are decreased.
- b. the energy of the system and the energy of the surroundings are increased.
- c. the energy of the system and the energy of the surroundings are decreased.
- d. the energy of the system is decreased and the energy of the surroundings are increased.