Mr. Bracken
AP Chemistry

Name _____
Period _____

Multiple Choice Review: Thermochemistry

1. If this has a negative value for a process, then the process occurs spontaneously.
   (a) Free energy change ΔG
   (b) Entropy Change ΔS
   (c) Heat of Vaporization
   (d) Heat of Fusion
   (e) Specific Heat Capacity

2. This is a measure of how the disorder of a system is changing.
   (a) Free energy change ΔG
   (b) Entropy Change ΔS
   (c) Heat of Vaporization
   (d) Heat of Fusion
   (e) Specific Heat Capacity

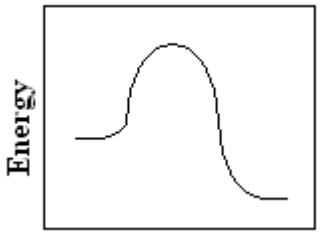
3. This is the energy released when a substance condenses.
   (a) Free energy change ΔG
   (b) Entropy Change ΔS
   (c) Heat of Vaporization
   (d) Heat of Fusion
   (e) Specific Heat Capacity

4. This is the energy absorbed by a substance when it melts.
   (a) Free energy change ΔG
   (b) Entropy Change ΔS
   (c) Heat of Vaporization
   (d) Heat of Fusion
   (e) Specific Heat Capacity

5. $\mathbf{2\ Al\ (s) + 3\ Cl_2\ (g) \rightarrow 2\ AlCl_3\ (s)}$

   The reaction above is not spontaneous under standard conditions but becomes spontaneous as the temperature decreases toward absolute zero. Which of the following is true at standard conditions?

   (a) ΔS and ΔH are both negative
   (b) ΔS and ΔH are both positive
   (c) ΔS is negative and ΔH is positive
   (d) ΔS is positive and ΔH is negative
   (e) ΔS and ΔH are both equal to zero



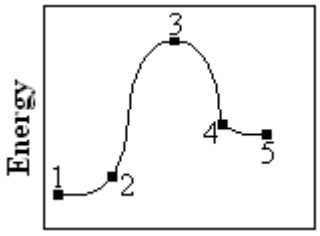
6. Which of the following is true of the reaction shown in the diagram above.

(a) The reaction is endothermic since the reactants are at a higher energy level than the products.
(b) The reaction is endothermic since the reactants are at a lower energy level than the products.
(c) The reaction is exothermic because the reactants are at a higher energy level than the products.
(d) The reaction is exothermic because the reactants are at a lower energy level than the products.
(e) The reaction is endothermic because the reactants are at the same energy level as the products.

7. The addition of a catalyst will have which of the following effects on a chemical reaction?

I. The enthalpy change will decrease.
II. The entropy change will decrease.
III. The activation energy will decrease.

(a) **I** only
(b) **II** only
(c) **III** only
(d) **I** and **II** only
(e) **II** and **III** only



8. Which point on the graph shown above corresponds to the activated complex or transition state?
(a) 1
(b) 2
(c) 3
(d) 4
(e) 5

9. In which of the following is entropy increasing?
   (a) $2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$
   (b) $CO(g) + H_2O(g) \rightarrow H_2(g) + CO_2(g)$
   (c) $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$
   (d) $2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g)$
   (e) $2\ H_2S(g) + 3\ O_2(g) \rightarrow 2\ H_2O(g) + 2\ SO_2(g)$

10. Which of the following describes a system that <u>cannot</u> be spontaneous?
   (a) ΔH is positive and ΔS is negative
   (b) ΔH is positive and ΔS is positive
   (c) ΔH is negative and ΔS is negative
   (d) ΔH is negative and ΔS is positive
   (e) ΔH is zero and ΔS is positive

11. Consider the following process: $\mathbf{H_2O}\boldsymbol{(s)} \rightarrow \mathbf{H_2O}\boldsymbol{(l)}$

   Which of the following is true of the reaction shown above at room temperature?
   I. ΔG is greater than zero.
   II. ΔH is greater than zero.
   III. ΔS is greater than zero.

   (a) **II** only
   (b) **III** only
   (c) **I** and **II** only
   (d) **I** and **III** only
   (e) **II** and **III** only

12. For which of the following reactions will ΔS be positive?

   I. $NaCl\ (s) \rightarrow Na^{1+}\ (aq) + Cl^{1-}\ (aq)$
   II. $2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g)$
   III. $CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$

   (a) **I** only
   (b) **II** only
   (c) **I** and **II** only
   (d) **I** and **III** only
   (e) **I**, **II**, and **III**

13. **$2\ C_6H_6(l) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(g)$**

The combustion reaction shown above would be expected to have:
(a) a positive ΔH and a negative ΔS
(b) a negative ΔH and a positive ΔS
(c) a positive ΔH and a positive ΔS
(d) a negative ΔH and a negative ΔS
(e) These predictions cannot be made.

14. When sodium is placed in an atmosphere of chlorine gas, the following spontaneous reaction occurs.

$$2\ Na\ (s) + Cl_2\ (g) \rightarrow 2\ NaCl\ (s)$$

Which of the following statements is true about the reaction?

I. $\Delta S > 0$
II. $\Delta H < 0$
III. $\Delta G > 0$

(a) **I** only
(b) **II** only
(c) **I** and **II** only
(d) **II** and **III** only
(e) **I**, **II**, and **III**

15. The evaporation of any liquid is expected to have
(a) a positive ΔH and a negative ΔS
(b) a negative ΔH and a negative ΔS
(c) a positive ΔH and a positive ΔS
(d) a negative ΔH and a positive ΔS
(e) These predictions cannot be made.

16. Calculate the ΔH for the reaction: $\mathbf{C_2H_2}\textbf{\textit{(g)}} + {}^{5}/_{2}\ \mathbf{O_2}\textbf{\textit{(g)}} \rightarrow \mathbf{2\ CO_2}\textbf{\textit{(g)}} + \mathbf{H_2O}\textbf{\textit{(l)}}$

$C(s) + O_2(g) \rightarrow CO_2(g)$	$\Delta H = -390$ kJ
$H_2(g) + \frac{1}{2}\ O_2(g) \rightarrow H_2O(l)$	$\Delta H = -290$ kJ
$2\ C(s) + H_2(g) \rightarrow C_2H_2(g)$	$\Delta H = +230$ kJ

(a) – 1300 kJ
(b) – 1070 kJ
(c) – 840 kJ
(d) – 780 kJ
(e) – 680 kJ

17. Calculate the ΔH for the reaction: $\mathbf{S}\textbf{\textit{(s)}} + \mathbf{O_2}\textbf{\textit{(g)}} \rightarrow \mathbf{SO_2}\textbf{\textit{(g)}}$

$2\ SO_3(g) \rightarrow 2\ SO_2(g) + O_2(g)$	$\Delta H = -200$ kJ
$2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$	$\Delta H = +800$ kJ

(a) 300 kJ
(b) 500 kJ
(c) 600 kJ
(d) 1000 kJ
(e) 1200 kJ

18. Calculate the ΔH for the reaction: $\mathbf{2\ NO}\textbf{\textit{(g)}} + \mathbf{O_2}\textbf{\textit{(g)}} \rightarrow \mathbf{N_2O_4}\textbf{\textit{(g)}}$

$N_2O_4(g) \rightarrow 2\ NO_2(g)$	$\Delta H = +57.93$ kJ
$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$	$\Delta H = -113.14$ kJ

(a) 171.07 kJ
(b) – 55.21 kJ
(c) – 171.07 kJ
(d) + 55.21 kJ
(e) – 85.54 kJ