Key

NAME
CHEMISTY
THERMODYNAMICS

1. Which describes the change in G and the change in spontaneity of the reaction as temperature increases if the reaction is exothermic and decreasing in entropy?

$-\Delta H$ $-\Delta S$

$\Delta G = \Delta H - T\Delta S$

$-\Delta H + T+\Delta S$

at low T | at high T

will make $\Delta G-$ | will make $\Delta G+$

at T↑, G↑

a. G decreases to values less than zero and the reaction achieves equilibrium.
b. G decreases to values less than zero and the reaction becomes spontaneous.
c. G decreases to values less than zero and the reaction becomes non-spontaneous
d. G increases to values greater than zero and the reaction becomes spontaneous.
e. G increases to values greater than zero and the reaction becomes non-spontaneous.

T↑ G↑ yes

2. All of the following reaction illustrates an increase in entropy EXCEPT:

a. $N_2O_{4(g)} \Rightarrow 2NO_{2(g)}$ 1 → 2 $+\Delta S$
b. $C_6H_{6(l)} \Rightarrow C_6H_{6(g)}$ l → g $+\Delta S$
c. $2KClO_{3(s)} \Rightarrow 3O_2 + 2KCl$ break apart $+\Delta S$
d. $3Fe_{(s)} + 2O_{2(g)} \Rightarrow Fe_3O_{4(s)}$ $\Delta S-$
e. $C_2H_5OH_{(l)} + 3O_{2(g)} \Rightarrow 3CO_{2(g)} + 3H_2O_{(g)}$ 3 → 6 $+\Delta S$

$\Delta G = \Delta H - T\Delta S$

must be $-\Delta G$ if $+\Delta S$ & $-\Delta H$ all Temps

3. For the burning of propane
$C_3H_{8(g)} + 5O_{2(g)} \Rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$
Which of the following is true at any temperature?

I. delta G < 0 −
II. delta S > 0 +
III. delta H < 0 −

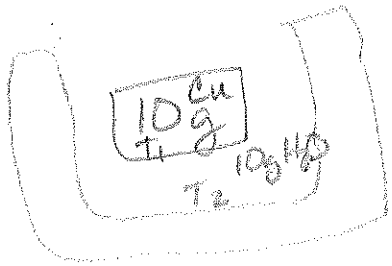
5 mol → 7 mol ↑ ΔS $+\Delta S$
increase movement
combustion is exothermic $-\Delta H$

a. I only
b. III only
c. I and II only
d. II and III only
e. I, II, and III

$T_1 > T_2$

4. A 10. g cube of copper at a temperature T_1 is placed in an insulated cup containing 10. g of water at a temperature T_2. If $T_1 > T_2$, which of the following is true of the system when it has attained thermal equilibrium? (The specific heat of copper is 0.385 J/(g·°C) and the specific heat of water is 4.18 J/(g·°C).)

(A) The temperature of the copper changed more than the temperature of the water.
(B) The temperature of the water changed more than the temperature of the copper.
(C) The temperature of the water and the copper changed by the same amount.
(D) The relative temperature changes of the copper and the water cannot be determined without knowing T_1 and T_2.



$(10)(0.385)\Delta T_1 = (10)(4.18)\Delta T_2$

↑ more ΔT ↑ less ΔT

reciprocal relationship

(#12)

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

ΔH $\quad -1207 \qquad -635 \quad -394$

$\qquad\qquad\qquad\qquad -1029$

$\Delta H = -1029 + (+1207) =$ **178 kJ/mol**

$\Delta S \quad 92.9 \qquad 39.8 \quad 213.7$

$\qquad\qquad\qquad\qquad 253.5$

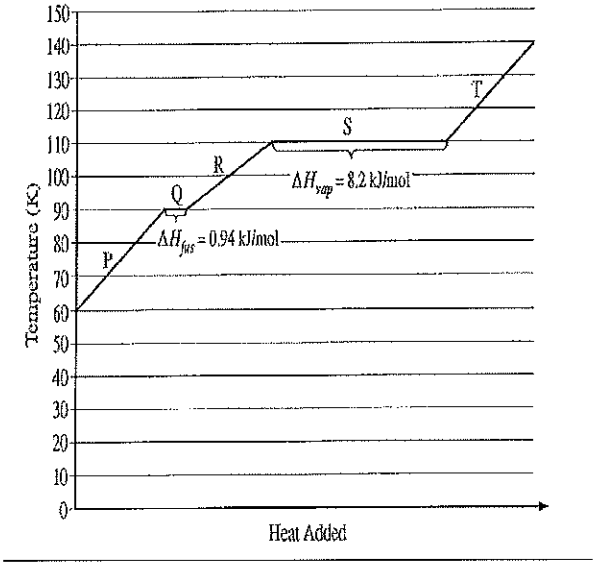
$\Delta S = 253.5 - 92.9 =$ **160.6 J/mol K**

Set $\Delta G = 0$ + solve for T

$$\Delta G = 0 = 178 - T\left(\frac{161}{1000}\right)$$

$$\frac{1000}{161} \cdot 178 = T$$

$$T = 1106\ K$$



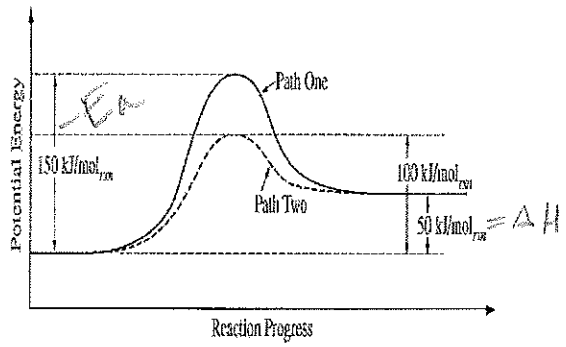
How much energy is required to melt 64 g of methane at 90 K? (The molar mass of methane is 16 g/mol.)

(A) 0.24 kJ
(B) 3.8 kJ
(C) 33 kJ
(D) 60. kJ

CH_4 16 g/mol $64\,g \left|\frac{1\,mol}{16\,g}\right| \frac{0.94\,kJ}{1\,mol} = 3.76\,kJ$

$XY_2 \rightarrow X + Y_2$

The equation above represents the decomposition of a compound XY_2. The diagram below shows two reaction profiles (path one and path two) for the decomposition of XY_2.



Which of the following best describes the flow of heat when 1.0 mol of XY_2 decomposes?

(A) 50 kJ of heat is transferred to the surroundings.
(B) 50 kJ of heat is transferred from the surroundings.
(C) 100 kJ of heat is transferred to the surroundings.
(D) 100 kJ of heat is transferred from the surroundings.

$H_2O(l) \rightarrow H_2O(g)$
$-285.8 \quad -241.8$ $\Delta H = -241.8 + (+285.8) = 44$ KJ/mol

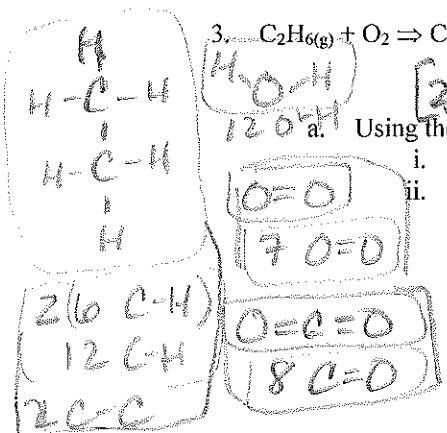
1. $H_2O_{(l)} \Rightarrow H_2O_{(g)}$
   a. If vaporize 10 grams of water, how much energy is required? (hint: calculate enthalpy and use stoichiometry)

$10\,g\,H_2O \left|\frac{1\,mol}{18\,g}\right| \frac{44\,kJ}{1\,mol} = 24\,kJ$

2. $CaCO_{3(s)} \Rightarrow CaO_{(s)} + CO_{2(g)}$
   a. At what temperature is this reaction become spontaneous? 1106 K

3. $C_2H_{6(g)} + O_2 \Rightarrow CO_2 + H_2O$ $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ $[2(83) + 12(99) + 7(119)]$ $[8(192) + 12(111)]$

   a. Using the bond energies table determine the enthalpy change of the reaction above.
      i. Sketch out each substance,
      ii. Label the number of bonds and indicate total energy of bonds in your calculation.



$\Delta H = R(\text{Bond Broken}) - P(\text{Bonds formed})$
$[166 + 1188 + 833) - (1536 + 1332)$
$2187 - 2868 = -681$ KJ