Chemistry 225 Semester 04-2016
Homework for Submission #4a

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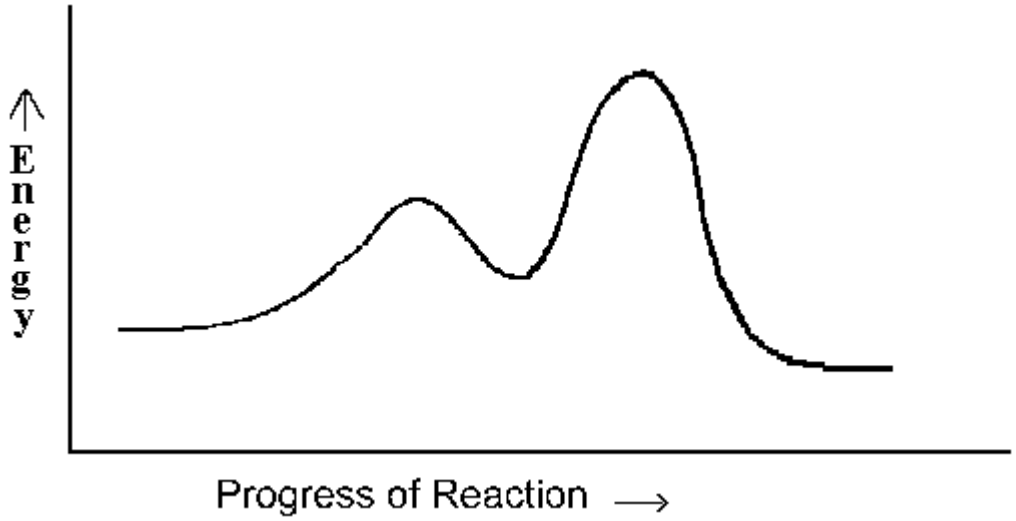
1) The following mechanism has been proposed for the reaction of NO with Br_2 in the gaseous state:

$$NO(g) + Br_2(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NOBr_2(g) \quad ...(1)$$

$$NOBr_2(g) + NO(g) \xrightarrow{k_2} 2NOBr(g)...(2)$$

The potential energy profile for this reaction is given below:



a) Write the equation for the overall reaction. (1)
b) Which step in the mechanism is the rate determining step? Give a reason for your answer. (2)
c) Identify an intermediate in the mechanism. (1)
d) Derive the rate law for the reaction from the mechanism. (3)
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f) If the rate constant is found to be $1.00\times10^{-3}s^{-1}$, what is the order of the reaction?(1)
   i) Determine the half-life of the reaction. (1)
   ii) Determine the time required for the concentration of NO to fall from 0.100M to 0.0750M. (3)

2) The reaction

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO + 6H_2O(g)$$

has $\Delta H° = -906.2$ kJ mol^{-1} and Kp is 3.97×10^{167} @25°C. (If your calculator can't handle the large numbers involved, use a spread sheet to do the calculations.)

a) Calculate $\Delta G°$, making sure to include units. What does the sign of this value tell you? (2)

b) Calculate ΔG when the partial pressures of NO, H_2O, NH_3, and O_2 are 2.00, 2.50, 1.00×10^{-25} and 1.00×10^{-30} atm respectively and determine the direction of reaction under these conditions. (3)

c) Estimate K_p at 1000°C. Why is this estimate liable to be very inaccurate? Is its magnitude relative to K_p at 25°C to be expected on the basis of Le Chatelier's principle? (5)

3) Determine the pH of each of the following solutions, all at 25°C:

a) 0.0200 M formic acid solution, $K_a(HCO_2H) = 1.77\times10^{-4}$.

b) 0.0600 M sodium hydroxide solution.

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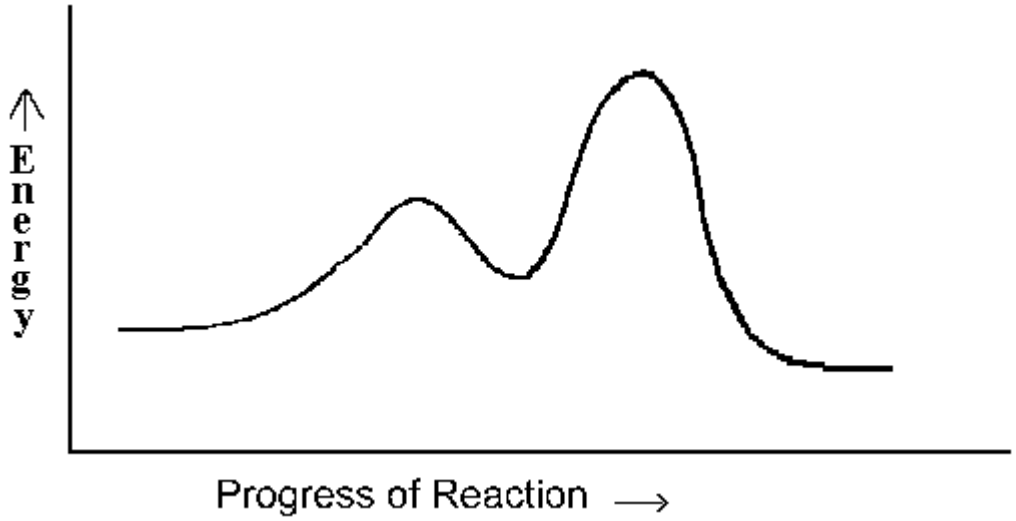

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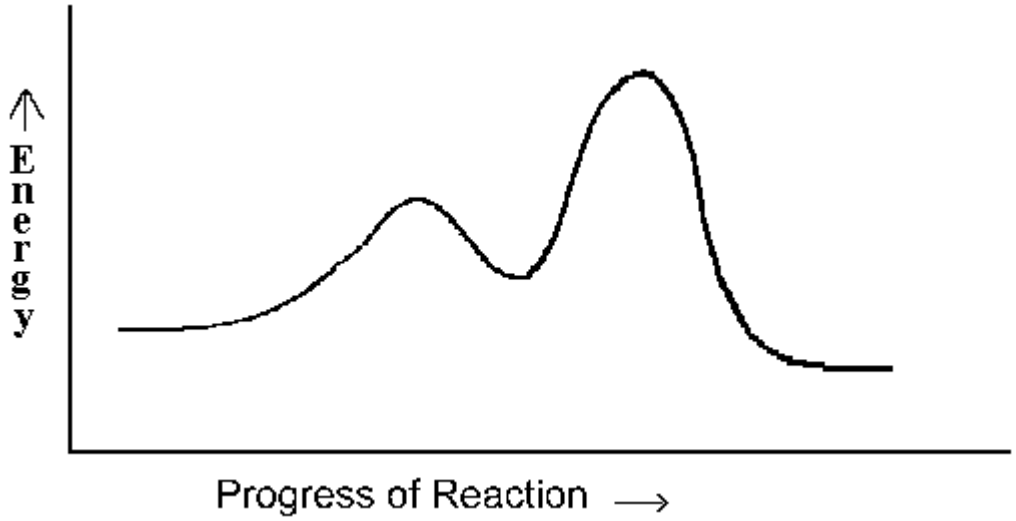

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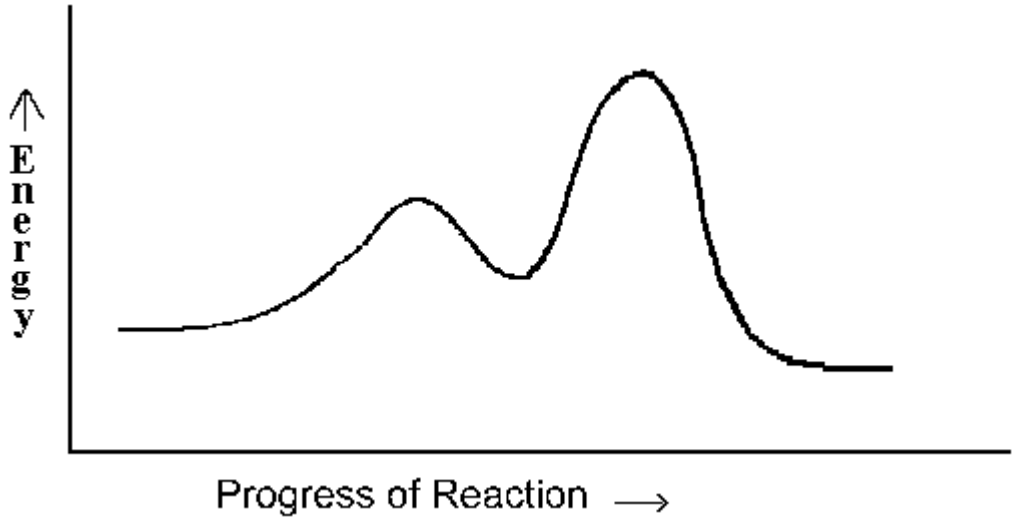

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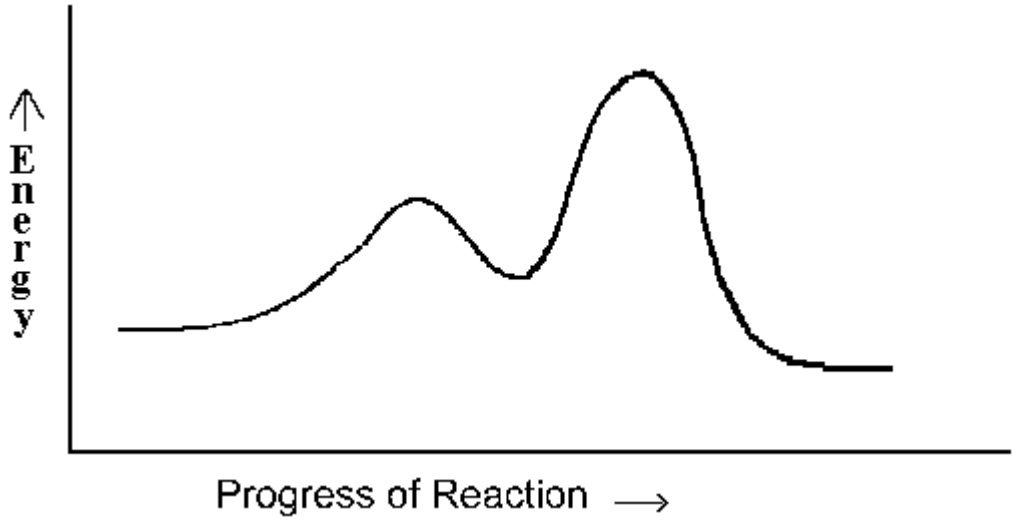

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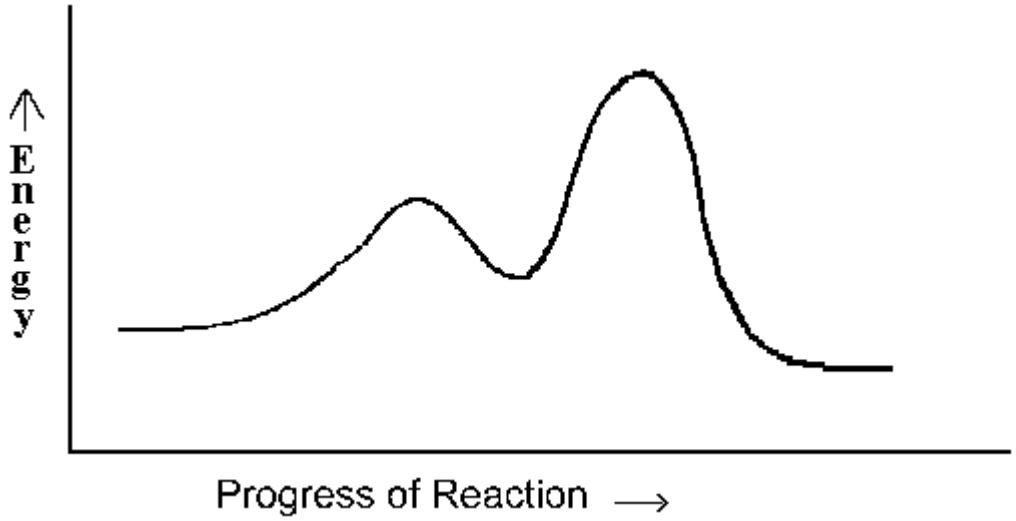

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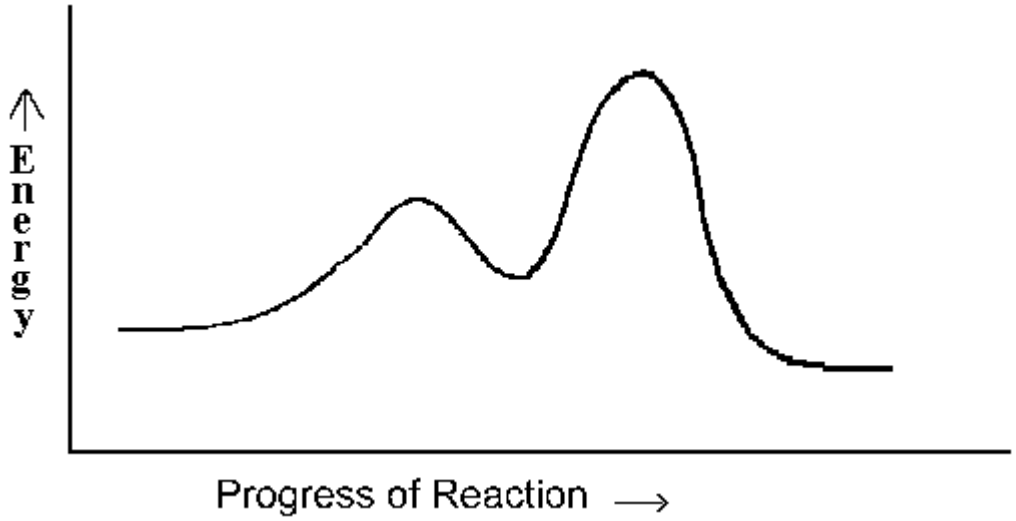

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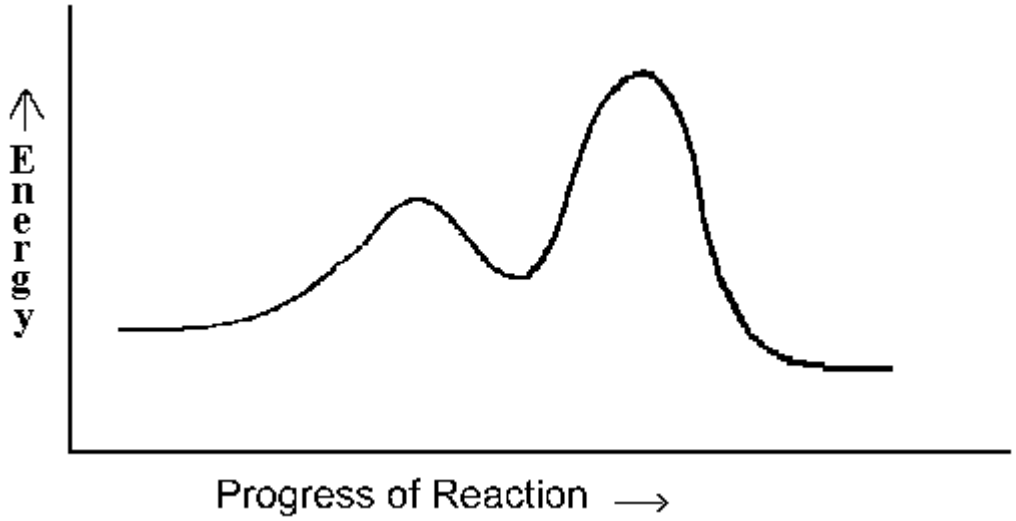

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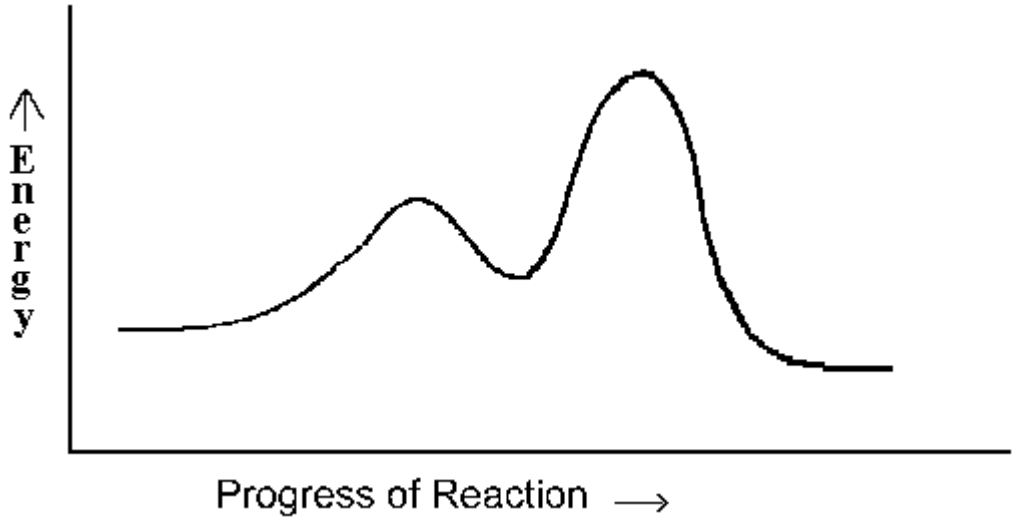

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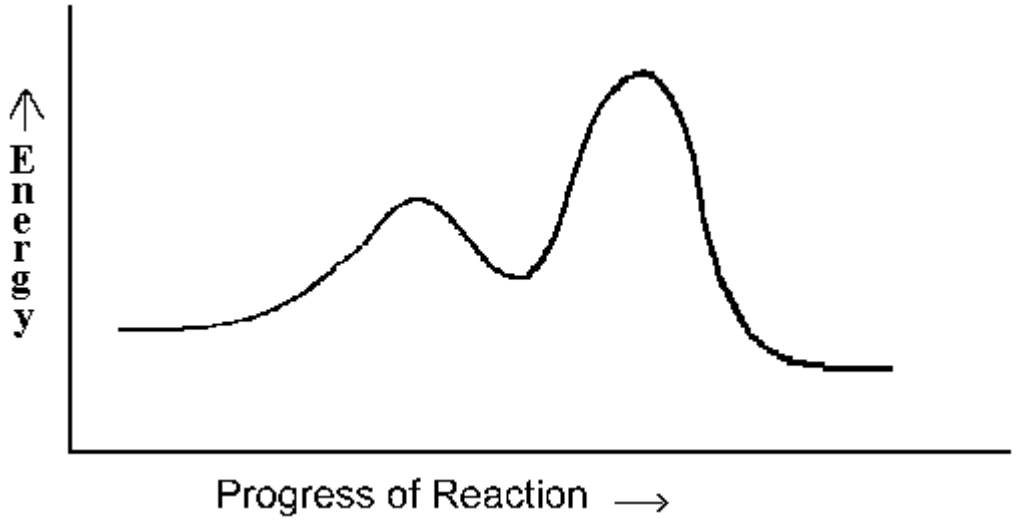

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2) The reaction

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO + 6H_2O(g)$$

has $\Delta H° = -906.2$ kJ mol^{-1} and Kp is 3.97×10^{167} @25°C. (If your calculator can't handle the large numbers involved, use a spread sheet to do the calculations.)

a) Calculate $\Delta G°$, making sure to include units. What does the sign of this value tell you? (2)

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c) Estimate K_p at 1000°C. Why is this estimate liable to be very inaccurate? Is its magnitude relative to K_p at 25°C to be expected on the basis of Le Chatelier's principle? (5)

3) Determine the pH of each of the following solutions, all at 25°C:

a) 0.0200 M formic acid solution, $K_a(HCO_2H) = 1.77\times10^{-4}$.

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Chemistry 225 Semester 04-2016
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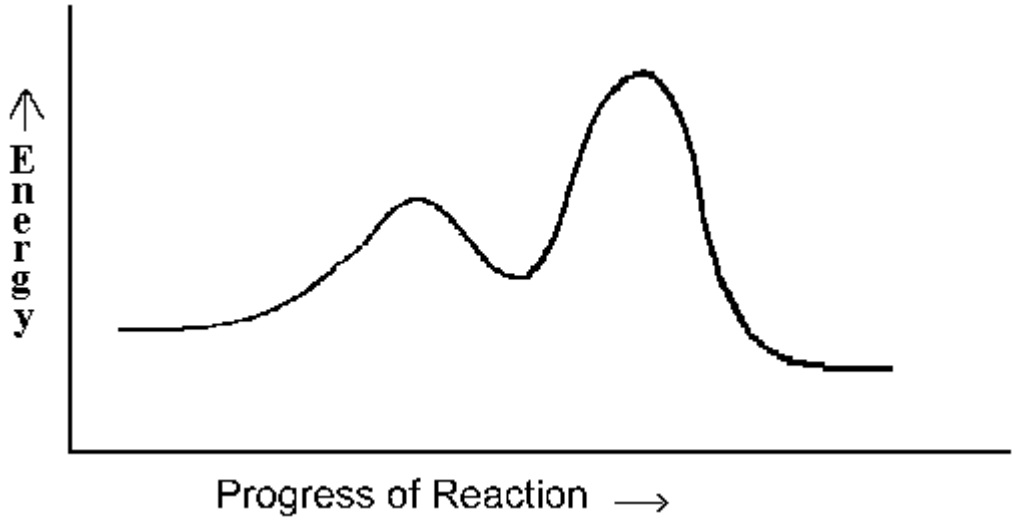

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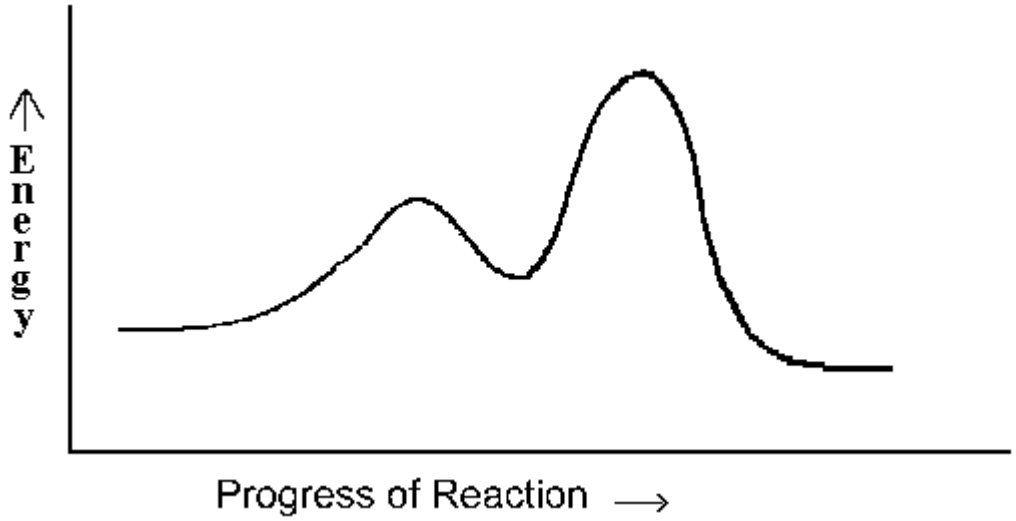

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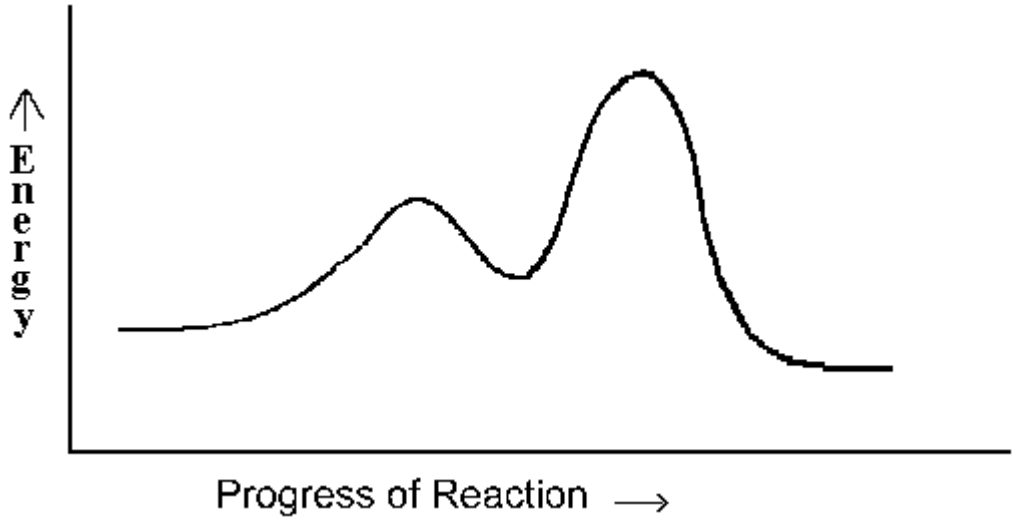

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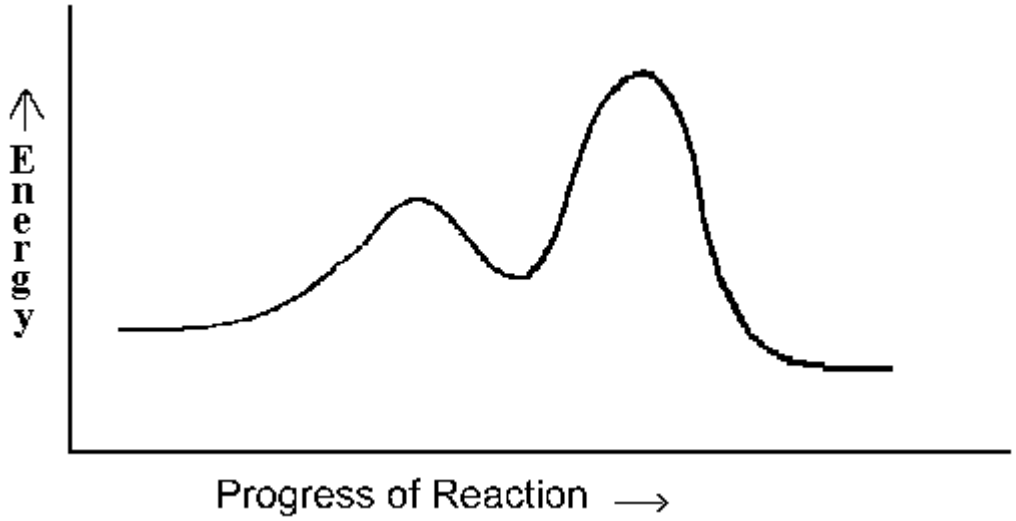

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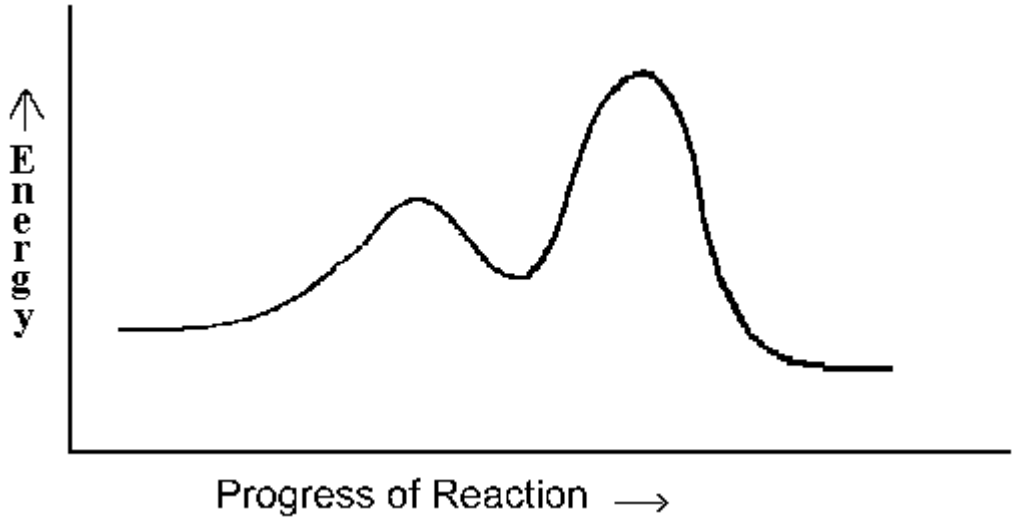

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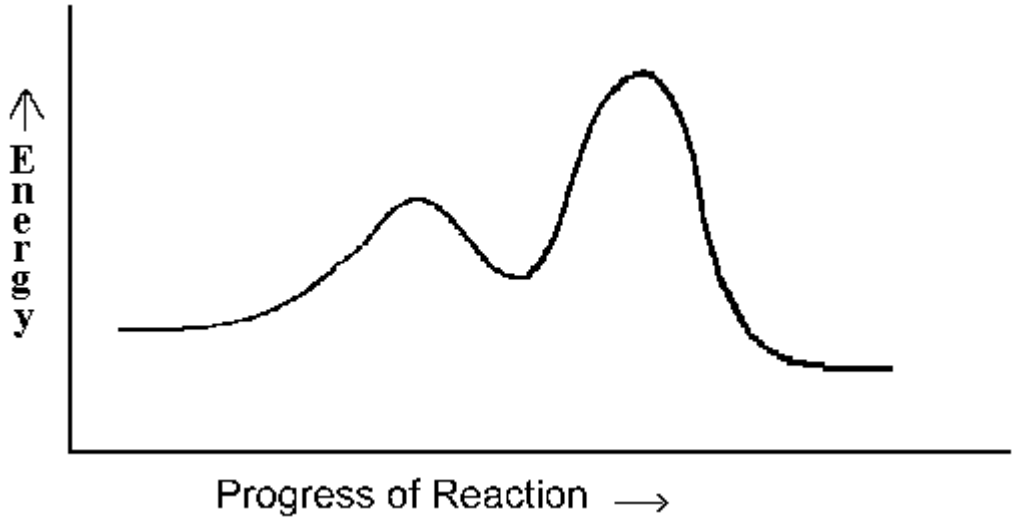

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