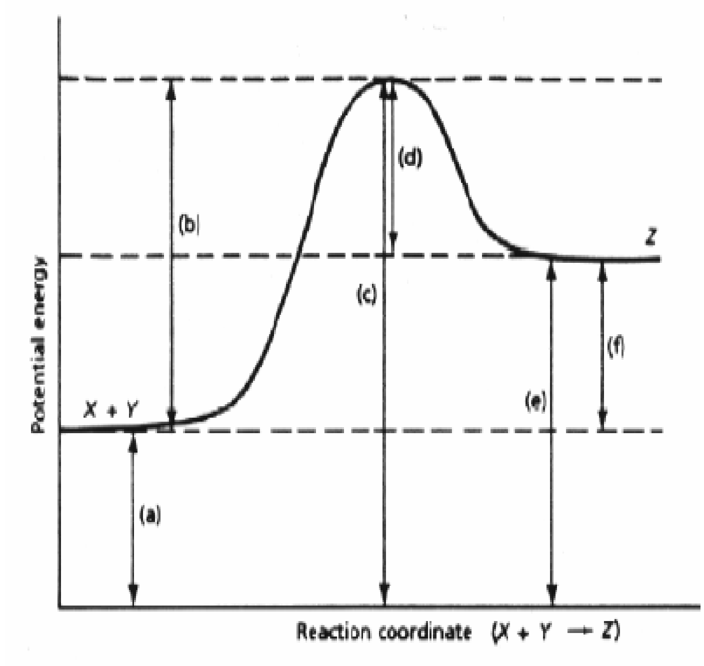
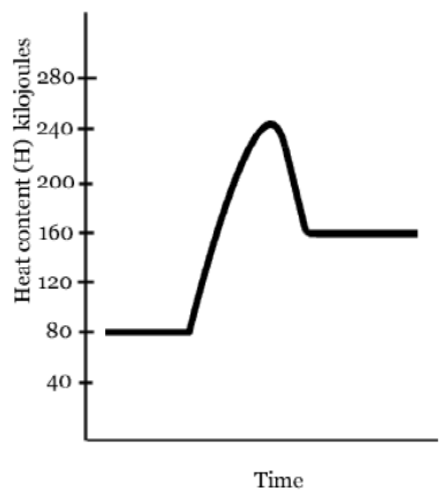
Honors Chemistry Classwork: Equilibrium

Potential Energy Diagrams



1. Which of the letters a–f in the diagram represents the potential energy of the products? _______
2. Which letter indicates the potential energy of the activated complex? ________
3. Which letter indicates the potential energy of the reactants? ________
4. Which letter indicates the activation energy? _____
5. Which letter indicates the heat of reaction? ______
6. Is the reaction exothermic or endothermic? ______
7. Which letter indicates the activation energy of the reverse reaction? ________
8. Which letter indicates the heat of reaction of the reverse reaction? ________
9. Is the reverse reaction exothermic or endothermic? ___



1. The heat content of the reactants of the forward reaction is about ______ kilojoules.
2. The heat content of the products of the forward reaction is about _______kilojoules.
3. The heat content of the activated complex of the forward reaction is about ______ kilojoules.
4. The activation energy of the forward reaction is about ______ kilojoules.
5. The heat of reaction (ΔH) of the forward reaction is about ______ kilojoules.
6. The forward reaction is _______________ (endothermic or exothermic).
7. The heat content of the reactants of the reverse reaction is about ________ kilojoules.
8. The heat content of the products of the reverse reaction is about _______ kilojoules.
9. The heat content of the activated complex of the reverse reaction is about _______kilojoules.
10. The activation energy of the reverse reaction is about _______ kilojoules.
11. The heat of reaction (ΔH) of the reverse reaction is about _______ kilojoules.
12. The reverse reaction is __________________ (endothermic or exothermic).

Collision Theory

1. Chemical reactions occur when reactants collide. For what reasons may a collision fail to produce a chemical reaction?

2. If every collision between reactants lead to a reaction, what determines the rate at which the reaction occurs?

3. What is the activation energy of a reaction, and how is this energy related to the activated complex of the reaction?

4. What happens when a catalyst is used in a reaction?

5. Name 4 things that will speed up or slow down a chemical reaction.

6. Draw an energy diagram for a reaction. (label the axis)

Potential energy of reactants = 350 KJ/mole

Activation energy = 100 KJ/mole

Potential energy of products = 250 KJ/mole

7. Is the reaction in # 6 exothermic or endothermic? Explain.

8. How could you lower the activation energy for the reaction in #6?

Equilibrium Expressions

1. Calculate the equilibrium concentration of HI for the reaction: $2HI = H_2 + I_2$ if Keq = 0.0186 and if the equilibrium concentrations are $[H_2]$ = 0.00290 and $[I_2]$ = 0.0017 (Ans: 0.0163 M)

2. Calculate the equilibrium concentrations at 400ºC of NH_3 for the reaction: $N_2 + 3H_2 = 2NH_3$. The equilibrium concentrations for the reactants at 400ºC are $[N_2]$ = 0.45 M and $[H_2]$ = 1.10 M. The Keq at this temperature is 0.0017. (Ans: $[NH_3]$ = 0.032M)

3. For the following equilibrium reaction: $N_2O_4 = 2NO_2$, a 3 liter flask at equilibrium is found to contain 10.8 moles of N_2O_4 and 5.25 moles of NO_2. Calculate Keq. (Ans: Keq = 0.85)

4. At a given temperature, the K_{eq} for the reaction $2HI(g) \rightarrow H_2(g) + I_2(g)$ is 1.40×10^{-2}. If the concentration of both H_2 and I_2 at equilibrium are 2.00×10^{-4}M, find the concentration of HI.
(Ans: 0.00169M)

5. Acetic acid dissociates in water. If $K_{eq} = 1.80 \times 10^{-5}$ and the equilibrium concentrations of acetic acid is 0.09986M, what is the concentration of $H^+(aq)$ and $C_2H_3O_2^-(aq)$?
(Ans:0.00134M)

$HC_2H_3O_2(aq) \rightarrow H^+(aq) + C_2H_3O_2^-(aq)$

6. At 60.2°C the equilibrium constant for the reaction $N_2O_4(g) \rightarrow 2NO_2(g)$ is 8.75×10^{-2}. At equilibrium at this temperature a vessel contains N_2O_4 at a concentration of 1.72×10^{-2}M. What concentration of NO_2 does it contain?
(Ans: 0.0388M)

7. At equilibrium, K for the decomposition of HI(g) was found to be 1.07×10^{-5}. The equilibrium concentration of HI(g) was found to be 0.129M. Calculate the concentration of I_2 at equilibrium.
(Hint – Let x = the concentration of I_2. What would the concentration of H_2 be if x is the concentration of I_2? Refer to the coefficients of the equation to help you.)

$2HI(g) \rightarrow H_2(g) + I_2(g)$

(Ans: 0.000422M)

8. In each problem, calculate the missing concentration or constant at equilibrium.

	[HI]	$[H_2]$	$[I_2]$	K_{eq}	
8.	1.78	0.172	0.172	X	(Ans: 0.00934)
9.	X	0.242	0.242	0.217	(Ans: 0.519)
10.	0.78	0.112	X	2.06×10^{-2}	(Ans: 0.112)

ICE Charts in Equilibrium Expressions

1. 1.60 moles of W and 2.4 moles of X react slowly in a 2 liter container to produce U and V according to the following equation: 2W + 3 X = U + 2V. At equilibrium, 0.50 mole of U is present. Calculate Keq. (Ans: Keq=7.6)

2. Given: A + 2B = 3C + D. 5.0 moles of A and 6.0 moles of B are originally placed in a 10 liter container. At equilibrium only 3 moles of B are left. Calculate Keq. (Ans: 0.43)

3. The reaction: A = 2C + B takes place in a 2.0 liter container. 7.5 moles of A are originally placed in the container and at equilibrium 3.0 moles of C have been produced. Calculate Keq (Ans:0.56)

4. We place 0.064 mol N_2O_4 (g) in a 4.00 L flask at 200K. After reaching equilibrium, the concentration of NO_2 (g) is 0.0030 M. What is K for the reaction: $N_2O_{4\,(g)} \leftrightarrow NO_{2\,(g)}$ (Ans: $1.6x10^{-4}$)

5. Phosphorus pentachloride decomposes into phosphorus trichloride and chlorine gas. What is the initial concentration of phosphorus pentachloride if at equilibrium the concentration of chlorine gas is 0.500 M? Given K=10.00 (Ans: 0.525 M)

6. A 1.000 L flask is initially filled with 1.00 mole of hydrogen gas and 2.000 moles of iodine gas at 448°C. At this temperature K_c is 50.5. Calculate the equilibrium concentrations for all the chemical species in the reaction, which is hydrogen gas and iodine gas produce HI gas.
HINT: You will need to use your Solver on your graphing calculator!! ☺ How exciting!
(Ans: $[H_2]$=0.065M,$[I_2]$=1.065M, [HI]=1.87 M)

LeChatelier's Principle

1. What is Le Chatelier's Principle?

____

Complete the following charts by writing →, ←, or none for "shift" & increase, decrease or stay the same for the concentrations of reactants and products.

Reaction: $N_2(g) + 3H_2\ (g) \leftrightarrow 2NH_3(g) + 100.4\ kJ$

Stress	Equilibrium Shift	[nitrogen]	[hydrogen]	[Ammonia]
Add nitrogen				
Add hydrogen				
Add ammonia				
Remove nitrogen				
Remove hydrogen				
Remove ammonia				
Increase temperature				
Decrease temperature				
Increase pressure				
Decrease pressure				
Add catalyst				

Reaction: $NaOH(s) \leftrightarrow Na^+(aq) + OH^-\ (aq) + 10.6\ kJ$ **remember pure (s) & (l) do not affect equilibrium values**

Stress	Equilibrium Shift	Amount NaOH (s)	[Na^+]	[OH^-]	K
Add NaOH (s)					
Add NaCl (adds Na ions)					
Add KOH (adds OH ions)					
Increase temperature					
Decrease temperature					
Increase P					
Decrease P					