Kinetics Class Notes

Some reactions are fast, like the very first one you saw on the first day. Remember the synthesis of water?

1. Hydrogen gas + oxygen gas + a touch of heat → _____ + _____

Some are rather slow, remember the decomposition of hydrogen peroxide?

2. Hydrogen peroxide → _____ + _____ + _____

That second one was SOOOOOOO SLOOOOWWWWWW it took a catalyst to make it happen!

3. The catalyst was potassium iodide, a white salt. Write it in the equation where it belongs….

_____ (put it there now)

4. The catalyst is not a _____ or a _____.

5. Kinetics is the part of chemistry that studies the _____ of _____

6. We will again examine reactions that absorb energy to occur, called _____

7. And their opposites, reactions that emit energy as a product, called _____

One of the simplest reactions we know is the combustion of methane.

$$CH_{4(G)} + 2O_{2(G)} \rightarrow 2H_2O_{(G)} + CO_{2(G)} + \text{energy}$$

We know a lot about this reaction too, let's start naming things:

8. This reaction is _____, it's _____, and

the heat is written with the _____.

The _____ (_____) for this reaction is _____ table I).

9. The forward reaction is _____ because energy is a _____ .

10. At the bottom of Table I it says that _____

11. The mole ratio of this equation would be: _____

The thermochemical mole ratio would be _____

12. Why is this chemical reaction irreversible?

This reaction is different: $2H_2O_{(L)} + \text{energy} \rightarrow O_{2(G)} + 2H_{2(G)}$

14. For starters, since energy is a _____.

this reaction is _____ _____

15. Table I shows this: _____ it's _____(?)

16. Wait a second, is this reaction even on table I?

17. The _____of water, is reversed from table I, so the ΔH for this is _____

18. For this decomp reaction: ΔH = _____

19. This reaction is the opposite from table I, energy is a _____.

This reaction is _____ _____

	Reactions from table I	Actual ΔH	Exo or endo
ex	$2C_8H_{18(L)} + 25O_{2(G)} \rightarrow 16CO_{2(G)} + 18H_2O_{(G)}$		
20	$N_{2(G)} + O_{2(G)} \rightarrow 2NO_{(G)}$		
21	$2C_{(S)} + H_{2(G)} \rightarrow C_2H_{2(G)}$		
22	$4Al_{(S)} + 3O_{2(G)} \rightarrow 2Al_2O_{3(S)}$		
23	$C_3H_{8(G)} + 5O_{2(G)} \rightarrow 3CO_{2(G)} + 4H_2O_{(G)}$		
24	$CO_{2(G)} \rightarrow C_{(S)} + O_{2(G)}$		
25	$NaOH_{(S)} \xrightarrow{H_2O} Na^{+1}{}_{(AQ)} + OH^{-1}{}_{(AQ)}$		
26	$2NH_{3(G)} \rightarrow N_{2(G)} + 3H_{2(G)}$		

27. Time and…

28. Time is...

29. Rate is ...

30. _____ ≠ _____

31. Rate has a weird unit of _____ or _____

The factors that affect the rate of a chemical reaction (NOT the time it takes)

32. _____ – hotter usually means the reaction will happen faster

33. _____ – which allows the reactants to react faster

34. _____ – more stuff, more chance for a reaction to happen

35. Adding a _____

36. Increase in Temperature causes MORE _____ between the particles.

37. Increase reactant surface area causes MORE _____ between the particles.

38. Increase the concentration of the reactants causes MORE _____ between the particles.

39. Catalysts have _____ on the collisions of particles, but they still speed up chemical reactions.

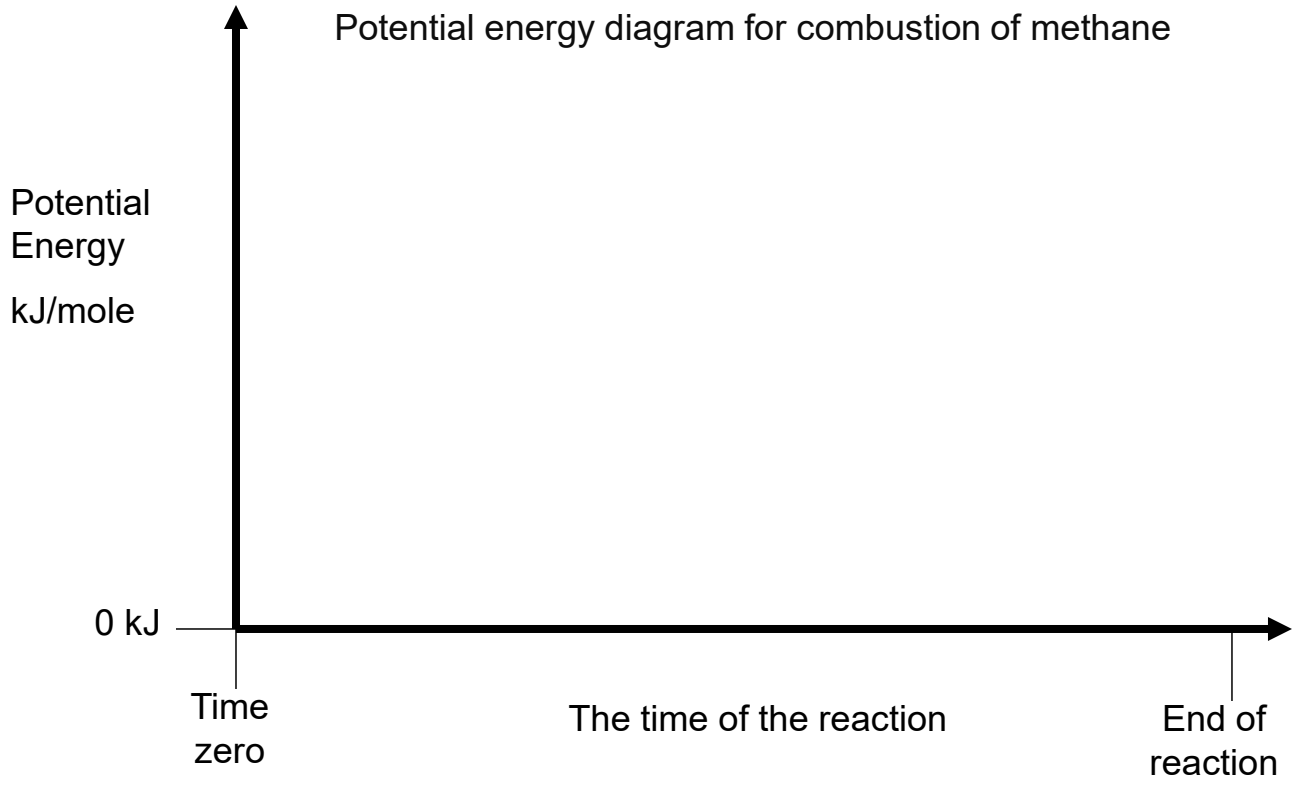
Kinetics Class #2: Potential Energy Diagrams are the graphs that show the flow of energy through chemical reactions. They come in 2 flavors, exothermic and endothermic.

40. Write the Law of Conservation of Energy

41. Potential energy diagrams _____

_____

42. Our first potential energy diagram (graph) will be for the first equation on Table I, the combustion of methane (look now)



Make sure this diagram has these labels with units, and these definitions below:

43. Potential Energy of Reactants: _____

44. Potential Energy of Products: _____

45. ΔH: _____ Here the ΔH is _____

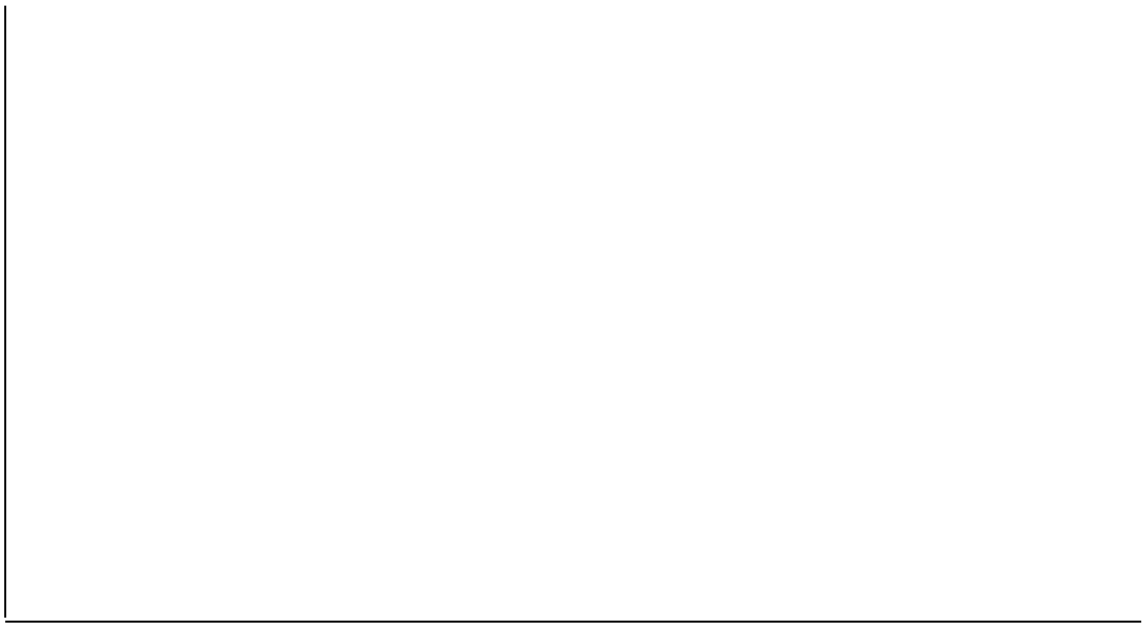
46. Activation Energy (AE): _____

47. Now we will draw the PE Diagram for the synthesis of C_2H_2 using Table I

48. The "DOT"…

49. Draw the potential energy diagram for the solvation of sodium hydroxide

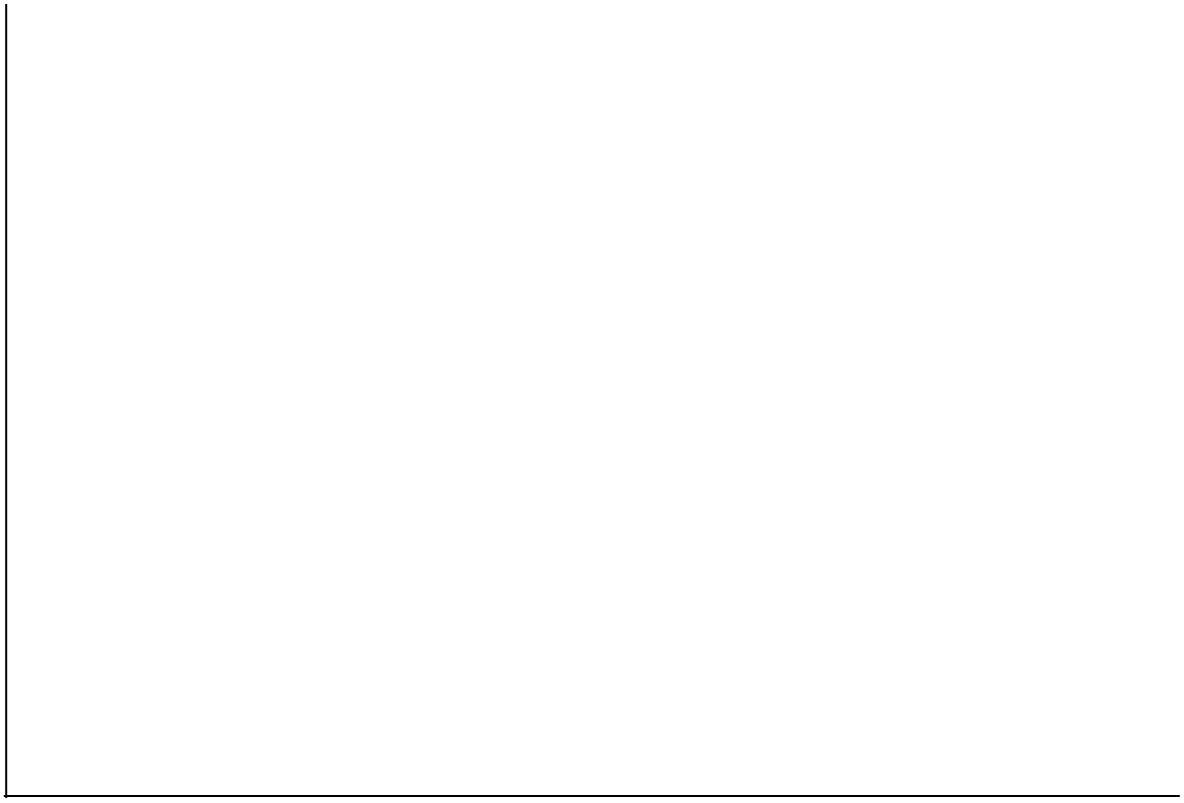
Write out the equation first: _____



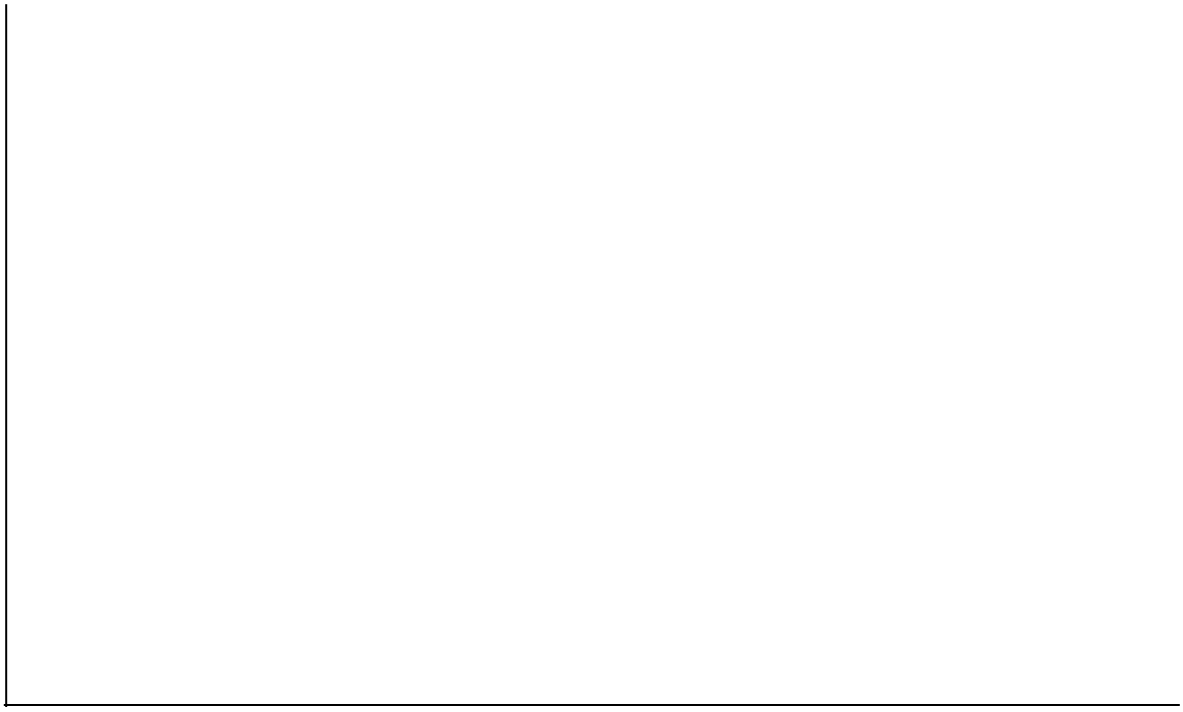
50. This energy is the _____

More Kinetics Vocabulary		
51	Potential energy	
52	Activation complex	
53	Activation energy	
54	ΔH	
55	Potential energy diagram	

56. Draw the PE Diagram for the synthesis of Aluminum Oxide.
Make the balanced thermochemical equation your title.



57. Draw the PE diagram for the solvation of sodium chloride, use dissociation symbols from table I for title.



58. Draw the PE diagram for the combustion of propane.

Kinetics Class #3 Objective: The affect of catalysts on chemical reactions

59. Draw 2 PE diagrams, LEFT IS EXOTHERMIC, right is endothermic.

combustion of $C_6H_{12}O_{6(S)}$

Synthesis of $HI_{(G)}$

60. CATALYST A substance…

It doesn't get…

Catalysts….

Catalysts…

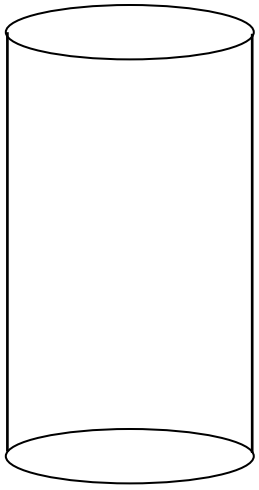
61. Go back to the 2 graphs you just drew and add in the affect of the catalyst by adding in a dotted line.

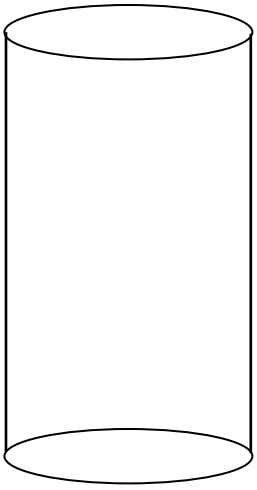
62. Catalysts _____ change the number of collisions. Catalysts are said to work in 2 different ways.

63. Catalysts lower _____ of a reaction.
This lets the reaction start in a less energetic way, so it can happen quicker than normal.

64. Catalysts provide _____
for the reaction to proceed. *This lets this reaction happen quicker. (Like a shortcut).*

65. Write out the chemical symbols for our demo: _____
Draw the diagram too…





Kinetics Class #4 Objective: Describing chemical reactions that are in dynamic equilibrium; we will learn how to "push" them forward, or reverse by using LeChatelier's Principle.

August 7, 1974, Manhattan, Phillipe Petit from France doesn't "drop" in!

66. Most…

67. Some reactions are reversible because…

68. The ΔH is…

69. One of the most important chemical reactions that is reversible, is

---

70. Dynamic equilibrium is when the…

71. In this reaction: $N_{2(G)} + 3H_{2(G)} \leftrightharpoons 2NH_{3(G)} + \text{energy}$ the…

72. It's constantly…

73. In a dynamic equilibrium you DO NOT necessarily have equal masses,
or equal moles, on opposite sides of the _____

74. The rate of the forward _____

75. It is possible to have equal masses or equal moles on both sides,

_____
it's only a possibility.

76. State LeChatelier's Principle (memorize it too)

77. You can disrupt an equilibrium by

78. The chemical system must…

79. What happens if we pump more ammonia into this closed system at equilibrium?

nitrogen + hydrogen $\leftrightharpoons$ ammonia + energy

add ammonia

80. This closed system is in dynamic equilibrium. Let's apply different stresses, and see which way the system will "push" to create a new dynamic equilibrium

$$N_2 + 3H_2 \leftrightharpoons 2NH_3 + \text{energy}$$

Add nitrogen

Add hydrogen

Add ammonia

Add energy (heat)

Add pressure

81.

Remove nitrogen

Remove hydrogen

Remove ammonia

Remove energy (cool system)

Lower pressure

82. This IS NOT a real dynamic equilibrium (write symbols)

_____

but… we can make believe, we can apply LeChatelier's Principles to ANY dynamic equilibrium.

83. The forward reaction is _____, the reverse is _____

84. The forward reaction is _____, the reverse is _____

85. We cannot know…

$$4Al_{(S)} + 3O_{2(G)} \leftrightharpoons 2Al_2O_{3(S)} + \text{Energy}$$

86	Add aluminum oxide
87	Remove oxygen
88	Remove heat (cool system)
89	Add aluminum
90	Add Heat
91	Increase pressure

92. Pressure only effects _____. Pressure does not effect solids, liquids, or aqueous.

93. If a stress "stops" or slows down a forward reaction, _____.

94. If a stress "stops" or slows down a reverse reaction, _____.

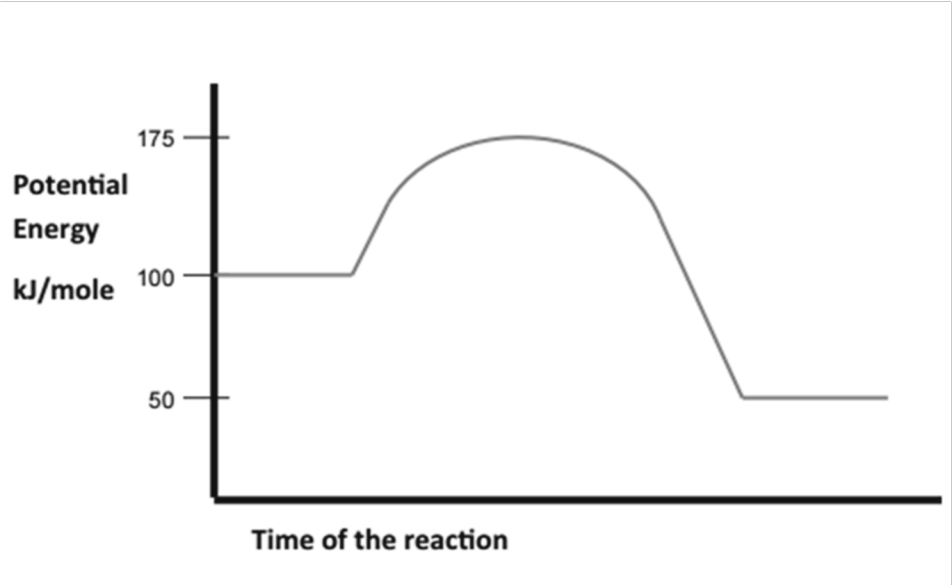
95. A new balance, or equilibrium _____

This is NOT a real dynamic equilibrium, but we will make believe" because of the double arrows.

$$CH_{4(G)} + 2O_{2(G)} \leftrightharpoons CO_{2(G)} + 2H_2O_{(G)} + \text{energy}$$

96	Add methane
97	Add water
98	Add heat
99	Remove carbon dioxide
100	Remove heat
101	Remove methane
102	Add carbon dioxide
103	Increase pressure
104	Decrease pressure

Review…



Questions

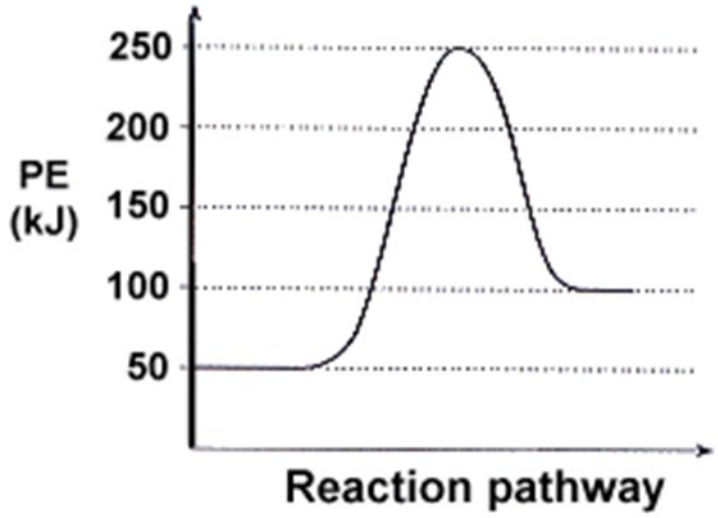
105. Is this an exo or endothermic reaction? _____

106. What is the potential energy of the activated complex? _____

107. What is the PE of the products? _____

108. What is the ΔH? _____

109. What would be a possible activation energy with a catalyst? _____



110. What is the PE of the reactants? _____

111. What is the activation energy for this reaction? _____

112. Is this reaction exothermic or endothermic? _____

114. What are possible AE values for this reaction with a catalyst? _____

115. What is the ΔH for this reaction? _____

116. Would the ΔH for this reaction change with a catalyst? _____

117. In this dynamic equilibrium… Which way does each stress push the reaction with all of these stresses?

$$3A_{(G)} + B_{(S)} \rightleftharpoons 3C_{(G)} + D_{(G)} + \text{energy}$$

Add heat
Add B
Inc. pressure
Remove D
Add C

118. LeChatelier's Principle is… Chemical systems at equilibrium tend to stay at equilibrium. When a chemical stress is put upon a chemical system in equilibrium, it will shift to relieve that stress, and a new dynamic equilibrium forms.

119. Stresses include changes in pressure, temperature, and adding/removing reactants.

120. Of the 4 factors that would that speed up a chemical reaction, three of them work one way, but the 4th factor works a different way. They are…

1

2

3

4

ALL FOUR…_____

ALL FOUR… _____

121. ENTROPY _____

122. PHASES and entropy…

123. Three solid compounds are at the same temperature and pressure, which has the most entropy, which has the least entropy, and why?

124. If mountains crumble to the sea, there will still be you and me. (from Thank You, by Led Zeppelin)

125. *From the NYS Curriculum:*

What's equal in a dynamic equilibrium? The rate of the forward reaction is equal to the rate of the reverse reaction. That's it. There is always the same number of everything, but sometimes the "stuff" is one side of the arrows, or the other. Etc. Finish up the notes in your mind.