Equilibrium

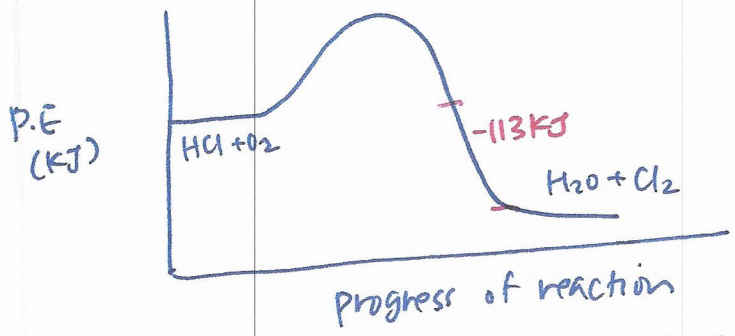
47. Answer the following questions regarding the following reaction at equilibrium:

$$\underline{4}\ HCl_{(g)} + \underline{1}\ O_{2(g)} \leftrightarrow \underline{2}\ H_2O_{(l)} + \underline{2}\ Cl_{2(g)} + 113\ kJ$$

a. Balance the equation.

b. Is the forward reaction endothermic or exothermic? exothermic

c. Sketch an energy diagram for this reaction.



d. In the table below, predict the changes that would take place in the above reaction in response to each of the stresses.

STRESS	WHICH REACTION IS FAVORED? (FORWARD OR REVERSE)	[HCl] INCREASE OR DECREASE?	$[Cl_2]$ INCREASE OR DECREASE?
Temperature Increases	reverse	increase	decrease
Pressure Decreases	reverse	increase	decrease
O_2 is removed	reverse	increase	decrease

48. A reaction stops. There are equal amounts of products and reactants. Is equilibrium established? Explain. NO. Equilibrium is established when the rate of the forward reaction equals the rate of the reverse reaction; the amount of product & reactants can differ.

49. What is the equation for calculating the equilibrium constant (K) for a chemical reaction?

$$aA + bB \rightleftharpoons cC + dD$$

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

50. The K_w for water at 25°C is 1×10^{-14}. Does this mean that the reactants or products are favored at equilibrium? reactants

51. The following reaction represents the decomposition of water. The reaction is at equilibrium.

$$2\ H_2O_{(l)} + \text{heat} \rightarrow 2\ H_{2(g)} + O_{2(g)}$$

Determine whether each of the following stresses will increase the rate of the **forward** or **reverse** reaction.

a. the temperature is increased — forward

b. the pressure is decreased — forward

c. the $[H_2O_{(l)}]$ is decreased — reverse

d. the $[O_2]$ is increased — reverse

e. the container volume is decreased — reverse

Solutions

52. List all of the intermolecular forces present between the following molecules or atoms.

a. Br_2 - covalent

b. H_2O -

c. NCl_3 -

d. He -

* If you had samples of each of the above substances, rank them in order of INCREASING boiling point.

53. Differentiate between the terms solute and solvent.

Solute - solid material that is dissolved in the solvent

54. What is the density of water 25°C? 1g/1mL

55. What is the meaning of "like dissolves like"? polar dissolves polar
nonpolar dissolves nonpolar

56. Describe each of the following as an electrolyte or a non-electrolyte. Justify your answer.

Compound	Electrolyte or Non-electrolyte	Why?
NaCl	electrolyte	ionic
HCl	electrolyte	acid
$C_6H_{12}O_6$	non-electrolyte	glucose -> non polar
KOH	electrolyte	base

57. Write the equations for determining molarity (M), molality (*m*) and parts per million (ppm).

M = $\frac{\text{moles}}{\text{L soln}}$ m = $\frac{\text{moles}}{\text{kg solvent}}$ ppm =

58. You dissolve 0.68 moles of NaCl in 1.95L of water. What is the molarity (M) of the solution?

0.35M

Gas Laws

59. Describe the relationship between each of the following measurable quantities with respect to gas laws as either **directly proportional or indirectly proportional**. Assume the unmentioned quantities are held constant. State which gas law relates the two values.

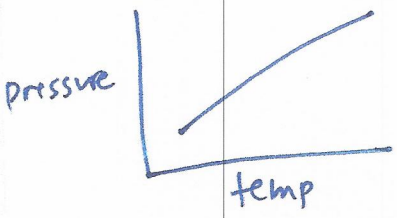
a) Pressure and Temperature - directly - Gay-Lussacs

b) Volume and Pressure - indirectly - Boyles

c) Volume and Temperature - directly - Charles

60. Write the equation for the combined gas law. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

61. Sketch a graph that shows the relationship between temperature and volume of a gas. Label the temperature on the x-axis and pressure on the y-axis.



62. What causes pressure? Write the equation for pressure.

63. A container has 8.0 L of O_2 gas at 50 °C. The gas is compressed to a volume of 3.0 L. What is the new temperature of the gas?

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $T_2 = -151K$

64. A gas in a 35mL container has a pressure of 75atm. If it is transferred to a 45mL container, what is the new pressure in atmospheres? (Hint: Use $P_1V_1=P_2V_2$)

58mL

65. On a cold winter morning when the temp is -16°C, the air pressure in the tire of your bicycle is 1.2 atm. After you ride your bike to school, the new temperature of the gas in the tire is 10°C. If the volume of gas in the tire does not change, what will be the new pressure in the tire? (Hint: Use $P_1/T_1=P_2/T_2$).

1.3atm

66. State the equation for the ideal gas law. What does each letter represent? What are the proper units for each measurement?

$PV=nRT$

P = pressure (atm/torr/Pa)
V = volume (L)
n = # of moles (mol)
R = gas law constant ($\frac{atm \cdot L}{mol\ K}$)
T = temperature (K)

67. What mass of Fluorine gas (F_2) is in a 96mL container at 27.0°C and 785 torr? (Hint: Use PV=nRT, then use the mole highway to convert to grams)

0.15g F_2

68. What mass of Hydrogen gas (H_2) has a volume of 33.6L at STP? (Hint: Remember, @STP 22.4L of any gas = 1 mole, then use the mole highway to convert to grams.)

3.02g

69. What are standard temperature and pressure values? 0° C, 1atm

70. a. Write the balanced equation for the combustion of methane gas.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

b. If 5.0L of methane react, what volume of carbon dioxide is produced at standard temperature and pressure?

5.0L

Acids and Bases

71. Determine the color of the acid base indicator in each of the following solutions.

Indicator	Acidic	Neutral	Alkaline
Red Litmus Paper	red	red	blue
Blue Litmus Paper	red	blue	blue
Phenolphthalein	clear	clear	pink

72. Describe the taste of acids and bases. Give examples of each that you may find in your home.

acid - sour ; lemon juice, vinegar
base - bitter ; glass cleaner, clorox bleach

73. Which acid is found in the stomach? HCl

74. Strong acids react with salts to produce H_2 gas.

75. Strong acids or bases are strong electrolytes, and therefore conduct electricity.

76. What are the products of a neutralization reaction? H_2O, salt

77. Write the balanced reaction of sulfuric acid with sodium hydroxide.

$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$

78. A solution contains 2×10^{-7} M $[H_3O^+]$.

a. What is the pH? (Hint: pH = -log $[H_3O^+]$) 7 = pH

b. Is it acidic, basic, or neutral? neutral

c. What is the pOH? pOH = 7

d. What is the $[OH^-]$? 5×10^{-8}

79. What is the purpose of a titration reaction?

to neutralize the acid or base

80. In a titration, 29.96 mL of $Ba(OH)_2$ requires 16.08 mL of 2.303 M H_2SO_4.

a. Write a balanced equation for this reaction.

$Ba(OH)_2 + H_2SO_4 \longrightarrow H_2O + BaSO_4$

b. What is the molarity of the barium hydroxide? (Hint: Use $X_AM_AV_A=X_BM_BV_B$)

$(2)(2.303M)(16.08mL) = 2(x)(29.96mL)$

$x = 1.236M$

81. What does amphoteric mean?

can act as both acid & base

82. Identify the acid and base in the following reaction. Then identify the conjugate acid/base pairs.

$HF_{(aq)} + H_2O_{(l)} \leftrightarrow F^-_{(aq)} + H_3O^+_{(aq)}$

acid base conj base conj acid

83. Differentiate between a strong and weak acid.

strong acid dissociates completely in H_2O / reaction
weak acids do not dissociate completely in H_2O

84. Name the 7 strong acids.

HCl, HBr, HI, H_2SO_4, HNO_3, $HClO_3$, $HClO_4$

85. Which elements on the periodic table tend to form strong bases when combined with hydroxide ions?

alkali metals & alkaline earth metals

86. Provide an example of each of the following:

- monoprotic acid: HNO_3
- diprotic acid: H_2SO_4
- triprotic acid: H_3PO_4

Thermochemistry

87. Which process is exothermic: evaporation or condensation?

88. What is the lowest possible temperature in the universe: in Kelvin? 0
in °C? -273°C

89. Describe the movement of the particles in a sample of matter at absolute zero.

particles don't move

90. What do each of the following values represent and what do their signs indicate about a chemical reaction?

a. ΔH:

If positive: endothermic

If negative: exothermic

b. ΔS:

If positive: entropy increases

If negative: entropy decreases

c. ΔG:

If positive: non-spontaneous

If negative: spontaneous

91. Write the equation that represents the relationship between these values.

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

92. Determine the sign of ΔG and whether a reaction will be spontaneous or not under each of the following conditions:

ΔH	ΔS	ΔG
+	+	spontaneous
+	-	depends on temp
-	+	spontaneous, —
-	-	depends on temp.

93. What is the difference between a calorie and a Calorie?

1000 calorie = 1 Calorie

94. How many joules are equivalent to 1 calorie? 1 calorie = 4.184 J

95. What is the equation used to calculate specific heat? Indicate the meaning and units of each variable.

$q = C \cdot m \cdot \Delta T$ — temp. difference

energy — specific heat constant — mass

96. A 35 g sample of H_2O at 5°C absorbs 630 J of energy. What will be the final temperature of the water?

$630\,J = (4.184\,J/g \cdot °C)(35g)(\Delta T)$

$\Delta T = 4.3°C$

$4.3°C = T_f - T_i$

$T_f = 9.3°C$

97. How much heat is released by the following reaction if 0.5 mole of sodium reacts completely with chlorine?

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)} + 822\ kJ$$

$0.5\ mol\ Na \times \frac{822\ kJ}{2\ mol\ Na} = 200\ kJ$

98. Find the ΔH for the reaction below, given the following reactions and subsequent ΔH values:

$$N_2H_{4(l)} + CH_4O_{(l)} \rightarrow CH_2O_{(g)} + N_{2(g)} + 3H_{2(g)}$$

flip $2NH_{3(g)} \rightarrow N_2H_{4(l)} + H_{2(g)}$ $\quad \Delta H = 22.5\ kJ$

same $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$ $\quad \Delta H = 57.5\ kJ$

flip $CH_2O_{(g)} + H_{2(g)} \rightarrow CH_4O_{(l)}$ $\quad \Delta H = 81.2\ kJ$

$-46.2\ kJ$

Redox and Electrochemistry

99. Differentiate between a voltaic cell and an electrolytic cell.

↙ chemical energy to electrical energy

↘ electrical energy into chemical energy.

100. Assign oxidation numbers to each atom in the following polyatomic ions:

- nitrate NO_3^- (+5, −2)
- nitrite NO_2^- (+3, −2)
- sulfate SO_4^{-2} (+6, −2)
- sulfite SO_3^{-2} (+4, −2)
- carbonate CO_3^{-2} (+4, −2)
- bicarbonate HCO_3^{-1} (+1, +4, −2)

101. Calcium reacts with chlorine to synthesize calcium chloride. Write the oxidation and reduction half reactions.

$Ca + Cl_2 \rightarrow CaCl_2$

ox: $Ca \longrightarrow Ca^{+2} + 2e^-$

red: $2e^- + Cl_2 \rightarrow 2Cl^-$

102. For the following reaction: $Na + H_2O \rightarrow NaOH + H_2$

a. Which species is oxidized? Na

b. Which species is reduced? H

c. Balance the reaction in acidic solution

ox: $2H_2O + 2Na \longrightarrow 2NaOH + 2H^+ + 2e^-$

$2e^- + 2H^+ + H_2O \longrightarrow H_2 + H_2O$

$2H_2O + 2Na \longrightarrow 2NaOH + H_2$