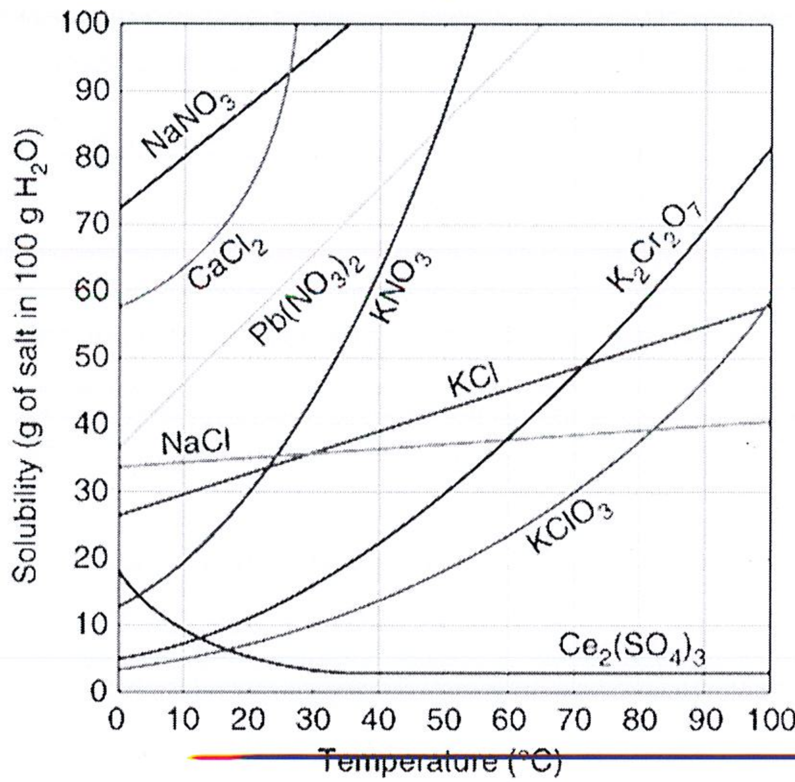
Key

Unit 5 Study Guide

Solutions



1.

a. In order to make a saturated solution of potassium chlorate at 70°C, how much potassium chlorate should be dissolved in 100 g of water?

30 g $KClO_3$

b. How many grams of NaCl should be dissolved in 500g of water in order to make a saturated solution at 90°C?

$\frac{40\text{g NaCl}}{100\text{ g }H_2O} \times 5 = \frac{200\text{g NaCl}}{500\text{g }H_2O}$

c. Which is more concentrated: a saturated solutions of sodium nitrate at 20°C or a super saturated solution of calcium chloride holding 83g of calcium chloride dissolved in 100g of water at 20°C?

2. Can a solution be dilute and saturated at the same time? Explain.

Absolutely yes. a saturated solution means the solvent cannot dissolve any more solute at that specific temperature. A dilute solution contains a small amount of solute. The terms are not mutually exclusive!

3. Use the equation for molarity to solve these problems: **M = n/V**

a. What is the molarity of a solution made by dissolving 130.0g of $Cu(NO_3)_2$ in enough water to make a 2.32L solution?

M = ?

n = 130.0g $Cu(NO_3)_2$ | 1mol / 187.57g = .69307458S mol

V = 2.32 L

$M = \frac{n}{V}$

$M = \frac{.69307458\text{5mol}}{2.32\text{ L}}$

M = .299 mol/L

n

M | V

$M = \frac{n}{V}$

b. How many moles of $CrCl_3$ were dissolved to make 0.75L of a 0.75M solution?

M = .75 mol/L

n = ?

V = .75L

$n = M \cdot V = (.75 \frac{mol}{L})(.75L) = .56 mol$

c. What is the mass of $MgSO_4$ used to create 101mL of a 1.11M solution?

M = 1.11 mol/L

n = ?

V = 101mL = .101L

$n = (1.11 \frac{mol}{L})(.101L) = .112 mol MgSO_4$

$mass = \frac{.112 mol MgSO_4 \mid 120.38g}{\mid 1 mol} = 13.5g MgSO_4$

4. Use the equation for dilutions to solve these problems: $\mathbf{M_1V_1 = M_2V_2}$

a. You have 13.00mL of 3.36M solution of sodium hydroxide, you need a concentration of 2.24M. What volume should you dilute the solution to?

$M_1 = 3.36M$

$V_1 = 13.00mL = .01300L$

$M_2 = 2.24M$

$V_2 = ?$

$(3.36 M)(.01300L) = (2.24M) V_2$

$\frac{.04368 M \cdot L}{2.24M} = \frac{(2.24M) V_2}{2.24M}$

$.0195L = V_2$

b. You have .250L of 12.0 M sulfuric acid. You dilute it to 1.250L. What is the new molarity of your solution?

$M_1 = 12.0M$

$V_1 = .250L$

$M_2 = ?$

$V_2 = 1.250L$

$(12.0M)(.250L) = M_2(1.250L)$

$\frac{3.00 M \cdot L}{1.250L} = \frac{M_2(1.250L)}{1.250L}$

$2.40 M = M_2$

5. What are colligative properties? Name 2.

Colligative properties only depend on the # of solute particles dissolved in solution & not what those particles are made of.

(1) boiling point elevation (2) freezing point depression

6. What would happen to the freezing point if you add sugar to water? What would happen to the boiling point? The freezing point would decrease & the boiling point would increase

7. Which solute would have the greatest effect on the boiling point of a solution:

a. $CaCl_2$ $(1 Ca^{2+} + 2 Cl^{-1})$ i = 3

b. Br_2 - covalent (i = 1)

c. $Al(NO_3)_3$ It has more ions $(1 Al^{3+} + 3 NO_3^{-1})$ i = 4

8. What would happen to the freezing point if you add sugar to water? What would happen to the boiling point?

9. Which solute would have the greatest effect on the boiling point of a solution:

a. $CaCl_2$

b. Br_2

c. $Al(NO_3)_3$

Acids/Bases

1. Define the following terms.

   a. Arrhenius acid releases H^{+1} in solution

   b. Arrhenius base releases OH^{-1} in solution

   c. Brønsted-Lowry acid donates H^{+1} in solution

   d. Brønsted-Lowry base accepts H^{+1} in solution

   e. Conjugate acid substance a Bronsted-Lowry base becomes after accepting H^{+1}

   f. Conjugate base substance a Bronsted-Lowry acid becomes after donating H^{+1}

   g. Amphoteric a substance that can act as both an acid or a base
   $HOH + HOH \rightarrow H_3O^+ + OH^-$

   h. pH power of Hydrogen - measure of how acidic or basic a substance is
   0 — 7 (neutral) — 14; acidic, basic

2. Identify the Brønsted-Lowry acid, Brønsted-Lowry base, conjugate acid, and conjugate base in the reactions below:

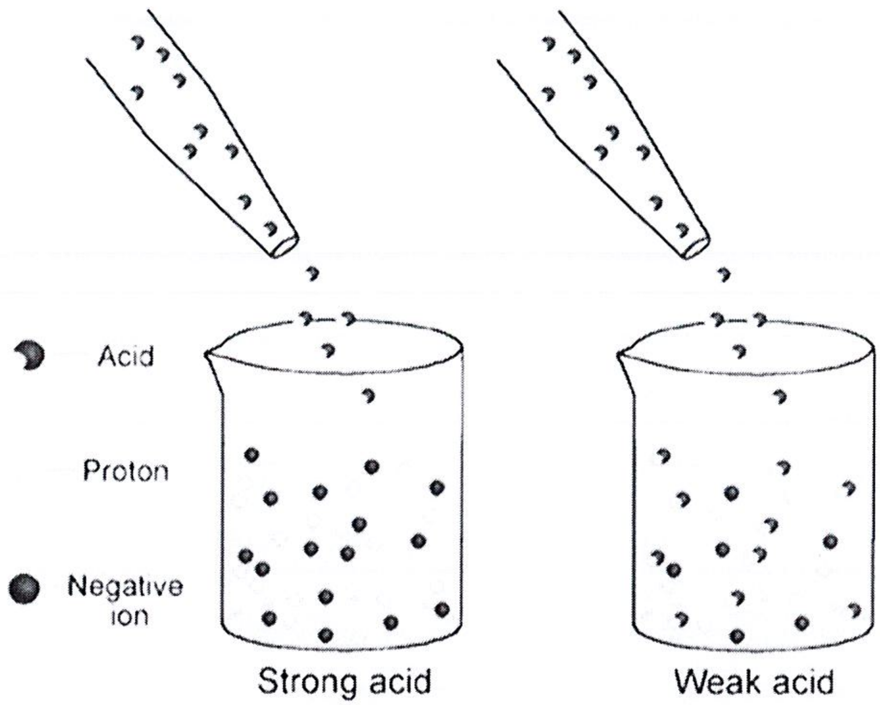
   a. $HSO_4^{1-} + NH_3 \rightarrow SO_4^{2-} + NH_4^{1+}$
   A, B, CB, CA

   b. $H_2O + NO_3^{1-} \rightarrow OH^- + HNO_3$
   A, B, CB, CA

   c. $H_2O + HCO_3^{1-} \rightarrow H_3O^{1+} + CO_3^{2-}$
   B, A, CA, CB

   d. $F^- + H_2SO_4 \rightarrow HF + HSO_4^-$
   B, A, CA, CB

3. Label the beaker in the picture that represents a strong acid. Label the beaker that represents a weak acid.



a. What makes an acid or base strong? It ionizes 100% in solution

b. What makes an acid or base weak? It ionizes 10% or less in solution

c. List 7 strong acids. HCl, HBr, HI, HNO_3, $HClO_3$, $HClO_4$, H_2SO_4

d. List 8 strong bases. $LiOH$, $NaOH$, KOH, $RbOH$, $CsOH$, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

4. List 4 properties of an acid. List 4 properties of a base.

Acids
- taste sour
- electrolytes
- react w/metals to produce $H_2(g)$
- turns blue litmus paper red
- reacts w/ basis to make a salt & water

Bases
- taste bitter
- electrolytes
- turn red litmus paper blue
- reacts w/acids to form a salt & water

5. Below is the pH of several substances. Determine if the substances are acidic, basic, or neutral
   a. Rain water: pH = 6.5 acid
   b. Egg: pH = 7.8 base
   c. Apples: pH = 3.0 acid
   d. Tears: pH = 7.4 base

Kinetics

1. Any change that happens over a period of time can be expressed as a rate.

2. What is reaction rate? How fast a reaction occurs, measured as a decrease in the concentration of a reactant over time.

3. Factors Affecting Reaction Rate

a. True or (False): One way to observe the rate of a reaction is to observe the changes in [products] over time.

b. True or (False): The rate of any reaction is a constant that does not changes when reaction conditions (temperature, concentration, etc.)

c. Generally, an increase in temperature will increase the reaction rate.

d. (True) or False: Storing milk in the fridge stops the reactions that would cause the milk to spoil.

e. How does an increase in surface area affect the exposure or reactants to one another? How does that affect the reaction rate? Increasing surface area means there is more reactant available to react, so the rate increases

f. True or (False): Increasing the concentration of reactants will generally slow down the reaction.

g. (True) or False: A piece of material dipped in a concentrated dye solution will change color more quickly than in a dilute solution.

h. Why does an increase in pressure speed up the rate of a reaction? An increase in the pressure of a gas increases collisions b/w particles which increases the rate

i. What is a catalyst?
a substance that speeds up a reaction w/o being a part of the reaction

j. True or (False): Because a catalyst is quickly consumed in a reaction, it must be added to the reaction over and over again to keep the reaction going?

k. In your own words, explain why lowering the temperature slows down a reaction.
Lowering temp. decreases collisions b/w particles which slows the rate

l. In your own words, explain why increasing the concentration of reactants will speed up a reaction?
increasing concentration means there are m

m. Complete the following table by writing either increase or decrease for the rate of the reaction.

Scenario	Increase or Decrease
Adding heat	Increase
Removing heat	Decrease
Adding a catalyst	Increase
Diluting a solution	Decrease
Removing an enzyme (catalyst)	Decrease
lowering the temperature	Decrease
decreasing the surface area	Decrease
increasing the concentration of a solution	Increase
breaking a reactant down into smaller pieces	Increase

n. Complete the following table by indicating which factor would have the greatest impact on the rate of the reaction. Choose from concentration, temperature, surface area, or catalyst.

Scenario	Factor that has the greatest impact
Blowing air on a campfire to help get it going.	concentration of $O_2(g)$
Raw carrots are cut into thin slices for cooking.	surface area
Protein is broken down in the stomach by the enzyme pepsin.	catalyst
A woolly mammoth is found, perfectly preserved, near the Arctic Circle.	temperature
More bubbles appear when a concentrated solution of hydrochloric acid is added to a magnesium strip than when a dilute solution of acid is added.	concentration
Exhaust from a car engine passes through a catalytic converter changing most of the poisonous carbon monoxide to carbon dioxide.	catalyst
A dust explosion occurs in a saw mill.	surface area

Equilibrium

4. Write the equilibrium expression for the following reversible reactions.

a. $2N_2H_4\ (g) + 2NO_2\ (g) \leftrightarrow 3N_2\ (g) + 4H_2O\ (g)$

$$K_{eq} = \frac{[N_2]^3[H_2O]^4}{[N_2H_4]^2[NO_2]^2}$$

b. $2NbCl_4\ (g) \leftrightarrow NbCl_3\ (g) + NbCl_5\ (g)$

$$K_{eq} = \frac{[NbCl_3][NbCl_5]}{[NbCl_4]^2}$$

c. $I_2\ (g) \leftrightarrow 2I\ (g)$

$$K_{eq} = \frac{[I]^2}{[I_2]}$$

d. $C_6H_6\ (l) \leftrightarrow C_6H_6\ (g)$

$$K_{eq} = [C_6H_6]$$

Remember, solids & liquids are never part of the equilibrium expression

e. $Fe_3O_4\ (s) + 4H_2\ (g) \leftrightarrow 3Fe\ (s) + 4H_2O\ (g)$

$$K_{eq} = \frac{[H_2O]^4}{[H_2]^4}$$

To determine which reaction is favored, look at Keq.
Keq < 1 - reverse reaction favored
Keq > 1 - forward reaction favored

5. $PCl_5\ (g) \leftrightarrow PCl_3\ (g) + Cl_2\ (g)$

Calculate Keq when $[PCl_5] = 0.0189$ M, $[PCl_3] = 0.0222$M, and $[Cl_2] = 0.1044$M. Is the forward or reverse reaction favored?

$$K_{eq} = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{[.0222M][.1044M]}{[.0189M]} = .123\ M$$

reverse reaction is favored

6. $N_2\ (g) + O_2\ (g) \leftrightarrow 2NO\ (g)$

Calculate Keq when $[N_2] = 1.01$M, $[O_2] = 1.10$M, and $[NO] = 0.999$M.

$$K_{eq} = \frac{[NO]^2}{[N_2][O_2]} = \frac{[.999M]^2}{[1.01M][1.10M]} = .898$$

reverse reaction is favored

7. $N_2\ (g) + O_2\ (g) \leftrightarrow 2NO\ (g)$

$K_{eq} = 6.2 \times 10^{-4}$ and $[N_2] = 0.05200$M and $[O_2] = 0.00120$M. Calculate [NO].

$$K_{eq} = \frac{[NO]^2}{[N_2][O_2]} \qquad 6.2 \times 10^{-4} = \frac{[NO]^2}{[.05200M][.00120M]}$$

$$[.00006240M^2] \cdot 6.2 \times 10^{-4} = \frac{[NO]^2}{[.00006240M^2]} \cdot [.00006240M^2]$$

$$3.8688 \times 10^{-8} M^2 = [NO]^2$$

$$\sqrt{3.8688 \times 10^{-8} M^2} = [NO]$$

$$1.97 \times 10^{-4} M = [NO]$$

reverse reaction is favored

Le Chatelier's Principle

A stress applied to a system at equilibrium will shift the position of equilibrium in order to reduce the stress.

Type of stress	Equilibrium shifts	why?
[reactant] ↑	right (products)	to use up extra reactant
[reactant] ↓	left (reactants)	to create more reactant
[product] ↑	left (reactants)	to use up extra product
[product] ↓	right (products)	to create more product
Volume ↑ (P ↓)	toward the side w/ more moles of gas	to ↑ P
Volume ↓ (P ↑)	toward the side w/ less moles of gas	to ↓ P
Temperature ↑	away from q (heat)	to ↓ T
Temperature ↓	toward the q	to ↑ T
add a catalyst	never shifts	

Examples

(1) $q + 3\,NO(g) \rightleftharpoons NO_2(g) + N_2O(g)$ q is +

(A) ↑ $[NO_2]$ left
(B) ↑ T right
(C) ↓ V right
(D) add a catalyst no shift
(E) ↑ [NO] right
(F) ↓ $[N_2O]$ right
(G) ↓ T left
(H) ↑ V left

(2) $N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g) + q$ q is −

(A) ↓ $[NH_3]$ right
(B) ↓ T right
(C) ↓ V right
(D) ↓ $[N_2]$ left
(E) ↑ $[H_2]$ right
(F) ↑ V left
(G) ↑ T left

Caitlyn
Ro
Arely
Justin
Hope
Luis
Ahja
3009

8. $H_2\ (g)\ +\ CO_2\ (g)\ \leftrightarrow\ H_2O\ (g)\ +\ CO\ (g)$

Keq = 1.60. Calculate the $[H_2]$ when $[CO_2]$ = .320M, $[H_2O]$ = .240M, and $[CO]$ = .240M.

$$K_{eq} = \frac{[H_2O][CO]}{[H_2][CO_2]}$$

forward reaction is favored

$$1.60 = \frac{[.240M][.240M]}{[\ H_2\ ][.320M]}$$

$$[H_2] \cdot 1.60 = \frac{.180\ M}{[H_2]} \cdot [H_2]$$

$$\frac{[H_2] \cdot 1.60}{1.60} = \frac{.180M}{1.60}$$

$$[H_2] = .113\ M$$

9. Using LeChatelier's Principle to fill in the chart. **N_2 (g) + $3H_2$ (g) ↔ $2NH_3$ (g)** The reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g) + q$$

Stress	Equilibrium Shifts…	Why?
↑$[N_2]$	right	to get rid of extra N_2
↑ $[H_2]$	right	to get rid of extra H_2
↑ $[NH_3]$	left	to get rid of extra NH_3
↑ temperature	left	to lower temp.
↓ $[N_2]$	left	to make more N_2
↓volume	right	to reduce pressure
↓$[NH_3]$	right	to make more NH_3
↓ $[H_2]$	left	to make more H_2
add a catalyst	no shift	catalysts do not affect equilibrium
↓ pressure	left	to increase pressure
↓ temperature	right	to increase temp.