KEY

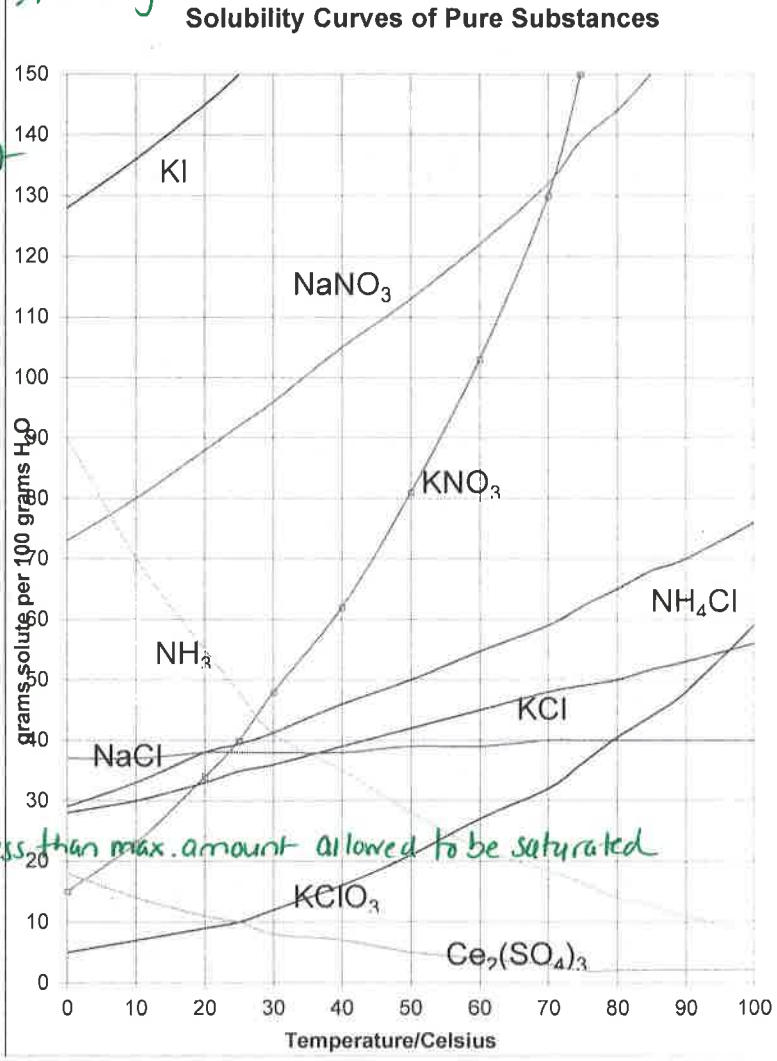
Honors Chemistry – Unit 7 Review

Chapter 16 – Solutions

SOLUTIONS & SOLUBILITY VOCABULARY & CONCEPTS

1. Solute is the substance that is dissolved.
2. solvent is the substance that does the dissolving.
3. solution is a homogeneous solution.
4. A saturated solution has the maximum amount of solute dissolved in a given amount of solvent.
5. An unsaturated solution can dissolve more solute.
6. Opposite of soluble is insoluble.
7. Solubility is how many grams of solute dissolves in 100 mL of water.
8. For most solid solutes, as temperature goes up, solubility goes up.
9. For most gas solutes, as temperature goes up solubility goes down.
10. What are the three factors that an increase the rate of dissolving of a solute? Explain how they aid a substance in dissolving on a molecular level. Temperature, surface area (particle size), stirring
11. Why must you keep a carbonated beverage cool to prevent it from going "flat"? As temp. goes up, solubility goes down
12. Explain the difference among saturated, unsaturated, and supersaturated solutions. max solute, some solute but can hold more above max (usually b/c heated)

SOLUBILITY CHARTS – *use the graph to the right*



13. What is the solubility of NaCl at 25°C? 38 g NaCl
14. What is the solubility of KNO_3 at 70°C? 130 g KNO_3
15. At what temperature is the solubility of $NaNO_3$ 90g/100mL H_2O? *Remember the density of water is 1.0 g/mL.* 23°C
16. How many grams of $KClO_3$ dissolve in 200 mL H_2O at 30°C? $\frac{12\text{g } KClO_3}{100\text{g } H_2O} = \frac{x}{200\text{g } H_2O}$ → 24 g $KClO_3$
17. How many grams of KCl would dissolve in 40 mL H_2O at 80°C? $\frac{50\text{g KCl}}{100\text{g } H_2O} = \frac{x}{40\text{g } H_2O}$ → 20 g KCl
18. How many grams of NH_3 would dissolve in 500 mL H_2O at 80°C? $\frac{14\text{g } NH_3}{100\text{g } H_2O} = \frac{x}{500\text{g } H_2O}$ → 70 g NH_3
19. If 30 grams of KNO_3 are dissolved in 100 mL H_2O at 20°C, will the solution be saturated or unsaturated? Explain why. Solubility is 33g KNO_3 per 100g H_2O @ 20°C, so 30g is less than max. amount allowed to be saturated
20. If a solution of $NaNO_3$ was cooled from 60°C to 10°C, how much solute would precipitate out of solution? 123g − 80g = 43g (123g, 80g)

MOLARITY 1000mL = 1 L

21. What is the molarity of a solution of Na_3PO_4 with 0.75 mol of solute in 950 mL of solution? $M = \frac{\text{mol}}{L} = \frac{0.75\text{ mol}}{0.950\text{L}} =$ 0.79 M
22. What is the molarity of a solution containing 10.00 g of H_3PO_4 dissolved in 500.0 mL of solution? $\frac{10\text{g } H_3PO_4}{1}\left|\frac{1\text{mol}}{98\text{g}}\right. = 0.1020\text{ mol}$; $M = \frac{0.1020\text{mol}}{0.500\text{L}} =$ 0.204 M
23. What mass of sodium chloride is needed to make 300.0 mL of a 0.50 M solution? $0.5\text{M} = \frac{\text{mol}}{0.3\text{L}}$; $0.15\text{mol NaCl}\left|\frac{58.44\text{g}}{1\text{mol}}\right. =$ 8.8 g NaCl
24. How many liters of solution are needed to dissolve 25.5 g sodium chloride if a concentration of 0.25 M is nee? $\frac{25.5\text{g NaCl}}{1}\left|\frac{1\text{mol}}{58.44\text{g}}\right. = 0.436\text{mol NaCl}$; $0.25\text{M} = \frac{0.436\text{mol}}{\text{L}}$ → 1.7 L

MOLAR DILUTIONS $M_1V_1 = M_2V_2$

25. You add 500.0 mL (V_2) to 100.0 mL (V_1) of a stock solution of 12 M HCl (M_1). What is the final concentration? ($M_2 = ?$) $M_2 = 2.0\text{M}$
26. To make 1000.0 mL (V_2) of a 1.0 M (M_2) dilution of phosphoric acid solution (H_3PO_4), what volume ($V_1 = ?$) of 6.0 M (M_1) stock solution should you use? $V_1 = 166.7\text{mL}$
27. If a 1000.0 mL (V_2) dilute solution of $CaCl_2$ is made from 550.0 mL (V_1) of 6.0 M (M_1) stock solution, what is the concentration of dilute $CaCl_2$ solution? ($M_2 = ?$) $M_2 = 3.3\text{M}$
28. How would you prepare 90.0 mL (V_2) of 2.0 M (M_2) sulfuric acid from 18 M (M_1) stock solution? ($V_1 = ?$) $M_1V_1 = M_2V_2$; $18\text{M} \cdot V_1 = 2.0\text{M} \cdot 90\text{mL}$ → $V_1 = 10\text{mL}$

Chapter 18 – Reaction Rates & Equilibrium

RATES OF REACTION

1. What are the four factors that affect the rate of a chemical reaction? Temperature, Concentration, Particle size, Catalyst/Inhibitor
2. Which of these statements is true?
   a. Chemical reactions tend to slow down when the temperature rises.
   b. Once a chemical reaction starts, the reacting particles no longer have to collide for products to form.
   c. Increasing the total surface area of solid or liquid reactants increases the rate of the reaction.
3. Catalysts alter the rate of a chemical reaction by: (*this is a multiple choice question – select the best answer*).
   a. increasing the number of collisions between reactant atoms.
   b. increasing the kinetic energy of each reactant atom.
   c. lowering the activation energy barrier.
   d. being consumed in the reaction.

Le CHATELIER's PRINCIPLE

Use the following equation to complete the tables below with respect to the desired item – how does the stress effect concentration, pressure, and temperature.

2 mol $12.6\ kcal + H_2(g) + I_2(g) \leftrightarrow 2HI(g)$ 2 mol

Stress	Equilibrium Shift	$[H_2]$	$[I_2]$	[HI]	K
1. Add H_2	right	——	decreases	increases	remains the same
2. Add I_2	right	decreases	——	increases	Same
3. Add HI	left	increases	increases	——	Same
4. Remove H_2	left	——	increases	decreases	same
5. Remove I_2	left	increases	——	decreases	same
6. Remove HI	right	decreases	decreases	——	Same
7. Increase Temperature	right	decreases	decreases	increases	Same
8. Decrease Temperature	left	increases	increases	decreases	Same
9. Increase Pressure	no change b/c = moles	Same	Same	Same	same
10. Decrease Pressure	no change b/c = moles	Same	same	Same	Same

EQUILIBRIUM CONSTANT EXPRESSIONS

1. Write the equilibrium-constant expression for this reaction.
   $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$
   $K_{eq} = \frac{[CH_3OH]}{[CO][H_2]^2}$

2. Write the equilibrium-constant expression for this reaction.
   $Fe_3O_4(s) + 4H_2(g) \rightleftharpoons 3Fe(s) + 4H_2O(g)$
   $K_{eq} = \frac{[H_2O]^4}{[H_2]^4}$

3. An analysis of the equilibrium mixture in a 1-L flask shows 0.30 mol NOCl, 1.2 mol NO and 0.60 mol Cl_2. Calculate the value of K_{eq} for this reaction at equilibrium.
   $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$
   = 0.30 M 1.2 M 0.6 M b/c in a 1 L flask the molarity of each = moles $M = \frac{mol}{L}$
   $K_{eq} = \frac{[NO]^2[Cl_2]}{[NOCl]^2} = \frac{[1.2]^2[0.6]}{[0.30]^2}$ $K_{eq} = 9.6$ favors products

4. At 750°C, the following reaction reaches equilibrium in a 1-L flask. The reaction begins with 0.10 mol H_2 and 0.10 mol CO_2. At equilibrium there is 0.047 mol H_2O and 0.047 mol CO. Calculate K_{eq} for the reaction.
   $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$
   * Find $[H_2]$ $[CO_2]$ $\frac{0.047\ mol\ H_2O}{1} \left| \frac{1\ mol\ H_2}{1\ mol\ H_2O} \right. = 0.047$ mol H_2 used to get to equilibrium
   initial 0.1M 0.1M — —
   equilibrium * 0.053M * 0.053M 0.047M 0.047M
   0.10 mol H_2 have − 0.047 mol H_2 used = 0.053 mol remaining at equilibrium } same for CO_2 b/c started with same amount & has same mole ratio
   * must find $[H_2]$, $[CO_2]$ @ equilibrium
   $K_{eq} = \frac{[CO][H_2O]}{[H_2][CO_2]} = \frac{[0.047][0.047]}{[0.053][0.053]}$ $K_{eq} = 0.786$

Chapter 19 – Acids, Bases & Salts

VOCABULARY & CONCEPTS

1. An ionic compound that forms from an acid-base neutralization reaction is a(n) SALT.
2. A(n) ELECTROLYTE is a substance that conducts electricity.
3. The reaction between an acid and a base is called a(n) NEUTRALIZATION REACTION
4. According to Arrhenius, a compound containing hydrogen that ionizes to yield hydrogen ions in an aqueous solution is called a(n) ACID.
5. According to Arrhenius, a compound that ionizes to yield hydroxide ions (OH^-) in an aqueous solution is called a(n) BASE.

Write "A" if the statement is a property of an acidic solution. Write "B" if the statement is a property of a base, and "X" if it is a property of both a basic and acidic solution.

6. Feels smooth and slippery B
7. Reacts vigorously with metals A
8. Has a bitter taste B
9. Is an electrolyte X
10. Has a sour taste A
11. Turns litmus paper from blue to red A
12. Turns litmus paper from red to blue B
13. Usually does not react with metals B

State "A" for acid, "B" for base and "S" for salt. In addition, write the name for the compound.

14. HCl A hydrochloric acid
15. $CaCl_2$ S calcium chloride
16. Na_2SO_4 S sodium sulfate
17. HNO_3 A nitric acid
18. NaOH B Sodium hydroxide
19. H_3PO_4 A phosphoric acid
20. $Mg(OH)_2$ B magnesium hydroxide
21. LiOH B lithium hydroxide

ACID & BASE PROBLEMS

22. What is the pH of peaches if the $[OH^-] = 3.16 \times 10^{-11}$ M? Are peaches acidic, basic or neutral?

$pOH = -\log(3.16 \times 10^{-11}) = 10.5$ $pH = 14 - 10.5 = 3.5$ pH = 3.5, ACIDIC

23. An aqueous solution contains a 0.0361 M OH^- concentration. Calculate the pOH, pH and $[H^+]$. Determine if the solution is acidic or basic.

$pOH = -\log(0.0361) =$ 1.44; $pH = 14 - 1.44 =$ 12.56; BASIC; $[H^+] = 10^{-12.56}$ $[H^+] = 2.75 \times 10^{-13}$ M

24. Lake Ontario has water with an $[H^+]$ of approximately 1.1×10^{-6} M. Determine whether the water is slightly acidic or slightly basic.

$pH = -\log[H^+] = -\log(1.1 \times 10^{-6}) =$ 5.96; less than 7 so ACIDIC

25. If the pH of a diet soda is 3.21 at 25°C, what are the hydrogen ion and hydroxide ion concentrations in the soda?

$[H^+] = 10^{-3.21}$ $[H^+] = 6.17 \times 10^{-4}$ M $pOH = 14 - 3.21$ $pOH = 10.79$ $[OH^-] = 10^{-10.79}$ $[OH^-] = 1.62 \times 10^{-11}$ M

26. Most fish species die in water with a $[H^+]$ of between 3.16×10^{-5} M and 1.0×10^{-5} M. What is the pH range where most fish species die? What are the corresponding $[OH^-]$ values for fish death?

$pH = -\log(3.16 \times 10^{-5}) = 4.5$ $pH = -\log(1 \times 10^{-5}) = 5$ pH range 4.5 – 5

$pOH = 9.5$ $pOH = 9$ $[OH^-] = 10^{-9.5} = 3.16 \times 10^{-10}$ M $[OH^-] = 10^{-9} = 1 \times 10^{-9}$ M $[OH^-]$ range $= 3.16 \times 10^{-10} - 1 \times 10^{-9}$ M

TITRATION PROBLEMS

27. What is the molarity of carbonic acid if 25.0 mL of the solution is neutralized by 48.3 mL of 0.20 M NaOH?

See back

28. What is the molarity of sodium hydroxide if 30.0 mL of the solution is neutralized by 40.0 mL of 0.50 M H_3PO_4?

29. How many milliliters of 1.0 M sulfuric acid are needed to neutralize 55 mL of a 0.75 M sodium hydroxide solution?

(27)

$H_2CO_3 + 2NaOH \rightarrow 2H_2O + Na_2CO_3$

? M
25.0 mL

0.20 M
48.3 mL

Step 1: Find moles of given BASE

$0.20M = \frac{mol}{0.0483L}$ → 0.00966 mol NaOH

Step 2: Fence post to moles ACID used

$$0.00966\,mol\,NaOH \left| \frac{1\,mol\,H_2CO_3}{2\,mol\,NaOH} \right. = 0.00483\,mol\,H_2CO_3$$

Step 3: Find unknown ACID (Molarity in this problem)

$M = \frac{0.00483\,mol\,H_2CO_3}{0.0250\,L} = 0.193\,M\,H_2CO_3$

---

(28)

$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

0.50 M
40.0 mL

? M
30.0 mL

Step 3: Find unknown BASE (molarity in this problem)

$M = \frac{0.060\,mol\,NaOH}{0.0300\,L} = 2.0\,M\,NaOH$

Step 1: Find moles of given ACID

$0.50M = \frac{mol}{0.0400L}$

Step 2: Fence post to moles BASE used

$$0.020\,mol\,H_3PO_4 \left| \frac{3\,mol\,NaOH}{1\,mol\,H_3PO_4} \right. = 0.060\,mol\,NaOH$$

---

(29)

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

? V
1.0 M

55 mL
0.75 M

Step 1: Find moles of given BASE

$0.75 = \frac{mol}{0.055} = 0.041\,mol\,NaOH$

Step 2: Fence post to moles ACID used

$$0.041\,mol\,NaOH \left| \frac{1\,mol\,H_2SO_4}{2\,mol\,NaOH} \right. = 0.021\,mol\,H_2SO_4$$

Step 3: Find unknown ACID (volume in this problem)

$1.0M = \frac{0.021\,mol}{L}$

0.021 L H_2SO_4
or
21 mL H_2SO_4