Solubility Curves

Based on the solubility below, decide whether each of the following is A: unsaturated, B: saturated, C: supersaturated, or whether D: not enough information is given. * assume it's dissolved *

1) 50 g KCl in 100 g of water at 90°C. __A__ 5) 65 g KNO_3 in 50 g of water at 70°C. __B__

2) 50 g KCl in 100 g of water at 60°C. __C__ 6) 25 g KNO_3 in 100 g of water. __D__

3) 50 g KNO_3 in 100 g of water at 60°C. __A__ 7) 25 g NaCl in 100 g of water. __D__

4) 50 g KNO_3 in 25 g of water at 60°C. __C__ 8) 40 g of KCl in 100 g of water at 20°C. __C__

9) How many grams of KCl can dissolve in 100.0 g of water at 65°C? __46g__

10) What temperature would be required to get 85 g of KNO_3 to dissolve in 100.0 g of water? 54°C

SHOW ALL WORK FOR THE FOLLOWING

11) How many grams of KNO_3 can be dissolved in 50.0g of water at 50.0°C? __39g__

12) What mass of KCl can be dissolved in 200.0 g of water at 15.0°C? __60. g__

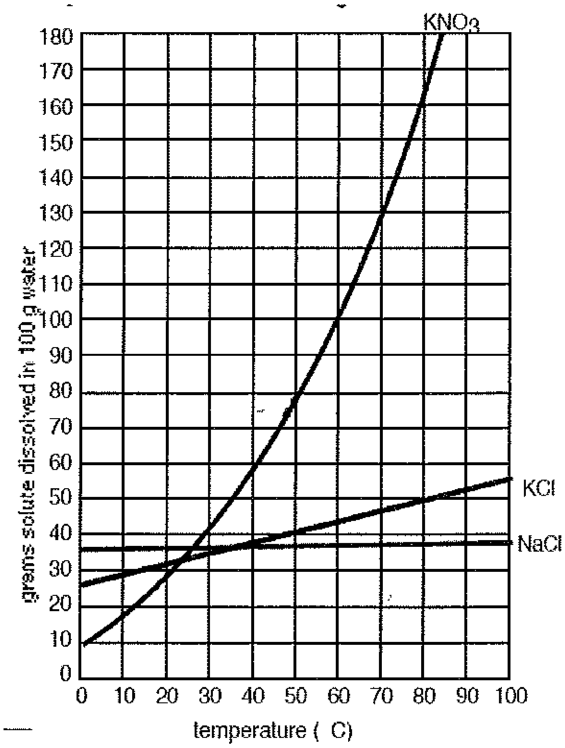
13) How much KNO_3 can be dissolved in 14.3 g of water at 69.0°C? __18g__

14) How many grams of water will it take to dissolve 28.0 g NaCl at 60.0°C? __76 g__

15) How much water is needed to dissolve 46.6 g of KNO_3 at 52°C? __57g__

16) What temperature would be required to get 51.0 g of KCl to dissolve in 156 g of water? 25°C

17) What is the % KCl in a solution that is saturated at 61°C? __31%__



18) What temperature is required to make a 50.0% KNO_3 solution? __60°C__

19) What temperature is required to make a 63.0% KNO_3 solution? __82°C__

20) Based on what you've learned in class about soda & fish, do gases behave the same as or different than solids when it comes to solubility & temperature? What do you think a solubility graph of gases would look like? Omit

21) Read about Henry's Law (go on-line!). Sketch what you think a pressure vs solubility graph would like like: Omit

Ans (iro+5): A, A, A, B, B, C, C, C, D, 18, 19, 25, 31, 39, 39, 46, 54, 57, 60, 60, 68, 76, 82

Units (iro+1): %, g, g, g, g, g, g, °C, °C, °C , °C, °C

(11) 78 g KNO_3 at 50°C in 100. g H_2O

$\frac{50.0g}{100.0g} \times 78g = 39g\ KNO_3$

(12) 30. g KCl at 15°C in 100. g H_2O

$\frac{200.0g}{100.0g} \times 30.g = 60.g$

(13) 125 g KNO_3 at 69.0°C in 100. g H_2O

$125g \times \frac{14.3g}{100.g} = 17.875 \rightarrow 18g$

(14) 37 g NaCl at 60.0°C in 100 g H_2O

$37g \cdot \frac{x}{100.g} = 28g \quad x = 75.68 \rightarrow 76g.$

(15) 82 g KNO_3 at 52°C in 100 g H_2O

$82g \times \frac{x}{100.g} = 46.6g \quad x = 56.8 \rightarrow 57g$

(16) $\frac{56g}{156g} = \frac{x}{100g} \quad x = 32.7g \rightarrow 33g$ from graph 25°C

(17) 45 g KCl in 100 g H_2O at 61°C

$\frac{45g}{145g} \times 100\% = 31\%$

(18) $\frac{100g}{200g} \times 100\% = 50\%$ 100 g of KNO_3 in 100 g H_2O at 60°C

(19) $\frac{170g}{270g} \times 100\% = 63\%$ 170 g of KNO_3 in 100 g H_2O at 82°C

Molarity

Determine the concentration (molarity) for each of the solutions:

a) 3.0 mol sugar dissolved in 2.0 L of solution. 1.5M b) 0.40 mol NaCl dis. in 10.0 L of soln. 0.040M

c) 0.030 mol KNO3 dis. in 50.0 mL of soln. 0.60M d) 350 g KNO3 dis. in 5.0 L of soln. 0.69M

e) 6.45 g of Na2SO4 dis in 250 mL of soln. 0.18M f) 465 mg KF of dis. in 0.054 L of soln. 0.15M

2. How many moles of sugar are needed to make 2.5 L of 1.4 M sugar solution?
Ans: 3.5 mol

3. How many moles of NaBr are needed to make 150 mL of 3.0 M NaBr solution?
Ans: 0.45 mol

4. How many grams of NaNO2 are needed to make 3.5 L of 0.50 M NaNO2 solution?
Ans: 121g

5. How many grams of K2CO3 are needed to make 300.0 mL of 1.25 M K2CO3 solution?
Ans: 51.83g

6. What volume of 0.25 M sugar solution can be made using 4.0 moles sugar? Ans: 16 L

7. How many mL of 2.50 M Na3PO4 solution can be made using 1.8 g of Na3PO4? Ans: 4.4 mL

8. 65.0 mL of K3PO4 solution are evaporated, and 1.54 g of solid K3PO4 are recovered. What was the molarity of the original solution?
Ans: 0.112 M

Ans (IRO +1): 0.040 0.112 0.15 0.18 0.45 0.60 0.69 1.5 2.85 3.5 4.4 16 51.8 120
Units: (IRO + 1): moles, moles, g, g, g, L, mL, M, M, M, M, M, M, M

164 Molarity

(a) $\frac{3.0\text{ mol}}{2.0\text{ L}} = 1.5\text{ M}$

(b) $\frac{0.40\text{ mol}}{10.0\text{ L}} = 0.040\text{ M}$

(c) $\frac{50.0\text{ mL} \mid 1\text{ L}}{\mid 1000\text{ mL}} = 0.050\text{ L}$

$\frac{0.030\text{ mol}}{0.050\text{ L}} = 0.60\text{ M}$

(d) $\frac{350\text{ g } KNO_3 \mid 1\text{ mol } KNO_3}{\mid 101.1\text{ g}} = 3.46\text{ mol } KNO_3$

$\frac{3.46\text{ mol}}{5.0\text{ L}} = 0.69\text{ M}$

(e) $\frac{6.45\text{ g } Na_2SO_4 \mid 1\text{ mol } Na_2SO_4}{\mid 142.04\text{ g}} = 0.0454\text{ mol } Na_2SO_4$

$\frac{0.0454\text{ mol}}{0.250\text{ L}} = 0.18\text{ M}$

$\frac{250\text{ mL} \mid 1\text{ L}}{\mid 1000\text{ mL}} = 0.250\text{ L}$

(f) $\frac{465\text{ mg} \mid 1\text{ g} \mid 1\text{ mol KF}}{\mid 1000\text{ mg} \mid 58.10\text{ g}} = \frac{0.00800\text{ mol KF}}{0.054\text{ L}} = 0.15\text{ M}$

(2) $1.4\text{ M} = \frac{x}{2.5\text{ L}}$ $x = 3.5\text{ mol}$

(3) $\frac{150\text{ mL} \mid 1\text{ L}}{\mid 1000\text{ mL}} = 0.150\text{ L}$

$3.0\text{ M} = \frac{x}{0.15\text{ L}}$

$x = 0.45\text{ mol}$

(4) $0.50\ M = \frac{x}{3.5\ L}$ $x = \frac{1.75\ \text{mol} \mid 68.99\ g}{\mid 1\ \text{mol}\ NaNO_2}$

$121\ g\ NaNO_2$

(5) $\frac{300\ mL \mid 1\ L}{\mid 1000\ mL} = 0.300\ L$

$1.25\ M = \frac{x}{0.300\ L}$ $x = \frac{0.375\ \text{mol} \mid 138.21\ g}{\mid 1\ \text{mol}\ K_2CO_3}$

$x = 51.83\ g$

(6) $0.25\ M = \frac{4.0\ \text{mol}}{x\ L}$

$x = 16\ L$

(7) $\frac{1.8\ g\ Na_3PO_4 \mid 1\ \text{mol}\ Na_3PO_4}{\mid 163.94\ g} = 0.011\ \text{mol}$

$2.50\ M = \frac{0.011\ \text{mol}}{x}$

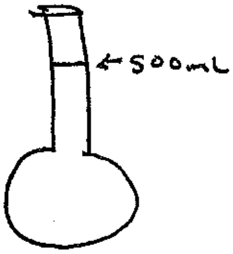
$x = \frac{0.0044\ L \mid 1000\ mL}{\mid 1\ L} = 4.4\ mL$

(8) $\frac{1.54\ g\ K_3PO_4 \mid 1\ \text{mol}\ K_3PO_4}{\mid 212.27\ g} = \frac{0.00725\ \text{mol}}{0.065\ L} = 0.112\ M$

$\frac{65.0\ mL \mid 1\ L}{\mid 1000\ mL} = 0.065\ L$

9. Sketch a volumetric flask and explain precisely how you would use a 500.0 mL volumetric flask to make some 1.500 M NaNO3 solution. (hint: look at the 5 steps on how to use a vol. flask). Be sure to show your calculations, including how many grams of solute to use

$1.500(.500) = 0.750$ mol $NaNO_3$ | $\frac{85.007\text{ g}}{}$ = 63.76 g $NaNO_3$



To the 500 ml Vol. flask add approx. 100 mL of H_2O & add the 63.76 g $NaNO_3$. Stopper & Shake to dissolve. ONCE dissolved add enough H_2O to the flask to fill to 500mL line.

10. Do this question after you've completed part 1 of the molarity lab:
You are handed a large flask containing a K2CO3 solution of unknown molarity. Describe precisely, step by step, how you would go about determining the molarity. Use any equipment you want! (hint: look at what you did in part 1 of the molarity lab)

I would use a spectrophotometer & compare the absorbance rate of the unknown to known solutions then calculate the molarity.

11. One grain of sugar with a mass of 0.25 mg is dissolved in a 25.0 m x 10.0 m x 3.0 m swimming pool filled with water. Determine the sugar concentration, and then use it to determine how many molecules of sugar would be contained in just one drop of the "sweetened" pool water solution. (sorry, answer not in ans. bank!)
[1 g = 1000 mg, 1 m3 = 1000 L, 20 drops = 1 mL, sugar = $C_{12}H_{22}O_{11}$]

$0.25\text{ mg} \left| \frac{1\text{ gram}}{1000\text{ mg}} \right| \frac{1\text{ mol}}{342.3\text{ g}} = 7.3\times10^{-7}$ mol

Volume $= 25\times10\times3 = 750\text{ m}^3$

$750\text{ m}^3 = 750000\text{ L}$

Ans: 2.93×10^{7} 'cules

$M = \frac{\text{mol}}{\text{vol}} = \frac{7.3\times10^{-7}}{750000} = 9.73\times10^{-13}$ M

$1\text{ drop} \left| \frac{1\text{ mL}}{20\text{ drops}} \right| \frac{1\text{ L}}{1000\text{ mL}} \left| \frac{9.73\times10^{-13}\text{ mol}}{1\text{ L}} \right| \frac{6.022\times10^{23}}{1\text{ mol}} = 2.93\times10^{7}$ 'cules

Dilutions

1. Determine the concentrations for each of the following mixtures:
a) equal volumes of 3.0 M KCl & water: 1.5 b) equal volumes of 3.0M KCl & 7.0 M KCl: 5.0

c) one vol. of 8.0 M KCl & one vol. water: 4.0 d) one vol. of 6.0 M KCl & two vol's water: 2.0

e) one vol. water & two vol's of 6.0M KCl: 4.0 f) one vol. of 5.0 M KCl & 4 vol's of water: 1.0

g) one vol. of 2.5 M KCl & 9 vol's water: 0.25 h) one vol. of 2.5 M KCl & 99 vol's water: 0.025

2. To make orange juice from frozen concentrate, one usually mixes the can of concentrate with three cans of water. This dilutes the concentrate to 1/4 (what fraction?) its original concentration.

3. Use the dilution equation to determine the concentrations of the following mixtures...

a) 45 L of 3.6 M KCl & 71 L of water:

45 (3.6) = 116 (M)

Ans: 1.4 M

b) 215 mL of 2.8 M KCl & 47 mL water:

215(2.8) = 262 (M)

Ans: 2.3 M

c) 45 mL of 3.6 M KCl & 71 mL of 6.2 M KCl:

0.045 (3.6) = 0.162 mol

.071 (6.2) = 0.440 mol

tot mol = 0.6022 V = 116 mL

$M = \frac{n}{V} = \frac{0.6022}{0.116}$

Ans: 5.2 M

d) 83 mL of 2.0 M KCl & 25 mL of water:

83 (2.0) = 108 (M)

1.5 M

Ans: 1.54 M

e) 38 mL of 6.0 M KCl dil. to a tot vol of 100 mL:

38(6.0) = 100 (x)

2.3 M

Ans: 2.28 M

4. To what total volume must 26.0 mL of 4.80 M KCl be diluted to reduce its concentration to...

a) ... 2.10 M

26.0 (4.80) = 2.10 (x)

Ans: 59.4 mL

b) ... 0.480 M

26 (4.80) = (0.480)V

Ans: 260. mL.

Ans (IRO+1): 0.025 0.25 1/4 1.0 1.4 1.5 1.5 2.0 2.0 2.3 2.3 3.6 4.0 4.0 5.0 5.2 59.4 125 260.
Units (IRO): M M M M M M M M M M M M M M M M mL mL

$$\text{Molarity} = \frac{\text{mol solute}}{\text{Liters of soln}}$$

(1)

(A) Assume 1 L of each

$$\frac{3(1)}{1+1} = 1.5\,M$$

(B)

$$\frac{3(1) + 7(1)}{2} = 5.0\,M$$

(C)

$$\frac{8(1)}{1+1} = 4.0\,M$$

(D)

$$\frac{6(1)}{1+2} = 2.0\,M$$

(E)

$$\frac{6.0(2)}{1+2} = 4.0\,M$$

(F)

$$\frac{5(1)}{1+4} = 1.0\,M$$

(G)

$$\frac{2.5(1)}{1+9} = 0.25\,M$$

(H)

$$\frac{2.5(1)}{1+99} = 0.025\,M$$

(2)

$$\frac{1 \text{ can}}{4 \text{ cans}} = \frac{1}{4}$$

(Warning: one of the questions on this page is impossible... When you find it, explain why it's mpossible!)

5. What volume of water must be added to 35 mL of 2.6 M KCl to reduce its concentration to...

a) ... 1.2 M

$35(2.6) = 1.2(V)$

$V = 75.8$

$V_{H_2O} = 75.8 - 35$

Ans: 41 mL

b) ... 0.26 M

$35(2.6) = 0.26V$

$V = 350$

$V_{H_2O} = 350 - 35$

Ans: 315 mL

6. What volume of 2.5 M KCl must be added to 37 mL of 6.0 M KCl to make the total concentration:

$0.037(6.0) = 0.222$ mol KCl

a) ... 1.5 M

Not possible trying to dilute to a concentration less than the solns used for diluting.

Ans: ______

b) ... 4.2 M

$$\frac{0.222 + 2.5X}{0.037 + X} = 4.2$$

$0.222 + 2.5X = 0.1554 + 4.2X$

$X = 0.039$

Ans: 39 mL

7. What volume of 2.5 M KCl must be added to 37 mL of water to make the total concentration 1.8M?

$$\frac{2.5X}{0.037 + X} = 1.8$$

$0.0666 + 1.8X = 2.5X$

Ans: 95 mL

8. You mix 32 mL of 4.5 M KCl, 56 mL of 6.2 M KCl and some water, and the total concentration comes out to be 1.7 M. How much water must have been added?

$$\frac{(0.032(4.5) + 0.056(6.2))}{(.032 + 0.056 + X)} = 1.7$$

$X = 0.201$ L

Ans: 201 mL

9. Sketch a volumetric flask and explain precisely how you would use a 500.0 mL volumetric flask to make some 1.500 M NaNO3 solution. (You have available some 2.000 M NaNO3 solution and whatever other lab equipment you need) **How much 2.000 M solution is needed?**

$(1.500(500)) = 2.00X$

$X = 375$

Add 375 mL of 2.00 M to 500 mL vol. flask. Dilute with sufficient H_2O to mark to make 500 mL total ~ 125 mL H_2O

10. You need to make up some 5.0 M KCl solution but all you have is 125 mL of 3.0 M KCl. Explain what to do to make up the 5.0 M solution. How much 5.0 M KCl will you get? Show calculations: (hint- calculate how much water to evaporate)

125 mL $(3.0) = 5.0(x)$

$X = 75$ mL total

Need to evaporate 50 mL of H_2O from ~~125 mL~~ 3.0 M soln.

$125 - 75 = 50$ mL H_2O

Ans (IRO+1): 39 41 75 95 172 201 315 375

Units(IRO) mL mL mL mL mL mL mL mL mL