

SOLUTIONS

Class One Objective: Describing what solutions are, how they form, and how we can measure their strength – or concentration.

1. A solution is a _____.
2. The _____ dissolves into the _____.
3. If you put sugar into coffee, the sugar is the _____ while the coffee is the _____.
4. When a solution holds the maximum amount of stuff it is a _____ solution.

5. If there is less than the maximum amount of stuff (_____) the solution is _____.
6. Compare a 10°C sugar solution to a 90°C sugar solution...

At 10°C you can fit _____ g sugar into solution.

At 90°C you can fit _____ g sugar into solution.

7. It's hard to see here, but the NaCl solubility increases just a tiny bit (_____ g → _____ g) in a 100 mL solution, a small increase, but a measurable increase.

8. Most solutions you think about will be aqueous which means dissolved in _____.

9. But they can also be gases like _____.

or even solid _____, such as _____ or _____.

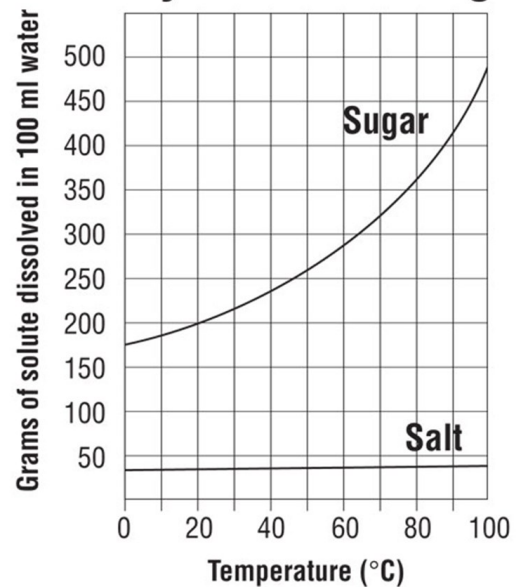
10. _____ = MORE SURFACE AREA = FASTER DISSOLVING

11. HOTTER TEMP = HIGHER KE = MORE MOTION = _____.

12. AGITATION = _____ = MORE MOTION = FASTER DISSOLVING

14. The rate of solvation increases with more surface area (smaller particles), higher temperatures and with more agitation. Try to memorize this one okay?

Solubility of Salt and Sugar



How much solute can dissolve into a solvent? *That depends on..*

15. _____

16. _____

17. _____

18. H₂O POLAR

19. CO₂ NON POLAR

20. How does Wegman's even get carbon dioxide into water? Doesn't like dissolve like? _____

21. Water is "bent" and polar. Carbon dioxide has radial symmetry and is nonpolar.

These molecules should not be able to form a solution.

The ONLY way to mix them is under _____

22. Qualitatively we can say things like _____ or _____

23. Or we could use "better" words like _____ or _____

24. With numbers and units, in a quantitative measure, we will use _____

25. Molarity is	$M = \text{_____}$
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26. What is the concentration of a NaNO_3 solution containing 4.50 moles of solute in 1250 mL volume?

Molarity =	mL ?? Liters??
Molarity =	
Molarity =	

27. SAY	
WRITE	
THINK	

28. What is the concentration of a 1650 mL salty water solution containing 125 g NaCl?
(write formula, then do some conversions)

Molarity =

Convert grams
to moles

Convert mL
to liters

Rewrite formula
Molarity =

Say

Write

Think

29. If you add 43.5 g NaCl to enough water to form a 648 mL solution, what is its concentration?

30. You put 111 g KCl solid into a volumetric flask.
You fill the flask to 250. mL, what is the molarity of this solution?



31. You put 74.0 g KCl solid into a flask. You fill the flask to 1600. mL, what is the molarity of this solution?

32. Calculate the molarity of 750. mL $\text{LiBr}_{(\text{AQ})}$ that has 215 g LiBr solute.

33. How many grams of sodium nitrate are in a 100 mL aqueous solution that is saturated at 10°C? _____g

34. How many grams of NaNO₃ fit into 325 mL of water at 10°C? Always write this out like this...

10°C	_____	_____	=	_____
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then do the cross multiplication...

35. What is the molarity of this 325 mL solution? Write a formula... work out your conversions...

36. Definitions to memorize ASAP

Solute – the stuff dissolved into the solvent of a solution (the salt of salty water)

Solvent – the part of the solution that the solute is dissolved into, the water of salty water.

Saturated – when a solution is holding the maximum solute at that temperature.

Unsaturated – when a solution is holding LESS THAN the maximum solute for that temp.

Table G – the solubility guidelines for 10 compounds over all liquid water temps.

Molarity – the measured concentration of a solution in moles/Liter units.

Molarity Formula: $M = \frac{\text{Moles of solute}}{\text{Liters of solution}}$

What units go into this formula (only) –

Objective: More practice with molarity problems, and how to make a solution properly (*and wrong!*)
plus... how to make a new solution from a solution that you have in the stock room on a shelf.

37. Calculate the molarity of a solution containing 259 g KCl in a solution with total volume of 750. mL

38. How many grams of sodium chloride are in an 100 mL aqueous solution that is saturated at 90°C? _____ g

39. How many grams of sodium chloride are in an 885 mL aqueous solution that is saturated at 90°C?

90°C

40. What is the molarity of the solution you made in question #39?

41. If you had two SATURATED $\text{NaCl}_{(\text{AQ})}$ One 25 mL, and another of 1275 mL...

Would they both taste exactly the same? Would they both conduct electricity? Are they "the same"?

42. How many grams of NaCl are required to form a 2.50 L of 0.900 M $\text{NaCl}_{(\text{AQ})}$?

43. Calculate the mass of KOH needed to make a 3.20 Liter solution of $\text{KOH}_{(\text{AQ})}$ with a 1.20 M concentration.

44. How do you NOT MAKE THIS SOLUTION CORRECTLY?

Draw it made “wrong”, then put an X through it →

45. Now draw how to prepare this solution CORRECTLY and write yourself a note WHY this way is right.



46. How would you mix up 2.65 liters of 2.50 M $\text{KNO}_{3(\text{AQ})}$ from scratch? (Math and steps you take in order)

To make a solution, not from scratch, but by diluting a solution that you have in the STOCK ROOM, from a stock solution, you need a new formula. You need to calculate how much of the stock you need to start with, and then, how much more water you need to dilute it with to make your new solution.

Using a 2.50M $\text{KNO}_3(\text{AQ})$ how would you make 1.64 Liters of 1.15 M $\text{KNO}_3(\text{AQ})$?

47 To do this, we need to have a new formula	The dilution formula	
M_1		M_2
V_1		V_2

48. Using a 2.50M $\text{KNO}_3(\text{AQ})$ how would you make 1.64 Liters of 1.15 M $\text{KNO}_3(\text{AQ})$?

49. How do you prepare a 135 mL $\text{NaCl}(\text{AQ})$ solution of 1.00 molarity from a stock solution of 5.50 M?

50. Is that it?

51. Hydrochloric acid solution comes to the school very concentrated – at 12.0 M! Using this stock solution, exactly what should your teacher do to make up 2.00 L of 2.25 M HCl solution? Do math, draw on flask.



Objective: Learning another way to measure low concentrations of very weak solutions called PARTS PER MILLION, and the colligative properties of water

52 PPM means...	53 write the parts per million formula PPM = _____ X
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54 You put 1502 grams NaCl into a swimming pool of 312,000 liters of water.
~~What is the molarity of this solution?~~ What's the concentration of this in PPM? Write the formula again.

55. Sometimes low concentration environmental _____ are measured this way.

56. There are 3 properties of called the _____ properties.

57. They are the properties that are affected by dissolving _____ into the solvent.
All solutions have colligative properties, but we will ONLY discuss aqueous — water solutions in class

58. The three colligative properties of water are			
59. The reason for all of the colligative properties of water is...			

60. For water to boil, the bonds that must break are called _____ bonds.

61. If solute like NaCl ions are dissolved into water, the hydrogen bonds still need to break, but now, the water must also overcome the polar attractions to the _____ too.

62. Water has a BP of _____. Salty water will have a _____ BP.

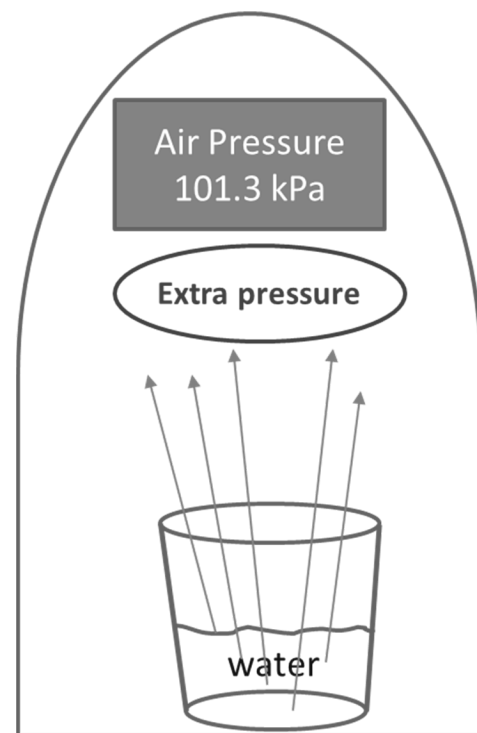
63. For water to freeze, the molecules must make those neat little _____ to solidify. The molecules are hydrogen bonded to each other.

64. When solute is dissolved into the water, these particles literally get in the way of the hydrogen bonding.

Water can't freeze at a normal 273 K, it has to be _____ in order for the ions to be pushed aside as ice forms. Draw 2 rings here, one of ice, and one of ice trying to form.

The more _____ (_____ like sugar, or _____) the colder the water has to be in order to freeze.

65. Draw this diagram and labels...



66. Vapor pressure is the

(like a bell jar).

67. Water has a _____ vapor pressure.

68. What is the vapor pressure of water at 25 centigrade? _____

69. Why does water have such a low vapor pressure? _____

70. What impact would dissolved polar molecules or ions (solute) have on vapor pressure?

71. Vapor pressure is odd. The stronger it is the _____ the evaporation rate.

72. The higher vapor pressure means that the molecules evaporate _____.

73 The boiling point ELEVATION for water is	0.50 K/mole particles per liter solution
74 The freezing point DEPRESSION for water is	1.86 K/mole particles per liter solution

	Formula	Numbers of moles of particles*
ex	1.0 M NaCl _(AQ)	1 mole Na ⁺¹ and 1 mole Cl ⁻¹ = 2 moles ions
75	2.0 M NaCl _(AQ)	__ moles Na ⁺¹ and __ moles Cl ⁻¹ = __ moles ions
76	3.0 M NaCl _(AQ)	__ moles Na ⁺¹ and __ moles Cl ⁻¹ = __ moles ions
77	2.0 M CaCl ₂ (AQ)	__ moles Ca ⁺² and __ moles Cl ⁻¹ = __ moles ions
78	3.0 M CaCl ₂ (AQ)	__ moles Ca ⁺² and __ moles Cl ⁻¹ = __ moles ions

	Formula	Numbers of moles of particles*
79	2.50 M NaCl _(AQ)	__ mole Na ⁺¹ & __ mole Cl ⁻¹ = __ moles ions
80	1.25 M NaCl _(AQ)	__ moles Na ⁺¹ & __ moles Cl ⁻¹ = __ moles ions
81	1.75 M NaCl _(AQ)	__ moles Na ⁺¹ & __ moles Cl ⁻¹ = __ moles ions
82	2.25 M CaCl ₂ (AQ)	__ moles Ca ⁺² & __ moles Cl ⁻¹ = __ moles ions
83	3.0 M Al(OH) ₃ (AQ)	__ mole Al ⁺³ & __ moles OH ⁻¹ = __ moles ions
84	1.0 M NH ₃ (AQ)	= __ mole of MOLECULES
85	2.50 M C ₁₂ H ₂₂ O ₁₁ (AQ)	= __ moles of MOLECULES
86	1.0 M AgCl	***

87. Calculate the temperature that a 1.00 liter, 2.00 M NaCl_(AQ) solution will boil in Kelvin.

88. Calculate the Kelvin BP of a 1.00 Liter, 3.00 M $\text{CaCl}_{2(\text{AQ})}$.

89. Calculate the temperature that a 1.00 liter, 2.00 M $\text{NaCl}_{(\text{AQ})}$ solution will freeze in Kelvin.
The FP Depression = 1.86 K/ mole of particles per liter

90. Calculate the FP in Kelvin of a 1.00 Liter, 3.00 M $\text{CaCl}_{2(\text{AQ})}$.

91. Express the concentration of this solution in parts per million: 98.0 g of lithium chromate (Li_2CrO_4) is dissolved into an aqueous solution with total volume of 57,800 liters

We can rank the vapor pressure of these solutions from lowest to highest by comparing the number of moles of particles per liter in each. Rank these solutions

	Aqueous solution	Number of moles of particles per liter	VP Rank
92	1.00 M NaCl		
93	1.00 M CaCl_2		
94	1.00 M NBr_3		
95	1.00 M $\text{Al}(\text{NO}_3)_3$		

	Compound	Write the Formula	What ions are formed when this is put into water
96	Sodium carbonate		
97	Ammonium sulfide		
98	Aluminum nitrate		
99	Lead (IV) acetate		
100	Silver chloride		

101. What is the freezing point of a 1.00 liter solution of 1.00 M Tin (IV) nitrate?
Round to nearest WHOLE KELVIN Temp

102. In a solution labeled 2.46 M $\text{KCl}_{(\text{AQ})}$ that is exactly 2.00 Liters in volume, how many grams of KCl are in this solution?

According to an article in the *New England Journal of Medicine*, mercury toxicity begins at 0.100 PPM.

103. If someone dropped 125 grams of $\text{Hg}_{(L)}$ into the school pool, that is 102,900 liters, would the mercury level be safe or over the limit of safety? (what is the PPM of this solution?)

104. What is the molarity of a solution when 278 g KCl is dissolved into a solution of 5000. mL total volume?

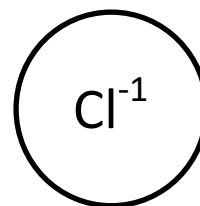
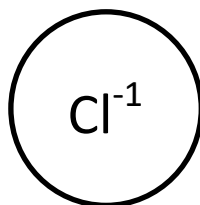
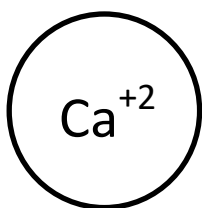
105. How do you prepare a 25.5 mL 0.850 Molar $\text{NaOH}_{(AQ)}$, if you start with a stock solution of 6.40 M?



106. You dissolve 2.25 moles of KBr into water forming a 1.00 liter solution. What is this solution's Boiling point and Freezing point? (**Round to nearest WHOLE Kelvin temperature**)

107. If you have a 2.40 M HCl stock solution, how do you make a 50.0 mL of 3.00 M HCl solution from it?

108. Three ions are shown below. Draw in 3 water molecules properly oriented to each of these three ions.



109. You prepare a 235 mL saturated solution of ammonium chloride at 20.°C. You go to lunch and come back in an hour. The room temperature has warmed up this solution by 5.0°C .

How would you best describe this solution at 25. °C ?

A. Saturated at 25.°C

B. Supersaturated at 25.°C

C. Unsaturated at 25.°C

D. Still saturated at 20.°C

110. If you have lots of sulfur solid floating on your pond (or lots of water strider bugs), and you wanted to clear the surface, you could add some soap. Explain in a decent English sentence how this works.

111. Oil floats on water. Explain why it floats, why it does not sink, and more importantly, and why it does not mix.

112. Using a 1.00 M stock of sugar water, tell how to make up a 26.0 mL solution of 0.350 M.