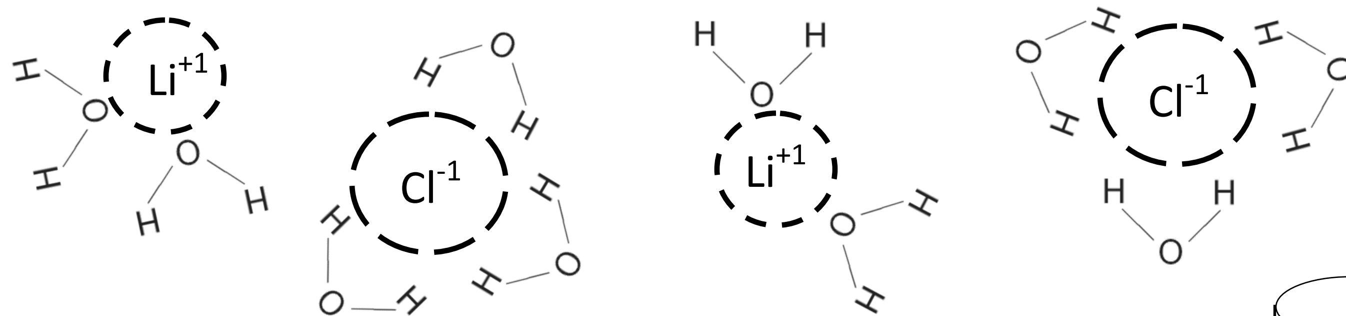
50 Water Questions ANSWERS

1. Immiscible—when 2 or more liquids can't dissolve together, probably due to "like dissolves like"
   Miscible—when 2 or more liquids can dissolve together, because like dissolves like.
2. Dissociation of sodium hydroxide $NaOH_{(S)} \xrightarrow{\text{water}} Na^{+1}_{(AQ)} + OH^{-1}_{(AQ)}$
3. Ionization of lithium dichromate $Li_2Cr_2O_{7(S)} \xrightarrow{\text{water}} 2Li^{+1}_{(AQ)} + Cr_2O_7^{-2}{}_{(AQ)}$
4. Draw the dissociation of 2 LiCl FU's + surround them with water molecules each, with proper orientation.

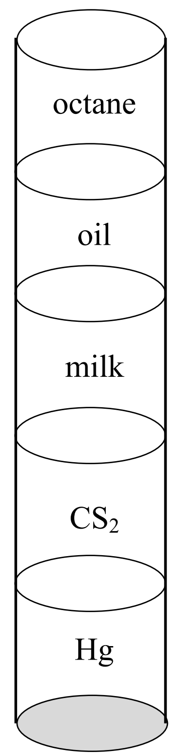


5. How many grams of NaCl dissolve into 145 mL water at 90°C? Show work.

90°C $\dfrac{40\text{ g}}{100\text{ mL}} = \dfrac{X\text{ g}}{145\text{ mL}}$ 100 X = 5800 X = 58 grams

6. The density of some liquids is in the chart.
   Using the numbers 1-5, put them
   into the graduated cylinder, in the right order.

1	CS_2	1.26 g/mL
2	milk	1.05 g/mL
3	octane	0.74 g/mL
4	mercury	13.5 g/mL
5	oil	0.92 g/mL



7. Dissociation of water $H_2O_{(L)} \rightarrow H^{+1}_{(AQ)} + OH^{-1}_{(AQ)}$
8. Surfactant: A surface active agent, a substance that can break surface hydrogen bonds in water, and create "holes" in the tension. It allows sulfur (or bugs) to fall through the surface of water.
   It interferes with the hydrogen bonding by getting between the water molecules, creating gaps in tension.

9. $q = mH_V$ = (61.2 g)(2260 J/g) = 20,440.8 Joules = 138,312 Joules = 138,000 with 3 SF
10. $q = mH_V$ = (15.7 g)(2260 J/g) = 35,482 Joules = 35,500 Joules with 3 SF
11. $q = mH_F$ = (500. g)(334 J/g) = 167,000 Joules with 3 SF
12. $q = mH_F$ = (49.0. g)(334 J/g) = 16,366 Joules = 16,400 Joules with 3 SF

13. Skip this one

14. How many grams of KI will saturate a 805 mL aqueous solution at 20°C?

20°C $\frac{145\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{805\text{ mL}}$ 100 X = 116,725 X = 1167.25 grams = 1170 grams with 3 SF

15. How many grams of $NaNO_3$ can be added to 100. mL $NaNO_{3(AQ)}$ at 30°C containing 70. g $NaNO_3$ already?
This solution could hold up to 96 grams of $NaNO_3$, so, 96 - 70 = 26 grams more would fit in solution.

16. When a saturated 100. mL $NH_4Cl_{(AQ)}$ solution at 90°C is cooled down to 25°C, how many grams of solid NH_4Cl precipitates out of the solution?
At 90°C, 73 grams fits in solution. At 25°C, only 40 grams fits. The difference is what falls out of solution. 73 g - 40 g = 33 grams precipitates out of solution with this cooling.

17. Once this ammonium chloride is precipitated, does it just sit on the bottom, or is something else going on?
Once this 33 g NH_4Cl precipitates to the bottom, it continues to dissolve into solution at a constant rate. To compensate, that same amount precipitates out of solution at the same rate. This creates what is called a dynamic equilibrium. It never stops. The same amounts remain dissolved and solid, but the actual particles change places in and out of solution constantly.

18. How many grams of KCl fits into a 450. mL solution at 10°C?

10°C $\frac{30\text{ g}}{100\text{ mL}} = \frac{X\text{ g}}{450.\text{mL}}$ 100 X = 13,500 X = 135 grams

19. If your $SO_{2(AQ)}$ solution is saturated, and it's at 50°C, how many grams of SO_2 are dissolved in the solvent?
That would be 5 grams if the solution is 100 mL. It could be more if the solution is bigger, or smaller if the solution is smaller. It will be this this proportion.

20. Explain how bugs can walk on water, and how sulfur with density of 2.00 g/mL can sit on the water without sinking.
At the surface of water there is surface tension created by the stronger intermolecular attractions between water molecules (called hydrogen bonding). It's not just density of the bug vs. the density of the water AT THE SURFACE. If the bug were to fall through the surface, and be IN the water, the higher density buy, or sulfur would surely sink as expected.

21. Define supersaturated and name one compound that can supersaturate in water.
Supersaturated is when a given volume of solvent (water for example) is holding more solute that would be possible at that temperature. To create this solution, you start hot, which usually means more solute can fit into the solvent, then cool the solution down slowly. The solute can stay in solution, but you could never stir in that much solute if you started cold. It's a chemistry "trick". Table sugar, sucrose, does this.

22. When you "click" the metal tab in a hot pad, why does the pad get hot? What's going on in there?
The metal clicker sends a small shock wave through the supersaturated solution of sodium acetate, which causes it to fall out of solution. A single crystal forms, then more and more ions drop out of solution, attaching to the seed crystal. And you know, when bonds form, energy is released.

23. Name the bonds inside of one water molecule. Single Polar Covalent

24. Name the bonds that hold solid water together. Hydrogen Bonds

25. Calculate the number of moles of water that are in 40.5 grams of water.

$$\frac{40.5 \text{ g Water}}{1} \times \frac{1 \text{ mole water}}{18 \text{ g water}} = 2.25 \text{ moles water}$$

26. Which of the compounds on table G dissolves the least well at 20°C? Best at 20°C?
At 20°C, KI dissolves best, and $KCLO_3$ dissolves worst.

27. Can any compound on table G supersaturate? No, not ever.

28. How would you mix together a supersaturated sucrose sugar solution (step by step).
First get some water, and put it on the stove to make it hot. Hotter water will hold more sugar.
Stir in sugar, and once as much will dissolve as possible, pour out into a clean container.
Let the solution cool without shaking or banging.

29. How much energy does it take to warm up a small pot of water (560. mL) from 20.0°C to 99.0°C?
$q = mC\Delta T = (560.\text{ g})(4.18 \text{ J/g•K})(79.0 \text{ K}) = 184{,}932.2$ joules = 185,000 Joules with 3 SF

30. Think about $NaClO_{AQ)}$ which is what people call "chlorine" for their pools. What is the solute, what is the solvent in this solution?
The solvent is water, the sodium hypochlorite is the solute.

31. What are the nonbonding electrons in the oxygen atom of water called?
Unshared pairs of electrons, or nonbonding electrons.

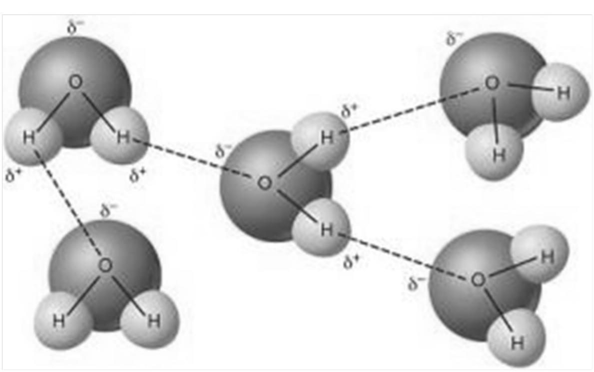
32. Define vapor pressure. The extra pressure created by the evaporation of a liquid in a closed system.

33. Define specific heat capacity constant. The amount of energy required to change the temperature of one gram of a substance by one Kelvin (or 1°C). For water this is = 4.18 J/g•K.

34. Which of these compounds would dissolve into water?
A. NaCl—YES B. $(NH_4)_2CO_3$—YES C. $MgCO_3$—NO D. NaOH—YES
E. $Ba(OH)_2$—YES F. $Al(OH)_3$—NO G. $Ca_3(PO_4)_2$—NO

35. The vapor pressure at 40°C of propanone at is about 58 kPa, and for ethanol about 17 kPa.

36. Draw seven water molecules, and indicate the hydrogen bonding with dotted lines.



37. Define solvation. The ability to form into solutions. Water undergoes solvation readily with most ionic compounds and almost all polar molecules.

38. Define dynamic equilibrium. Make an example with an $NaCl_{(AQ)}$ solution.
Dynamic equilibrium is when the rate of the forward reaction is equal to the rate of the reverse. If you put too much sodium chloride into water, some precipitates to the bottom. It continues to dissolve at a constant rate, and of course, precipitates out at a constant rate. $NaCl_{(S)} \rightleftharpoons Na^{+1}_{(AQ)} + Cl^{-1}_{(AQ)}$

39. Show the dissociation of barium hydroxide in water. $Ba(OH)_{2(S)} \rightleftharpoons Ba^{+2}_{(AQ)} + 2OH^{-1}_{(AQ)}$

40. When sugar goes into water it dissolves pretty quickly. Why won't sugar water conduct electricity?
Sugar is molecular, when it dissolves in water it breaks down into super small particles called molecules, but not into ions. Solutions with loose, mobile ions can conduct. Sugar water has no ions in solution.

41. Name the three colligative properties of water that we discuss in our class.
Boiling point, freezing point and vapor pressure. All are affected by the amount of moles of particles that are dissolve in each liter of solution.

42. Why does the county road crew use $CaCl_2$ instead of NaCl to melt road ice?
Calcium chloride provides three moles of ions (per mole of solid) while sodium chloride provides only two moles of ions per mole of solid. The more moles of particles on the ice, the lower the freezing point. If the salt can lower the freezing point sufficiently, the ice melts (it can't get cold enough to freeze). No more ice = safe roads.

43. When 1 mole of aluminum chloride dissolves into water, how many moles of ions are in the solution?

$AlCl_{3(S)} \xrightarrow{water} Al^{+3}_{(AQ)} + 3\ Cl^{-1}_{(AQ)}$ one mole of compound releases 4 moles of ions

44. When 4 moles of lead (IV) acetate dissolve into water, how many moles of ions are present?
$Pb(C_2H_3O_2)_{4(S)} \xrightarrow{water} Pb^{+3}_{(AQ)} + 4\ C_2H_3O_2^{-1}{}_{(AQ)}$ 1 mole releases 5 moles of ions

45. When 2.5 moles of NaCl are dissolved into water, how many moles of ions are in solution?
$2.5\ NaCl_{(S)} \xrightarrow{water} 2.5\ Na^{+1}_{(AQ)} + 2.5\ Cl^{-1}_{(AQ)}$ = 5 moles of ions total

46. When 2.0 moles of silver chloride (AgCl) are put into water, how many moles of ions are present?
None (ha!). Look always on Table F. Silver chloride is INSOLUBLE in water. That means if you put a billion AgCl into water, maybe one or two will ionize, but you wont' notice. Practically zero.

47. Define electrolyte, give four examples and also give an example of a NON-ELECTROLYTE solution.
Electrolytes are tricky to describe because of the "exceptions". Electrolytes are ionic compounds that would be aqueous in solution, or are ionic compounds that are already dissolved in water.
The loose and mobile ions conduct electricity. The more ions, the better the conduction of electricity. No ions = no conduction. Molecular compounds (sugar water) have no ions, they are not electrolytes.

Lastly, all ionic compounds will conduct if MELTED or MOLTEN. The heat is able to make the ions come apart. You will not likely ever see melted silver chloride, but it could conduct. It's still NOT an electrolyte.

48. How would you describe making a concentrated cup of hot tea as compared to a dilute cup of hot tea?
These words are qualitative only, no numbers or units. Put a tea bag into hot water for 20 seconds and take it out makes weak, or dilute tea. Put the same teabag in for 2 minutes, the tea is much stronger, or concentrated.

49. Water in rivers and lakes has some dissolved oxygen, even though oxygen is a nonpolar molecule (that's what keeps the fish alive). Compare and contrast some lake water that's cooler vs. hotter, in regards to dissolved oxygen concentration.
Hot water would hold less oxygen that cool water. Fish would have more oxygen to absorb through their gills when in cooler water than warm. Of course, cold water would make the fish colder too, and slow it down, while a hot fish would be more energetic than a cold, there are optimal temperatures for fish physiology to perform at the best rate.

50. Describe how much CO_2 fits into a cold, sealed can of seltzer and why once you drink it quickly, you burp (and it's almost unavoidable).
The carbon dioxide is in the water (seltzer is mostly water). Drink it down quickly, and all the dissolved CO_2 stays in solution. Inside of you, it warms quickly, and molecular compounds like this one have a lower solubility in warmer water. The gas escapes the solution, and fills your stomach.
The burp in going to happen.