Like-dissolves-like self test

1. Use the principle of similar forces between solute and solvent to predict the likelihood that the following solutes will dissolve in polar and non-polar solvents. In each cell, circle "Yes" if the solute is likely to be soluble, "No" if is not likely to be soluble, and "Maybe" if there are reasons that seem to conflict. Provide an explanation which should include how you have categorized the solute (ionic, covalent-molecular, metallic, network covalent).

Solute*	**Solvent (water)**	**Solvent (non-polar)**	**Explanation:**
1. K_2SO_4	Yes No Maybe	Yes No Maybe	
2. AgCl	Yes No Maybe	Yes No Maybe	
3. $SiCl_4$	Yes No Maybe	Yes No Maybe	
4. Cu	Yes No Maybe	Yes No Maybe	
5. $\underline{C}H_2O$	Yes No Maybe	Yes No Maybe	
6. H$\underline{O}$Cl	Yes No Maybe	Yes No Maybe	
7. SiC**	Yes No Maybe	Yes No Maybe	
8. CH_3NH_2	Yes No Maybe	Yes No Maybe	
9. $Ca(NO_3)_2$	Yes No Maybe	Yes No Maybe	
10. $PbSO_4$	Yes No Maybe	Yes No Maybe	
11. $NH_4C_2H_3O_2$	Yes No Maybe	Yes No Maybe	
12. $CH_3CH_2CH_2OH$	Yes No Maybe	Yes No Maybe	
13. P_4	Yes No Maybe	Yes No Maybe	
14. HCl	Yes No Maybe	Yes No Maybe	
15. $CrCl_3$	Yes No Maybe	Yes No Maybe	
16. $Al_2(CO_3)_3$	Yes No Maybe	Yes No Maybe	
17. SF_2	Yes No Maybe	Yes No Maybe	
18. CO	Yes No Maybe	Yes No Maybe	

*central atom underlined
** network covalent

2. Which of the water-soluble solutes form electrolytes in solution?

3. If a solute and solvent have very similar intermolecular forces and are of the same phase (s, l, g), they may be ***miscible***, that is, they may form solutions of any proportion without one being only of limited solubility in the other. For example, nitrogen and oxygen are miscible and methanol (CH_3OH) and water are miscible. What is the range of values for mole fraction for miscible solutions? What is the range of values for mass percent for miscible solutions?

4. Name the solutes except for CH_2O, CH_3NH_2, for $CH_3CH_2CH_2OH$, which are named using organic nomenclature rules that we have not covered in Chm 203. As for the others, be sure you can name substances such as these.

Answers available at the course website.

Like-dissolves-like self test ANSWERS

1.

Solute*	**Solvent (water)**	**Solvent (non-polar)**	**Explanation:**
1. K_2SO_4	Yes	No	This is an ionic compound, so you need to use the ***Solubility Rules*** for ionics in water. In this case, "All Group 1 salts are soluble in water." Ionic compounds are not soluble in non-polar solvents (lecture notes)
2. AgCl	No	No	This is an ionic compound, so you need to use the ***Solubility Rules*** for ionics in water. In this case, "All halide salts are soluble in water, except AgX, PbX_2, and Hg_2X_2, where X^- = Cl^-, Br^-, I^-. ." Ionic compounds are not soluble in non-polar solvents (lecture notes)
3. $SiCl_4$	No	Yes	This is a covalent-molecular (non-metal + non-metal), so we 1. Sketch the Lewis dot structure and if there are electron pair groups ("E" groups), the compound is polar; if there are no E groups, the compound is most likely non-polar. This compound has 4 bonding groups and no electron pair groups (AB_4) so it is non-polar.
4. Cu	No	No	***Rule: Metals are not soluble in any normal solvent.*** (Don't confuse reactivity with dissolving! For example, Cu will react with HNO_3(aq) and it may look a bit like it's dissolving, but we are NOT forming Cu(aq) which is what it means to dissolve in water. (We get Cu^{+2}(aq) in the case of HNO_3 + Cu(s).)
5. CH_2O	Yes	Maybe	This is a covalent-molecular (non-metal + non-metal), so we 1. Sketch the Lewis dot structure and if there are electron pair groups ("E" groups), the compound is polar; if there are no E groups, the compound is most likely non-polar. The C has AB_3 and the O has ABE_2 so the compound is polar according to the oxygen anyway. For non-polar solvents, the answer is "maybe" because the C is AB_3.
6. HOCl	Yes	No	This is a covalent-molecular and a weak acid. 1. Sketch the Lewis dot structure: O is AB_2E_2 so it is polar.
7. SiC**	No	No	***Rule: Network covalents are insoluble in all solvents.***
8. CH_3NH_2	Yes	Maybe	This is a covalent-molecular (non-metal + non-metal), so we 1. Sketch the Lewis dot structure and if there are electron pair groups ("E" groups), the compound is polar; if there are no E groups, the compound is most likely non-polar. The C has AB_3 and the N has AB_3E so the compound is polar according to the N anyway. For non-polar solvents, the answer is "maybe" because the C is AB_4.
9. $Ca(NO_3)_2$	Yes	No	Ionic compound: Solubility Rules state that all nitrates are soluble.
10. $PbSO_4$	No	No	Ionic compound: Solubility Rules state that all sulfates are soluble except $BiSO_4$, Hg_2SO_4, and $PbSO_4$.
11. $NH_4C_2H_3O_2$	Yes	No	Ionic compound: ammonium acetate. Solubility Rules state that all ammonium salts are soluble. Another solubility rule states that all acetates are soluble.
12. $CH_3CH_2CH_2OH$	Maybe	Yes	This is a covalent-molecular with three C atoms that are non-polar AB_4 centers and one O that is polar: AB_2E_2. Taken together, it is mostly non-polar, so we guess "Yes" for solubility in non-polar solvents, but maybe for solubility in water.

13. P_4	No	Yes	You can skip this one, it is tricky. Look up the structure of P_4 and you will see that it is perfectly symmetric, like N_2, which is non-polar.
14. HCl	Yes	No	You should recall that HCl forms a strong acid in water. Otherwise, you will still predict it is a polar covalent-molecular.
15. $CrCl_3$	Yes	No	Ionic compound. Solubility Rule: All chlorides are soluble except AgCl, Hg_2Cl_2 and $PbCl_2$.
16. $Al_2(CO_3)_3$	No	No	Ionic compound. Solubility Rule: All carbonates are insoluble except Group I and ammonium.
17. SF_2	Yes	No	Covalent-molecular, AB_2E_2.
18. CO	Yes	No	We predict that CO should be polar and it is. Nevertheless, CO is a gas and is not very soluble in any liquid solvent.

2. Which of the water-soluble solutes form electrolytes in solution? K_2SO_4, HOCl is a weak acid and forms a weakly electrolytic solution similar to acetic acid; CH_3NH_2 (I wouldn't expect you to be able to predict this one prior to Chap 14), $Ca(NO_3)_2$, $NH_4C_2H_3O_2$, HCl, and $CrCl_3$.

3. What is the range of values for mole fraction for miscible solutions? Answer: 0 – 1. What is the range of values for mass percent for miscible solutions? Answer: 0% - 100%.

4. Names:

Solute	**Name**	**Naming rule used**
1. K_2SO_4	Potassium sulfate	Ionic naming rules
2. AgCl	Silver chloride	Ionic naming rules
3. $SiCl_4$	Silicon tetrachloride	Covalent-molecular naming rules
4. Cu	Copper	Name of element
6. HOCl	Hypochlorous acid	Naming oxyacids
7. SiC**	Silicon carbide	Covalent-molecular naming rules
9. $Ca(NO_3)_2$	Calcium nitrate	Ionic naming rules
10. $PbSO_4$	Lead(II) sulfate	Ionic naming rules. Note that we must specify oxidation state for the metal except for Groups I and II and aluminum.
11. $NH_4C_2H_3O_2$	Ammonium acetate	Ionic naming rules. Note: Ionic compounds do not always have to contain metal cations! Ammonium is a good cation without any metals.
13. P_4	Phosphorus	Name of element
14. HCl	Hydrogen chloride	Covalent-molecular naming rules. Note: When HCl is dissolved in water, it is called "hydrochloric acid," but when it is not in water, it is a gas and is named using the covalent-molecular naming rules.
15. $CrCl_3$	Chromium(III) chloride	Ionic naming rules. Note that we must specify oxidation state for the metal except for Groups I and II and aluminum.
16. $Al_2(CO_3)_3$	Aluminum carbonate	Ionic naming rules.
17. SF_2	Sulfur difluoride	Covalent-molecular naming rules.
18. CO	Carbon monoxide	Covalent-molecular naming rules.