

Lesson 6.3 Review Answers

d) Rates of Dissolution and Surface Area

- Increasing surface area of a solid solute increases the rate of dissolution.

This is accomplished by crushing the solute. A larger surface area allows more solvent molecules to surround the solute, allowing more intermolecular forces to form per unit of time. Note: this only speeds up the **rate of dissolution**, not the solubility. 5 g of sugar in 1.00 L of water will dissolve faster when the sugar is fine (obviously) but 5 g of sugar cubes in 1.00 L of water will still dissolve completely – it will just take much longer.

e) Rates of Dissolution and Agitation

- Increasing agitation increases the rate of dissolution.

This is accomplished by vigorous stirring. Stirring will bring fresh solvent molecules into contact with solute so they can form more intermolecular forces with each other per unit of time. It will also help speed up the movement of both solute and solvent particles. Again, this affects the rate of dissolution, not the solubility.

Lesson 6.3: Developing and Using Solubility Rules; Writing Equations using Solubility Rules

Recall: Electrolytes are substances that form ions in aqueous solutions (dissolved in water). Positive and negative ions carry current (conduct electricity) in an aqueous solution. Usually these are soluble ionic salts, strong acids (completely dissociate), and strong bases (completely dissociate). Substances that will not dissociate in solution are insoluble and nonelectrolytes (cannot conduct electricity). The following table is a guide to whether a solution is soluble or not.

SOLUBILITY RULES: memorize!!!

1. Most alkali metal salts AND NH_4^+ salts ARE **soluble**
2. Cl^- , Br^- , I^- are **soluble**, *except for Ag^+ , Hg_2^{+2} , Pb^{+2}
3. F^- are **soluble**, *except for IIA metals
4. NO_3^- , ClO_3^- , ClO_4^- , and CH_3COO^- are **soluble**
5. SO_4^{-2} are **soluble**, except for Ca^{+2} , Sr^{+2} , Ba^{+2} , Ag^+ , Pb^{+2} , Hg_2^{+2}
6. CO_3^{-2} , PO_4^{-3} , $\text{C}_2\text{O}_4^{-2}$, CrO_4^{-2} , S^{-2} , OH^- , and O^{-2} are **INSOLUBLE** (rule 1 takes priority!)*

It can be assumed that ionic cmpds. that dissolve in water are strong electrolytes and are therefore soluble.

*hydroxides of Ca^{+2} , Sr^{+2} , Ba^{+2} are soluble

Heavy metal

Review: Identify the following compounds as either electrolytes or nonelectrolytes. If the solution is electrolytic, write a dissociation equation to show how the ions form. Assume the solvent is water.

- | | | |
|------------------------------|-------------------------------|--|
| 1) LiCl | Electrolyte | $\text{LiCl(s)} \rightarrow \text{Li}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ |
| 2) $(\text{NH}_4)_2\text{S}$ | Electrolyte | $(\text{NH}_4)_2\text{S(s)} \rightarrow 2\text{NH}_4^+(\text{aq}) + \text{S}^{2-}(\text{aq})$ |
| 3) Ammonium chlorate | Electrolyte | $\text{NH}_4\text{ClO}_3(\text{s}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{ClO}_3^-(\text{aq})$ |
| 4) Ca(OH)_2 | Electrolyte | $\text{Ca(OH)}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq})$ |
| 5) Mg(OH)_2 | Nonelectrolyte
(insoluble) | |

6) Silver chloride *Nonelectrolyte (insoluble)*

Precipitates: These are insoluble solids that emerge from an aqueous solution. The emergence of the insoluble solid from solution is called **precipitation**.

Precipitates can form when two soluble salts react in solution to form one or more insoluble products. The insoluble product separates from the liquid and is called a **precipitate**. Precipitates can also form when the temperature of a solution is lowered. The lower temperature lower temperature reduces the solubility of the salt resulting in the formation of a precipitate. This process is called crystallization.

Any ions that do not participate in the formation of precipitate are called **spectator ions**.

Writing Equations Using Solubility Rules

Typically, these are double replacement/displacement reaction types that, if a reaction occurs, will form one solid precipitate. **Net ionic equations** are used to show which chemical species are actively reacting and eliminates spectator ions.

Below is an example of how these are done.

EXAMPLE: $\text{KCl}_{(aq)} + \text{Pb}(\text{NO}_3)_{2(aq)} \rightarrow$

1. a. Take only one of the first cation(s) and match it with one of the second anion(s). (Write the cation first)
- b. Take only one of the second cation(s) and match it with one of the first anion(s). (Write the cation first)



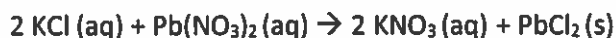
2. Correct the formulas of the products based on the charges of the ions. (Note the subscript change on Cl)



3. Balance the equation.



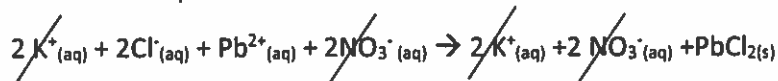
4. Consult the solubility rules and assign the correct state symbol. This should agree with any observations concerning the formation of a precipitate which gets the symbol (s). If water is formed, water is a molecule; it does not ionize to any significant extent. It is given (l). Note the state variables on the product side. Why does KNO_3 get (aq) and PbCl_2 get (s).



5. Write the **total ionic equation**. All compounds that are aqueous (aq) break up into individual cations and anions



6. Eliminate spectator ions. Spectator ions are in the same form on each side of the equation arrow.



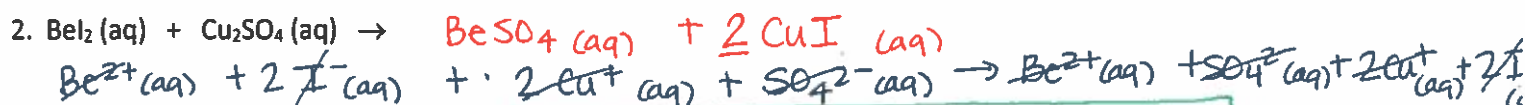
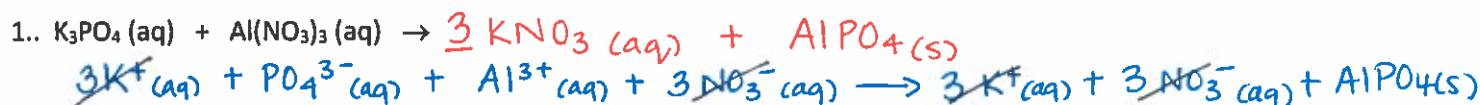
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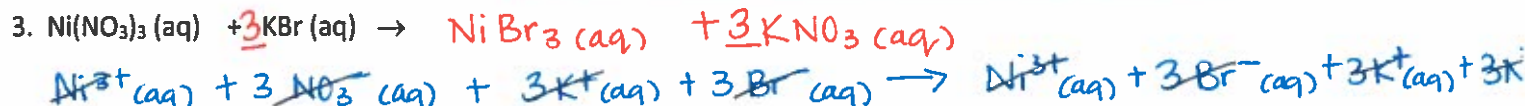
5. Write the Net Ionic Equation. The convention is to write the cation first followed by the anion on the "reactants" side. Don't forget that chemical equations are written using the lowest common coefficients (including net ionic equations). If all ions cancel each other out then it is NR, and no precipitates will form.



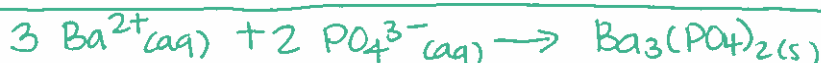
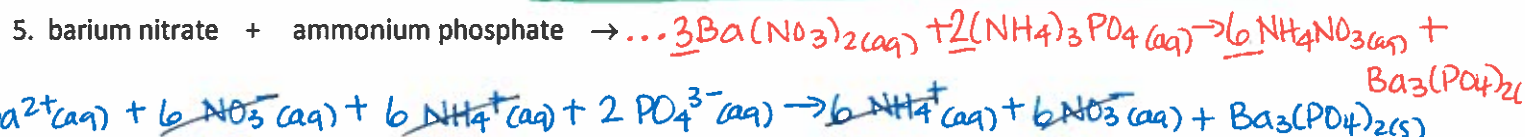
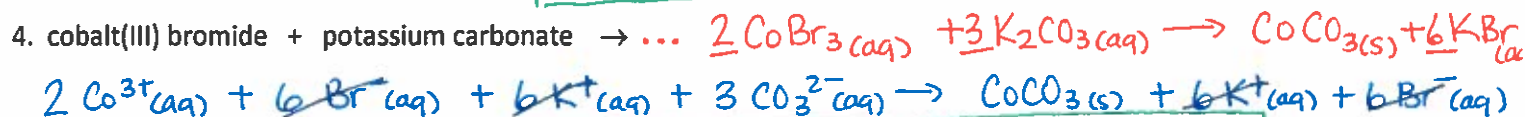
Review: Write and balance the net ionic equation for the following reactions. All states must be present.



no reaction - all products are soluble



no reaction - all products are soluble



Lesson 6.5: Types of Solutions

There are many ways to classify solutions:

- a) By particle size and ability to scatter light – solution, colloid or suspension

These can be distinguished from each other by passing a bright light (like a flashlight) through a sample.

Depending on the size of the solute particle, light may either pass through the sample straight through or will be scattered by larger solute particles. This effect is called the Tyndall effect.

- Solutions have dissolved solute particles that measure less than 1 nm in diameter. A solution is a homogeneous mixture; it cannot be filtered to separate the solute from the solvent. You must use distillation to separate the parts. The particles are invisible to your eye. The particles will not scatter light. Solutions appear transparent. Example: tap water, clear drinks

Lesson 6.3 Homework

Lesson 6.2

1. Summarize and explain the effects of various factors on the solubility of a solid solute.
2. Summarize and explain the effects of various factors on the solubility of a gaseous solute.
3. Summarize and explain the effects of various factors on the rate of dissolution of a solute.

Lesson 6.3

Write and balance the net ionic equation for the following reactions. All states must be present. If no precipitate forms, write "NR" at the end.



NR (no reaction)

