Name: _____ Date: _____ Period: _____

Double Replacement Reactions: A Step-by-Step Guide

Example	Practice
Solutions of lead (II) nitrate and calcium phosphate are mixed.	Solutions of sodium sulfate and zinc chloride are mixed.
1. *Write formulas for the reactants. Because these are ionic compounds (metal + nonmetal), you have to find the charge of each ion:* Pb^{2+}: lead is a transition metal, so its charge is included in the name as the roman numerals NO_3^{1-}: nitrate is a polyatomic ion that you memorized! Ca^{2+}: calcium is in the 2nd column of the Periodic Table. PO_4^{3-}: phosphate is a polyatomic ion that you memorized! *Now put them together and cross the charges into subscripts:* $Pb^{2+}\ NO_3^{1-} + Ca^{2+}PO_4^{3-}$ *You will need parentheses around nitrate and phosphate because they are polyatomic and you have more than one. Reduce the subscripts whenever they have a common denominator.* $Pb(NO_3)_2 + Ca_3(PO_4)_2$	
2. *Identify the type of reaction by the pattern of the reactants:* AX + BY → AY + BX is a DR reaction. $Pb(NO_3)_2 + Ca_3(PO_4)_2$ →	
3. *Predict the products, based on the reaction type.* *Identify the positive ions and write them in:* AX + BY → AY + BX $Pb(NO_3)_2 + Ca_3(PO_4)_2$ → Pb^{2+}____ + Ca^{2+}____ *Fill in the negative ions, switching from the original order:* AX + BY → AY + BX $Pb(NO_3)_2 + Ca_3(PO_4)_2$ → $Pb^{2+}PO_4^{3-}$ + $Ca^{2+}NO_3^{1-}$ *Now cross the charges into subscripts, using parentheses around the polyatomic ions. Reduce the subscripts if there is a common denominator.* AX + BY → AY + BX $Pb(NO_3)_2 + Ca_3(PO_4)_2$ → $Pb_3(PO_4)_2$ + $Ca(NO_3)_2$	
4. *Balance the reaction. Change only the coefficients, NOT subscripts! Just work your way from left to right, balancing each ion you encounter.* *Balance Pb:* $\underline{3}Pb(NO_3)_2 + \_\_Ca_3(PO_4)_2$ → $\underline{1}Pb_3(PO_4)_2$ + $\_\_Ca(NO_3)_2$ *Balance NO_3:* $\underline{3}Pb(NO_3)_2 + \_\_Ca_3(PO_4)_2$ → $\underline{1}Pb_3(PO_4)_2$ + $\underline{3}Ca(NO_3)_2$ *Balance Ca:* $\underline{3}Pb(NO_3)_2 + \underline{1}Ca_3(PO_4)_2$ → $\underline{1}Pb_3(PO_4)_2$ + $\underline{3}Ca(NO_3)_2$ *Balance PO_4 and double-check the others:* $\underline{3}Pb(NO_3)_2 + \underline{1}Ca_3(PO_4)_2$ → $\underline{1}Pb_3(PO_4)_2$ + $\underline{3}Ca(NO_3)_2$	
5. *Now check your products for solids, which are **insoluble**. Find your products in your solubility rules by looking up the negative ion first. Soluble compounds stay dissolved (aq). Always check the exceptions!* $Pb_3(PO_4)_2$: Lookup phosphate. It is solid according to rule #5 $Ca(NO_3)_2$: Lookup nitrate. It is soluble according to rule #1.	

6. *Now write a **net ionic reaction** for any solid you make. Write two separate reactions if the solubility rules indicate that two solids form. If both of the products are soluble, this reaction does not occur, and there are no net ionic reactions to write.* *Start with the solid, which will be on the product side:* _____ + _____ → $Pb_3(PO_4)_2$ *Then list the ions (with charges!) making up that solid as reactants. If you do not know the charges, you may be able to "uncross" the subscripts to get the charges. Remember that the HONClBrIF rule applies only to molecules of those gasses in their elemental form, **not ions**.* ___Pb^{2+} + ___PO_4^{3-} → $Pb_3(PO_4)_2$ *Finally, balance the reaction.* $\underline{3}Pb^{2+}$ + $\underline{2}PO_4^{3-}$ → $Pb_3(PO_4)_2$	

More Practice!

1. Barium oxide and cadmium sulfate

2. Tin (IV) chloride and mercury (II) chlorate

3. Ammonium hydroxide and hydrochloric acid (HCl)

4. Calcium bromide and ammonium nitrate

5. Magnesium sulfide and molybdenum (IV) chloride