Name: _____ Lab Partner(s): _____

Double Replacement Reaction Lab (Formative C)

Introduction:

In the study of chemical reactions, it is helpful to know when to expect a precipitate to form. A soluble compound will dissolve readily in water and, therefore, will not form a precipitate. An insoluble compound will not dissolve readily in water and, therefore, will form a precipitate.

How do you know which ionic compounds form precipitates and which do not? To find out, you can make a large number of mixings involving many different cations and anions. By observing the results and correlating them in a logical fashion, you can formulate some general solubility rules. These rules can be used to describe the behavior of ionic compounds in solution and determine which combinations of compounds will form precipitates.

Purpose:

Directions: After reading the introduction, Fill in the blank with what we are doing in the lab today.

I can deduce the experimental results, which combinations of ions form _____, using

_____ rules table. I can write a _____ equation for each reaction

Background:

From manufacturing materials to Artist's pigment paint, Solubility rules could be useful in our everyday life. But they are also extremely important in medicine. Drug synthesis, cavities/tooth decay, formation of kidney stones, to the water we drink all has to do with solubility rules. Sometimes doctors prescribe more than one medication to be administered by the intravenous (IV) route. IV bags are 1000 mL of saline solution and small amounts of medications (molecules) are sometimes dissolved in IV bags. IV bags are then connected to the bloodstream through the veins. Mixing solutions can have very serious consequences when the solutions interact to form a precipitate.

For example, Mg^{2+} ions such as magnesium sulfate is used as an electrolyte or anticonvulsant. (Anticonvulsant means to reduce the effects of epileptic seizures and/or convulsions.) Ca^{2+} ions like in Calcium chloride are indicated in the immediate treatment of hypocalcemic tetany (abnormally low levels of calcium in the body that causes muscle spasm). What will happen if we mix them?

Calcium Chloride and Magnesium Sulfate in an IV Line- Video

$$CaCl_2\ (aq) + MgSO_4\ (aq) \rightarrow CaSO_4\ (s) + MgCl_2\ (aq)$$

As a new doctor at Walter Reed's medical center, your task is to test 6 ionic compounds used in the medical facility to make sure other doctors are prescribing the right combination of IV solution.

To Do this you will have to:

1) Test out the 7 chemical compounds with each other and record your findings
2) Write all the balance chemical equations to show understanding of Solubility
3) Perform hypothetical scenarios as the trained Pharmacutical doctor

Chemicals need: Sodium Phosphate (Na_3PO_4), Sodium Acetate ($NaC_2H_3O_2$), Potassium Iodine (KI), Calcium Chloride ($CaCl_2$), Calcium Nitrate ($Ca(NO_3)_2$), Magnesium Sulfate ($MgSO_4$), Magnesium Chloride ($MgCl_2$)

Table 1 – Data and observation

- Record whether a precipitate (ppt) is formed
- Record the color of the precipitate if any

	Na_3PO_4 (aq)	$NaC_2H_3O_2$ (aq)	KI (aq)	$CaCl_2$ (aq)	$Ca(NO_3)_2$ (aq)	$MgSO_4$ (aq)	$MgCl_2$ (aq)
$MgCl_2$ (aq)	#1	#2	#3	#4	#5		
$MgSO_4$ (aq)	#6	#7	#8	#9	#10		
$Ca(NO_3)_2$ (aq)	#11	#12	#13				
$CaCl_2$ (aq)	#14	#15	#16				
KI (aq)	#17	#18					
$NaC_2H_3O_2$ (aq)							
Na_3PO_4 (aq)							

Directions- For each reaction, write the following:

a. Balanced chemical equation
    i. Partner 1 does the 1- 9 and partner 2 does 10-18

b. In each reaction, there are two possible products. Use the solubility rules (blue sheets) to write the phase of matter [Important in order to do scenario questions]

1. $3\ MgCl_2\ (aq) + 2\ Na_3PO_4\ (aq) \rightarrow Mg_3(PO_4)_2\ (s) + 6\ NaCl\ (aq)$

2. $MgCl_2\ (aq) + 2\ NaC_2H_3O_2\ (aq) \rightarrow Mg(C_2H_3O_2)_2\ (aq) + 2\ NaCl\ (aq)$

3. $MgCl_2\ (aq) + 2\ KI\ (aq) \rightarrow MgI_2\ (aq) + 2\ KCl\ (aq)$

4. $MgCl_2\ (aq) + CaCl_2\ (aq) \rightarrow MgCl_2\ (aq) + CaCl_2\ (aq)$

5. $MgCl_2\ (aq) + Ca(NO_3)_2\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + CaCl_2\ (aq)$

6. $3\ MgSO_4\ (aq) + 2\ Na_3PO_4\ (aq) \rightarrow Mg_3(PO_4)_2\ (s) + 3\ Na_2SO_4\ (aq)$

7. $MgSO_4\ (aq) + 2\ NaC_2H_3O_2\ (aq) \rightarrow Mg(C_2H_3O_2)_2\ (aq) + Na_2SO_4\ (aq)$

8. $MgSO_4\ (aq) + 2\ KI\ (aq) \rightarrow MgI_2\ (aq) + K_2SO_4\ (aq)$

9. $MgSO_4\ (aq) + CaCl_2\ (aq) \rightarrow CaSO_4\ (s) + MgCl_2\ (aq)$

10. $MgSO_4\ (aq) + Ca(NO_3)_2\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + CaSO_4\ (s)$

11. $3\ Ca(NO_3)_2\ (aq) + 2\ Na_3PO_4\ (aq) \rightarrow Ca_3(PO_4)_2\ (s) + 6\ NaNO_3\ (aq)$

12. $Ca(NO_3)_2\ (aq) + 2\ NaC_2H_3O_2\ (aq) \rightarrow Ca(C_2H_3O_2)_2\ (aq) + 2\ NaNO_3\ (aq)$

13. $Ca(NO_3)_2\ (aq) + 2\ KI\ (aq) \rightarrow CaI_2\ (aq) + 2\ KNO_3\ (aq)$

14. $3\ CaCl_2\ (aq) + 2\ Na_3PO_4\ (aq) \rightarrow Ca_3(PO_4)_2\ (s) + 6\ NaCl\ (aq)$

15. $CaCl_2\ (aq) + 2\ NaC_2H_3O_2\ (aq) \rightarrow Ca(C_2H_3O_2)_2\ (aq) + 2\ NaCl\ (aq)$

16. $CaCl_2\ (aq) + 2\ KI\ (aq) \rightarrow CaI_2\ (aq) + 2\ KCl\ (aq)$

17. $3\ KI\ (aq) + Na_3PO_4\ (aq) \rightarrow K_3PO_4\ (aq) + 3\ NaI\ (aq)$

18. $KI\,(aq) + NaC_2H_3O_2\,(aq) \rightarrow NaI\,(aq) + KC_2H_3O_2\,(aq)$

Scenario 1: [2 points]

Let's revisit the scenario from introduction again-
Mg^{2+} ions such as magnesium sulfate is used as an electrolyte or anticonvulsant. (Anticonvulsant means to reduce the effects of epileptic seizures and/or convulsions.) Ca^{2+} ions like in Calcium chloride are indicated in the immediate treatment of hypocalcemic tetany (abnormally low levels of calcium in the body that causes muscle spasm).

$$CaCl_2\,(aq) + MgSO_4\,(aq) \rightarrow Ca_2SO_4\,(s) + MgCl\,(aq)$$

As the doctor, you know Calcium chloride and Magnesium Sulfate will kill the patient if they get a mixture of those two solutions due to the formation of precipitate, but we still need two solutions to alleviate the convulsions and muscle spasm. Is there another combination of compounds that will yield the same results?

1) What are the two compounds needed to be put into IV Bag?

   $MgCl + CaCl_2$

2) How do you know? Use the solubility rules to explain in detail.

   All Chloride ions are soluble in water besides Ag, Pb, Hg

Scenario 2: [2 points]
A patient comes into the Medical Center complaining about cramps, exhaustion, nausea and headaches. After some blood work was done, it was found that they were hyponatremic, had low levels of sodium (Na^+ ions) in the blood and hypokalemic, had low levels of potassium (K^+ ions) in their blood. Na^+ ions regulate osmotic pressure and the body's water content, transmit nerve signals, and help your muscles contract. K^+ ions help regulate heart muscle contractions.

1) As the doctor you decide to hook the patient up with a IV bag mix with two chemicals. Can both #17, and #18 compounds work? Why or why not?

Yes, because there is no chemical reaction between potassium iodine with either sodium acetate or sodium phosphate

2) Explain your reasoning using the solubility rules.

   - All sodium, potassium and iodines are soluble in water
   - All phosphates are insoluble in water besides Na+, K+, NH_4+

Scenario 3: [2 points]
Another Doctor prescribes Sodium phosphate and Calcium chloride for a patient. You interject and say that will not be a good idea.

1) Why did you interject? (Use the solubility rules as your proof)

   A precipitate will form

   $3\,CaCl_2\,(aq) + 2\,Na_3PO_4\,(aq) \rightarrow Ca_3(PO_4)_2\,(s) + 6\,NaCl\,(aq)$

   - All phosphates are insoluble in water besides Na+, K+, NH_4+

2) Is there another combination of electrolytes of sodium and calcium into the patients bloodstream?

$$CaCl_2\,(aq) + 2\,NaC_2H_3O_2\,(aq) \rightarrow Ca(C_2H_3O_2)_2\,(aq) + 2\,NaCl\,(aq)$$

Scenario 4: [2 points]
It was late at night and the nurse just did the rounds and replaced an IV bag for Mr. Johnson. The IV bag contained **Magnesium Sulfate** and **potassium iodine** solution. Mr. Johnson was sleeping peacefully in his bed, when around 2 a.m. someone sneaks into the hospital wing. The nurses on the overnight shift were busy with other patients so they didn't see the person sneak in, or that they grabbed an unattended needle and a bottle of solution off a medical cart.

The burglaror goes into the room Mr. Johnson was staying. Took 100 ml's of solution and injected it into the IV solution bag, dropping the needle and bottle before running away. As the doctor doing a turn of overnight shifts, you saw the mysterious figure run out. Instead of chasing them, you called a Code Orange (suspicious intruder), while running into Mr. Johnson's room. You seize the bottle and look at it, it was **Sodium phosphate** solution. More people from Nurses, to other doctors come into help, you tell them what was in the bottle.

1) Will Mr. Johnson be alright or do the doctors and nurses need to intervene to save Mr. Johnson's life?

Mr. Johnson will most likely die if the medical proffessionals do not intervene quickly since a perciptant is forming in the bloodstream.

2) If the medical professionals need to intervene, what ionic compound is interacting with sodium phosphate and what precipitate is forming? [Yes, you can write the chemical equation down here to answer the question]

$$3\,MgSO_4\,(aq) + 2\,Na_3PO_4\,(aq) \rightarrow Mg_3(PO_4)_2\,(s) + 3\,Na_2SO_4\,(aq)$$