Experiment 22: Solubility rules

Notes

Procedure

1. Draw up a results table as shown below.

Solution to be tested	Cation present	$NaNO_3$ anion added NO_3^-	$NaC\ell$ anion added $C\ell^-$	Na_2SO_4 anion added SO_4^{2-}	Na_2CO_3 anion added CO_3^{2-}
KNO_3	K^+	n.v.r.	n.v.r.		
$AgNO_3$	Ag^+	n.v.r.	white ppt.		
$Pb(NO_3)_2$	Pb^{2+}				
$MgSO_4$	Mg^{2+}				
$FeSO_4$	Fe^{2+}				

2. Place about 1 mL of each of the solutions to be tested (KNO_3, $AgNO_3$, $Pb(NO_3)_2$ etc) into separate clean test tubes.
3. Place about 20 mL of 0.1 mol L^{-1} $NaNO_3$ into a clean 100 mL beaker. Use a dropper to add about 1 mL of the $NaNO_3$ solution to each of the solutions in the test tubes. Where a precipitate occurs indicate its colour in the table. If no reaction is observed indicate with the letters 'n.v.r.' (no visible reaction).
4. When all of the solutions have been tested with the $NaNO_3$ solution carefully clean the test tubes, and repeat the procedure with the 0.1 mol L^{-1} $NaC\ell$ solution (column 4), 0.1 mol L^{-1} Na_2SO_4 solution (column 5) and 0.1 mol L^{-1} Na_2CO_3 solution (column 6).

Processing of results and questions

1. Examine your observations in column 3 of the results table. Can any generalisation be made about the solubilities of nitrates?
2. Examine columns 4, 5 and 6 of the table in the same way as you did for column 3 in question 1.
3. Write ionic equations for all cases in which a precipitate was formed.
4. Research and classify the cations tested as essential body nutrient or poison.
5. What ions are provided in a common lawn fertiliser? Name the salts if included on the label.
6. What are kidney stones and why do they form?

Investigation 23: Identify the unknowns I

The situation

A freak storm has forced rainwater to flood down and through the chemical storage room. Labels have smudged and some have completely fallen off a number of bottles. Luckily you know that one set of the now unlabelled bottles contains solutions of cations and a second set contains solutions of anions.

The task

Design and carry out an investigation that will identify the set of unlabelled solutions of different cations with the same anion (nitrate ion) and a second set of solutions of different anions with the same cation (sodium ion).

Identification of cations

Set 1 (unknown cations): 0.1 mol L^{-1} nitrate solutions of iron(II), lead, silver, copper(II) and magnesium, randomly labelled A, B, C, D and E.

Set A (known test solutions): 0.1 mol L^{-1} solutions of sodium hydroxide, ammonia, sodium chloride and potassium iodide.

Identification of anions

Set 2 (unknown anions): 0.1 mol L^{-1} solutions of sodium carbonate, sodium hydroxide, sodium chloride, sodium sulfate or sodium nitrate randomly labeled as unknown solution F, G, H, I and J.

Set B (known test solutions): 0.1 mol L^{-1} solutions of lead nitrate, silver nitrate, iron(II) sulfate (fresh), copper(II) sulfate and sulfuric acid.

Planning the investigation

1. Plan an investigation to correctly identify the unknown cations and anions.
2. Write out your proposed plan, list the equipment required and identify the safety requirements.

SAFETY NOTE:
- **Check your plan with your teacher before you start.**
- **Sulfuric acid is corrosive! Handle with care.**

Conducting the investigation

1. Conduct the investigation, collecting and recording the data as you proceed.

Processing the data

1. From your observations identify each of the unknowns in the set. Include the reasons for your identifications and write chemical equations for all reactions that were observed.
2. Write an ionic equation showing how each precipitate forms.

Evaluating the investigation

1. Evaluate the effectiveness of your procedure and describe any modifications you would make to improve it.
2. Discuss your confidence in the findings of the investigation.

Notes

Use precipitation reactions to determine which cation you have in each bottle. You must make a record of each experimental test you do and explain how/why your testing determines the correct cation.

Investigation 24: Identify the unknowns II

Notes

Different substances dissolve in water to varying extents. The different solubilities of these substances have several applications. For example, chemists use knowledge of solubilities to identify the presence of certain ions, to prepare compounds, in electrolytic processes, horticulture and in rehydration. It also helps in various forensic tests and separation methods.

The task

Apply the solubility rules to identify a set of unknown solids or solutions.

Your teacher will allocate you one or more of the following sets of solids or solutions. Each member of the set provided will be labeled only as A, B, C ... etc.

Set 1: 1 mol L^{-1} solutions of $BaC\ell_2$, $CuSO_4$, H_2SO_4, $NaC\ell$ randomly labeled as A, B, C, D.

Set 2: 1 mol L^{-1} solutions of $AgNO_3$, $ZnSO_4$, $BaC\ell_2$, $NaC\ell$ randomly labeled as G, H, I, J.

Set 3: 1 mol L^{-1} solutions of H_2SO_4, $BaC\ell_2$, Na_2CO_3, $Pb(NO_3)_2$, KOH and 2 mol L^{-1} $HC\ell$ randomly labeled as M, N, O, P, Q, R.

Set 4: Solid samples of $BaC\ell_2$, $Zn(NO_3)_2$, Na_2CO_3, $CaCO_3$ randomly labeled as W, X, Y, Z. (Distilled water, dilute hydrochloric acid and limewater solution are also provided to test the unknown solid samples.)

It will be necessary for you to plan a procedure to identify the unknowns provided, carry out the procedure and evaluate your results.

Equipment

Unknown samples in Set 1, 2, 3 or 4 as listed above with each chemical labeled only as A, B, C etc.
set 1-3 solutions in dropper bottles
set 4 solid samples in small sample bottles; if Set 4 unknowns are used, the following solutions in labelled dropper bottles as well as delivery tubes are also provided:
- hydrochloric acid [$HC\ell$] 1 mol L^{-1}
- limewater solution [$Ca(OH)_2$]

spatula
test tube racks
test tubes (several)
distilled water
beakers (two 100 mL)

Notes

Planning the investigation

1. Plan an investigation to identify the unknown solids or solutions provided. For Sets 1-3 you may only use the solutions provided. For Set 4 the solid samples can be tested with the hydrochloric acid, limewater and distilled water provided. For each test, use a minimum amount of sample - for solids about a pea-sized sample; for solutions about 2-3 mL.

2. Write out your proposed plan, list the equipment required and identify the safety requirements.

3. Check the proposed plan with your teacher.

SAFETY NOTE:
- **Check your plan with your teacher before you commence.**

Conducting the investigation

Conduct the investigation, collecting and recording the data in a table as you proceed.

Processing the data

From your observations identify each of the unknowns in the set. Include the reasons for your identifications and write chemical equations for all reactions that were observed.

Evaluating the investigation

1. Evaluate the effectiveness of your procedure and describe any modifications you would make to improve it.

2. Discuss your confidence in the findings of the investigation.

Experiment 25: Electrolytes and conductivity

Notes

Electrolyte materials can be found in all sorts of places in and around the home. Your medicine cabinet for example, may contain vitamins and minerals. Have you any sports drinks in the refrigerator? Do you have a swimming pool? What about plant fertilisers in the garden shed? All of these materials contain electrolytes.

Electrolytes are chemical compounds like salts that when they dissolve, the resulting solution contains free ions that are capable of conducting electricity. Blood plasma contains important dissolved electrolytes. The dissolved electrolytes in the blood contribute to the general functioning of organs such as the kidney and heart, regulating the body's fluid and pH balance. Electrolytes also carry electrical currents that help nerve and muscle function. Important electrolytes include ions of magnesium, calcium, potassium, sodium, chloride and phosphate.

In this experiment you will investigate a number of different solutions that could be found around the house.

Equipment

power supply (0-12 V)
plate electrode system as shown in Figure 25.1
switch
ammeter (or 2.5 V globe)
electrical leads (four)
beakers (two 100 mL)
distilled water (50 mL) used in the iron found in the laundry
50 mL of each of the following:
tap water
sugar solution
1 mol L^{-1} acetic acid [CH_3COOH] in vinegar, found in the kitchen
1 mol L^{-1} ammonia solution found in the laundry
1 mol L^{-1} hydrochloric acid [$HC\ell$] found in the pool shed
1 mol L^{-1} potassium nitrate [KNO_3] in some fertilisers found in the shed
swimming pool water if you have some available

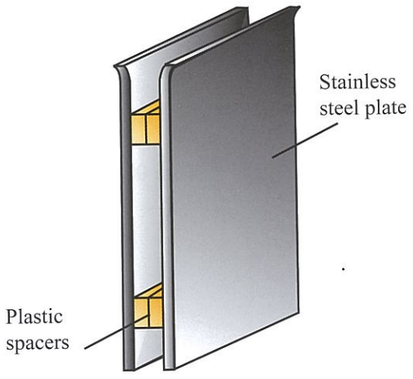

Figure 25.1: Plate electrode

Figure 25.2: Conductivity test set-up for solutions

Procedure

1. Set up the circuit and the electrodes as shown in Figure 25.2. Set the power supply to 6V.

2. Place 20 mL of 1 mol L^{-1} $HC\ell$ in a 100 mL beaker, put the electrodes into the solution and briefly close the switch. If a glow is not detected or the ammeter reading is very low on the 6 V power setting increase the voltage to 8 V (up to a maximum of 12 V). Tabulate your results.

3. Record the reading on the ammeter or the brightness of the globe.

4. Wash out the beaker and electrodes with distilled water and then in turn test the conductivity of 20 mL samples of: distilled water, tap water, sugar solution, acetic acid 1 mol L^{-1} , ammonia solution 1 mol L^{-1} , potassium nitrate 1 mol L^{-1} and swimming pool water.

Processing of results and questions

1. If you had to classify these substances in to 3 groups, what rule would you use? Compare your rule with others used around the class.

2. What general rule can you make up from the class results?

3. Explain your results using diagrams where appropriate and by describing the type of species present in each of the different solutions.

4. Read the label of a garden or lawn fertiliser. Draw up a table of the active ingredients contained in the fertiliser, giving the name and formula and have a column that classifies the component as a non-electrolyte, weak electrolyte or strong electrolyte.

Notes