Question #79115

i'm struggling to produce a method to distinguish solutions of 9 ionic compounds labelled A-I by a series of test tube reactions. This method needs to be in a logical sequence to prevent too many test being done unnecessarily. These must be test tube reactions so no flame tests.

These are the ionic compounds

potassium iodide

potassium chloride

potassium bromide

potassium sulfate

potassium hydroxide

potassium carbonate

ammonium chloride

barium chloride

magnesium chloride

thank you

Solution/Answer:

First of all, we can identify a tube with KOH by a litmus paper (pH should be > 11) or by a reaction with phenolphthalein (crimson color).

After that, we can identify NH₄Cl and MgCl₂ by those reactions (you can also use NaOH):

$$NH_4Cl + KOH \rightarrow NH_3 \uparrow + KCl + H_2O$$

(gas is released which gives an alkaline reaction on the wet litmus paper)

$$MgCl_2 + KOH \rightarrow Mg(OH)_2 \downarrow + KCl + H_2O$$
 (white slightly soluble precipitate)

Also, we can identify potassium carbonate and barium chloride by the reaction with H₂SO₄:

$$K_2CO_3 + H_2SO_4 = K_2SO_4 + H_2O + CO_2 \uparrow (gas\ production)$$

 $BaCl_2 + H_2SO_4 = BaSO_4 \downarrow + 2HCl (white\ precipitate)$

After that, we should use argentum nitrate (AgNO₃):

$$KCl + AgNO_3 = AgCl \downarrow + KNO_3$$
 (white precipitate)
 $KBr + AgNO_3 = AgBr \downarrow + KNO_3$ (pale yellow precipitate)
 $KI + AgNO_3 = AgI \downarrow + KNO_3$ (yellow precipitate)
 $K_2SO_4 + 2AgNO_3 = Ag_2SO_4 \downarrow + 2KNO_3$ (white precipitate)

To separate argentum sulfate and argentum chloride, we should use concentrated ammonia solution (only argentum sulfate reacts with ammonium hydroxide (the white precipitate is dissolved)):

$$Ag_2SO_4 \downarrow +4NH_4OH = [Ag(NH_3)_2]_2SO_4 + 4H_2O$$

Also, we can use a mixture $AgNO_3$ and NH_4OH (ammonium solution of argentum nitrate), which exist as a complex compound – $[Ag(NH_3)_4]OH$ (hydrogen is more active than ammonium cation):

$$AgNO_3 + 4NH_4OH = [Ag(NH_3)_4]OH + HNO_3 + 3H_2O$$