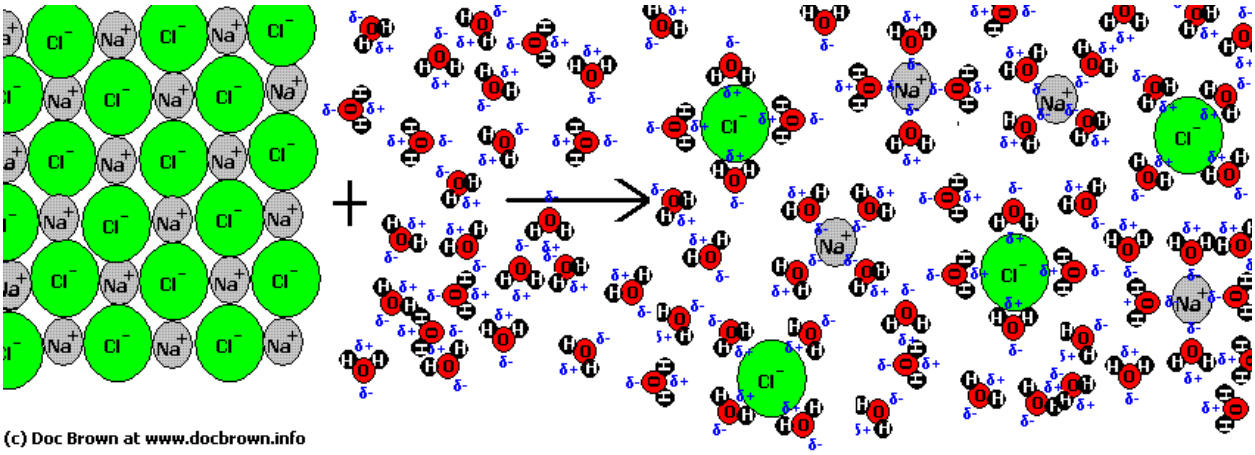
What role does water play in the reaction involved in procedure no. 1? In a dry watch glass, mix a pinch of each crystal lead (II) acetate [Pb(C2H302)2] and potassium chromate (K2CrO4). pour the mixture on a piece of light green colored paper. Try to separate the crystals by agitating the mixture. Has there been an reaction? Return the crystals into the watch glass, Add distilled water and stir. observe.

Solution

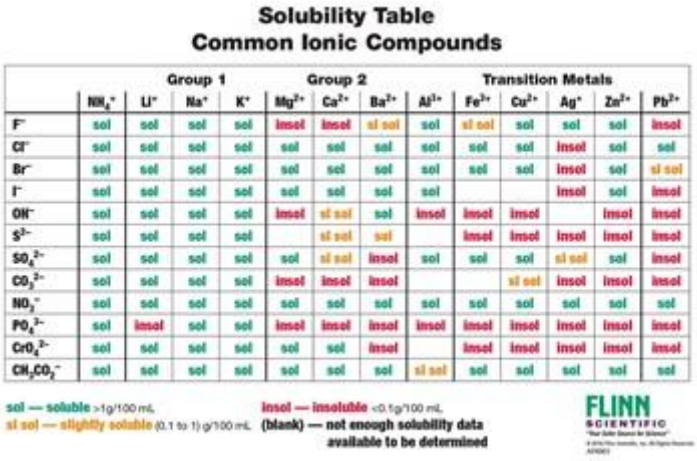
We have two ionic substances: $Pb(CH_3COO)_2$ and K_2CrO_4. The reaction between ionic substances takes place when we have free ions, that means, that the ionic structure of a substance (crystal) should be broken. There should be forces that broke our ionic crystal into free ions.

When we mix crystal lead (II) acetate $Pb(CH_3COO)_2$ and potassium chromate K_2CrO_4 (without water) no reaction takes place because we have no forces that break ionic crystal structures of these two salts. No free ions obtained. Therefore ions that are bounded in one ionic substance can not react with the ions in the other ionic substance to give new substances.

When we add distilled water to the mixture of salts the process of dissolution takes place. That means that the water molecules (which are polar molecules: have negatively and positively charged sides) come to the ionic crystal (that have positively and negatively charged ions) and break ionic bonds between ions of a substance. If the charge of an ion is negative water molecules turn to this ion with their positively charged side (for example : Pb^{2+}, K^+, Na^+). If the charge of an ion is positive water molecules turn to this ion with their negative charge side (for example: CH_3COO^-, CrO_4^{2-}, Cl^-). Then we get hydrated ions, which are free ions, that means they can react with each other to form a new substance.



This process takes place when the salts used are soluble in water (we should check up this in the solubility table).



Solubility Table
Common Ionic Compounds

	Group 1				Group 2				Transition Metals				
	NH_4^+	Li^+	Na^+	K^+	Mg^{2+}	Ca^{2+}	Ba^{2+}	Al^{3+}	Fe^{3+}	Cu^{2+}	Ag^+	Zn^{2+}	Pb^{2+}
F^-	sol	sol	sol	sol	insol	insol	sl sol	sol	sl sol	sol	sol	sol	insol
Cl^-	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	insol	sol	sol
Br^-	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	insol	sol	sl sol
I^-	sol	sol	sol	sol	sol	sol	sol	sol			insol	sol	insol
OH^-	sol	sol	sol	sol	insol	sl sol	sol	insol	insol	insol		insol	insol
S^{2-}	sol	sol	sol	sol		sl sol	sol		insol	insol	insol	insol	insol
SO_4^{2-}	sol	sol	sol	sol	sol	sl sol	insol	sol	sol	sol	sl sol	sol	insol
CO_3^{2-}	sol	sol	sol	sol	insol	insol	insol			sl sol	insol	insol	insol
NO_3^-	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol	sol
PO_4^{3-}	sol	insol	sol	sol	insol	insol	insol	insol	insol	insol	insol	insol	insol
CrO_4^{2-}	sol	sol	sol	sol	sol	sol	insol		insol	insol	insol	insol	insol
$CH_3CO_2^-$	sol	sol	sol	sol	sol	sol	sol	sl sol	sol	sol	sol	sol	sol

sol — soluble >1g/100 mL
sl sol — slightly soluble (0.1 to 1) g/100 mL
insol — insoluble <0.1g/100 mL
(blank) — not enough solubility data available to be determined

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We can see that $Pb(CH_3COO)_2$ and K_2CrO_4 are soluble in water. When in water these salts dissociate into ions, that are evenly spread in the volume of solvent (diffusion process).

$Pb(CH_3COO)_2 \rightarrow Pb^{2+} + 2CH_3COO^-$;

$K_2CrO_4 \rightarrow 2K^+ + CrO_4^{2-}$.

Ions Pb^{2+} and CrO_4^{2-} react with each other and give salt $PbCrO_4$ that is not soluble in water (table of solubility). Yellow crystals of $PbCrO_4$ precipitate.

$Pb(CH_3COO)_2$ (aq) $+K_2CrO_4$ (aq) $= 2CH_3COOK$(aq) + $PbCrO_4$ (s)

You can see this process on the video: https://www.youtube.com/watch?v=Jt0eGtHHV04

(on the video $Pb(NO_3)_2$ is used instead of $Pb(CH_3COO)_2$, but the observations are the same).

Answer: the role of water is: 1. to break ionic bounds in the ionic crystal to get free ions;

2. to provide the diffusion process (free ions are evenly spread in the volume of solvent).