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Answers to 2015 O level Science Chemistry 5076/5078 Paper 5

In the first question, students were given three solutions, X, Y and Z. It is given in the question that one of the salts contains two anions. Students were then asked to perform two tests to identify the anions present in the solutions, as follows:

	Solution X	Solution Y	Solution Z	Teacher's Comment
Add dil. HNO_3.	No visible change.	Effervescence is observed. Gas evolved formed a white ppt with limewater.	Effervescence is observed. Gas evolved formed a white ppt with limewater.	Students should be able to infer that the gas was CO_2 as carbonate is the only anion in the syllabus that produces effervescence when dilute acid is added to it.
Add barium nitrate solution.	White ppt formed.	White ppt formed.	No visible change.	SO_4^{2-} is present.

Since the gas evolved from **Y** and **Z** after the addition of dilute nitric acid formed a white ppt with limewater, the gas is carbon dioxide gas. Thus, the carbonate anion is present in solutions **Y** and **Z**.

A white ppt formed in **X** and **Y** upon addition of barium nitrate solution; it is barium sulphate. Thus, the sulphate anion is present in solutions **X** and **Y**.

Anion(s) present in

(i) **X**: SO_4^{2-}
(ii) **Y**: SO_4^{2-} and CO_3^{2-}
(iii) **Z**: CO_3^{2-}

In the second part, an unknown solution P was given. The tests performed with it is as follows:

Test	**Observation**	**Teacher's Comment**
Add dil. NaOH to P until no further change is seen.	A green ppt forms.	The green ppt formed is $Fe(OH)_2$, which confirms the presence of Fe^{2+} in P.
Add another 1 cm^3 of NaOH into P.	No visible change.	The addition of NaOH in this step is to ensure that there remains enough strong base in the solution to react with NH_4^+ and evolve NH_3 in the next step.
Heat the solution, taking care not to boil it, and record any observation.	Pungent and colourless gas evolved that turned damp red litmus blue.	Ammonia gas is evolved. Therefore, P also contains the ammonium cation (NH_4^+).
To 2 cm^3 of P, add 8 cm^3 of deionised water.	No visible change.	This step is just a dilution of solution P for the next part of the experiment.
To 2 cm^3 of the diluted P, add $KMnO_4$ solution dropwise until the solution turns a permanent pale pink. Label this solution Q.	The purple solution turns colouress as it enters solution P, before one drop changes P to a pale pink colour.	This is an oxidation of the Fe^{2+} in P to Fe^{3+} by $KMnO_4$, which is one of the two known strong oxidising agents in the syllabus.
Add dil. aqueous NH_3 to Q until no further change is seen.	A red-brown ppt forms.	The red-brown ppt formed is $Fe(OH)_3$, which confirms the presence of Fe^{3+} in P after the addition of $KMnO_4$.

Cation(s) present in

(i) **P**: Fe^{2+} and NH_4^+
(ii) **Q**: Fe^{3+}

Teacher's comment:

P was most probably ammonium iron (II) sulfate, or Mohr's Salt, which is a compound containing both the Fe^{2+} and NH_4^+ cations. Mohr's salt is resistant to oxidation by air to Fe^{3+}. Additionally, the instructions specifically state that solution P is to be heated gently (not to boil it). This is probably to prevent the evolution of sulfur dioxide gas, meaning that students were expected to evolve and test for ammonia gas instead.