Demonstrate understanding of aspects of chemical reactions Last minute Reminders – Part 2 of 2.

A lot of information is provided in the resource booklet; you no longer need to memorise colours.

Colours of selected ions and solids

Colourless ions	chloride, iodide, sulfate, hydroxide, carbonate, calcium, magnesium, zinc, lead, barium, silver
Blue ions	copper
Pale green ions	iron(II)
White solids	calcium sulfate, calcium hydroxide, calcium carbonate, magnesium hydroxide, magnesium carbonate, zinc carbonate, lead chloride, lead sulfate, lead carbonate, barium sulfate, barium hydroxide, barium carbonate, silver chloride
Green solid	iron(II) hydroxide, iron(II) carbonate
Blue solid	copper hydroxide
Yellow solid	lead iodide
Cream solid	silver iodide

All the 'solids' listed here are insoluble solids.

Solubility rules

nitrates	All **soluble**
chlorides	All **soluble** except silver chloride, lead chloride
iodides	All **soluble** except silver iodide, lead iodide
sulfates	All **soluble** except barium sulfate, lead sulfate, calcium sulfate
hydroxides	All **insoluble** except potassium hydroxide, sodium hydroxide
carbonates	All **insoluble** except potassium carbonate, sodium carbonate

Activity series

Ca Mg Al Zn Fe Pb (H) Cu Ag

<u>Interpreting Displacement reaction data to establish order of reactivity.</u>

Example: Metals can be put into a reactivity series based on the reactions between metals and solutions. The table below shows the results of putting metals A, B, and C into metal sulfate solutions.

Key: ✓= reaction × = no reaction

Solution	Metal A	Metal B	Metal C
Metal A sulfate		×	×
Metal B sulfate	✓		✓
Metal C sulfate	✓	×	

Analyse the results to determine the order of reactivity for the three metals A, B, and C.
Justify your answer by linking the results to your knowledge of displacement reactions.

A more reactive metal will displace a less reactive metal from a solution of its salt. Metal A is the most reactive as it displaces both Metal B and C from Metal B sulfate solution and Metal C sulfate solution.

- Metal A + Metal B Sulfate → Metal B + Metal A sulfate
- Metal A + Metal C Sulfate → Metal C + Metal A sulfate

Metal C is the next most reactive metal as it can displace Metal B from Metal B sulfate solution but since there is no reaction with Metal A sulfate solution, then metal B is less reactive than Metal A.
Metal B is clearly the least reactive metal of the three as it cannot displace any metals.

<u>Mislabelled / unlabeled solutions of ions.</u>

You will use the Solubility rules and the table of colours to come up with a method.

<u>Positive ions/cations</u>

A sample of water is required to be tested for the presence of calcium ions and silver ions. Explain how the sample of water could be tested to show whether or not it contains calcium ions, or silver ions, <u>or both</u>. In your answer, you should name any chemicals you would use.

Look at the solubility rules and find any compounds of calcium or silver that are insoluble. E.g. calcium sulfate is insoluble – and using the colours, calcium sulfate is a white solid. Silver chloride is insoluble – and is a white solid.

1. Take the water sample and add chloride ions e.g. sodium chloride solution. A white precipitate would confirm silver as silver chloride is insoluble, but calcium chloride is soluble so there would be no precipitate.
2. Take some more of the water sample and add sulfate ions e.g. dilute sulfuric acid. A white precipitate would confirm calcium as calcium sulfate is insoluble, but silver sulfate is soluble so there would be no precipitate.
   A positive result in 1 and 2 means the sample contains both calcium and silver ions.

Negative ions / anions

One of the solutions contains sulfate ions, one of them contains chloride ions, and one contains iodide ions. How could the solutions be tested to determine which solutions contain each of the three ions: sulfate, chloride, and iodide? In your answer, you should describe a method that could be carried out in a school laboratory, using barium nitrate and silver nitrate as test solutions

Colours of selected ions and solids

Colourless ions	chloride, iodide, sulfate, hydroxide, carbonate, calcium, magnesium, zinc, lead, barium, silver
Blue ions	copper
Pale green ions	iron(II)
White solids	calcium sulfate, calcium hydroxide, calcium carbonate, magnesium hydroxide, magnesium carbonate, zinc carbonate, lead chloride, lead sulfate, lead carbonate, barium sulfate, barium hydroxide, barium carbonate, silver chloride
Green solid	iron(II) hydroxide, iron(II) carbonate
Blue solid	copper hydroxide
Yellow solid	lead iodide
Cream solid	silver iodide

Solubility rules

nitrates	All **soluble**
chlorides	All **soluble** except silver chloride, lead chloride
iodides	All **soluble** except silver iodide, lead iodide
sulfates	All **soluble** except barium sulfate, lead sulfate, calcium sulfate
hydroxides	All **insoluble** except potassium hydroxide, sodium hydroxide
carbonates	All **insoluble** except potassium carbonate, sodium carbonate

1. Take the 3 unknown solutions; add barium nitrate to each. Check solubility of the new substances formed;
   - Sulfate + barium nitrate → barium sulfate + nitrate: Barium sulfate is insoluble "sulfates – all soluble except barium sulfate ...." Barium sulfate is a white solid. Observation would be "a white precipitate forms".
   - Chloride + barium nitrate → barium chloride + nitrate: Barium chloride is soluble "chlorides – all soluble except silver chloride, lead chloride ...." Observation would be "Colourless solution, NO precipitate forms".
   - Iodide + barium nitrate → barium iodide + nitrate: Barium iodide is soluble "iodides – all soluble except silver iodide, lead iodide ...." Observation would be "Colourless solution, NO precipitate forms".

   However this test has identified the **sulfate** ion.
2. Take the 2 solutions not yet identified; add silver nitrate to each.
   Chloride + silver nitrate → silver chloride + nitrate: Silver chloride is insoluble and white. Observation would be "white precipitate of silver chloride".
   Iodide + silver nitrate → silver iodide + nitrate: Silver iodide is insoluble and cream. Observation would be "cream precipitate of silver iodide".

Summary:
Add barium nitrate to all 3 unknowns; White precipitate confirms sulfate.
Add silver nitrate to remaining 2 solutions: White precipitate confirms chloride. Cream precipitate confirms iodide.

Problems involving more than one type of reaction type.

E.g. A solution is known to contain zinc ions OR lead ions. How could a piece of iron metal, and a solution of sodium chloride, each be used to decide the identity of the metal?

Activity series

Ca	Mg	Al	Zn	Fe	Pb	(H)	Cu	Ag

Add iron (Fe) to the solution containing zinc ions or lead ions. Since Fe is higher in the activity series than lead there will be a reaction. $Fe + Pb^{2+} \rightarrow Fe^{2+}$ and Pb. A coating of grey lead will form on the iron. BUT, since Fe is lower in the activity series than zinc, when Fe is placed in a solution containing Zn^{2+} ions, no reaction will occur. The solutions are already identified by this but adding sodium chloride to each will confirm their identity. Adding chloride to them will give a white precipitate with one – this is insoluble lead chloride, and a colourless solution with the other – this is because zinc chloride is soluble.

ALL of these questions can be answered using the information supplied in the resource booklet.