E4 SALTS AND THEIR SOLUTIONS

INTRODUCTION

The ions in a solid ionic salt are held in position by the strong attractive forces between the oppositely charged ions. When the salt is placed in water, the ions attract the polar water molecules. If this force of attraction is strong enough, and the ions become surrounded by enough water molecules, the force between the ions is so reduced that they split off and dissolve in the water. The solubility of a salt in water depends on how greatly the ions in the salt attract each other and how strongly they attract water molecules. Salts are usually more soluble in hot water as the heat adds energy, which can help to break the ionic bonds.

Only a certain mass of a particular salt will dissolve in a given volume of water at a specific temperature. This mass of salt will give a saturated solution and if more salt is added, it will not dissolve. When a hot, saturated solution is allowed to cool, the salt crystallises out. If a small crystal of the salt is suspended in the hot solution, the salt tends to crystallise on this "seed" crystal and a larger crystal forms.

LAB-WORK

Experiment 1: Preparation of a saturated solution and the recrystallisation of copper(II) sulfate–5-water.

(1.1) Tare a 100 mL beaker and then weigh into it 35 g of copper(II) sulfate crystals. Add 80 mL of tap water to the beaker and heat the resultant solution with stirring until all the solid has dissolved. Remove from the bunsen, filter while hot, and then allow to cool to about 30 ^{o}C.

To prepare a seed crystal, select a reasonably large copper(II) sulfate–5-water crystal and carefully tie the end of a piece of cotton thread (about 25 cm long) around it. The thread should be suspended from a copper wire so that when the wire rests across the top of the beaker, the crystal of copper(II) sulfate–5-water is suspended in the middle of the saturated solution. Suspend the crystal in the solution as indicated above. Label the beaker with your name, session, lab and work-space and set aside for a week in the safe place indicated so the crystal can grow.

Experiment 2: Testing the conductivity of copper(II) sulfate solution

After the crystal has been allowed to grow for a week, it should be removed, dried with a tissue or filter paper, and examined. Retain the saturated solution for use in Experiment 3.

How does it compare with the seed crystal?

Use the supplied probes to test some de-ionised water, the crystal and the remaining saturated solution for conduction. Record and explain your observations.

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Experiment 3: Determination of the solubility of copper(II) sulfate–5-water in water at room temperature.

(3.1) Label a clean, dry, 100 mL beaker with your name, session, lab and work-space. Place 2 anti-bumping crystals in the beaker and weigh it. Using a 100 mL measuring cylinder, measure out exactly 20 mL of the saturated copper(II) sulfate solution and carefully pour it into the beaker. Heat the beaker over a bunsen until **almost** all the water has evaporated. Turn off the bunsen, leave the beaker on the hot gauze, and allow the whole system to cool.

CAUTION: Do not evaporate to dryness as the water of crystallisation will be lost.

(3.2) Solubility determination of copper(II) sulfate
Weigh the beaker and crystals. Calculate the mass of copper(II) sulfate–5-water remaining. This is the mass of copper(II) sulfate–5-water present in 20 mL of a saturated solution of the salt. From this result, calculate the mass of copper(II) sulfate–5-water which is present in 1000 mL (1 litre) of a saturated solution of the salt at room temperature. Hence calculate the molar solubility (the number of moles of the salt that dissolve in 1 litre of solution).

Mass of labelled beaker + granules =	g
Mass of labelled beaker + granules + crystals after evaporation =	g
Mass of $CuSO_4 \cdot 5H_2O$ crystals weighed out =	g

Thus 20 mL of saturated solution contained ____ g of $CuSO_4 \cdot 5H_2O$ crystals.

Thus 100 mL of saturated solution contains ____ = ____ g of $CuSO_4 \cdot 5H_2O$.

And 1000 mL of saturated solution contains ____ = ____ g of $CuSO_4 \cdot 5H_2O$.

Solubility of copper(II) sulfate–5-water at room temperature = ____ g L^{-1}

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POST-WORK

Given the atomic weights: H = 1.01, O = 16.00, S = 32.07, Cu = 63.55,
calculate the molar weight of $CuSO_4 \cdot 5H_2O$.

Molar solubility of $CuSO_4 \cdot 5H_2O$ at room temperature = ____ = ____ mol L^{-1}

Is copper(II) sulfate–5-water more soluble in hot or cold water? Give a reason for your answer.

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