Hydrated copper sulfate, CuSO4.***x***H2O (***x*** represents an unknown amount of water), is blue, however, the anhydrous form (CuSO4) is white. A sample of hydrated copper sulfate was weighed and fully dehydrated by heating. The results of the experiment are shown below.

*Note: Two additional blank lines have been left in the table below for rough working out only. You may or may not wish to use these lines.*

*Table 3:* **Masses For Calculating the Water of Crystallisation in CuSO4.*x*H2O**

|  |  |
| --- | --- |
| **Item Measured** | **Mass (grams)** |
| *Crucible and lid* | 29.30 |
| *Crucible, lid and hydrated sample* | 39.49 |
| *Crucible, lid and sample after heating* | 35.87 |
| *Crucible, lid and sample after additional heating* | 35.85 |
|  |  |
|  |  |

1. Calculate the percentage by mass of water in the original hydrated sample.

 (3 marks)

1. Find the number of moles of water in the hydrated sample.

 (1 mark)

1. Calculate the value of ‘***x***’ in the hydrated sample and thus determine its empirical formula.

 (4 marks)

1. What was the purpose of providing additional heating to the final hydrated sample?

 (1 mark)

ANSWER

4. (a) mass of original CuSO4.xH2O(s) = mass (crucible, lid & hydrate) – mass (crucible & lid)

 mass of original CuSO4.xH2O(s) = 39.49g – 29.30g

 mass of original CuSO4.xH2O(s) = 10.19g [1]

 mass of water = mass (crucible, lid & hydrate) – mass (after further heating)

 mass of water = 39.49g – 35.85g

 mass of water = 3.64g [1]

 percentage of water by mass:

  x 100 = 3.57 x 101 % [1]

 (b) n(H2O) = 

 n(H2O) = 

 n(H2O) = 2.02 x 10-1 mol [1]

 (c) mass (CuSO4) = mass hydrated CuSO4 – mass H2O

 mass (CuSO4) = 10.19g – 3.64g

 mass (CuSO4) = 6.55g [1]

 n(CuSO4) = 

 n(CuSO4) = 

 n(CuSO4) = 4.10 x 10-2 mol [1]

 Find ratio of n(H2O):n(CuSO4)

* 1. x 10-1 : 4.10 x 10-2
1. : 4.9 (5)

 Empirical formula of hydrate: CuSO4.5H2O [2]

 (d) The purpose of heating the hydrated sample, weighing and then heating further is to ensure that all water has been detached from the ionic lattice so that the mass of pure CuSO4(s) can be determined. Heating and weighing can continue until consistent masses are obtained. [1]