Solution

AP Chemistry Review Challenge

Name _____ Period _____

A student is assigned the task of determining the mass percent of silver in an alloy of copper and silver by dissolving a sample of the alloy in excess nitric acid and then precipitating the silver as AgCl.

First the student prepares 50. ml of 6 M HNO_3. 24

1. The student is provided with a stock solution of 16 M HNO_3, two 100 ml graduated cylinders that can be read to ±1 ml, a 100 ml beaker that can be read to ±10 ml, safety goggles, rubber gloves, a glass stirring rod, a dropper, and distilled water.

   a. Calculate the volume, in ml, of 16 M HNO_3 that the student should use to for preparing 50. ml of 6 M HNO_3.

   $M_1V_1 = M_2V_2$

   +4 $V_1 = \frac{M_2V_2}{M_1} = \frac{6M \cdot 50.mL}{16M} \approx 20 mL$

   b. Briefly list the steps of an appropriate and safe procedure for preparing the 50. ml of 6 M HNO_3. Only materials selected from those provided to the student (listed above) may be used.

   - goggles / Gloves
   - add water to 100ml grad cylinder (~50ml)
   - add ~20ml HNO_3 to water
   - dilute to 100ml w/ water
   - stir w/ glass stir rod

   +4

   c. Explain why it is <u>not</u> necessary to use a volumetric flask (calibrated to 50.00 ml ±0.05 ml) to perform the dilution.

   The 6M HNO_3 is an <u>excess</u> reagent and will not be used <u>quantitatively</u>.

   +2

   d. During the preparation of the solution, the student accidentally spills about 1 ml of 16 M HNO_3 on the bench top. The student finds three bottles containing liquids sitting near the spill: a bottle of distilled water, a bottle of 5 percent $NaHCO_3$(aq), and a bottle of saturated NaCl(aq). Which of the liquids is best to use in cleaning up the spill? Justify your answer.

   +2 5% $NaHCO_3$ would be the best solution because $NaHCO_3$ is a base and will neutralize the acid.

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Then the student pours 25 ml of the 6 M HNO_3 into a beaker and adds a 0.6489 g sample of the alloy. After the sample completely reacts with the acid, some saturated NaCl(aq) is added to the beaker, resulting in the formation of an AgCl precipitate. Additional NaCl(aq) is added until no more precipitate is observed to form. The precipitate is filtered, washed, dried, and weighed to constant mass in a filter crucible. The data are shown in the table below.

Mass of sample of copper-silver alloy	0.6489 g
Mass of dry filter crucible	28.7210 g
Mass of filter crucible and precipitate (first weighing)	29.3587 g
Mass of filter crucible and precipitate (second weighing)	29.2599 g
Mass of filter crucible and precipitate (third weighing)	29.2598 g

2. Calculate the number of moles of AgCl precipitate collected.

Mass AgCl = (mass of filter crucible + precipitate) − (mass of dry crucible)

+3 = 29.2598 g − 28.7210 g = 0.5388 g AgCl

$$0.5388\ g\ AgCl \left(\frac{1\ mol\ AgCl}{143.4\ g\ AgCl}\right) = 3.757 \times 10^{-3}\ mol\ AgCl$$

+3

3. Calculate the mass percent of silver in the alloy of copper and silver.

$$3.757 \times 10^{-3}\ mol\ AgCl \left(\frac{1\ mol\ Ag}{1\ mol\ AgCl}\right)\left(\frac{107.9\ g\ Ag}{1\ mol\ Ag}\right) = 0.4054\ g\ Ag$$

+3

$$\%\ Ag = \left(\frac{0.4054\ g\ Ag}{0.6489\ g\ alloy}\right) \times 100 = 62.47\%$$

+3

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