Transcript: “A conservator’s guide to preparing solutions”

Video length: 6:29 minutes

[Music plays throughout the video.]

Gyllian Porteous, Archaeological Conservation Fellow, 2017-2018: “Oh, hey there!

I'm actually just getting ready to make some solutions, for a conservation treatment.

Come along as I demonstrate the proper technique for preparing precise solutions for use in conservation.

As conservators, we don’t always need the most exact concentration of solutions for our purposes, but there are instances where accurate and precise solutions are necessary, like when preparing a set of standards, experimenting with different concentrations of a chemical, or publishing a treatment method.

In this video, I’ll be demonstrating the proper technique for preparing precise solutions for use in conservation.

Unlike in chemistry where concentrations are expressed in molarity, in conservation we typically use percentages to denote concentration.

Like, weight-by-weight, weight-by-volume, or volume-by-volume.

In a solution, there are two components: the solute and the solvent.

The solute is the chemical being dissolved or diluted.

The solvent is the liquid doing the dissolving or diluting.

There may be more than one solute or more than one solvent in any given solution.

In order to calculate concentration percentage, the weight or volume of the solute is divided by the total weight or volume of the final solution.

It's essential to note how you're measuring the concentration of your solutions, because each preparation will give different results.

For example, water has a density of 1.00 g/mL, meaning that weight-by-weight and weight-by-volume aqueous solutions are roughly equivalent.

Acetone, however, has a density of 0.79 g/mL, which means that a 10% weight-by-volume solution of Paraloid B72 in acetone will contain more adhesive and will be more viscous than a 10% weight-by-weight solution.

Before making a solution, consider the degree of precision and accuracy required.

Precision is how reproducible the concentrations are, whereas accuracy is how close the concentration is to the desired final value.

Proper equipment is essential for preparing accurate and precise solutions.

When it comes to weight measurements, analytical balances, like the one here, are more precise than top-loading balances.

This analytical balance can measure to 0.1 milligrams, whereas this top-loading balance can be used to measure to 10 milligrams.

An analytical balance is best for situations requiring a high degree of accuracy and precision, for example, when you're creating standards for desalination measurements.

It's also important to select the proper glassware.

Beakers, graduated cylinders, graduated pipettes, volumetric flasks, and volumetric pipettes are all examples of common glassware found in conservation labs.

As a general rule, volumetric glassware is the most precise for measuring volumes of liquids, whereas beakers are the least precise.

Glassware will sometimes have volumetric tolerances written on the sides.

This beaker for example, measures a volume between 25 to 200 mL plus or minus 5% of the volume measured meaning that if I fill the beaker to the 100mL mark, the volume will actually be somewhere between 95 and 105 mL.

This volumetric flask however, measures 25 mL plus or minus .03 mL, so it's more precise.

When measuring a volume, ensure that the bottom of the meniscus is touching the line marked on the glassware.

The meniscus is the curved surface of the solvent shown here.

Bring the line on the glassware level with your eye to be properly read.

Now let's get into the procedure for making solutions.

I want to make a 100 mL solution of 5.00 % weight-by-volume ammonium citrate dibasic in water.

I would like my methods to be accurate and reproducible so that other conservators will be able to recreate my concentration.

To do this, I will use the analytical balance and a volumetric flask.

First, I partially fill my flask with distilled water – the solvent.

Next, I make sure my analytical balance is level.

I place my weighing dish on the balance, close the glass doors, and set the balance to zero.

I weigh out 5.00 grams of ammonium citrate dibasic, the solute, into my weigh dish, and again close the doors to check the final reading on the balance.

I then transfer the ammonium citrate dibasic to the volumetric flask using a clean funnel.

Next, I rinse the weigh dish with distilled water into the funnel and then rinse the funnel with distilled water into the flask.

This technique is called a quantitative transfer, which is used to ensure that all of the solute ends up in the flask.

I cap my flask and swirl the solvent around to dissolve the ammonium citrate dibasic.

Finally, once it’s all dissolved, I add more water, bringing the bottom of the meniscus level with the fill line on the 100 mL flask.

This procedure can be adapted to make weight-by-weight and volume-by-volume percent solutions.

The same rules apply: partially fill the container with the solvent, add the measured solute and dissolve it, and then add more solvent to obtain the final desired volume or weight.

Simply measuring the solute and the solvent separately and mixing them will not give the correct concentration.

Here’s why this is problematic: I have measured 10 mL of PEG 400 (polyethylene glycol 400) into a volumetric flask using a 10 mL volumetric pipette.

After 90 mL of water is transferred into the flask using a 100 mL graduated cylinder, you can see that I don’t have a solution of 100 mL.

While this results in a small difference in concentration that may not always be significant, it's a good practice to follow the correct procedure in order to reduce the risk of error when exact concentration is needed.

Well, that's it from me.

I hope that this has been informative and that you'll use these techniques in your practice.

Thank you all for listening!

Oh, and one last thing, don't forget to label your containers!"

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