Solutions Preparation

- A solution that has a known, accurate concentration is a **standard** solution.

- Good quality **glassware** and **procedures** are needed to prepare a standard solution

- There are 2 ways to create a standard solution

  - By dissolving a solid
  - By diluting a more concentrated solution

Preparing a standard solution from a solid

Step 1: Calculate what mass of solid is needed to make the required volume and concentration of solution

$c = \frac{n}{v}$ $n = \frac{m}{M}$

① n = cv ② m = nM

Step 2: Measure out the mass of solid using an electronic scale

Step 3: Dissolve the solid in half of the required volume of water

Step 4: Transfer dissolved solid into a volumetric flask (make sure the volumetric flask is the size needed)

Step 5: Fill the volumetric flask to the marking for the volume of the solution needed

Step 6: Place top on volumetric flask and invert to mix.

Example

What are the steps for preparing 100 mL of a 0.750 mol/L sodium hydroxide solution?

1. $n = cv$
$= (0.750 mol/L)(0.100 L)$
$= 0.0750 mol$

$m = n \cdot M$
$= (0.0750 mol)(40.00 g/mol)$
$= 3.00 g$

2. Measure out 3.00 g of NaOH
3. Dissolve NaOH in 50 mL of H_2O
4. Transfer solution into a 100 mL volumetric flask.
5. Fill volumetric flask to the 100 mL line
6. Invert flask to mix.

1. To test the hardness of water (Figure 3), an industrial chemist performs an analysis using 100.0 mL of a 0.250 mol/L standard solution of ammonium oxalate. What mass of ammonium oxalate, (NH4)2C2O4(s), is needed to make the standard solution?

$n = cv$
$= (0.250\ mol/L)(0.1000\ L)$
$= 0.0250\ mol$

$m = nM$
$= (0.0250\ mol)(124.12\ g/mol)$
$= 3.103\ g$
$= 3.10\ g$

2. Calculate the mass of solid lye (sodium hydroxide) (Figure 4) needed to make 500 mL of a 10.0 mol/L strong cleaning solution.

NaOH

$n = cv$
$= (10.0\ mol/L)(0.500\ L)$
$= 5.00\ mol$

$m = nM$
$= (5.00\ mol)(40.00\ g/mol)$
$= 200\ g$

3. List several examples of solutions that you prepared from solids in the last week.

4. You have been asked to prepare 2.00 L of a 0.100 mol/L aqueous solution of cobalt (II) chloride for an experiment. What mass of $CoCl_2$ will you use? Write out the steps necessary to produce the solution of cobalt (II) chloride.

$n = cv$
$n = (0.100\ mol/L)(2.00\ L)$
$= 0.200\ mol$

$m = nM$
$= (0.200\ mol)(129.83\ g/mol)$
$= 25.966\ g$
$= 26.0\ g$

5. A technician prepares 500.0 mL of a 0.0750 mol/L solution of potassium permanganate as part of a quality-control analysis in the manufacture of hydrogen peroxide. Calculate the mass of potassium permanganate required to prepare the solution.

$KMnO_4$

$5.93\ g$

Preparing a standard solution by dilution

- A stock solution is an initial, usually concentrated, solution from which samples are taken for a dilution.

- We can prepare solutions by diluting an existing solution to a desired concentration.

Formula: $C_1V_1 = C_2V_2$

C_1 = initial concentration C_2 = final concentration
V_1 = initial volume V_2 = final volume

To make a standard solution using dilution follow the following steps.

Step 1: Calculate the volume of the stock solution needed to make the solution.
$C_1V_1 = C_2V_2$

Step 2: Measure the volume of the stock solution using a pipette

Step 3: Add the volume of stock solution to the appropriate sized volumetric flask

Step 4: Fill volumetric flask to line

Step 5: Put on cap and invert to mix

Example:
What are the steps to make 250mL of 1.0 mol/L hydrochloric acid from a concentrated (12 mol/L) solution of hydrochloric acid?

1. $C_1V_1 = C_2V_2$

$(12\ mol/L)\ V_1 = (1.0\ mol/L)(250\ mL)$

$V_1 = \dfrac{(1.0\ \cancel{mol/L})(250\ mL)}{12\ \cancel{mol/L}}$

$= 20.83\ldots = \boxed{21\ mL}$

2. Pipette 21mL of HCl into 250mL volumetric flask
3. Fill volumetric flask to line
4. Invert to mix

1. 12 mL of concentrated $NH_{3(aq)}$ (14 mol/L) is diluted to make 250mL of solution for cleaning windows. What is the concentration of th solution made?

$C_1V_1 = C_2V_2$

$(14\ mol/L)(12mL) = C_2(250mL)$

$C_2 = 0.672\ mol/L = \boxed{0.67\ mol/L}$

2. Radiator antifreeze (ethylene glycol) is diluted with an appropriate quantity of water to prevent freezing of the mixture in the radiator. A 4.00 L container of 94% V/V antifreeze is diluted to 9.00 L. Calculate the concentration of the final solution.

$C_1V_1 = C_2V_2$

$(94\%\ v/v)(4.00L) = C_2(9.00L)$

$\boxed{C_2 = 42\%\ v/v}$

3. Many solutions are prepared in the laboratory from purchased concentrated solutions. Calculate the volume of concentrated 17.8 mol/L stock solution of sulphuric acid a laboratory technician would need to make 2.00 L of 0.200 mol/L solution by dilution of the original concentrated solution.

$(17.8\ mol/L)V_1 = (0.200\ mol/L)(2.00L)$

$V_1 = 0.02247...L$

$= \boxed{22.5mL}$ or $\boxed{0.0225L}$

4. In a study of reaction rates, you need to dilute the copper(II) sulfate solution prepared in Investigation 5.3. You take 5.00 mL of 0.005000 mol/L $CuSO_4(aq)$ and dilute it to a final volume of 100.0 mL.
(a) Determine the final concentration of the dilute solution.
(b) What mass of $CuSO_4(s)$ is present in 10.0 mL of the final dilute solution?
(c) Can this final dilute solution be prepared directly using the pure solid? Defend your answer

a) $(5.00mL)(0.005mol/L) = C_2(100.0mL)$

$\boxed{C_2 = 0.000250\ mol/L}$

b) $n = cv = (0.00025)(0.010L) = 2.5\times10^{-6}\ mol$

$m = nM = (2.5\times10^{-6}\ mol)(159.62\ g/mol)$

$= \boxed{3.99\times10^{-4}\ g}$ $0.000399\ g$

1. (a) Briefly describe two different ways of making a soluon.

(b) When should you use each method?

2. In an analysis for sulfate ions in a water treatment plant, a technician needs 100 mL of 0.125 mol/L barium nitrate soluon. What mass of pure barium nitrate is required?

3.27g

3. A 1.00 L bole of purchased acec acid is labelled with a concentraon of 17.4 mol/L. A technician dilutes this enre bole of concentrated acid to prepare a 0.400 mol/L soluon. Calculate the volume of diluted soluon prepared.

43.5L

4. A 10.00 mL sample of a test soluon is diluted in a laboratory to a final volume of 250.0 mL. The concentraon of the diluted soluon is 0.274 g/L. Determine the concentraon of the original test soluon.

0.0110 g/L