Analysis of an Alloy

***Percentage of Copper in Brass***

Alloys are homogeneous mixtures of two or more elements which exhibit metallic properties. The elements which compose an alloy are typically metals, although some common alloys such as carbide steel (iron and carbon) contain non-metallic elements. In this lab, we will use spectrophotometry to determine the percentage of copper in a sample of brass.

Spectrophotometry is an analytical technique which involved measuring the amount of light of a selected wavelength which is absorbed (or transmitted) by a solution of the sample being analyzed. Since each substance (element or compound) absorbs a particular wavelength (color) of light better than others, we can target our analysis to focus on that particular wavelength for the substance being analyzed.

In this lab, we will analyze a solution made by dissolving brass in nitric acid, first to determine which wavelength of light the solution absorbs best (known as **max**), then to determine the concentration of copper ions in the brass solution. To accomplish the former, we will create a ***spectral curve*** which is a graph of absorbance vs. wavelength. The peak in this graph will indicate (max) for the copper ions in the brass solution. To accomplish the latter, we will measure the absorbance at max for several solutions with known concentrations of copper ions and compare the absorbance of the brass solution to the values for these known solutions. To quantify this comparison, we will apply the ***Beer-Lambert Law***, which states that the absorbance of a substance at max is in direct proportion to the concentration of the substance in the sample. This relationship is represented in the equation;

absorbance = k•concentration

where k is a proportionality constant known as the calibration constant, which is characteristic of a specific substance. The value for k can be established using a single calibration point, but is generally considered more reliable when obtained from a calibration “curve” constructed using several points. Once we create this calibration curve and use it to determine the concentration of copper ions in the brass solution, we can use this information to find the percentage of copper in the original brass sample.

**Objectives:**

In this experiment, you will;

* Use spectrophotometry to generate a spectral curve for a solution of dissolved brass,
* Inspect the spectral curve to determine the max value for copper ions in the brass solution,
* Generate a calibration curve of the absorbances of several known solutions of copper ions at max,
* Measure the absorbance of the brass solution at max
* Apply the Beer-Lambert Law to calculate the concentration of copper ions in the brass solution,
* Use this information to estimate the percentage of copper in the original brass sample.

**Procedure:**

**Part A – Establishing the Spectral Curve**

1. Calibrate your spectrophotometer according to the instructions on the card which accompanies the instrument.
2. Measure the absorbance values for the brass solution at a variety of wavelengths, starting at 400nm and continuing at 25nm intervals up to 700nm. Enter these values into an Excel file or other graphing tool.
3. Find the wavelengths of the two highest absorbance values in step 2 and measure at 5 nm intervals between these two wavelengths. (These can be added to the end of your list, or inserted in wavelength order.)
4. Graph a spectral curve (x = wavelength, y = absorbance). The curve SHOULD have ONE PEAK at max.

**Part B – Generating a Calibration Curve**

1. Your instructor may provide a series of copper solutions of known concentration or you may need to mix them.
2. Calibrate the spectrophotometer at max and measure the absorbance of each copper solution and that of the brass solution.
3. Using a graphing utility such as Excel or a graphics calculator, create a calibration “curve” by plotting the concentration, absorbance coordinate pairs.
4. Using the graphing utility, calculate the line of best fit for the calibration curve.

**Data Tables:** This experiment was performed on \_\_\_\_\_\_\_\_\_\_\_\_\_(date) using a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ spectrophotometer.

|  |  |
| --- | --- |
| Wavelength (nm) | Absorbance |
| 400 |  |
| 425 |  |
| 450 |  |
| 475 |  |
| 500 |  |
| 525 |  |
| 550 |  |
| 575 |  |
| 600 |  |
| 625 | Equation for the calibration curve:  Correlation coefficient (R2): |
| 650 |  |
| 675 |  |
| 700 |  |
|  |  |
|  |  |
|  |  |
|  |  |

|  |  |
| --- | --- |
| Concentration (mol/L) | Absorbance |
| 0.1 |  |
| 0.2 |  |
| 0.3 |  |
| 0.4 |  |
| 0.5 |  |
| Brass (conc. Unknown) |  |

**Analysis:**

1. Use the equation for the line of best fit to calculate the concentration of copper ions in the brass solution.
2. Your instructor will provide the concentration of brass in the brass solution. Using this and the above information, calculate the percentage of copper in the brass sample.

**Questions:**

1. What is a spectral curve? Describe 3 conclusions you can draw about any sample by looking at its spectral curve.
2. Explain the relationship between colors of light which are best absorbed by a sample and the colors we perceive when we look at that sample.
3. Describe the relationship between concentration and absorbance.
4. Comment on the linearity of your calibration curve. What factors might explain any inconsistencies?
5. Using common sense and a non-mathematical approach, state what the y-intercept of your calibration curve SHOULD be and WHY. If the y-intercept of your graph is NOT what it SHOULD be, offer a few possible reasons why it isn’t.
6. In your report, include a schematic diagram of the inner workings of a spectrophotometer. At a minimum, your diagram should include a light source, a diffraction grating (or prism), a slit, a shutter, a sample compartment (with a cuvette and sample in it), a photomultiplier tube and a display (analog or digital).