The Essentials of Preparing Projects at High School Level Explained with a Project

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Abstract

Dysprosium, which is the 66th element in the periodic table, is an element found on the outer surface of the disks in a HDD (Hard disk drive.) HDDs are found in almost every electronic device we use today, and in time these devices become old, and thrown away. Through some steps, this dysprosium can be recycled and used again in industry. By shredding a disk into smaller pieces and putting them into hydrochloric acid (HCl) and sulfuric acid (H_2SO_4) solutions, each with different molarities, we were able to identify which solution with a specific molarity was able to unravel most dysprosium. UV Light Spectrophotometer was used in order to specify Dy^{+3} ions. The amount of Dy^{+3} ions, which refers to recycled dysprosium, was greatest in 2M HCl solutions. Taking all these facts into consideration, instead of throwing HDDs away, recyclable parts can be regained, such as dysprosium, and can be reused in other industrial areas. Dysprosium is also used in wind turbines which means dysprosium is used in clean energy industry. Since the demand towards the clean energy is increasing day by day, dysprosium's importance is also increasing.

The document here is an altered version of the original experiment report; all values and calculations are the same as they are in the original report. Some additions were made in order to accommodate with the focus of the conference: Education. Additionally, some of the information that was unnecessary due to being academically complex or irrelevant was removed without affecting the integrity of the report here.

1. Introduction

The value of education increases everyday, and since companies increase both their requirements and expectations from their employees, a detailed and auspicious education is the key to success. During high school, which is one of the most important stages of education since the fundamentals of subjects that are taught more deeply at university level are being taught then, it is essential for students to engage in different projects. As two high school students from Istanbul, Turkey, we engaged in such a project and prepared it by using the information taught in the high school chemistry curriculum. The project focuses on recycling dysprosium while explaining how high school students can engage to such projects; what should be kept in mind while choosing a project topic, what are the significant parts etc.

2. Identifying the Goal of the Project

Initially, the first thing that should be kept in mind while preparing to do a project in high school level is choosing the topic. Which problem are you going to solve, and which subjects are you going to utilize in this project to solve that problem. Will you use mathematics, chemistry, or biology etc.? Lets take a look at the following statement:

“The humanity is using the resources on earth to satisfy its needs. However, it is a known fact that these resources are limited, and at some point they will deplete, so alternative ways should be found, like recycling these resources so that they withstand more.”

The statement above is the one that is used in our project. It is addressing what is being focused as a problem, which is recovering an expensive element so that it will be reused in industry. The statement also gives us the idea that there is a problem that needs to be solved.

3. Question / Proposal

Once the aim of the project is identified, it is time to brainstorm and find what is to be done towards your goal. In this project, we chose to do something about recycling. After hours of brainstorm and research, we came up with the idea that we should focus on electronic devices, since they basically take role in every part of our daily life. Then, we agreed on doing something about everyday devices like smartphones and computers. Check the example that we used in our original report below:

"Today, just like our need of resources and education, we are in need of many technological devices, including but not limited to smartphones and computers of various types. In these devices, there is a part called "Hard Disk Drive" (HDD) which is responsible for storing data. An element called Dysprosium is being used while manufacturing HDDs, and because of its high susceptibility of magnetization, it is a vital part in the manufacturing process.
Dysprosium is a metallic element, which has the symbol Dy. It is one of the Rare Earth Elements, in the Lanthanide Series of the periodic table. The compounds of dysprosium are found in gadolinite, xenotime, euxenite, and fergusonite in Norway, the U.S., Brazil, India, and Australia. Its salts are either yellow or yellow-green in color, the most common being a chloride, $DyCl_3$; a nitrate, $Dy(No_3)_3 \bullet 5H_2O$; and a sulfate, $Dy_2(SO_4)_3 \bullet 8H_2O$. The salts of dysprosium have an extremely high magnetic susceptibility. [1]
With the usage of acids, it is possible to extract the dysprosium on the disks of HDDs."
As you can see, we narrowed the topic as much as we can so that it became clear what we are doing. Starting from the idea of recycling, we ended up with a bunch of chemical formulas that include an element called Dysprosium, which is what our experiment is based on.

4. Method / Testing

4.1 The Report & Calculations Part of the Original Report

We aimed to solve molecules that contain dysprosium in acids. In order to do that, we prepared solutions in different molarities. We determined the acid solution that solves the most dysprosium by comparing ratios of absorbance of dysprosium. UV Spectrophotometer was used in order to obtain ratios of absorbance.

Reaction of dysprosium with acids

Dysprosium metal dissolves readily in dilute sulphuric acid to form solutions containing the yellow aquatic Dy(III) ion together with hydrogen gas, H2.

$2Dy(k) + 3H_2SO_4(aq) \rightarrow 2Dy^{3+}(aq) + 3SO42\text{-}(aq) + 3H2(g)$ [2]
$Dy_2O_3 + 6\ HCl \rightarrow 2\ DyCl_3 + 3\ H_2O$ [2]

For the net analysis of absorption values, standard dysprosium sample from Sigma Aldrich Company was used.
%37 by mass HCl and %95-97 by mass H_2SO_4 acids were used to prepare 0.01, 0.1, 0.5, 1 and 2 M solutions for each acid. First of all, %37 by mass and %95-97 by mass units were converted. The following calculations were made in order to achieve the correct and accurate results.

4.2 Calculations

M=10*d* %c / Mw where;
M= molarity
d = density
c = by mass percentage
Mw = Molecular Weight
(d_{HCl}: 1.19 g/ml) %37 by mass (Mw_{HCl} = 36.5 g/mole)
M_{HCl} = 10*1.19*37/36.5 = 12 M
(d_{H2SO4} : 1.84 g/ml)%96 by mass (Mw_{H2SO4} = 98 g/mole)
M_{H2SO4} = 10*1.84*96/98 = 18 M

After converting by mass unit into molarity, acid solutions in 0.01, 0.1, 0.5 , 1 and 2 molarities were prepared. For instance, method of preparing a 0.01 M HCl solution is shown below:

$M_i * V_i = M_f * V_f$ where
M_i = Initial Molarity of solution, V_i = Initial Volume of solution
M_f = Final Molarity of solution, Vf = Final Volume of solution

M_i = 12 M	$M_iV_i = M_fV_f$	
V_i = x	$12*V_i = 0.01*100$	
M_f = 0.01 M	V_i = 0.08 mL	V_f = 100 mL

4.3 The Importance of the Method & Testing Part in Terms of Academic Value

Since we are high school students, there is a limit for the amount of detail that we can have in the project. However, pushing the limits is the required act for success.

The whole calculations in the previous section are included in the Turkish Chemistry Curriculum, however UV spectrometer is not. On the contrary, it is an advanced machine that is used by laboratories and universities. Additionally, it is an expensive machine which most of the schools cannot afford.
By contacting a laboratory near to our high school, we got permission to use their UV spectrometer. This gave us the opportunity to include a detail that wouldn't expect from us.

5. Conclusion

Taking all these facts into consideration, the preparation of a project is not as simple as it might look. All the projects done during the high school years prepare students for greater challenger that they will face during the university. Considering this fact, if these projects are prepared with greater care and eager, students will benefit both during high school and in university. Gaining as much experience as you can during high school years will have significant bonuses in your university life. When preparing a project, it is best if some extra information is added. Adding diverse information to your project is a great way to leave an impression on whoever is evaluating it.

References

[1] "Lanthanide Series." *Funk & Wagnalls New World Encyclopedia* (2014): 1p. 1. *Funk & Wagnalls New World Encyclopedia*. Web. 10 Apr. 2015.
[2] http://www.webelements.com/dysprosium/chemistry.html