

# Kit Grant Application

## APPLICANT'S ORGANIZATION

Organization A

## ORGANIZATION'S WEBSITE

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## ORGANIZATION'S ADDRESS

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## PROJECT LEADER'S NAME

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## PROJECT TITLE

Hard materials demonstrations for Organization A field trip and future visits

## PROJECT SUMMARY

This project is executed by the Organization A outreach team and entails a three-day field trip at Example University in May 2022. During this field trip, up to 120 students from three middle and high schools will visit to perform three experiments related to materials science and chemical engineering, polymer chemistry, and biomedical engineering. Students will also be given three lab tours in research groups related to the experiments. The overall aim of this project is to correct the underrepresentation of Black and Hispanic students in the STEM workforce. This is achieved by exciting students from schools with high minority enrollment about STEM fields through science demonstrations. Organizing lab tours related to these experiments and building strong academic and personal relationships with these students during these activities is expected to help motivate them in pursuing careers in STEM. We especially want to encourage students to learn more about the hard materials science field and show them the feasibility of career paths in sectors such as aerospace. Probing students' interest and retention of science concepts through surveys will help us understand the magnitude of our impact.

Black and Hispanic workers are currently underrepresented in STEM fields. Hence, there is a need to further introduce, excite, and encourage students from high minority enrollment schools to pursue a career in STEM. The Organization A team aims to achieve this by performing interactive demonstrations that focus on the scientific method. Demonstrations in the materials science and chemical engineering field that focus on hard materials are however lacking and outside of our budget. These Materials Science Classroom Kits would allow us to introduce the students to hard materials demonstrations during the field trip and Example City school visits in the next few years.

## ANTICIPATED START DATE

05/18/2022

## ANTICIPATED END DATE

05/20/2022

## TARGET AUDIENCE

9th grade students from Example STEM Academy, 7th and 8th grade students from Example Middle School, and 8th grade students from Example B Middle School. These schools have high minority enrollment which is our ideal target audience.

## APPROXIMATE NUMBER OF PEOPLE SERVED BY THIS PROJECT

120

## GEOGRAPHIC AREA TO BE SERVED BY THIS PROJECT

Example Area and/or Example City

**HOW MANY MATERIALS SCIENCE CLASSROOM KITS ARE YOU REQUESTING? (0 TO 10)**

6

**HOW MANY MINI KITS ARE YOU REQUESTING? (0 TO 50)**

0

**WHAT IS THE TOTAL AMOUNT OF SUPPLEMENTAL FUNDING YOU ARE REQUESTING? (UP TO \$600)**

We are requesting the minimum recommended funding of \$300 for 6 Materials Science Classroom Kits for our project.

**BRIEFLY DESCRIBE HOW YOU WILL USE THE SUPPLEMENTAL FUNDING.**

The supplemental funding would be used to get supplies and materials needed to run the experiments, like safety glasses, propane cylinders, hotplates, thermometers, and some supplies to extend the lessons like DIY greeting card kits that would work well with the "Piezoelectric materials" demonstration.

We also receive funding from our Departments of Chemical Engineering and Materials Science and Biomedical Engineering, our Materials Research Science and Engineering Center, and our Center for Sustainable Polymers, but that funding limits us to a few dollars per student per visit. Our demonstrations also often require donations from our members and their respective research labs to make them successful, such as reagents, PPE, and lab supplies. Budgeted items below would allow us to use each experimental kit and provide long-lasting equipment to aid future visits.

Experiment	Item	Price per	Quantity	Total
All	Safety glasses (48 pack)	\$47	1	\$47
Thermal Shock	Matches	\$1	4	\$4
Thermal Shock	Propane Cylinder	\$5	6	\$30
Hot or not	Thermometer	\$11	3	\$33
Memory Shape Alloys	Pliers	\$4	3	\$12
Candy Fiber Pull	Hotplate	\$17	2	\$34
Candy Fiber Pull	Jolly Ranchers	\$10	1	\$10
Candy Fiber Pull	Wooden stirrer	\$9	1	\$9
Piezoelectric Materials	Multimeter	\$15	2	\$30
Piezoelectric Materials	DIY Greeting Card Kit	\$10	3	\$30
Glass bead on a wire	Borax	\$5	1	\$5
Glass bead on a wire	Watch Glass 10 pack	\$12	1	\$12
Thermal Processing	Rulers	\$12	1	\$12
Thermal Processing	Plastic Cups	\$8	1	\$8
Thermal Processing	Pennies	\$0.01	1,000	\$10
How strong is chocolate?	Aluminum foil	\$3	1	\$3
How strong is chocolate?	Chocolate bars	\$11	1	\$11
Grand Total				\$300

**STATEMENT OF NEED**

Black and Hispanic workers continue to be underrepresented in STEM fields and careers as reported by Richard Fry, Brian Kennedy, and Cary Funk.[1] Their report showed that Black and Hispanic people only make up 9% and 8% of the STEM workforce compared to the 11% and 17% of the overall workforce that they comprise, respectively. The Black community is particularly underrepresented in the fields of life science, physical science, and engineering, only making up 6%, 6%, and 5%.

By guiding students from local middle and high schools with high minority enrollment through interactive demonstrations that focus on the scientific method, we can motivate students to pursue careers in STEM fields. However, demonstrations of materials science and chemical engineering focused on hard materials, like ceramics and alloys, have higher materials costs than our current funding allows. Our materials science department only has a few groups researching hard materials which further contributes to the lack of demonstrations in this field. These Materials Science Classroom Kits would allow for hard materials science demonstrations at our field trip event and future visits to Example City schools.

**GOALS AND OBJECTIVES**

Organization A works closely with teachers from local public middle and high schools with high minority enrollment to develop new experimental demonstrations that not only reinforce concepts already covered in their science curriculum but also exhibit new and exciting phenomena. In general, we aim to work with the students throughout the year in order to cultivate a strong academic and personal relationship and to motivate them to pursue a career

in STEM. This project is specifically focused on exciting students about hard materials science, demonstrating the practicality of such careers, and motivating them to pursue those careers to help correct the underrepresentation seen in the STEM workforce.

This academic year we have been working with students in the Example City area from the Example Middle School, Example STEM Academy, and Example B Middle School. These schools have our ideal target audiences with Example Middle School and Example STEM Academy having greater than 93% minority enrollment with Example school's student diversity being 58.0% Hispanic and 30.4% Black and Example STEM Academy's student diversity being 99.0% Black. [2],[3],[4] Since September, we have visited each of the schools about once a month to perform demonstrations and build our relationships with the students. To culminate this year of visits, students will come to the Example University campus to tour lab spaces and perform more sophisticated experiments using the superior capabilities of a lab compared to a classroom. This field trip is particularly exciting for students and provides an excellent opportunity for us to capitalize on that excitement to motivate students to pursue STEM careers.

The field trip project will ideally incorporate demonstrations in the fields of chemical engineering and materials science, biomedical engineering, and chemistry. Despite the exciting application areas such as aerospace that students might find as an interesting career field at their age, demonstrations within the subfield of hard materials science, with a focus on ceramics and alloys, have been lacking due to materials costs outside of the organization's current budget. These classroom kits would allow us to introduce students to hard materials science at the field trip event as well as future visits over the next few years. Demonstrations in this sub-discipline would fit well with a tour of a hard materials laboratory at the university which would demonstrate the practicality of such career paths. Given that motivation is hard to measure and it would be difficult to monitor each of the students' career paths, we instead survey students before and after each of our visits to see if they learned the key concepts of our demonstrations. Similar surveys will be given before and after the field trip. Our belief is that a students' interest and implicit motivation to pursue STEM subjects will be reflected in their retention of knowledge.

We plan to fulfill our goal of motivating Black and Hispanic students to pursue STEM careers by exciting them with hands-on hard materials demonstrations and showing them the practicality of hard materials research with a laboratory tour. Hopefully their increased interest in science will begin to correct the underrepresentation in the STEM workforce.

## **IMPLEMENTATION PLAN**

Our main focus is to utilize the Materials Science Classroom Kits during the field trips to Example University by three Example City schools (Example Middle School, Example STEM Academy, and Example B Middle School), which are planned from 05/18/2022 to 05/20/2022. One school will visit per day, during which students will participate in three experiments. The experiments will be related to the fields of materials science, chemical engineering and materials science, polymer chemistry, and biomedical engineering. Each experiment will consist of 45 minutes of experiments and a lab tour of 15 minutes related to the field of the experiment. After thorough examination of all nine lessons in the kits, we are planning to perform the "Thermal Shock!" and "Hot or not?" experiments during the field trips. After the field trips, the kits will still be used at least once per semester (per school) to perform the lessons with less safety concerns (e.g. "Piezoelectric materials" and "How strong is your chocolate?") during school visits in the 2022-2023 academic year. Selected lessons appropriate for the field trips during the 2023 spring semester are "Candy fiber pull" and "Shape memory alloys".

By inviting the students to our university through a field trip, we can carry out demonstrations that are normally not practical when performing the experiments in a classroom setting at their schools. Having proper lab space available will help in terms of safety concerns, space constraints, and additional capabilities. We can perform more sophisticated experiments which will help in further exciting the students about STEM fields. This especially holds for hard materials experiments, as high temperatures and increased safety concerns are generally present. These experiments are also more costly to perform and currently underrepresented in Organization A demonstrations.

While running the experiments, we aim to encourage and motivate the students in that they could very well be suited for the STEM field, and especially the hard materials field. We will inform the students by giving them more background on the importance of the field and by sharing our personal experiences as researchers. During the lab tour the students can see what a typical day looks like for researchers in this field. These interactions will continue to foster our relationships with them. At the end we will gauge what key concepts they retained and how their interest in hard materials has changed by letting the students fill in a survey before and after the field trip. Overall, we expect that these demonstrations could help in motivating students to pursue a STEM career, and eventually

positively impact the representation of Black and Hispanic students in STEM.

Over the three days, up to 120 students from three schools are expected to participate in the field trip, which will require 7-14 Organization A volunteers each day to guide these experiments and to give a tour of a hard materials lab. Each school will be accompanied by 1-2 teachers and some chaperones from that school.

Each Organization A volunteer will guide three to four students in performing the experiments. This includes introducing key concepts during a short presentation, introducing the students to the experiment itself, ensuring that students are equipped with proper PPE before starting the experiment, assisting them in carrying out the experiment properly and within the timeline, and finally letting the students reflect on the observations they made during the experiment. The latter is achieved by asking the students' opinion about their thoughts on the experiment, which is a standard procedure for Organization A volunteers during demonstrations. Each Organization A volunteer will carry out the "Thermal Shock!" experiment during the 45 minutes time slot. The "Hot or not?" experiment will be combined with the lab tour, where an Organization A volunteer will briefly demonstrate how materials can be specifically designed to insulate from extreme temperatures. The teachers from the schools will be present to make sure that students are behaving and engaged in these activities.

Organization A has been active with outreach since 2015 and typically works with 3-4 schools every academic year. One of the teachers we are currently working with has been working with Organization A since 2016. By adapting our visits to a virtual format during COVID-19, we ensured that the outreach could continue. Due to the recurrent funding available (Departments of Chemical Engineering and Materials Science and Biomedical Engineering, Materials Research Science and Engineering Center, and Center for Sustainable Polymers) and the opportunity of receiving these Materials Science Kits along with additional funding from CGIF, we expect that this organization will be financially stable for the foreseeable future. From the volunteers' side (graduate students), there has always been a lot of interest to engage in Organization A, as it is fun, helps them gain experience in teaching, and lets them add a line to their CV. The growth of hard materials science groups in our department will ensure that there is a sufficient supply of volunteers to initiate and coordinate hard materials demonstrations.

**HOW DID YOU HEAR ABOUT THIS GRANT OPPORTUNITY?**

Personal network

**APPENDIX**

(1) Fry, R.; Kennedy, B.; Funk, C. STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity. Pew Research Center Science & Society, 2021.

(2) Example Middle School website/news article link

(3) Example STEM Academy website link

(4) Example B Middle School website link

**HIDDEN FIELD**

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