

# **The building and launching of model rockets in order to promote interest in space exploration for teenagers from poorly schools in the London area.**

## **Proposal for PHAS0017**

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### **Aims:**

The aim of our proposal is to engage younger students (ideally from schools which are considered to be underperforming in STEM) to pursue a career in STEM subjects. We hope to especially target female students as they are under-represented when it comes to STEM fields. This project will spark enthusiasm for science in students as it is centred around an activity that most youth would enjoy. The project is split into two stages. The activity stage and the teaching stage.

The activity stage consists of providing students with equipment as well as instructions to construct a model rocket and fire it in a controlled environment. The rockets will include a GPS module to track the movement of the projectile and computer software will record its path. This stage captivates students and gets them interested in science. Activities like this are what appeal to younger students.

The teaching stage consists of using equations of motion to help students understand the Physics of what's happening with the projectile. This stage will cause the students to associate the excitement of firing a rocket into the air with learning Physics.

Another aim that we have is to get female students interested in a predominantly male field. We will accomplish this in the way we present our project to the school that we choose.

### **Objectives:**

Our first objective is to find a school that would be willing to partner with our program. We would then go into the school and host an assembly where we would present this idea to the students. The activity would be completely voluntary but we would strive to have an equal number of girls and boys take part. We would actively try and get girls engaged by having the female member of our team lead the presentation and talk to the female students and encourage them to be involved in STEM fields.

Then we would focus on finding a venue to conduct the project at. The ideal venue would be an open field that is privately owned and available to rent. Along with this, we would need to purchase the equipment needed. The budget for the equipment and venue hire is laid out in the justification of the resources section of this report.

Another objective would be to plan the learning section of the activity in such a way that it not only engages the students but also teaches them about the science of what is occurring. There would also be a brief safety lesson before the activity that ensures that everyone is safe. Rockets would be fired one at a time and supervised by adults at all times.

## **Summary:**

Our aim is to promote curiosity and interest in STEM fields, more specifically in the area of space exploration, for 15-16-year-olds in a school. By having a one-day event where these students will be placed in groups and guided through the process of building their own rockets and testing their performance, via a launch. The point of the rocket project will be an opportunity to use some of the knowledge the students will have from their GCSE Maths and Physics classes and applying it.

The event begins through the process of advertising it to the school administrators, the headmaster/mistress and such, asking if they would be willing to host our event in their school. We will begin by reaching out to multiple schools which meet this criterion inside of the Greater London area, the initial list being:

- London South East Colleges, Bromley
- Haverstock School, Camden
- St Andrew's CofE Voluntary Aided High School, Croydon
- Chace Community School, Enfield
- The John Roan School, Greenwich
- Phoenix Academy, Hammersmith and Fulham
- Parkside Studio College, Hayes
- Hewens College, Hayes
- Caterham High School, Ilford

[This list is sourced from

“<https://www.mirror.co.uk/news/uk-news/englands-worst-schools-revealed-your-11913069>”]

These schools have been chosen specifically to meet the ideal aim of getting some of the students from schools, which are underperforming, to provide some type opportunity, hope, and curiosity, to the students for a future in STEM.

If permission is given we will aim to bring in representatives to speak to the specific year group(s), most likely year 10 or 11, which we will be at the event. In most scenarios, we expect to do this roughly one week before the event happens, so it is still fresh in the students' memory when we arrive. The talk will run over the specifics for that scenario and go over the general outline of the planned 2:30 hours this event should take for the students.

The decision making to when the event will be is going to be dependent on the forecasted weather predictions also. The conditions necessary would require near zero wind speeds, or at least low enough to not make the path of the rockets be so extremely affected.

The event will take place at whatever time the school can allocate us which will be most convenient for the students and the school. This may mean that it will take some time before the initial talks between the school and the actual event happening.

On the day of the event the students will initially be split into their normal class sizes (we expect this to be roughly 30 in each group) We are expecting to be dealing with roughly 180 people in the year group which we are allocated. The idealistic situation would be if the school was to strongly encourage the students to attend, which would mean we are able to many more students. In the case where fewer turn up, for argument's sake half, then we would simply reduce class sizes to accommodate for the number of staff we have.

Once the students are in this class size they will be then given a short roughly 10-minute presentation by the event manager(s) and this will be to address everyone and remind them of the event plan, from last week. Groups will then be split and each has a group leader, possibly more than one depending on the turnout. These group leaders will then address their corresponding group of 30(ish) students. They will go over the corresponding theory which the students could think about when making their rockets and also try and promote current space exploration ventures. After this, the students will be split once again in these class size groups into groups of 10.

They will then go on to build their own rockets over the course of just an over an hour and a half. This will be using the resources available to them which we have taken inspiration from...

<https://www.teambuilding.co.uk/activities-outdoor/rocket-launch.html>

Once roughly two hours have passed for the whole event all building of the rockets will be terminated and the launching will begin. At which point the students will have a chance to ask any questions to members of staff about how to get more involved and anything else.

### **Project Personnel:**

The project personnel required for this event will be dependent on how many students we are receiving. Assuming we are going to be allocated a year group of 180 students it is not unreasonable to then say that we will be expecting a turn out roughly 60% of the year group as a good estimate. What is good about this project as well is that the fact that it will be able to handle vastly smaller and larger numbers with no problem since this can be accounted for by adding people into the initial class size groups, which will not infringe on the learning experience significantly, and also can be accounted for by either increasing the majority of group sizes from 10 to 11 (if there are more than expected), or decreasing to 9.

Assuming we have a 60% turnout we will, therefore, be expecting 110 students roughly (108 to be exact). Using the estimate of accounting for 30 people in a class from the 180 we will be utilising  $(180/30)$  6 group leaders for this exercise. The point of this event is also the fact that we can get more university students of STEM fields engaged in inspiring the next generation. Therefore for the event to happen, we will be needing 6 people but would be willing to accepting more people to help in order to assist the stress on each of the main 6 group leaders. In this case, we could go up to possibly 12 people since that would give every group 2 people now instead of 1. This estimate of people needed for the event could likely be adjusted in the future though since it is hard to put an estimate on how many people will be necessary at this point.

### **Group Leaders:**

The role of the group leader will be to guide their group of roughly 30 students through initially explaining the concept of gravity and explaining the idea of escape velocity and how rockets work, in the least mathematical way possible. They will then have the role of supervising over the students while they build the rocket and providing any assistance where necessary, without essentially doing the project for them (more hints than solutions).

The group leaders will be recruited through the UCL student body of STEM degrees, specifically, those students who have a close affiliation with Physics, Engineering, Maths, and Space Exploration.

The minimum number of volunteers needed as group leaders are 6 but would ideally be around 10 with the max being roughly 13.

### **Event Leader:**

This role will be taken as an add-on to one of the group leaders and will involve the addressing of the year group at the beginning of the event as well as the managing of the event to make sure everything runs smoothly and according to the schedule.

This person will coordinate the other members to make sure that everyone is aware of what he or she are doing and will provide the rocket resources to the group leaders, so that he or she may distribute them, and will also provide a document detailing the theory and ongoing projects.

Only one person needed but if the event leader feels it is necessary to have more support for this role he/she could nominate a Co-Event Leader who in this case would simply help with the workload and

### **Event Organisers:**

This person again will also be one of the group leaders but will now have the added role of being the one to reach out to schools and communicate our aims and idea to the administrators. They will also be the one who will coordinate all communication with the school and represent the whole team in that sense.

This person will also be in charge of all aspects of inviting media coverage and developing a website or social media page where we are able to provide an update about our program.

This role should only require 2 people but if needed more can be added

### **Related activities:**

Here we have our plans for engagement activities we intend to run during the Spark Awards. Before holding the events, we should stick to our dissemination plans to popularise our activities, as to attract teenagers interested in space and science to come to our optional events. The entire series of activities are separated into 2 parts for each time we tour a school, which is teaching sessions and practical sessions. The total procedure could take up to 3 hours (Max) and the pattern of combined activities could be repeated for touring in different schools. We are expecting feedback in form of questionnaires and interviews after each day's activities. The activities are expected to be educational, inspiring and stimulating to teenagers in both genders.

We could run several exhibitions to present our targeting audiences in school with the basic structure and theory of the main thrust of the rockets, as well as the historical evolution and big events in the past.

We are going to give a fair number of lectures or teaching sessions inside schools which form a partnership with us. This stage consists of using equations of motion to help students understand the physics of what's happening with the projectile and that comes as the essential part because it is the most direct and effective method to impart the knowledge about the rockets and related aircraft. The number of lectures given depends on the number of schools we tour to.

Also, we are about to hold optional laboratory sessions after that, as to enhance students' understanding of basic theories by handing out bought materials to students so that they could assemble their own rocket models under our instruction. In this stage, teenagers are motivated to become a maker and be more familiar with the rocket structures. Later on, we would find an open venue to fire these rockets. There would be a brief safety lesson before the activity, also the models should be fired one by one and from a distant range under adults' supervision. This activity would be extraordinary for the students and could easily raise their enthusiasm for the rockets and will help them associate the excitement of firing a rocket into the air with learning physics. Besides, we could also organize the teenagers to watch videos of real rockets launching process, which is a great way for teenagers to understand the importance of rockets and how the technology has been progressed.

On the other hand, there will be some potential risks generally. To be more specific, one of the potential risks is the lack of teenagers who take part in. This could be big trouble because we are unable to organise the subsequent events if there is not enough participants. Considering this situation, we must make our themes and content attractive enough in order that the young adults can be into our project. Then some other potential risks could be the safety problem. Specifically, running an exhibition can be fantastic, however, we should pay attention to the care of the huge items as well as the order to make it in progress. To solve it, the security should be guaranteed, the damage on exhibiting items should be minimised.

### **Awareness Raising, Dissemination and Networking:**

#### **Awareness raising:**

During the past several decades, the human scientific and technological level has witnessed a striking revolution. We can see that the rate at which satellites are being launched into space has increased dramatically as many countries around the world have now mastered the key to the manufacture of rockets. This phenomenon revealed an increasing interest in exploring the galaxies as well as the demand for a larger number of rockets to carry satellites and other precise instruments into space. Besides, several private companies were established all over the world whose aims are to help the government and professional institute, such as NASA, manufacture spare parts of rockets. Among all those corporations, Space Exploration Technologies Corp. founded by Elon Musk is of much success and attractiveness. Despite cooperating with official organisations and assembling rocket to compensate the tremendous needs for rockets in many missions, Space Exploration Technologies Corp. also dreamed big and kept trying to invent new technologies that were deemed to be impossible at that time, one example is its orbital rocket Falcon 9, which performed the propulsive landing and succeeded to be reused for the second launch in 2015. The come out of this fairly new rocket caused a sensation all over the world, especially for the fans of new science. Many cases have proved that private companies are more capable and also have such potential to be as professional as other official agencies. Also, we should notice that modern science lessons should focus more on cultivating kids' creativity and interest in physics areas, instead of merely imparting knowledge about formulae and traditional routines. Therefore, it is of great significance to teach teenagers at this age, who are currently taking GCSEs or more advanced courses and possess the ability to perform basic calculations, to learn more aspects about what they can really do with the help of the knowledge. Also, teenagers at this age will normally come up with more interesting and marvellous ideas, since they are still curious about everything.

### **Dissemination:**

We have come up with a dissemination plan to publicize our learning outcomes, outputs and other results to wider audiences. At the beginning of our program, we will start to establish a relative website that can be used for showing our resources and progresses regularly to the public. By formatting the website to be concise and precise, we are able to spread the latest accurate data to the public via tables, pictures, powerpoint demonstration and etc. Furthermore, during the whole program, we plan to invite university student volunteers and journalists to join our teaching classes. By doing so, more and more people will notice our program and throw themselves into our project if they are interested in this. Moreover, we can keep tracing and recording the academic performance and social achievements achieved by teenagers who have attended our classes in the long run, by regularly communicating with them and comparing their overall performance with other students, we are able to draw a reasonable conclusion in the end.

### **Networking:**

We regard networking as the most significant part of our program. Although our team was very dedicated and has accumulated a lot of knowledge, the resources are still very limited compared with experts. We need to build a connection with specialists in many areas, not only in physics and astronomy but also in education. We need such experts to help us evaluate our method of teaching, find the drawbacks in it so that we are allowed to find a quick and effective way to make improvements. As a result, kids will get a better understanding, and on the other hand, we can learn from this experience and keep expanding our horizons and become better at future teaching.

### **Monitoring and evaluation:**

Our project has not been started, hence we could not yet provide outcomes or tell any impact of our project activities at the moment. However, we would definitely offer further reporting and relevant documentation as our project work going on, which would help us improve our activities and practices in the future.

To perform our plan we need to acquire enough information through monitoring to qualitatively evaluate the rationality and feasibility of the ongoing activities, though we are not likely to evaluate all the issues we investigated. Here we will outline how and from which aspects we are going to judge our performance for each activity:

- **Human resources:**

How efficiently group members were allocated to specific roles in an activity.

- **Financial budgets:**

This is indicated by listing out the transportation fees, dissemination costs, material costs, etc.

- **Organizational resources:**

Resources associating with activities themselves: technical support from other bodies, volunteering subsidies, site rents...

- **Management:**

whether we are clear about aims, objectives, roles & responsibility and adaptability to our roles all the time while performing activities

- **Cost-effectiveness:**

We shall check the costings against each one of the listed activities specifically. Budgets are set around the project goals and objectives, to avoid non-correspondence between budgets and programs. Overall, we add up the cost for each small activity to get the number in the budget.

We should ensure the cost is rational as to avoid adding up the repetitive cost. Also, each one of the costs should be clarified for its use specifically with a necessity to avoid unnecessary costs.

- **Sustainability:**

We should always be clear of any possible finance or volunteer rundown as our activities going on. We shall make certain backup plans in case this happens.

- **Issues and questions external to our group:**

- **Acceptability** – We should always focus on how effective our designed activities are, as to achieve better engagement of our audiences. We should always ask ourselves that how relevant projects are to our audience to interest them and to keep our activities on track with our aims and objectives which is to better engage publics into physics learning.

- **Effectiveness** – We should focus on whether we are achieving your objectives after each activity, for example, in relation to attitudes & values; performances in activities; public support; community capacity; the wider movement, etc.)

- **Outside interference** – We should always be aware of the internal or external factors which are facilitating or constraining progress of carrying out activities.

- **Impact** – What is our impact on audiences? (e.g. in relation to the ultimate changes in people's lives or the environment as a result of our initiatives, which requires feedback as follow-up tracking of our audiences)

- **Contribution/attribution** – What contribution have we made to outcomes and impacts (in relation to other factors)? We shall have a clear log of the activities we've done accompanied with collected feedback from our audiences (could possibly be questionnaires or afterwards interviews).

Our aims for monitoring are to increase the quality of our performance each time we perform our work to the public to achieve better engagement with them. We have had this process of monitoring so that we could always look back with our evaluation scheme when performing our activities in progress and fix the issues and problems we've encountered for next time.

To ensure that our resources and spending is accountable, we are now classifying the costs of our activities while making the list of estimated cost, in order to give a better sense of the expenditure of the project as well as a direct way of how our evaluation scheme works.

Spending associated with activities:

Material for model and equipment fees: This part of costs includes the budget in purchasing models in parts that could be assembled and fired, as well as fine models and posters being shown, printing fees and projectors, etc. This could go up to £1000-1500.

### **Dissemination costs:**

This part of costs include budgets on establishing a relative website that can be used for showing our resources and progresses regularly to the public, as well as the cost for leaflets and poster making. To achieve this, it's necessary for us to buy a domain name and hire skilled agencies to develop, specialize as well as maintain our website. Usually, the cost could range from £500-1000.

Site/venue rents:

This part of cost depends on our further negotiation with our partner schools, the best case is that we could use the common hall for the exhibition, labs for assembling models, and playground for firing the model rockets. In this way, all of the active processes would be going on inside the schools and we could avoid the possible risks associated with getting students outside. The cost of renting a school area is probably £50 an hour, then the total cost might go up to £300-500. If the playground is previously occupied and could not be applied, we might need an open field which is privately owned and available to rent, which could possibly go up to £1000.

Technical support from other bodies:

This part includes the cost to invite other technical support, for example, students' parents, specialists in relative areas, university student volunteers and journalists to join our teaching sessions, which could go up to £2000.

Volunteering subsidies:

We definitely need someone to help to hand out materials and supervising the process of firing the models. This could be £7-10 per hour per person, up to £500.

Transportation costs: The cost includes both human and materials transportation, which could range from £200-500 depending on the number of schools we are to perform our activities too.

### **Case for support:**

About the science public engagement record, from the last several years, we have been involved in the science related field and the technology linked activities. As for the astronomy and aircraft which are related to the application, in 2015, some group member of us were invited to attend an exhibition of the models of the aircraft including the well-designed rockets, and the models of the spaceship as well. This was definitely beneficial to our sights in the fields of aircraft. Moreover, in 2013, some of us were asked to attend a live space teaching session. As its name implies, the teachers were the astronomers who had been sent to the space station in the universe which was called Heavenly Palace 1 through a rocket (manned spacecraft). The live session enabled us to not only viewed the environment of the universe, study the physical knowledge about the cosmology but also to motivate our interests in these huge aircraft and the theory of the universe. In addition, we have been studying classical mechanics and the universe through the high schools and the college, which is also essential for the rocket teaching project.

Overall, our project is designed to set up in order to help the teenagers to study and understand the rockets well, which includes not only the theory of them but also the handling abilities. We are supposed to organize the exhibition as well as the academic teaching session under the support the SEFC. In this way, we hope the teenagers who are invited to join this session will become eager of the knowledge of the rockets and get ready to be involved in this field if possible.

The found from the Spark Award will be spent in the different ways. At first, some sophisticated models of the rockets can be bought, which allows us to run several exhibitions in the public areas. Before the events start, we are required to popularise our fairs by the poster or online advertisements, in this case, we can potentially increase the amount of the people, especially the teenagers who will be willing to attend the event. During the fairs, we are able to teach the teenager about the theory and structures of the rockets as well as the past biggest events on them such as the launching of a huge manned spaceship. In other words, this could also be done by adding labels to



each item, which enables teenagers to find interesting parts in their minds. Then, opening the teaching sessions in senior high schools and colleges is the essential part. This is because it is the most direct and effective method to impart the knowledge about the rockets and related aircraft. The teaching sessions can be made by the lecture's way, and optional laboratory sessions are available as well. The materials can be bought and handed out to the students, in this way, they are able to assemble the simulated model of rockets, which could probably be a better way to make them understand the structure of rockets well than by a lecture teaching module. Besides, we could also organize the teenagers to watch the videos of rockets launching process, this can be a really good way to get the feel of the importance of rockets and how the technology has been progressed. Even more, organising the young adults to a rocket launching lively will certainly be more exciting. However, this should be undergone with the permission of the certain association and from a distant range. But it would be extraordinary for the young and could easily raise their enthusiasm for the rockets. I conclude, by opening a teaching session, it is directed to make the teenagers get the hang of the essential knowledge they should know about the rockets; by the exhibition, it could be easier to raise people to get involved into this area whether they are the fan of rocket or not. Then by a laboratory session which gives the chance for the participants to assemble the model of the rockets, teenagers are motivated to become a maker and be more familiar with the rocket structures. At last, organising a lively watching of rockets launching would be so inspiring, which is able to stimulation the young's enthusiasm to some degrees. On the other hand, there will be some potential risks generally. To be more specific, one of the potential risks is the lack of teenagers who take part in. This could be big trouble because we are unable to organise the subsequent events if there is not enough participants. Considering this situation, we must make our themes and content attractive enough in order that the young adults can be into our project. Then some other potential risks could be the safety problem. Specifically, running an exhibition can be fantastic, however, we should pay attention to the care of the huge items as well as the order to make it in progress. To solve it, the security should be guaranteed, the damage on exhibiting items should be minimised.

When it comes to the evaluation, our project has different methods to be shown. The scale and the amount of the people who take part in could directly indicate both output and outcome of the project on the exhibition, which can be easily evaluated. What is more, the quality of the teaching sessions and laboratory course can directly show the input. And the outcomes of our project could be captured and evaluated by the degree of acceptance and the performance of the teenagers who have already taken these sessions. Basically, how perfect they did in assembling the model of the rockets and to what degrees they have got the hang of the basic theory of the rockets including the knowledge of the classical mechanics, material sciences and usage of fuels can be an important indicator for the outcomes and evaluations. However, about the impacts, they are unable to be performed in a short time, because the impacts of teaching about rockets field can last a long time and perform slightly over a time period. It contributes to the construction and development of the aircraft and astronomy.

The dissemination of the project is very crucial as well. Before the project starts, we will put our organised events in the poster and the online advertisement, school popularisation is considered as well. In this case, we attempt to attract more people especially teenagers to get involved in our project of teaching session of the rocket. That is also our foundation for the project. And what we have bought, what we have made and all the items we have should be clearly listed and shown to the public. The outcomes are required to record in detailed sentences followed by the potential impacts that may take a long time to reveal. To modify our project strategies, we can invite the students taking part in the sessions to do the questionnaires then try to improve us. All the process of the project should be clearly shown to the public, which may appear online in one way. Due to the frequent use of the internet, our project could also be disseminated by an online method such as sending the email to teenagers who are interested in this part. In addition, we can interview the participants, talking about the feelings of studying rockets, what they have received from our

project as well as the potential participant and the detailed views of professional astronomy physicists, the engineers and authorities like NASA. Combining our interview, a brief document programme can be produced, which enables us to show and disseminate our project's resources, outputs and outcomes in an appropriate way. By these effective methods, we could conveniently disseminate our project to the public, which can attract the potential audiences as well. This can be an optimum circulation.

### **Justification of Resources:**

First of all, the resources allocated to buy the sophisticated model of rockets is truly essential. The reason for it is that we are able to open an exhibition for a long time, which gives people the most direct feelings on the rockets. During the exhibition, the visitors can be taught about the theory and structures of the rockets or just the labels for them to read according to their personal preferences. The combination of both visual and sound effect does contribute to the attractions and gathering of participants into our project. In this case, the subsequent procedures can be taken only.

Secondly, we would like to spend some of the resources on running an academic session at schools or some certain organisations for teenagers. This is very basic because most of the theory of knowledge related to the rockets such as astronomy, mechanics, aircrafts structures, material sciences and etc. is imparted in the process. To make teenagers be a potential physicist in this field, it is crucial to be familiar with the basic theory on it.

For those teenagers who decide to join us, we plan to rent a related laboratory for our teenagers to visit, for their safety, it is our duty to hire a full-time driver for transportation, and a security guard. At the meantime, we also need professors to introduce those sophisticated instruments for teenagers, which will allow them to gain a better understanding and comprehension in the research area, they will understand what real scientists are doing every day. This will trigger their motivation to be a researcher in the future if they are really interested in the whole program. Despite this, we do need a powerful team of teachers who are good at imparting knowledge, observing children's behaviour.

In order to evaluate the value of this program, we should spend money on keeping tracing and analysing the outcomes, some specialists may be hired to help to evaluate and make some suggestions.

We will upload every progress to the website, therefore maintaining and updating our website regularly need resources as well.