

# **The Superheroes in Science Project**

## **Teachers and Guardians Guidelines**

### **Useful Information for the project creation and criteria for school participation in the Superheroes in Science Project**

The Superheroes in Science project is an initiative to involve schools in the creation of science based exhibits on the real science behind superheroes. The best exhibits will be shown in schools and at the Esplora Interactive Science Centre during the Superheroes in Science event in Saturday November 10th and Sunday November 11th.

Students will be given the possibility of creating science exhibits pertaining to the real science behind superheroes and how students can apply scientific principles being taught in their syllabus, discoveries and innovations. The aim of this project is to stimulate the students 'sense of curiosity and fun, to discover and research science through the world of Superheroes.

***In the event of any unforeseen difficulty during the course of the project, please feel free to contact us on [euromediaforum@gmail.com](mailto:euromediaforum@gmail.com) and we will be very happy to assist you.***

### **The role of the educator in the project**

As the first contact point for the student/s your task is to introduce and guide the participant through the stages of a scientific project (see figure below). The first part would be to choose a topic and do some research. It is important for the students to understand that these two steps can (and many times should) be repeated many times for different topics. It is recommended, but of course each educator can have different systems, to set a deadline at some arbitrary time for students to have a preliminary topic. This will help the students to have something solid to work on otherwise there is the risk that the student will get lost in different topics and will not go through with any one of them. The next part is then to have a clear idea how the scientific investigation is going to act on the hypothesis and finally conducting the experiment or hypothesis or practical project. Finally, a report in the style as indicated by the rules and guidelines should be written up and submitted. It is important that if at any point any student or participant has a question which you are not able to answer because of insufficient details or because you are unsure, please do not hesitate to contact us through our provided email.

# Creating the Project

## Projects submitted can be in the form of:

- **Experiment-** a scientific procedure used to test a hypothesis, answer a question, or prove a fact/particular theory or to explain the conditions necessary for a phenomenon to occur. Two types of experiments that can be used are simple experiments (**Example:** The aim of the experiment is to find whether a plant grows better if you mist it with water. You study how the plant is growing without being misted and then compare this with growth after you start misting it) and controlled experiments(**Example:** The aim of the experiment is to find whether a plant grows better if it is misted it with water. Two plants are grown, one is misted with water (the experimental group) and the other is not misted with water (the control group).  
Examples of related experiments: the formation of crystals, the cultivations of bean plants under specific conditions to explain genetic variations/mutations. The experiment conducted must be backed by documentation on the synthesis of the materials and method used, conditions, constants and variables, all results noted and recorded to be verified. Diagrams, graphs and/or info graphics can be used to aid in explaining the results achieved. The Experiment must be presented in such a way as to show the direct relation to the superhero or super villain powers or abilities it represents.
- **Practical/ Visual Demonstration-** set up to demonstrate the mechanics of a particular theory in practical terms. Example - a functioning periscope, generation and conduction of electricity or a simple mechanical arm. The relation to the superhero, super villain abilities or provenance must be clearly shown. Practical demonstration must be backed by a detailed explanation of how it works and the materials used. Photographic and/or Video Documentation of the construction process are essential. Info graphics are also acceptable.

A PowerPoint presentation is optional to further explain and add value to the project but is considered only added value and not a necessity.

USING THE

# SCIENTIFIC METHOD



## 1 QUESTION

Ask yourself, "What do I want to learn more about?", or "I wonder what would happen if . . .?"

## 2 HYPOTHESIZE

Research to help you make an educated guess, or hypothesis, and then answer your question.

## 3 EXPERIMENT

Test your hypothesis by making a plan and conducting an experiment.

## 4 OBSERVE & RECORD

Make careful observations and write down what happens.

## 5 ANALYSE

Use your information to draw conclusions about your experiment. Was your hypothesis correct?

## 6 SHARE RESULTS

Explain your results by presenting your experiment, observations, and conclusions.

# A starting place for research

This section is aimed for teachers to give a hint or a small idea for students to then begin their own research. It is particularly useful if a student goes to an educator with problems in actually finding an idea for the project. The following are all facts and details pertaining to a variety of different superheroes, from which a student can select one or more to start their research. **It is important to emphasise that a student does not have to choose one of the following but is free to research or select any superhero or supervillain.** The important thing as stated before is that the project be one that joins the superhero/supervillain world with science in any way imaginable by the mind of the students.

The following is a list of Superheroes and Super villains and their various abilities and/or origin together with the scientific fields of study with which they can be linked to present a project.

## Guidelines and Examples of Student's Science Exhibits involving Superheroes:

An interesting fact is that many of the superheroes are in fact scientists by profession with sound knowledge of the basis of physics, biology and chemistry:

- **Hope Van Dym** is an expert in many fields of science. Her passions in chemistry and physics, contribute to the development of **The Wasp Suit** that enables miniaturisation in which a person or object shrinks in size rapidly.
- **Barry Allen** who is known as **The Flash** is a forensics scientist.
- **Spider-Man** is Peter Parker an accomplished science student.
- **Dr Jemma Simmons** is a biochemist who works for S.H.I.E.L.D. She is tasked with providing Coulson and the rest of her team with key information.
- **Dr Reed Richards** real identity is Mr. Fantastic from Fantastic Four. Dr Richards holds doctorates in physics and electrical engineering.
- **Bruce Wayne (Batman)** turns to chemistry to understand the criminal mind.
- **Poison Ivy's** real name is **Pamela Lillian Isley**, a Gotham City botanist obsessed with plants, ecological extinction, and environmentalism. One of the world's most notorious eco-terrorists, she uses plant toxins and mind-controlling pheromones for her criminal activities, which are usually aimed at protecting endangered species and the natural environment.

- **Doctor Henry Pym** is an entomologist and physicist who developed the **Ant-Man** Suit.
- **Tony Stark**, a mechanical engineer created the **Iron Man** suit.
- **Bruce Banner**, a nuclear physicist who specialises in gamma radiation and its effects on living tissue, and turns into the **HULK**.
- **Dr. Caitlin Snow** is a bio-engineer and a former scientist. She was working during the particle accelerator disaster and tended to **Barry Allen** during his coma. She eventually becomes Killer Frost.
- **Martian Man hunter**, John Jones and other alien superheroes and super villains such as **Green Lantern** and **Thor** - (the Dynamics of the Universe - origin and components) The students can give presentations on the **origin of the universe**, the formation of planets, make models of the solar system or create through chemicals an artificial nebula. Explain the force of gravity both on Earth and the gravitational pull created by large satellites and planets on any bodies approaching their atmosphere. The units forming the universe like quasars (a massive and extremely remote celestial object, emitting exceptionally large amounts of energy, which typically has a star like image in a telescope. It has been suggested that quasars contain massive black holes and may represent a stage in the evolution of some galaxies and pulsars (a celestial object, thought to be a rapidly rotating neutron star, which emits regular pulses of radio waves and other electromagnetic radiation at rates of up to one thousand pulses per second.)
- **Superman** and **Super girl** - (Kryptonite-the properties of crystals). The debilitating effect of Kryptonite on Superman as it was the substance from which his planet was composed and from which its name is derived - The students could work on crystal formation, they could make a presentation and exhibition on the formation of crystals from different substances and the conditions required for them to form.
- **Spider-Man's** powers to apply the concept of mutation due to radioactivity exposure, properties of his tensile web (tension theory- $T = mg + ma$ , the principle of centripetal acceleration when he uses his web to travel, Kevlar ropes for strength), His spider sense to perceive danger). In 2013 an inventor in the United States unveiled a "spider-sense" bodysuit, equipped with ultrasonic sensors and hepatic feedback systems, which alerts the wearer of incoming threats; allowing them to respond to attackers even when blindfolded. Professor Mateevitsi has built a series of sensors that literally operates as a type of "spider-sense." It's comprised of tiny robotic arms equipped with ultrasonic sensors. As the ultrasonic sensors detect nearby objects, the arms exert more and more pressure on the skin. There are 7 different sensors, so someone wearing the suit can

feel the direction that the object is in. In creating this suit, Mateevitsi was inspired by the new abilities for sensors that see things humans can't<sup>1</sup>.

- Spider-Man's villain **Electro** gained the ability to control electricity after being struck by lightning while working on a power line. Students can create an exhibit that shows which materials are good electrical conductors or bad conductors.
- **The Thing** from Fantastic Four was turned into an indestructible strong man made out of rock. Student can make a presentation on the porosity of different rocks and can make tests to identify the composition of rocks.
- **The Human Torch** gained his powers on a spacecraft bombarded by cosmic rays. His entire body ignites into flames; he can project heat, and control it by sheer force of will. Students can conduct an experiment to determine the rate at which a liquid cools down from a specific temperature.
- **Plastic Man** is a super-hero whose unique completely malleable body chemistry allows him to stretch to great lengths and contort himself into any position imaginable. Students can conduct experiments as to the elasticity of various materials.
- **X-Men** - The importance of mutations in evolution and the way it helps create variation that enables animals and plants adapt to different and sometimes harsh or extreme environments.
  - E.g.: **The Sub- Mariner** can breathe underwater and has great strength to resist pressure. This can be connected to the study on deep sea creatures and their adaptation to the depth they live in.
  - **Forge's** mutation of high intelligence and the capability of building anything to change the environment to his advantage. This can be connected to the capability of humans to create instruments and vehicles to brave environments deemed impossible for human life such as the deep sea, the sky/stratosphere and space.
  - X-Men such as **Wolverine** (adamantium skeleton). Metal has been used extensively in the manufacturing of orthopaedic implants in a multitude of different forms. Implants made from iron, cobalt, chromium, titanium, and tantalum are commonly used. Clinical studies have demonstrated that alloys made from these metals can be used safely and effectively in the manufacturing of orthopaedic implants that are left in vivo for extended periods. The mechanical, biologic, and physical properties of these materials play significant roles in the longevity of these implants.
- **Polaris** and **Magneto** who can manipulate metals (Can be used to illustrate a project on the properties of metals). Examples of magnetism-A **magnet** are a material or object that produces a magnetic field. A **magneto** is an electrical generator that uses permanent magnets to produce periodic pulses of alternating

current. Hand-cranked magneto generators were used to provide ringing current in telephone systems, Use of such ignition magnetos for ignition is now limited mainly to Engines without a low-voltage electrical system, such as lawnmowers, chainsaws and aircraft engines.

- An **Iron Man** exhibit to explain the physics of Iron Man's suit. The Iron Man suit can also be used to illustrate the state of current technology to make exoskeletons that are being used in medicine and the military, and the use of jet-packs and how they work.
- **Flash's** incredible speed to explain how light travels, Newton's laws of motion, explaining the principle of inertia). X-Men-**Quicksilver** (calculating speed -velocity-  $v=s/t$ ) (molecular motion, thermodynamics and friction are all principles that could be explained in relation to velocity and the transfer of energy). **Flash** also time-travels due to the manipulation of Einstein's Laws and the opening of wormholes to other times and places. How possible is this? Superman also reverses the course of linear time by reversing the Earth's rotation, students can use Einstein's theories to explain whether this is possible or fiction.
- **Doctor Octopus**, a veteran Spider-Man foe, who has four robotic tentacles- like arms, would serve to introduce a fascinating presentation on prosthetic limbs and bionic properties. (Principle of hydraulics-e.g.: bicycle pump, car booth and Periscopes). Doctor Octopus' superhuman abilities derive from the four mentally-controlled, electronically-powered, telescopic, prehensile titanium -steel tentacles attached to a stainless steel harness encircling his body from lower chest to waist. The titanium-steel alloy is light, has high-tensile strength, a high melting point, and high thin-wall rigidity. The motors get their power from a small nuclear-powered thermo-electric generator, which can provide several hundred watts per hour for up to five years before needing to replace its U-239 core. Telescoping: Each tentacle is approximately six feet long at full contraction, but can extend to a maximum of 24 feet in length.
- The many gadgets of **Batman**: bullet proof suit, the Bat Mobile, the computers in the Bat cave that are used to hack into computer systems, etc. (batman's gear- use of Kevlar, bat flight-glider, weapons using sonar/sound, long distance hearing- instrument to pick up radio waves, night vision technology, creating a smoke screen, periscopes, stealth technology, voice activation, principles behind gyros).
- **Ultron's** artificial intelligence (Avengers Age of Ultron) - robotics, computer components for example the microchip, basics of the binary system) and X-Men's **Sentinels** and **Nemesis** robots that hunt

mutants and have adaptive intelligent systems. Is true AI possible? What is being done in this field?

- **Iron Man's** arc reactor bears a passing similarity to a fusion reactor that fuses hydrogen into helium to produce energy. It also needs an electromagnetic field to operate and may provide a clean source of energy. This can be also used to distinguish between NUCLEAR FISSION (currently used in nuclear reactors and involving the breaking down of radioactive elements such as Uranium and Thorium) and NUCLEAR FUSION which still is experimental and has to break even. What are the pros and cons?
- X-Men - **Storm** (cloud formation and formation of extreme weather conditions such as tornadoes, climate control, and lightning). In conjunction with lightening comes the creation of **Electro** who gains his super powers when struck by lightning. The students can use their knowledge on charged particles to explain charge manipulation of this super villain and the creation of electric fields. Another ability is Electrolysis-the ability to separate elements back into their original state.
- Flash's villain - **Captain Cold** (deep freezing-cryogenics), Batman's **Mr. Freeze**, Justice League villains **Killer Frost** and **Jack Frost**.
- **Daredevil**, a blind superhero can be used as an example of how blind creatures can navigate using echolocation and acoustics. (Sonar, echo principle, also applying the principle of transfer of energy as molecules transfer energy from one to the other to explain how sound travels and heat is transferred).
- A science exhibit that explains the various forms of communication within the world of nature and how humans have learnt to communicate with for e.g.: bats, dolphins and ants, emulating **Batman, Aqua man** and **Antman**. Real-life examples are Dr Norman Gary the apiculturist who can summon and control swarms of bees, teaching sign-language to apes and chimps, parrot and dolphin communication.
- **Batman** (Avian/Bat morphology and characteristics).
- **Aqua man** (Propulsion and sound travel in water and different mediums, echo communication, ocean currents and whale migration, properties of water). **Sonar** (originally is a technique that uses sound propagation (usually underwater, as in submarine navigation) to navigate, communicate with or detect objects on or under the surface of the water, such as other vessels. Two types of technology -*passive* sonar is essentially listening for the sound made by vessels; *active* sonar is emitting pulses of sounds and listening for echoes. Acoustic location in air was used before the introduction



of radar. Sonar may also be used in air for robot navigation, and SODAR -upward looking in-air sonar) is used for atmospheric investigations. The term *sonar* is also used for the equipment used to generate and receive the sound.

- X-men's **Angel** (biomechanics of flight/aerodynamics).
- Spider-Man's villain, **The Lizard** and the superhero the **Hulk**, due to exposure to gamma radiation (cellular regeneration and in case of the Hulk studies on radioactivity, its discovery, its use in energy production and its effects on the environment).
- **The Atom** - (to explain the fundamental units of life-the atomic structure). Also include **Ant-Man** and **Wasp** who explore the Quantum Dimension together. Another field related to Ant Man and Wasp is the insect world (metabolism, photoreceptors in vision of insects such as the ant).

**Students through their research can also make an exhibit on real life superpowers analysing the marvels of the human body for e.g.:**

- Wim Hof is able to withstand, and even thrive, in temperatures that could be fatal to the average person. Known as '**The Ice Man**', Hof has spent the past 20 years testing his talent in the most extreme conditions, from scaling mountain tops wearing nothing but a pair of shorts to swimming under sheets of ice in the North Pole.
- Daniel Browning Smith, known as **The Rubber boy**, is an American contortionist; he holds the title of the most flexible person in history, owning a total of seven Guinness World Records. Smith owes his flexibility to the rare medical condition Ehlers-Danlos-like syndromes. Ehlers-Danlos-like syndromes have been shown to be hereditary in Himalayan cats, some domestic shorthair cats, and in certain breeds of cattle and dogs.
- The humans who survived multiple strikes of thunderbolts, passing incredible amounts of electricity through their bodies.
- Reports of normal persons who in extreme situations, lifted weights many times heavier than their own, such as cars, to save lives.
- Persons who survived, many times completely unharmed, falls from great heights which normal human beings would not.

**<sup>1</sup> Prosthesis for the visually impaired Links**

<https://www.forbes.com/forbes/welcome/?toURL=https://www.forbes.com/sites/alexknapp/2013/02/23/prototype-suit-gives-you-real-life-spider-sense/&refURL=https://en.wikipedia.org/&referrer=https://en.wikipedia.org/>

## **Criteria for Project submission:**

The Superheroes in Science Project is open to students who are in Forms 1 to 4(Grades 7 to 10). For students to be eligible to participate they must be in Form 1(Grade 7) to Form 4(Grade 10) during the scholastic year 2018-2019. Students can participate individually or as a team, with a maximum number of three students in a team. All projects, whether in the form of an experiment or of a practical demonstration, must be submitted, together with the necessary documentation, as shown below:

- A submission form- this form is available for downloading from the website <http://superheroescience.info/> and must be signed by a parent or guardian.
- A report which documents the project presented in the scientific method (table describing the scientific method is found below, the table is also found in the Superheroes in Science Project booklet for students). The report must be typed out in an A4 size paper document and should not exceed 500 words in total.
- The Report Template- Each submitted report must have, as front page, the report template. This template is available for downloading from the website <http://superheroescience.info/>
- Projects submitted should not exceed 120 cms x 60 cms in dimensions for practical purposes. Project judging to choose the finalists: Only two projects from each school or NGO will go to Esplora as finalists for the final judging. The chosen finalist projects must be two projects from the Senior Group. The judging and choice of the finalists to go to Esplora is entirely at the discretion of the respective schools and NGOs, using any method or criteria fitting to the school's or NGO's ethos. Once the finalists have been chosen, following the deadline date for project submission, the school or NGO must send the names of the finalists together with a copy of the submitted report to Euro Media Forum via email on [euromediaforum@gmail.com](mailto:euromediaforum@gmail.com) by not later than noon Monday 5th November 2018. Schools or NGOs must indicate if any students do not wish to be photographed and any other relevant information about their participation during the event such as who will be accompanying the students during the event ,requests for a board to set up any information or infographics and a light socket for power point presentations or light sources, etc.

### **Superheroes in Science Event and the final Judging:**

The finalist projects chosen by the school or NGO must be brought to the Esplora Interactive Science Centre on Friday 9th November 2018 between the hours of 15:30 and 19:00. These can be set up in their designated area by any representative/s sent by the school or NGO. Representatives bringing in the projects must present themselves at the Esplora reception where one of the Superheroes in Science team will indicate will guide them.

The project set up must include the student/s name/s, grade and school or NGO they are representing clearly indicated. On the event date Esplora will be open to the public at the below times: Saturday 10th November & Sunday 11th November- 10am till 6pm. Students must be accompanied by an adult/s these can be parents, guardians, teachers or NGO representatives as indicated in the emails by the schools or NGOs. These adults are responsible for the students they are accompanying. Euro Media Forum and Esplora are not responsible for students left to wander the premises unaccompanied during the event.

A colour coded tag will be given to the students indicating their preference whether they want to be photographed or not. The final judging of the projects will be carried out by a panel of three judges from Euro Media Forum and Esplora. A winner and a runner up (individual or team) will be chosen from the Junior Group and a winner and a runner up (individual or team) will be chosen from the Senior Group.

Winners will be given the opportunity to make a presentation of their project within the science theatre at Esplora during the event to the attending public. The winners and runners up from each group will receive Superhero themed prizes. If the winner or runner up project is from a team, each member of the team will receive a prize not collectively.

All finalists who participated and brought their projects to Esplora during the event will be awarded a Certificate of Participation. All projects being exhibited at Esplora during the event must remain at Esplora for the duration of the two day event.

Group 1 and Group 2 in the Booklet refer to two levels of understanding:

Group 1/ Group 1 and Group 2- general science topics

Group 2- more advanced topics