

Student and Teacher

Science & Engineering Fair Handbook

for Experimental & Engineering Projects

Senior Division (Grades 9-12)

**Greater Kansas City
Science and Engineering Fair**

Presented by:



INSPIRING SCIENTIFIC CURIOSITY AND LEARNING FOR A BETTER COMMUNITY

Science & Engineering Fair Guide

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I. INTRODUCTION

Congratulations! You are about to take the first step in preparing a project eligible to compete with over 1,200 other projects from the Greater Kansas City Metropolitan area at this year's Greater Kansas City Science and Engineering Fair. Presented by Science Pioneers and supported by local businesses and individuals interested in promoting science, the fair offers you the opportunity to compete for almost 300 prizes and awards. Senior high students also have an opportunity to travel to the International Science and Engineering Fair (ISEF).

II. GENERAL INFORMATION

ORGANIZATION OF THE FAIR

The Fair is organized by Grade Divisions, Category and Entry Type.

GRADE LEVEL

There are three Grade Divisions:

- Intermediate 4th, 5th and 6th grades
- Junior 7th and 8th grades
- Senior 9th, 10th, 11th and 12th grades

The categories are as follows:

Animal Science (AS): Study of animals, their life cycles, anatomy, and classification; physiology; animal husbandry; entomology; ichthyology; ornithology; herpetology; mammalogy; development; nutrition and growth; animal Mendelian genetics; ecology; systematics and evolution.

Behavioral and Social Sciences (BE): Study of human and animal behavior; social and community relationships; psychology (cognitive, physiological, and social); sociology; anthropology; linguistics; learning; perception; reading problems; educational testing; social media dynamics.

Chemistry (CH): Study of the composition, structure, properties, and reactions of matter. Includes all forms of chemistry investigations – analytical; environmental; computational; inorganic; organic; materials; physical; and nanomaterials.

Chemical Energy (CE): Alternative fuels; fossil fuel energy, fuel cells and battery development; microbial fuel cells (also **MI**); solar materials; fluid and gas dynamics; thermodynamics; remediation; waste management; chemical pollution.

Computational Science, Bioinformatics and Mathematics (CM): *Applications of computers to analyze a particular problem – see CS below for computer systems.* **Biological applications of computers:** biomedical engineering; various computer applications, including pharmacology, biomodeling, bioinformatics; evolutionary biology; neuroscience, and genomics. **Mathematics:** the study of measurement; properties and relationships of quantities and sets; using numbers and symbols; deductive study of numbers, geometry, various abstract constructs, sets or structures; algebra analysis; combinatorics; graph theory; game theory; topology; number theory; probability and statistics.

Computer Systems, Electronics, Robotics (CS): **Computers include:** the study of information processes including structures, process procedures, and implementation of processing systems; systems analysis and design; data analysis; network design and operations; application and system software design; programming; data center operations; networking and data communications; algorithms.

Electronics: circuits; microcontrollers; integrated optics; sensors; signal processing; energy conservation. **Robotics:** biomechanics; cognitive systems; control theory; machine learning (includes AI); robotic kinematics; algorithms; databases; operating systems; programming languages.

Earth and Environmental Sciences (EA): *EA differs from EE by measuring/monitoring these areas, not applying a solution to problem.*

Earth Science: the study of science related to plant earth to include geosciences; mineralogy; water science; physiography; oceanography; meteorology; speleology; seismology; geography. **Ecology:** populations, communities; ecosystems. **Environmental Science** *defined Man's interaction with the ecosystem:* climatology; atmospheric science; environmental effects on ecosystems; geosciences, (mining, fracking etc.); water sciences (aquifers, pollution); recycling; waste management; water resources management.

Energy and Environmental Engineering (EE): **Energy:** solar; Power including hydro, nuclear, solar, thermal, geothermal, wind; sustainable design; renewable energies – also includes the theories, principles and laws governing energy and the effect of energy on matter – solid state; optics; acoustics; particle; nuclear; atomic; plasma; superconductivity; fluid and gas dynamics; thermodynamics; semiconductors; magnetism; quantum mechanics; biophysics. **Environmental Engineering:** *EE differs from EA by applying science to solve a problem* and includes bioremediation, land reclamation, pollution control, recycling and waste management; water resources management.

Engineering Mechanics (EM): Engineering including aerospace and aeronautical, civil, mechanical; computational mechanics; control theory; ground vehicle systems; industrial engineering-processing; naval systems; space travel equipment such as rockets, etc.

Materials Science (MS): Biomaterials; ceramics and glasses; composite materials; computation and theory (as applied to materials) electronic materials; optical materials; magnetic materials; nanomaterials; polymers; plastics.

Microbiology (MI): Antimicrobials; antibiotics; bacteriology; applied microbiology; environmental microbiology; microbial genetics; virology;

prions; study of prokaryotic cell processes and organelles.

Molecular Bio/Chem & Health Sciences (MO): Study of vital processes occurring in living macromolecular systems (Eukaryotic) including the processes by which these substances enter into, or are formed in the organisms (chemically and/or genetically), and/or react with each other and the environment; biochemistry (analytical, medicinal, structural); disease diagnostics and treatment: drug development and testing; epidemiology; nutrition; physiology; pathology; cell physiology; eukaryotic genetics; immunology; neurobiology; pathophysiology.

Physics and Astronomy (PA): **Physics:** atomic, molecular, optical, biological, computational, nuclear and particle physics, theoretical; condensed matter and materials; instrumentation; magnetism – electromagnetic and plasmas; mechanics; optics, lasers, and masers.

Astronomy: Anything in the universe beyond Earth such as the positions, dimensions, distribution, motion, composition, energy, and evolution of celestial bodies and related phenomena; astronomy; cosmology; computational astrophysics.

Plant Science (PS): Study of plants and their life cycles; structure; growth; macro processes, classification; evolution; agronomy; macro genetics; development; pathology; physiology; organics; GMO's; taxonomy; ecology; hydroponics.

Inventions (NV): (Grades 4-8 only) Creation or modification of devices or processes that solve or alleviate challenges in our lives.

Students may enter a project individually or as part of a team of no more than 3 students.

III. PRE-PROJECT PLANNING

Please read this section carefully before you begin any experimentation relating to your project.

The Greater Kansas City Science and Engineering Fair is an affiliate of the International Science and Engineering Fair (ISEF). Each year, two projects are selected to enter this international competition. In order for a project to be eligible to compete at the ISEF, a specific protocol (specified by ISEF) must be followed.

All students from schools that do not have science fairs can enter as a single individual or group. To be allowed to do so students must fill in this form and submit to Science Pioneers for approval.

Prior Approval to Enter as an Individual or team (non-school sponsored)

All Senior Level projects entering the Greater Kansas City Science and Engineering Fair are required to complete the necessary ISEF forms to be eligible for competition.

All Senior Projects Must Include the Following Forms:

1. **Checklist for Adult Sponsor (1)** (to be completed prior to experimentation)
2. **Student Checklist (1A)**
3. **Approval Form (1B)**

Most Senior Projects Will Need One or More of the Following Forms:

(Consult the **Required Forms Checklist for a complete list** of which forms are needed for every type of project.)

1. **Regulated Research Institutional/Industrial Setting Form (1C)** (to be completed after experimentation)
2. **Qualified Scientist Form (2)**
3. **Risk assessment (3)**
4. **Human Participants Form (4)**
5. **Vertebrate Animal Form (5A)** (for research conducted at a non-regulated research site)
6. **Vertebrate Animal Form (5B)** (for research conducted at a regulated research site)
7. **Potentially Hazardous Biological Agents Form (6A)**
8. **Human Tissue Form (6B)**
9. **Project Continuation Form (7)**

FAX all forms that need Science Pioneers Science Rules Committee (SRC) signature to 816-501-4802.

Unsure if you need additional forms? Use the ISEF Rules Wizard to determine what forms you need.

<https://apps2.societyforscience.org/wizard/index.asp>

Projects not following proper protocol as described by ISEF will be rejected by the Greater Kansas City Science & Engineering Fair Review Committee.

As you plan your project for the Greater Kansas City Science & Engineering Fair you should:

- Read this booklet carefully.
- Consult the complete ISEF Rules & Guidelines. You may download this information at <https://student.societyforscience.org/international-rules-pre-college-science-research> . ISEF grants permission to reprint with credit.
- **DO NOT** begin your experimentation until you fill out and have signed all necessary forms.
- Begin your project early in the school year. **However, no data collected before January in the year of the fair is eligible for the upcoming ISEF.**
- Seek help.

We have several programs that are geared specifically to helping teachers and students with entering the Greater Kansas City Science and Engineering Fair.

Teachers:

Mentor Directory – a resource for locating mentors for students on science projects is available to teachers who request a copy from Science Pioneers at 816-460-2261 or admin@sciencepioneers.org.

Science & Engineering Fair Kickoff- teachers who are considering or planning to have their students do Fair projects, will learn how to organize a science & engineering fair, generate ideas for projects and use activities to motivate students. The rules for the Greater Kansas City Science & Engineering Fair will be covered.

Students and Teachers:

Saturday STEM Seminars – offer timely topics for people seeking enrichment and extended science knowledge. 9-10 am on Saturdays throughout the school year. Check our website for complete schedule.

Meet the STEM Mentor Day– students can discuss science & engineering fair project ideas with STEM professionals and brainstorm to help find new ideas. They can also view projects done by professionals as a model.

Please check our website at www.sciencepioneers.org for details on all these programs.

IV. FAIR RULES and REGULATIONS

GENERAL RULES

1. The following types of projects are **NOT** permitted in the Fair:
 - Projects that are demonstrations, models, collections or reports.
 - Projects that use only qualitative or subjective data. Data collected for all experimental projects must be measurable (quantitative & objective). Surveys and opinion polls are unacceptable.
 - Projects that demonstrate scientific principles that are already common knowledge (green plants need visible light to grow, magnets attract iron, batteries can make a light bulb glow, etc.)
2. Any exhibit that has been previously entered in the Greater Kansas City Science & Engineering Fair may not be reentered in the competition, but you may do a continuation project according to ISEF protocols.
3. You may not enter more than one project in the fair.
4. Your exhibit dimensions are not to exceed the following: 76 cm (30 in) deep, 122 cm (48 in) wide

5. Your exhibit must be completely self-contained and self-supporting. The display board should be sturdy enough to withstand wind currents present in Union Station
6. **All unclaimed projects are disposed of as part of the fair dismantling. Science Pioneers doesn't keep any projects.**
7. **Do not place valuables or sensitive equipment as part of a display.** Union Station and Science Pioneers are not responsible for stolen or damaged equipment or other valuables.

SAFETY RULES

1. All electrical equipment must be constructed according to standard electrical safety laws. Exhibits requiring electrical current for operation, or illumination, must be designed for operation on alternating current at 110 volts. If batteries are used, they should be storage batteries to ensure continuity of operation.
2. Ordinary doorbell push buttons and open knife switches may not be used to control 110-volt apparatus. Only suitably rated UL 110 volt toggle or push button type switches mounted on panels or switch boxes are allowed.
3. All wiring, switches and metal parts carrying 110-volt current must be grounded properly and out of reach of visitors.
4. All electrical points must be soldered and taped properly (following UL regulations.)
5. Nails, tacks and un-insulated staples may not be used for fastening wires. Use porcelain or other approved types of insulators.
6. All wiring must be **properly insulated** for voltage used.
7. Dangerous chemicals, open flames, flammable liquids, and explosives are strictly prohibited.
8. If bacteria are displayed, they must be in sealed containers.
9. No live animals, vertebrate or invertebrate, are to be displayed at the Fair.

THE FAIR SAFETY COMMITTEE RESERVES THE RIGHT TO INSPECT AND DISQUALIFY ANY EXHIBIT THAT DOES NOT CONFORM TO THE RULES AND REGULATIONS IN THIS BOOKLET.

V. ENTERING THE FAIR

NUMBER OF ENTRIES PER SCHOOL

Each Senior Level School (grades 9-12) is allowed to submit **any QUALITY Entries** to the Greater Kansas City Science and Engineering Fair.

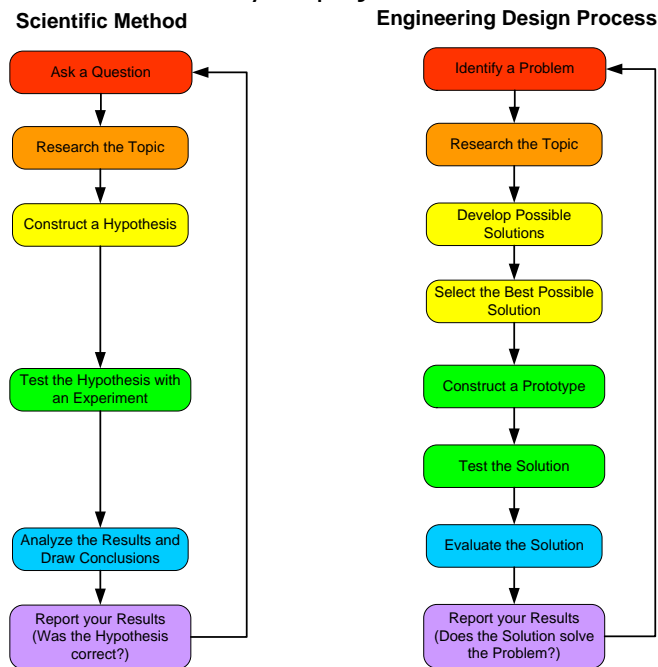
APPLICATIONS

1. A copy of the Official Application Form can be found on the Science Pioneers website at www.sciencepioneers.org.

2. Applications should be completed and received at Science Pioneers office **no later than the Application Form Date at 5:00 pm. NO EXECEPTION!**
3. All applications should be accompanied by the registration fee and a copy of all required forms.
 - Be sure to have all certification forms filled out and signed by the appropriate people (e.g., teacher/sponsor, qualified scientist, etc.) **before** you begin experimentation.
 - **Applications without all necessary completed forms attached will be rejected.**
 - All applications should include:
 - a. An adequate abstract (experimental) or description (engineering). The description of the project provided on the application form is the only means the review committee has to evaluate and classify your project.
 - b. A clear description of the problem.
 - c. The type of data collected (experimental) or testing done (engineering).

Any Invention project will fall into one of several engineering categories, please refer to our newly revised list of categories. They can be found on our website www.sciencepioneers.org.

4. Engineering Projects: Not all areas of study are best served by scientific methods based research. Engineers sometimes have different objectives than those of other sciences; they follow a different process in their work. Use the flowcharts below to see how the Scientific Method differs from the Engineering Design Process. You may use whichever method better fits your project.



See scoring guide on Science Pioneers website www.sciencepioneers.org to check criteria for judging.

5. Science Pioneers will review all entry forms within two weeks of the final deadline. Any applications not complying with the rules and regulations set forth in this booklet will be returned to the student's teacher with a written explanation.

Teachers: If any applications are returned, please advise your students as soon as possible.

VI. SETTING UP AT THE FAIR

1. For detailed information regarding dates and times of this year's fair, please refer to the Science Fair Schedule on the Science Pioneers website at www.sciencepioneers.org.
2. The student, parent, or teacher can set up the project. **Note: project set-up requires approximately 15-20 minutes.**
3. When setting up your project, you must bring:
 - Your paper
 - Display board and any accessories or models
 - The project number card sent to you by Science Pioneers. This number identifies the placement of your project. Maps will be at the entrance for your assistance. **Please make sure that your project number matches your table location.**

VII. JUDGING and AWARDS

Each project is reviewed by two judges:

Academic Judges evaluate each project based on how well experimental, computer science, engineering or invention processes and principles were followed. See the Judge Scoring Guide for a complete description of how your project will be judged. Each project will be given a **gold, silver or bronze rating** based on the marks received on the scoring guide, and the appropriate ribbon will be awarded. In addition, the top projects in each grade level and category will be selected for **Academic Awards**. Students winning Academic Awards will be asked to attend the Charles N. Kimball Awards Ceremony to receive recognition for their accomplishments.

The **Pioneers in Science Awards** are given to the top five senior level projects. The goal of the award is to recognize more outstanding examples of student research, innovation and design.

The **Grand Award** is given to the three best ISEF eligible projects in the Senior Level. Students winning the Grand Award will receive an all-expense paid trip to the International Science and Engineering Fair.

Over 60 organizations present Special Awards at the Fair. **Special Award Judges** evaluate the projects based upon their organization's interests and priorities. Each organization determines its own awards including plaques, prizes and cash. Students winning Special Awards are asked to attend the Charles N. Kimball Awards Ceremony to receive their award from the sponsoring organization. A list and description of Special Awards organizations may be found on the Science Pioneers website at www.sciencepioneers.org.

VIII. Student Checklist

BEFORE experimentation, make sure that you...

- Read and comply with all ISEF Rules and protocol as you plan your project.
- Make arrangements to work with a mentor (if needed)
- All students from schools that do not have science & engineering fairs can enter as a single individual or team. To be allowed to do so students must fill in this form and submit to Science Pioneers. **Prior Approval to Enter as an Individual or Team (non-school sponsored)**
- Consult the Required Forms Checklist to determine ISEF forms necessary and complete the following forms with correct signatures and dates BEFORE experiment START DATE! Please contact Science Pioneers at 816-460-2261 if you have any questions.
- Checklist for Adult Sponsor Form/ Safety Assessment (1) (*all projects*)

- Research Plan Form (1A) (*all projects*)
- Approval Form (1B) (including Science Pioneers (SRC) or IRB approvals) (*all projects*)

AND IF APPLICABLE:

- Regulated Research Institutional/Industrial Setting Form 1C – Projects conducted in a regulated research institution or industrial setting
- Qualified Scientist Form (2) - Projects involving potentially hazardous agents, vertebrate animals, controlled substances and humans.
- Risk Assessment (3) - Projects using hazardous chemicals, activities or devices or regulated substances.
- Human Participant Form (4) - Projects involving humans. Prior approval needed.
- Vertebrate Animal Form (5A or 5B) - Requires Science Pioneers pre-approval on Form (5A).
- Potentially Hazardous Biological Agents Form (6A) - Required for all research involving microorganisms, rDNA and fresh tissue, blood and body fluids. Prior approval needed.
- Human Tissue Form (6B) - Required for all projects using fresh tissue, primary cell cultures, blood, blood products and body fluids. If the research involves living organisms, please ensure that the proper human or animal forms are completed. ALL PROJECTS USING ANY TISSUE LISTED ABOVE, MUST ALSO COMPLETE FORM 6A.
- Project Continuation Form (7) – Required for projects that are a continuation in the same field of study from a previous year(s)' project.

Fax completed forms to 816-501-4802 for pre-approval by Science Pioneers Scientific Review Committee (SRC).



Failure to properly complete this step **BEFORE EXPERIMENTATION** will result in your project being rejected.



AFTER experimentation, make sure that...

- You complete any post-experimentation signatures and forms *if applicable*:
 - **Science Pioneers SRC approval after experimentation *if applicable* (1B)**
 - **Form 1C (Must be signed by Qualified Scientist – NOT YOUR TEACHER)**
- You fill out all blanks on your application and ensure the abstract or description has been approved by your teacher/sponsor.
- You check with your teacher/sponsor to be certain your project is classified correctly to ensure proper judging.
- Arrangements have been made for your application and entry fee to be sent to the Science Pioneers office by deadline date at 5:00pm.
- Your project meets the criteria of an Experimental or Engineering project.
- Your exhibit meets all safety and size requirements.
- Your paper meets the guidelines for writing a paper or project description.
- You acknowledge those who helped with your project in your paper and with a thank-you note.

IX. Teacher Checklist

Teachers, make sure ...

- Your students refer to the ISEF rules and protocol procedure before they begin their projects. The official ISEF Rules can be found at <https://student.societyforscience.org/international-rules-pre-college-science-research> .
- If you are unsure whether a project needs special forms visit the ISEF Rules Wizard at <https://apps2.societyforscience.org/wizard/index.asp>
- All certification forms are
 - A. Filled out correctly
 - B. Signed and dated
 - C. Signed by the appropriate people (Qualified Scientist, Parent, etc.)
 - D. Approved by the Science Pioneers SRC **BEFORE** experimentation begins (if required). Fax completed forms to [816-501-4802](tel:816-501-4802) for pre-approval.
- Mentors are available to work with your students, if necessary.
- All blanks on entry form are completed and a complete abstract or description is included.
- Each project is classified correctly. (This will ensure proper judging.)
- Arrangements have been made for the applications, along with the entry fee for each project, to be sent to Science Pioneers office by 5:00 pm deadline date. (Please send only one check per school.)
- Your students **and their parents** know that projects are not to be removed from the Fair before last day of the fair and that all projects not claimed **will be discarded.**

TEACHERS! You are NOT PERMITTED to sign the following:

FORM 1B, items 2 or 3

FORM 1C

FORM 2 (**Unless you are the Qualified Scientist OR Designated Supervisor**)

FORM 3 (**Unless the Qualified Scientist is unable to supervise the experiment**)

FORM 4 (**Unless you are the Science Teacher**)

FORM 5A (**Unless you are the Designated Supervisor for Form 5A**)

FORM 5B

FORM 6A (**Unless you are the Designated Supervisor**)

FORM 6B (**Unless you are the Designated Supervisor**)

If you have questions about forms, dates or anything else, call or e-mail Science Pioneers:

(816) 460-2261 or admin@sciencepioneers.org

For prior approval of projects, fax the completed form to 816-501-4802.

X. Required Forms Checklist

1. Forms Required for All Projects (no exceptions):

- Checklist for Adult Sponsor (1). Must be completed prior to experiment start date.
- Student Checklist (1A). The actual experiment start date must be later than all approval dates, including Science Pioneers SRC approval, on Form 1B.
- Approval Form (1B). All signatures on #1 and #2 must be prior to actual experiment start date on Form 1A.

All Scientific Review Committee (SRC) signatures are given through the Science Pioneers office. Teachers are not allowed to sign any SRC approval. To obtain SRC approval please fax all completed forms to 816-501-4802.

2. Forms Required for Human Participants Projects

- Human Participants Form (4). All approval signatures must be prior to actual experiment start date on Form 1A.

If IRB (from Form 4) determines there is more than a minimal risk, then you also need the following forms:

- Qualified Scientist Form (2). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Registered Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation is complete.

3. Forms Required for Vertebrate Animals Projects - (Prior SRC Approval Needed)

- Vertebrate Animal Form (5A or 5B). Must be completed and signed prior to actual experiment start date on Form 1A.
- Qualified Scientist Form (2). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Registered Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation.
- Human and Vertebrate Animal Tissue Form (6B). Required for all projects using fresh tissue, primary cell cultures, blood, blood products and body fluids.

4. Forms Required for Microorganisms and Controlled Substances Projects - (Prior SRC Approval Needed)

- Qualified Scientist Form (2). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Registered Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation is done
- Potentially Hazardous Biological Agents Form (6A). SRC/IACUC/IBC/RAC approval required before experimentation.

5. Forms Required for DNA Projects - (Prior SRC Approval Needed)

- Qualified Scientist Form (2). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Registered Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation is done.
- Potentially Hazardous Biological Agents Form (6A). Required for all research involving rDNA.

6. Forms Required for Human and Animal Tissue Projects - (Prior SRC Approval Needed)

- Potentially Hazardous Biological Agents Form (6A). Must be completed and signed prior to actual experiment start date on Form 1A.
- Human and Vertebrate Animal Tissue Form (6B). Must also use Form (6A).

If you are going to handle non-commercial tissues then you also need the following form:

- Qualified Scientist Form (2). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Regulated Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation is done.

7. Forms Required for Hazardous Substances or Devices Projects

- Risk Assessment Form (3). Must be completed and signed prior to actual experiment start date on Form 1A.

If experimentation takes place at a registered research institution then you also need the following form:

- Registered Research Institutional/Industrial Setting Form (1C). Must be completed after experimentation is done.
- Potentially Hazardous Biological Agents Form (6A). Must be completed and signed prior to actual experiment start date on Form 1A.

Failure to comply with all of the above requirements will result in your project being rejected.

If you have any questions regarding forms, please call the Science Pioneers office at (816) 460-2261.

Complete Science Fair rules and forms are available and can be downloaded from:

- www.sciencepioneers.org - Greater Kansas City Science & Engineering Fair
- <https://student.societyforscience.org/forms> - International Science & Engineering Fair