# Covestro PRSEF 2020 Teachers’ and Students’ Handbook

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Important Dates and Deadlines

Covestro Pittsburgh Regional Science and Engineering Fair (PRSEF) Wednesday, March 25, 2020 at Carnegie Science Center

2020 Student Registration Deadlines

School Registration Deadline – November 15, 2019 (online registration available in October)

Student Registration Deadline for projects requiring preapproval – November 29, 2019

Note: All projects involving human subjects, non-human vertebrate animals, potentially hazardous chemicals, activities and devices require pre-approval

Student Registration Deadline – January 3, 2020

Student Registration Deadline for schools with science fairs – February 7, 2020.

ISEF Student Deadlines (9th – 12th grade only):

One copy of the student’s research paper and application must be mailed to Carnegie Science Center, Attn: PRSEF Director, One Allegheny Avenue, Pittsburgh PA 15212 – February 28, 2020

One copy of the student’s research paper must be emailed to PRSEF@CarnegieScienceCenter.org – February 28, 2020

Final paperwork must be submitted to ISEF by winners – April 2, 2020

Student must attend ISEF prep session – April 2020

ISEF will be held on May 10-16, 2020 in Los Angeles, California

Note: Student must be a Covestro PRSEF participant and complete the appropriate paperwork to apply for ISEF

See Appendix 1 Science Fair Timelines for additional information
Pathway to a Research Project

Why do a research project?

In ALL aspects of a student’s life the knowledge and skills gained by completing a science or engineering research project will always be with them personally and professionally. These skills include critical thinking, data analysis, perseverance, public speaking and collaboration. **These are important for any career path.**

Please see Appendix 2 How Student Science Research Projects Provide Support for Meeting PA State Science Standards and Assessment Anchors.

What is a Research Project?

A research project is when you use a step-by-step approach, like the scientific method, to answer a question or solve a problem.

Good scientists, both young and old, follow a similar approach to study what they see in the world. Research is the process by which people create new knowledge about themselves or the world in which they live in order to answer a question or solve a problem. When choosing your topic, give careful thought to how your research might enhance the world and its inhabitants. Questioning is probably the most important part of scientific creativity and is often followed by an "if...then" statement. Questioning usually leads to experiments or observations.

Students should learn to be skeptical of all research results, especially their own. A good experiment may or may not answer the questions asked, but almost always leads to fresh questions requiring new experiments or observations. The final hypothesis is often developed after the researcher has run a number of preliminary experiments, analyzed a body of results, and reached a tentative conclusion.

Some projects do not look like what we usually think of when we hear the term “science fair project”.

Engineers create things that never were or improve on a previous design. An engineering project should state the engineering goals, the development process and the evaluation of improvements.

Computer science projects involve creating and writing new algorithms to solve a problem or improve an existing algorithm. Simulations, models or "virtual reality" are other areas on which to conduct research.

Mathematics projects involve proofs, solving equations, etc. Math is the language of science and is used to explain existing phenomena or prove new concepts and ideas.

Theoretical projects involve a thought experiment, development of new theories and explanations, concept formation or designing a mathematical model.

Social sciences projects which do not involved an experiment or data are not appropriate for competition at PRSEF.
Students Should Complete the Following Steps Involved in a Research Project

1. Pick a topic of interest. Use the ideas in Appendix 3 Projects to Avoid for guidance.

2. Ask a question or identify/define a problem.

3. Search and review published materials related to the question or problem. Visit Appendix 4 Links to Recommended Covestro PRSEF Resources, Appendix 5 Science Projects Research Ideas from Sponsors, Appendix 6 Recommended Chemistry Resources, and Access PA Power Library for appropriate resources. To determine if an internet resource is reliable check the tips at https://acscareers.wordpress.com/2013/08/05/its-on-the-internet-it-must-be-true/. Students should do this in November to be ready for Covestro PRSEF in March.

4. Develop a research plan. Research plans must include at least 5 (five) major references (e.g. science journals, books, articles, internet sites will be checked and must be well documented). See Appendix 7 A General Guide for Scientific References for guidelines regarding formatting references. **Urls alone are not acceptable as references to scientific resources.**

5. Teachers: Before students start their research, work with them to choose a category for each project. See Appendix 8 Project Categories for a complete list of categories. Choosing the correct category ensures that the project is evaluated by judges who are appropriate subject matter experts and will increase the chances of a project being recognized with an award.

6. Use the rules wizard at https://ruleswizard.societyforscience.org/ to help you complete the correct approval forms. Be sure to read Most Common SRC Problems before submitting the forms. The following forms must be submitted for **ALL** projects:
   - Form 1, Checklist for Adult Sponsor
   - Form 1A, Student Checklist
   - Research Plan (page 2 of Form 1A)
   - Form 1B, Approval Form
   - Signature page from online registration

7. Teachers: Submit the forms at PRESF.STEMisphere.org. Once the project has been reviewed, you will receive an email either requesting additional information or approving students’ research. **When you receive a confirmation notice of approval—HAVE YOUR STUDENTS START THEIR RESEARCH!**

8. Evaluate possible solutions and make an educated guess (hypothesis) or begin preparing engineering designs. Students should do this in December to be ready for Covestro PRSEF in March.

9. Challenge and test the hypothesis through experimentation (data collection) and analysis or build and test an engineering model. Students should do this in February to be ready for Covestro PRSEF in March. Note: Keep track of all data in a project data book.

10. Examine and organize the data. Evaluate the results of the experiment or engineering project and reach conclusions based on the data. Use the statistics suggestions in Appendix 9 Using Statistics for ideas about how to analyze data.

11. Prepare a report and presentation board. Write a research paper.

12. Assemble a display and construct a presentation board.
Teachers: All students must be registered and have submitted the required forms on or before January 3, 2020 unless the school has a science fair in which case the deadline is extended to February 7, 2020.

Teachers: In mid-March, fair day logistics will be emailed to you to share with the students.

**What Must Students Bring to the Science Fair?**

**Presentation Board**

- **Reminder:** The student’s name and the school’s name should not appear anywhere on the presentation board or paperwork. If this information is included on the student’s board, the student will be required to remove it or cover it at the fair before judging. A liquid correction fluid can be used where necessary.
- The standard presentation board is a three-panel (24” middle panel with 2 12” side panels), free-standing structure that folds for ease in transporting to and from the fair. Be sure to adhere to the specific size limitations and safety rules. Presentation boards can be purchased at a local office supply store. Your board may not exceed the following:
  - Width: 48” (122 cm)
  - Depth: 30” (76 cm)
  - Height: 78” (198 cm) for tabletop exhibits, 108” (274 cm) for floor exhibits. Note: Please inform the Covestro PRSEF office of floor exhibits prior to Covestro PRSEF.
  - Weight: no more than 250 lbs. All exhibits exceeding 100 lbs. must be mounted on a dolly with rubber casters. Oversized exhibits will be disqualified.
- All exhibits must be freestanding (no wall mounts).
- Students must set-up their own project displays. Heavy, wooden, double-stacked, plastic or metal display boards are not recommended.
- Make sure the display is sturdy. It must remain intact all day.
- Include only the current year’s work.
- Contents should include: title, purpose, hypothesis, procedure, results, conclusion.
- Project data books, abstracts, and research papers are not required, but recommended. (Judges evaluate your research, any three-dimensional objects displayed are incidental.)

**Project Data Book**

- A project data book is your most treasured piece of work. Record accurate and detailed notes to make a logical and winning project. Good notes show consistency and thoroughness to the judges and will help you when writing your research paper. Judges highly recommend displaying a data book.

**Abstract**

- After finishing research and experimentation, you are required to write a (maximum) 250-word, one-page abstract. An abstract should include: (a) purpose of the experiment, (b) procedures used, (c) data, and (d) conclusions. It also may include any possible research applications. Only minimal reference to previous work may be included. The abstract should focus on work done since the last Covestro PRSEF and should not include: a) acknowledgments, or b) work or procedures done by the mentor.

*A completed abstract MUST be submitted online on or before February 7, 2020.*
Projects do not need to be completed to submit an abstract. You can simply state that experimentation is continuing and results will be available on fair day. Sponsor award judges and other special award judges have access to student abstracts prior to competition day to determine which projects address their special areas. In addition, category judges review abstracts prior to interviews for a summary of the research. Abstracts must be submitted online by teachers.

Abstract Samples –

**Project Title: What Type of Trash Makes the Most Biogas**
Fossil fuels are becoming a rare resource because they are nonrenewable. My experiment provides us with an alternative way to produce gas. I wanted to find out which type of organic material produces the most biogas. To do that, I pureed apples, blueberries, onions, and lettuce, put them in bottles filled to the top with water, and sealed the top with a balloon. Then, every day for a week, I measured the circumference of the balloon. After the one week, the apples ended up producing the most biogas, rejecting my hypothesis that the blueberries would produce the most biogas.

**Project Title: Landfill Chemistry**
Landfills are a major problem and this study evaluated ways to increase the decomposition rate of newspaper, a common ingredient. Eight simulated landfills were built, and the rate of the decomposition of newspaper was tested by adding various agents: “yeast with Yeast Energizer,” “Campden Tablets,” and “Amalayse Enzyme.” Microbial growth and biodegradability of the newspaper were then examined. Newspaper treated with Alpha Amylase underwent a significant increase in decomposition as compared with untreated samples and the other agents. Future studies are being planned in an effort to increase the decomposition rate of plastics and organic garbage.

**Project Title: Cetuximab_DHA Antitumor Effect**
Cetuximab is EGFR-specific antibody treatment for head and neck cancers. Since only 10-20% of patients respond clinically, there is an interest in enhancing cetuximab’s efficacy. Docosahexaenoic Acid (DHA) is an omega-3 fatty acid that can inhibit tumor progression. The effects of combining DHA and cetuximab on cell proliferation, EGFR expression, and antibody dependent cell-mediated cytotoxicity (ADCC) were studied in vitro. Combination treatment better reduced proliferation, and DHA upregulated phospho-EGFR while combination treatment mitigated this effect. Pre-treatment of tumor cells with DHA increased ADCC by healthy donor effector cells. These findings show co-administration enhances the antitumor effects the treatments had alone.

**Research Paper** (Required for ISEF. Not required, but highly recommended, for Covestro PRSEF)

- A research paper should be prepared and available along with a project data book and any necessary forms or relevant written materials. A research paper helps organize data as well as thoughts. A good paper includes the following sections:
- **Title Page and Table of Contents** – The title page and table of contents allows the reader to follow the organization of the paper quickly.

- **Abstract** – Summary of your experiment in 250 words.

- **Introduction** – The introduction sets the scene for your report. The introduction includes the purpose, your hypothesis, problem or engineering goals, an explanation of what prompted your research, and what you're hoped to achieve.

- **Materials and Methods** – Describe in detail the methodology used to collect your data or make your observations, design apparatus, etc. Your report should be detailed enough so that someone could repeat the experiment from the information in your paper. Include detailed photographs or drawings of self-designed equipment. Only include this year's work.

- **Results** – The results include data and analysis. This should include statistics, graphs, etc.

- **Discussion** – The discussion section is the essence of your paper. Tell your readers exactly what you did and thought. Compare your results with theories, published data, commonly held beliefs, and expected results. Discuss possible errors. How did the data vary between repeated observations of similar events? How were results affected by uncontrolled events? What would you do differently if you repeated this project? What other experiments should be conducted?

- **Conclusion** – Briefly summarize your results. Be specific. Do not generalize. Never introduce anything in the conclusion that has not already been discussed. This is a good place to discuss practical applications.

- **Appendix including acknowledgments** – Credit those who assisted you, including individuals, businesses, and educational or research institutions. Note any financial or material donations. Do not list teachers, parents, school, etc. by name.

- **Bibliography** – Include any documentation not your own (i.e., books, journal articles). See an appropriate reference in your discipline or Appendix 7 A General Guide for Scientific References for format ie. APA, MLA or Chicago Manual of Style to learn more about how to format your bibliography. Urls alone are not acceptable references.

**Other Items to bring to the fair**

- Signed copies of forms. Although copies were submitted with the registration form, students should bring a duplicate set to the fair.

- Ideas, knowledge and enthusiasm. Students will be interviewed by the judges. They should understand their research and be able to communicate their process and results research effectively.

- See Appendix 10 for the Electronic Devices Policy.
Display Hints

- **Photographs** - Many projects involve elements that may not be safely exhibited at Covestro PRSEF, but are an important part of the projects. Take photographs of important parts/phases of your experiment to use in your display. You must have signed consent forms from human test subjects pictured in photographs. All photos must have a credit line of origin (“Photograph taken by...” or “Image taken from...” or “Graph/Chart/Table taken from...”) printed on the poster. All images MUST BE properly cited.

- **A Good Title** - Your title should be simple, accurate and an attention-grabber. It should make the observer want to know more.

- **Organization** - Make sure your display is logically presented and easy to read. A glance should permit anyone (particularly the judges) to quickly locate the title, experiments, results, and conclusions. When you arrange your display, imagine that you are seeing it for the first time.

- **Eye-catching** - Make your display stand out. You could do this by including photographs, using neat, colorful headings, charts, and graphs. Pay special attention to the labeling of graphs, charts, diagrams, and tables - each item must have a descriptive title. Anyone should be able to understand the visuals without further explanation.

- **Ask adults for advice when needed.**

- **Your goal is to make the observer want to know more.** Make it easy for interested spectators and judges to assess your study and the results. Make the most of your space using clear and concise elements. Headings should stand out. Draw graphs and diagrams clearly and label them correctly.

**Display Safety**

- "**When in doubt, do without.**" Leave glassware and chemicals at home.
- Do not bring...
  - Living organisms, including plants
  - Taxidermy specimens or parts
  - Preserved vertebrate or invertebrate animals
  - Human or animal food
  - Human/animal parts or body fluids (for example, blood, urine)
• Plant materials (living, dead, or preserved) which are in their raw, unprocessed, or non-manufactured state (Exception: manufactured construction materials used in building the project or display)
• Laboratory/household chemicals including water (Exceptions: water integral to an enclosed apparatus)
• Poisons, drugs, controlled substances, hazardous substances or devices (for example, firearms, weapons, ammunition, reloading devices)
• Dry ice or other sublimating solids
• Sharp items (for example, syringes, needles, pipettes, knives)
• Flames or highly flammable materials
• Batteries with open-top cells
• Awards, medals, business cards, flags, endorsements and/or acknowledgments (graphic or written) unless the item(s) are an integral part of the project
• Photographs or other visual presentations depicting vertebrate animals in surgical techniques, dissections, necropsies, or other lab procedures
• Active Internet or e-mail connections as part of displaying or operating the project
• Glass or glass objects (Exception: glass that is an integral part of a commercial product such as a computer screen)

• Any apparatus deemed unsafe by the Scientific Review Committee, Lead Inspector or Covestro PRSEF personnel will be removed during the Inspection Process.

**Fair Day Schedule**

Use the directions and map at [http://www.carnegiesciencecenter.org/visit/parking-directions/](http://www.carnegiesciencecenter.org/visit/parking-directions/) for information about parking and entrances.

**Teacher Schedule – Wednesday, March 25, 2020**

8:00 am – 9:30 am  
Check-in, Lobby of Carnegie Science Center

8:00 am – 2:00 pm  
Hospitality Room, Carnegie Science Center, Highmark SportsWorks

10:00 am – 11:30 am  
Teacher Workshop at Carnegie Science Center – The topic for 2020 will be announced in February. Previous workshops have included Sports and & STEM and Teaching Content through Game Design. Limit 30 attendees, RSVP is required.

12:00 pm – 1:00 pm  
Teacher Luncheon – Sponsored by Bayer School of Natural and Environmental Sciences at Duquesne University - The Bayer School of Natural and Environmental Sciences at Duquesne University is again sponsoring a teacher luncheon on fair day, March 25. The lunch and a special show for teachers is from 12 pm – 1 pm at Carnegie Science Center. Please register online at [www.duq.edu/prsef](http://www.duq.edu/prsef) by March 9. Note: Each teacher must register separately and provide a different email address. Duplicate email addresses will void the registration. Space is limited.
2:00 pm – 4:00 pm
View student projects and interview students throughout Carnegie Science Center

4:00 pm – 4:30 pm
Meet students at designated dismissal areas.
Note: Students are not permitted to leave the exhibit floor until 4:00 pm

4:30 pm – 5:00 pm
Buses Depart

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**Student Schedule – Wednesday March 25, 2020**

7:00 am – 9:00 am
Project set-up and inspection, Student Exhibit areas, Carnegie Science Center

9:00 am – 9:50 am
Student orientation, Carnegie Science Center, various locations

10:00 am – 12:30 pm
Interviews with judges, Student Exhibits areas in Carnegie Science Center

12:30 pm – 2:00 pm
Visit RiverView Café at Carnegie Science Center, Highmark SportsWorks and Rangos theater

2:00 pm – 4:00 pm
Sponsor Award Judging / Presentation - Students are not permitted to leave until 4:00 pm

4:30 pm
Buses Depart

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**Teachers and Students – Thursday, March 26, 2020**

6:00 pm
Doors open at Carnegie Music Hall

6:30 am – 8:30 am
Science Fair Awards Celebration
Rules of Participation

See 2020 PRSEF guidelines and 2020 ISEF guidelines for full details.

Ethics Statement: Scientific fraud and misconduct are not condoned at any level of research or competition. This includes plagiarism, forgery, use or presentation of other researcher’s work as one’s own and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF. Covestro PRSEF reserves the right to revoke recognition of a project subsequently found to have been fraudulent.

- You must not have reached age 20 on or before May 1, 2020.
- Must be in grades 6-12.
- You must live in one of the following counties: PENNSYLVANIA: Allegheny, Armstrong, Beaver, Bedford, Blair, Butler, Cambria, Clarion, Clearfield, Fayette, Greene, Indiana, Jefferson, Lawrence, Mercer, Somerset, Venango, Washington, Westmoreland or MARYLAND: Garrett.
- Team Projects (2 or 3 students) are permitted in all divisions. All team members must attend grades which are assigned to the same division. For example, a sixth grader (junior division) cannot work with a seventh grader (intermediate division). All team members must be present on Fair Day.
- Covestro Pittsburgh Regional Science & Engineering Fair is the ONLY science fair in Western PA which is affiliated with the International Science & Engineering Fair. Please note for students new to your school (moving from other regions), a student may compete in only one ISEF affiliated fair in any one school year.
- The project must be solely the work of the exhibitor(s) in research, construction and design of the exhibit. Parents or sponsors may only advise. (Supervision and assistance with the use of power tools is exempt.)
- All work must be done within the 12 months prior to competition day. Continuation projects which rely on previous work are acceptable, but only work done in the prior 12 months may be presented in the competition.
- Note: Teachers that sponsor students from different schools (ie. Intermediate, high school) must register each school separately.
- Each student MUST HAVE an adult sponsor (parent /teacher/mentor) who is ultimately responsible for the health and safety of the student conducting the research and of any human or animal subjects. An adult sponsor may be a teacher, parent, university professor or scientist who has a solid background in science and will closely supervise the student's research.
- All students (in all divisions) conducting research involving vertebrate animals, human subjects, tissue, recombinant DNA, microbes, and pathogenic or controlled substances, must fill out special approval certification forms (See 2020 PRSEF Guidebook BEFORE starting the project. Paperwork deadline for these projects is Nov. 29, 2019.
- Human Participant Studies - Projects involving the consumption, ingesting, tasting, applying, absorbing of any substance will be accepted with the approval of both the local Institutional Review Board (IRB) on Form 4 and of the Covestro PRSEF Scientific Review Committee (SRC). Research completed at a Regulated Institution and approved by the institute’s IRB on
Form 4 does not need PRSEF SRC approval. **Covestro PRSEF’s SRC reserves the right of final approval of all other projects submitted to the competition.** See [Human Participants](#) for more information.

- **Bacteria Projects:** Many students collect bacteria in a home environment. This is acceptable as long as the collected bacteria are immediately transported to a lab with the appropriate level of biosafety containment and petri dishes remain sealed. See [Potentially Hazardous Biological Agents](#) for more information.

- **Mold Projects:** Many students observe mold growth on food. This is acceptable as long as the experiment is terminated at the first evidence of mold.

Students must set up their own exhibit at the fair for project inspection. If parents or teachers are present in the exhibit area during set up, the student will be disqualified.

- High school seniors that are enrolled in college courses are eligible provided they are also enrolled in high school and will receive their diploma in the academic year in which they participate in PRSEF.

- Students must be present at their project board during official category judging time on Wednesday, March 25, 2020. The exhibit area is a restricted area during official judging. **ONLY** students, judges, and official Covestro PRSEF volunteers/staff are permitted on the exhibit floor during judging times.

- The Category Award Selection Procedure has been designed to ensure all projects are evaluated on a consistent basis and ranked appropriately with regard to receiving awards. The decisions of the judges, determined on the day of the fair, are final. See Appendix 11 Category Award Selection Procedure for details.

- All student project boards must be removed from the exhibit area when students depart on Fair Day. Remaining projects will be discarded due to space limitations.
Judging and Category Award Selection Procedure

Students should be ready to talk in depth about their research. They should be able to have a conversation about their work and results. Students should practice explaining their research to parents, friends, teachers, and especially people who don't understand their research. They should tell everyone to ask them at least three questions.

Judges look for well thought-out research. They consider how significant the project is in its field, as well as how thorough the student was in conducting their research. Did they leave something out? Did they start with four experiments and finish only three?

Judges recognize students who can speak freely and confidently about their work. They are not interested in memorized speeches but prefer simply to TALK with students about the project to see if they have a good grasp of their research from start to finish. Note cards are permitted, but students should not read from them. Besides asking the obvious questions, judges often ask questions to test students’ insight into their project, such as, "What was your role?" or "What didn't you do?" and "What would be your next step?"

Judges expect the student to demonstrate that they did the work themselves.

Some students who compete at Covestro PRSEF have had opportunities to work in industrial research or teaching hospital labs. Students, parents and judges have expressed concern about equity in judging these projects in competition with those done in more traditional places, i.e., home or school labs. Covestro PRSEF strives to maintain a level playing field.

Research is usually an activity that proceeds faster when ideas are exchanged and techniques are shared. This is especially true whenever the ideas shared are in part generated by a specialist or scientist working actively in the field in question. A student stands to gain considerable knowledge by association with these professionals and also usually has access to the latest research equipment. To this point, however, it is essential that the judge determine how the student connected with the lab. A student who chose the project and created the lab situation will be more highly rated than one who was led to those choices by someone of influence. The judge is evaluating the creativity of the student, not the mentor.

The student researcher shall convince the judges of the following:

- **The student did all of the work.** All of the work reported must be done by the student. It is unacceptable to present other’s work, and any project doing that will be disqualified.
- **A higher level of science is expected.** Whenever work is done in these labs it is expected to be more complex and advanced. In and of itself, this shall not influence a judge’s evaluation. More complex science is usually presented in these cases; this is as expected and does not influence the rating.
- **The student has a complete understanding of the work reported.** Each judge shall thoroughly test the student’s knowledge of the subject. If a judge is not familiar with the science of the project a Category Chair shall be notified and other judges assigned. Here especially, judges shall not be satisfied with “canned” presentations.
- **The student made use of the tools available.** The judge shall determine how effectively the student used resources available in the lab.
When deciding which of these projects to advance for Category awards, judges shall consider the judges’ rubric attributes (See Appendix 12 Judges’ Rubrics) and reward projects that have scored well against those criteria. Just as judges are not unduly influenced by a flashy poster, they should not automatically assume that these are better science projects.

See Appendix 11 Category Award Selection Procedure for details about the judging and award selection process.
Science Fair Awards

Covestro PRSEF awards fall into several different categories.

Category Awards - Awards are distributed based on the number of entries in each category. Multiple second, third and fourth place awards may be awarded. Only one first place will be awarded in each category.

Senior Division (Grades 9 – 12)

$300 – First Place
$150 – Second Place
$75 – Third Place
$25 – Fourth Place

Intermediate Division (Grades 7 – 8)

$150 – First Place
$75 – Second Place
$35 – Third Place
$20 – Honorable Mention

Junior Division (Grades 6)

$75 – First Place
$50 – Second Place
$30 – Third Place
$15 – Fourth Place

Note: Teams will split the award money equally among team members.

International Science and Engineering Fair (ISEF) Awards

Senior Division, Grades 9 – 12
Each student researcher entering an exhibit may apply for participation in the International Science and Engineering Fair (ISEF). Senior division student researchers will be chosen from the applicants and will win an all-expenses paid trip to compete at ISEF.

Junior and Intermediate Division (Grades 6 – 8)
Category Award Winners (1st, 2nd & 3rd places) are nominated to advance to Broadcom MASTERS competition, a program of Society for Science and the Public.

Sponsor Awards
Companies which sponsor Covestro PRSEF may award a $50 prize to a student of their choosing. Sponsors use their own criteria to select projects. Some look for projects from their special field of interest. See Appendix 5 Science Project Research Ideas from our Sponsors for more information.
Affiliate Sponsor Awards - Covestro PRSEF is a regional science fair affiliated with the International Science & Engineering Fair (ISEF). Affiliated sponsor awards are presented at Covestro PRSEF based on criteria received from ISEF.

Scholarships - Senior Division Covestro PRSEF participants (9th-12th grade) are eligible to be judged and receive scholarships from participating colleges and universities. More than 100 scholarships are expected to be awarded.

Collegiate Awards - Awards, which include certificates and school giveaways, are determined and selected by local college students. Only Junior Division students are eligible for collegiate awards.

Perseverance Awards

Honorary Scientist
Eleventh and twelfth grade students with five or more years of active participation.

Associate Scientist
Eleventh and twelfth grade students with three or four years and tenth grade students with four or five years of active participation.

Junior Scientist
Eighth and ninth grade students with three or four years of active participation.

Merit Awards - Category Judges select the students who exhibit excellence in Creativity, Presentation, or Scientific Method. Students will receive a certificate of excellence that signifies his or her outstanding performance in one of these areas.

Conditions of Awards
All cash awards will be paid in the year they are awarded, if the student has provided the necessary documentation (W9 forms) to process payment. Awards not distributed within one year of the award date will be subject to forfeiture. Internal Revenue Service (IRS) regulations require that Carnegie Institute file IRS Form 1099 for Miscellaneous Income for recipients of award monies which total $600 or more during a calendar year. Award recipients will receive their copy of Form 1099 from Carnegie Institute in January of the year following the year award payments are made.

Sponsors
The Covestro Pittsburgh Regional Science & Engineering Fair is presented by FedEx Ground and leading corporations, foundations, professional societies and universities in this region.
Appendix 1 Science Fair Timeline

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<th>Suggested Time Required</th>
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<td>CHOOSE a topic/explore your world—almost anything can be the basis for a science project</td>
<td>1 week</td>
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<tr>
<td>COMPLETE preliminary research on the general topic to narrow the topic</td>
<td>1-2 weeks</td>
</tr>
<tr>
<td>FORMULATE a question to explore the topic, write a proposal</td>
<td>1 week</td>
</tr>
<tr>
<td>DESIGN an experiment to answer the question</td>
<td>1 week</td>
</tr>
<tr>
<td>GATHER materials to do the experiment</td>
<td>1 week</td>
</tr>
<tr>
<td>BEGIN the experiment</td>
<td>1 or 2 days to 3 or 4 weeks (or longer) depending on the experiment</td>
</tr>
<tr>
<td>OBSERVE and record data</td>
<td>Varies</td>
</tr>
<tr>
<td>RESEARCH your topic at the library to find background information</td>
<td>1-2 weeks</td>
</tr>
<tr>
<td>ORGANIZE recorded data into charts, graphs, tables</td>
<td>2 weeks</td>
</tr>
<tr>
<td>ANALYZE data using quantitative methods and form conclusions</td>
<td>2 weeks</td>
</tr>
<tr>
<td>PREPARE display and presentation</td>
<td>1-2 weeks</td>
</tr>
</tbody>
</table>

Important Dates to Remember

<table>
<thead>
<tr>
<th>Item</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Registration and Fee</td>
<td>Friday, November 15, 2019</td>
</tr>
<tr>
<td>Student Registration Forms (includes Form 1, 1A, Student's Research Plan, 1B, Student Registration Form)</td>
<td>November 29, 2019 for pre-approval project January 3, 2020 unless prior approval is required February 7 for schools with school science fairs</td>
</tr>
<tr>
<td>Student's Abstract entered online</td>
<td>On or before Friday, February 7, 2020</td>
</tr>
<tr>
<td>Submit Preliminary Application to PRSEF for International Science &amp; Engineering Fair (ISEF) 9th-12th grade students only</td>
<td>February 28, 2020</td>
</tr>
<tr>
<td>Covestro PRSEF Competition at Carnegie Science Center</td>
<td>Wednesday, March 25, 2020</td>
</tr>
<tr>
<td>Covestro PRSEF Awards Ceremony</td>
<td>Thursday, March 26, 2020</td>
</tr>
</tbody>
</table>

Visit [www.pittsburghsciencefair.org](http://www.pittsburghsciencefair.org) for recommended websites and project ideas from our sponsors.
There has been much discussion and debate regarding the value of students doing student science research projects. In doing science research projects students follow what is known as the “Inquiry Cycle” (similar to but significantly different from the old “scientific method”). The Inquiry Cycle has 8 parts:

1) the student identified question to be solved,
2) background research,
3) experimental design (procedure) to follow,
4) data taking through completion of the procedure,
5) analysis of data,
6) conclusions based on empirical evidence from the experiment,
7) dissemination of the findings to peer group/ professional scientists and
8) new question(s) raised from dissemination.

This sets the stage for another research question as new questions are raised from others and the process repeats itself.

From this it can be seen that logical problem solving is practiced by the student if they follow these steps. But how does this help the students meet the Pennsylvania Science and Technology Standards? How are they prepared for the PSSA Assessments that will be starting in Spring, 2007? To see, let’s look at the State Science Standards and the newly released “Assessment Anchors” and “Eligible Content” that will drive the PSSA Science Assessment. There are 8 major areas that the standards are divided into. These standards comprise what the students of Pennsylvania are expected to know and be able to do in the areas of Science, Technology and Environmental Education. (These are found at the PDE website.) The areas identified are:

1) Unifying Themes of Science
2) Inquiry and Design
3) Biological Sciences
4) Physical Science, Chemistry and Physics
5) Earth Sciences
6) Technological Education
7) Technological Devices
8) Science, Technology and Human Endeavor
Standards 1, 2, 6, 7 and 8 bring in new areas of thinking for the students. They will be highlighted to demonstrate that by having students doing student science research, they will have opportunities to learn, practice and ‘‘hone’’ their skills and knowledge in these areas.

Standards 3, 4 and 5 -- Biological Sciences, Physical Science, Chemistry and Physics, and Earth Sciences are the content-driven standards. These areas key on facts and concepts of science disciplines. Portions of the content of the various science disciplines, as identified in standards 3, 4 and 5, would be addressed in science research project as the students 1) do the background research for the problem or area under consideration and 2) perform the experimentation—“doing the science” that reveals the content identified in the content standards. A student researcher must know and understand the underlying, foundational concepts—the knowledge—identified in these standards so that they can understand and extend the learning from the research project. As can be seen standards 3, 4 and 5 are compatible with rather than in opposition to the inquiry and process standards 1, 2 6, 7 and 8. (‘‘Knowledge -- facts, principles, theories and laws verifiable through scientific inquiry by the world community of scientists; includes physics, chemistry, earth science and biological sciences.’’)¹

In Standard 1---Unifying Themes of Science— students are challenged to be able to identify the concepts of systems, model design, patterns, scale and change in the natural world. This is a key area that student researchers develop as they complete their experimental design (through systems and “scale usage”) and make their observations through quantitative data measurement. Then by analysis and interpretation the researcher develops their skills in seeing patterns, change and model design to answer their initial research question. The research project gives the students a real life opportunity to see how these unifying themes in science can be observed through their own experimentation and inquiry.

In standard 2, Inquiry and Design, students are challenged to “develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions.”¹

In addition they are to “apply the elements of scientific inquiry to solve problems by:

• Generating questions about objects, organisms and/or events that can be answered through scientific investigations.
• Evaluating the appropriateness of questions.
• Designing an investigation with adequate control and limited variables to investigate a question.
• Conducting a multiple step experiment.
• Organizing experimental information using a variety of analytic methods.
• Judging the significance of experimental information in answering the question.
• Suggesting additional steps that might be done experimentally.”¹

Where will students have the opportunity to have these rich, scientific experiences on an ongoing basis—not a once a week, “guided inquiry”, cookbook lab that most science texts provide? **Students and teachers will find that through the completion of a long-term student science research project they will be continually experiencing these scientific process skills while still dealing with the content and knowledge demanded by the state and national science standards.**

**Standard 6 and 7** deals with **Technology Education** and **Technological Devices**. Depending on the project selected the student will have a greater or lesser amount of learning about technology, technological tools and technological problem solving. However, since almost all projects use computers and measurement devices, there is a portion of the standards that science research projects work with. Such standard indicators as “select and safely apply appropriate tools, materials and processes necessary to solve complex problems” and “apply advanced tool and equipment manipulation techniques to solve problems”\(^1\) point to the student use and understanding of measurement and to the use of technology to solve problems, which is done during student science research projects. In addition, the standards statement “apply basic computer operations and concepts” challenges students to use computers in their problem solutions, **something that is done as they complete their student science research project.**

**Standard 8** encompasses **Science, Technology and Human Endeavors**. This area requires the student to be able to analyze and apply solutions of science to real world conditions. Standard statements such as:

1) Analyze the relationship between societal demands and scientific and technological enterprises,

2) Analyze how human ingenuity and technological resources satisfy specific human needs and improve the quality of life and

3) Evaluate possibilities consequences and impacts of scientific and technological solutions require students to be able to apply their science learning to real world situations and conditions. This aspect too is part of student-driven science research. The student scientist is required to apply their investigation and project to a real world application. For many students, this is a first time experience of taking something they have “discovered” and think through how to apply this learning to a practical situation or condition. Rarely will students be asked to apply learning like this. Often textbook learning requests an application but seldom do teachers have students think about how their investigative discovery could apply to a real life situation. **Once again, the student science research project provides the means for standards-driven learning.**

The new PA Science Assessment Anchors provide teachers and students “eligible content” that the PSSA Science Assessment could incorporate in the assessment, starting in 2007. A few of the following are areas of “eligible content” that are strongly dealt with through the performance of student science research projects:

• Evaluate the appropriateness of research questions (e.g., testable vs. not-testable).
• Explain how specific scientific knowledge or technological design concepts solve practical problems.
• Analyze or compare the use of both direct and indirect observation as means to study the world.
• Use appropriate quantitative data to describe or interpret change in systems.
• Critique the elements of an experimental design (e.g., raising questions, formulating hypotheses, developing procedures, identifying variables, manipulating variables, interpreting data, and drawing conclusions) applicable to a specific experimental design.

• Critique the elements of the design process (e.g. identify the problem, understand criteria, create solutions, select solution, test/evaluate and communicate results) applicable to a specific technological design.
• Use data to make inferences and predictions, or to draw conclusions, demonstrating understanding of experimental limits.
• Critique the results and conclusions of scientific inquiry for consistency and logic.
• Communicate results of investigations using multiple representations.
• Evaluate appropriate methods, instruments, and scale for precise quantitative and qualitative observations.
• Analyze and predict the effect of making a change in one part of a system on the system as a whole.
• Use appropriate quantitative data to describe or interpret a system.
• Compare the accuracy of predictions represented in a model to actual observations and behavior.
• Describe or interpret recurring patterns.
• Analyze stationary patterns and physical patterns of motion to make predictions or draw conclusion.


These along with any of the content pieces that the student science research project deals with demonstrates once again the great value of having students meet the standards as well as preparing for the state science assessment by using the science research project platform.

In Closing
Knowledge of what science is incorporates carefully developed and integrated components:

• Nature of Science
• Unifying themes of science
• Inquiry
• Process skills
• Problem solving
• Scientific thinking
As you can see from the above summarization from the Pennsylvania Science & Technology Standards, students must learn science by doing. Inquiry is the key component for understanding science. How do students experience this? **By doing science as real scientists!** Where do they get the experiences like this? **By doing science research!** What platform allows this to happen on an ongoing, long-term basis? **Student Science Research Projects!**
# Appendix 3 Top Projects to Avoid

<table>
<thead>
<tr>
<th>Science Project Topics to Avoid</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any topic that boils down to a simple preference or taste comparison. For example, &quot;Which tastes better: Coke or Pepsi?&quot;</td>
<td>Such experiments don't involve the kinds of numerical measurements we want in a science fair project. They are more of a survey than an experiment.</td>
</tr>
<tr>
<td>Most consumer product testing of the &quot;Which is best?&quot; type. This includes comparisons of popcorn, bubble gum, make-up, detergents, cleaning products, and paper towels.</td>
<td>These projects only have scientific validity if the Investigator fully understands the science behind why the product works and applies that understanding to the experiment. While many consumer products are easy to use, the science behind them is often at the level of a graduate student in college.</td>
</tr>
<tr>
<td>Any topic that requires people to recall things they did in the past.</td>
<td>The data tends to be unreliable.</td>
</tr>
<tr>
<td>Effect of colored light on plants</td>
<td>Several people do this project at almost every science fair. You can be more creative!</td>
</tr>
<tr>
<td>Effect of music or talking on plants</td>
<td>Difficult to measure.</td>
</tr>
<tr>
<td>Effect of running, music, video games, or almost anything on blood pressure</td>
<td>The result is either obvious (the heart beats faster when you run) or difficult to measure with proper controls (the effect of music).</td>
</tr>
<tr>
<td>Effect of color on memory, emotion, mood, taste, strength, etc.</td>
<td>Highly subjective and difficult to measure.</td>
</tr>
<tr>
<td>Any topic that requires measurements that will be extremely difficult to make or repeat, given your equipment.</td>
<td>Without measurement, you can't do science.</td>
</tr>
<tr>
<td>Graphology or handwriting analysis</td>
<td>Questionable scientific validity.</td>
</tr>
<tr>
<td>Astrology or ESP</td>
<td>No scientific validity.</td>
</tr>
<tr>
<td>Any topic that requires dangerous, hard to find, expensive, or illegal materials.</td>
<td>Violates the rules of virtually any science fair.</td>
</tr>
<tr>
<td>Any topic that requires drugging, pain, or injury to a live vertebrate animal.</td>
<td>Violates the rules of virtually any science fair.</td>
</tr>
<tr>
<td>Any topic that creates unacceptable risk (physical or psychological) to a human subject.</td>
<td>Violates the rules of virtually any science fair.</td>
</tr>
<tr>
<td>Any topic that involves collection of tissue samples from living humans or vertebrate animals.</td>
<td>Violates the rules of virtually any science fair.</td>
</tr>
</tbody>
</table>

Source: http://www.sciencebuddies.org/science-fair-projects/project_question.shtml#examples
<table>
<thead>
<tr>
<th>What Makes a Good Science Fair Project Question?</th>
<th>For a Good Science Fair Project Question, You Should Answer “Yes” to Every Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the topic interesting enough to read about, then work on for the next couple months?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Can you find at least 3 sources of written information on the subject?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Can you measure changes to the important factors (variables) using a number that represents a quantity such as a count, percentage, length, width, weight, voltage, velocity, energy, time, etc.?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Or, just as good, are you measuring a factor (variable) that is simply present or not present? For example, Lights <strong>ON</strong> in one trial, then lights <strong>OFF</strong> in another trial, <strong>USE</strong> fertilizer in one trial, then <strong>DON'T USE</strong> fertilizer in another trial.</td>
<td></td>
</tr>
<tr>
<td>Can you design a “fair test” to answer your question? In other words, can you change only one factor (variable) at a time, and control other factors that might influence your experiment, so that they do not interfere?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Is your experiment safe to perform?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Do you have all the materials and equipment you need for your science fair project, or will you be able to obtain them quickly and at a very low cost?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Do you have enough time to do your experiment more than once before the science fair?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Does your science fair project meet all the rules and requirements for your science fair?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Have you checked to see if your science fair project will require SRC (Scientific Review Committee) approval?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Have you avoided the bad science fair project topic areas listed in the “Science Project Topics to Avoid” table?</td>
<td>Yes / No</td>
</tr>
</tbody>
</table>

Appendix 4 Links to Recommended Covestro PRSEF Resources

Determining Reliable Internet Sources

If a publication is listed in a reputable source, like those below, you can be assured that they are accurate and legitimate:

NASA Headquarters Library

NASA Jet Propulsion Laboratory Video Series
How to do a Science Fair Project

Rubber, Plastic and More - Top Science Project Ideas

Carnegie Library Science & Technology Resources
Articles, Databases & More

Access PA POWER Library
(A research database) Requires a library card

Science Buddies

International Science and Engineering Fair

The World-Wide Web Virtual Library: Science Fairs

Broadcom MASTERS Program

Discovery Young Scientists Challenge

Neuroscience for Kids

PubMed
A database of all published biomedical literature

Google Scholar
References to scholarly literature

See also, Appendix 6 Recommended Chemistry Resources
Appendix 5 Science Project Research Ideas from our Sponsors

Our sponsors are a very important part of the Covestro Pittsburgh Regional Science & Engineering Fair. To increase the number of projects to be considered for a Sponsor Award, Sponsors have supplied us with project criteria to encourage students to conduct research related to the sponsor’s field of interest.

Research Projects Related to Air & Water Pollution
Air & Waste Management of Western PA Section will present two student awards related to air and water pollution.

Research Projects Related to ALCOSAN
will present an award to one Senior Division student research project that proves in what way(s) pollution affects the environment. It is required that the project presents the different types of pollution, as well as their effects. The research project must demonstrate high-level thinking and reasoning, knowledge of the subject area, and a concern for water quality.

Research Projects Related to Allegheny County Health Department
Three students will be awarded in the areas of environmental health, air pollution and public health.

Research Projects Related to Allegheny County Medical Society Alliance
One Science Fair student and teacher award in the field of medicine/biology presented in honor ACMS Alliance members. Winning projects should promote healthy living, improve public health and/or the advancement of medicine.

Research Projects Related to Allegheny County Medical Society Foundation
Two awards will be presented to students with projects in a topic related to Medicine. Projects should demonstrate ideas that could improve health care for patients in the future or promote quality improvement in a medically related area. The project should demonstrate knowledge of the subject area and how it relates to the field of Medicine.

Research Projects Related to American Society for Quality
American Society for Quality will present an award to a student who applies quality techniques to his/her project. The judging criteria are: the students’ ability to eloquently and accurately describe their project and a theme of quality within the project, which often involves the use of statistical methods for high school students or the inclusion of quantitative reasoning for middle school students.

Research Projects Related to American Society of Civil Engineers
The American Society of Civil Engineers, ASCE, Pittsburgh Section will present two Science Fair student awards in civil engineering. Projects involving dams and waterways will be considered since they are an integral part of our region. An award in the Junior Division and Senior Division will be presented.

Research Projects Related to ASM International, Golden Triangle Chapter
An award will be presented to one Science Fair student project in the field of materials science and engineering. The winning project will be chosen based on the following: a) project must be based on some aspect of materials-related concepts, for example: solidification processing, heat treatment, mechanical testing, corrosion, etc.; b) clarity of presentation; c) demonstration of a clear understanding of the scientific method; d) aesthetics - project layout, neatness, readability, etc.
Research Projects Related to The Aviation Foundation
Two student awards will be selected as follows: i) *Aviation Weather Prediction* - How to predict ceiling, visibility, wind and temperature needed by pilots. ii) *Unique Aircraft Design* – Develop an unusual design for an aircraft. Determine any advantages of this design.

Research Projects Related to Braskem America
Braskem America will present two awards to students with projects that demonstrate innovation with a focus on sustainability. We have a special interest in the areas of polymers, plastics, engineering, and chemistry.

Research Projects Related to Bridges
Two (2) students awards for bridge related projects sponsored by the Association for Bridge Construction and Design.

Research Projects Related to Carnegie Mellon University, Leonard Gelfand Center for Service Learning and Outreach.
Carnegie Mellon will present three student and sponsoring teacher awards. The Leonard Gelfand Center presents three awards annually. These are selected by Carnegie Mellon faculty or students and focus on the judges’ area of research.

Research Projects Related to Chemistry
The Pittsburgh Section of the American Chemical Society will award students for projects that demonstrate creativity and knowledge in topics related to chemistry.

Research Projects Related to Duquesne University - Bayer School of Natural and Environmental Sciences
The Bayer School of Natural and Environmental Sciences at Duquesne University will award three students for their projects based on the areas of biology, chemistry, environmental science, forensics, and physics. Creativity, ingenuity and a strong understanding of the scientific method should be demonstrated.

Research Projects Related to Electrical Power:
Eaton will present awards for projects in the field of engineering relative to electrical power distribution, which demonstrate creativity and knowledge in topics related to energy efficiency, circuit protection, renewable power, electrical safety or power quality.

Research Projects Related to Electrical and Electronics Engineering - IEEE Award
The Institute of Electrical and Electronics Engineers (IEEE) will present The Institute of Electrical and Electronics Engineers (IEEE) will present two awards in the field of electrical and electronics engineering. Winning projects will demonstrate significant knowledge of electrical principles, electronics, robotics, computer design, software development or mathematical techniques. Students are encouraged to submit projects to the Science Fair categories such as Engineering, Robotics, Computer, Physical Science, etc. to be considered for these awards.

Research Projects Related to Innovation Works
Innovation Works will make awards based on the potential to commercialize technology to solve real-world problems. The technology can be based in any scientific or engineering discipline (robotics,
energy, life sciences, information technology, materials science, etc.) as long as there is a demonstrable need and the scientific research addresses the need with a solution that could be mass produced and marketed.

**Research Projects Related to National Association of Corrosion Engineers, Pittsburgh Section**
NACE International’s Pittsburgh Section will present awards for the studies of corrosion mitigation that help protect people, assets, and the environment from the adverse effects of corrosion. Select an industry (Pipelines; Bridges; Drinking and Waste Water; Department of Defense; etc) and identify the threats of corrosion, the consequences of a corrosion event, and provide recommendations of mitigation measures for improvement. Creativity, ingenuity and a strong understanding of corrosion should be demonstrated.

**Research Projects Related to Industrial Hygiene**
The Pittsburgh section of the American Industrial Hygiene Association will present two awards in the field of Industrial Hygiene. Winning projects will be based on how well the student understands the health & safety industry which focuses on issues such as indoor air quality, exposure to chemicals, noise, heat/cold, vibrations, and repetitive motion.

**Research Projects Related to Mining, Mining Engineering or the Field of Geology or Mineralogy**
The Society for Mining, Metallurgy, and Exploration (SME) Pittsburgh Section would like to present an award to a project related to the application of mining and mining engineering or the fields of geology or mineralogy.

**Research Projects Related to Neuroscience**
Projects related in any way to the nervous system will be judged on their use of sound scientific methods and reasoning, and the quality of results obtained. This award is sponsored by the Department of Neuroscience, University of Pittsburgh.

**Research Projects Related to Paints, Coatings and Related Materials**
PPG will present six (6) awards for projects involving chemistry, physics, engineering, or material science which demonstrate creativity and knowledge in topics related to fiberglass, glass, coatings, paints, plastics, inks, adhesive, color, optically transparent material, polymers or chemicals. Two awards in each division (6th, 7th-8th, 9th-12th).

**Research Projects Related to Pittsburgh Geological Society**
PGS will present two awards. Awards will be presented for earth science / geoscience projects that examine how the geologic basis of our environment relates to everyday life. Ideas for project topic areas include the following. A rock stratigraphic column is a good place to start as it sets the framework for your investigation. Mineral resources are an important part of the Pennsylvania economy and the legacy of historic mining still causes problems of acid mine drainage, mine subsidence and hazardous materials contamination. Coal, oil, and gas development can interact with rural and urban development and affect both the quality and quantity of surface and groundwater resources. The current Marcellus shale gas drilling demonstrates the importance of that resource and its associated environmental controversies to the community you live in. Landslides destroy houses, close roads and disrupt utilities. The recognition of causes is an important municipal planning tool. Knowledge of the various types of rock and their properties are aspects of mineralogy, geochemistry, geophysics, geotechnical engineering and the durability of building materials, even gravestones. Fossils are important to understanding the role of evolution in a changing historical landscape and understanding differences in depositional
environments. Western PA even has volcanic rocks. Projects are not limited to Pennsylvania problems. Listen / read the news, look at an outcrop, let your mind wonder to the question Why!

Research Projects Related to Pittsburgh Intellectual Property Law Association (PIPLA)
PIPLA will award two students for projects that demonstrate creative ideas resulting in new and functional processes or devices. Projects in Engineering/Robotics, among others, will be considered.

Research Projects Related to Psychoanalysis
Pittsburgh Psychoanalytic Center will make an award(s) that offers a way of understanding ourselves, our relationships and how we conduct ourselves in the world. Winning projects could include the following topics: Dreams, the Unconscious, Development, Relationships, Trauma, or Anxiety/Defense.

Research Projects Related to Sigma XI - Carnegie Mellon University
Sigma XI - Carnegie Mellon University awards a student in any discipline of science or mathematics for a project that shows innovation, diligence, relevance to everyday life and quantitative analysis. We have a special interest in experiment design and use of statistical methods to interpret results.

Research Projects Related to Spectroscopy
An award will be presented by the Spectroscopy Society of Pittsburgh to the six Science Fair student projects in spectroscopy or its components, including optics, lenses, prisms, mirrors, lasers, dispersion, interference. Three awards will be selected from Senior and three from Intermediate/Junior Divisions. Winning projects will involve topics dealing with spectroscopy and will have completed all components of the Covestro PRSEF project (lab notebook, report and poster).

Research Projects Related to Society for Mining, Metallurgy, and Exploration
The Pittsburgh Section of the Society for Mining, Metallurgy, and Exploration (SME) would like to present their award to a project related to the application of mining and mining engineering or the fields of geology or mineralogy. Creative or innovative uses of modern technology, such as electronics, computerization, and/or robotics, in mining, mineral exploration, geology, mining equipment, miner safety, or mine rescue would merit strong consideration for a prize award.

Research Projects Related to Society of Military Engineers
What is the current condition of the nation’s electrical generation and transmission grid and how will carbon reduction mandates, decreased electrical generation by coal, aging infrastructure, and alternative energy sources such as solar and wind affect the reliability of the power grid and the cost of electricity?

Given the impact of aging infrastructure nationwide, and the importance of maintenance to extend the service life, students could evaluate the infrastructure condition in their municipality, the budgets in place to maintain or replace infrastructure, and explore what planning options should be considered for maintenance and replacement of the municipality’s infrastructure.

Research Projects Related to Society of Women Engineers
An award will be presented to one middle school female student and one high school female student for research projects showing practical applications of engineering principles (civil, chemical, industrial,
Winning projects will demonstrate a creative, yet practical, application of the selected engineering discipline.

Research Projects Related to Sustainable Materials
Covestro will present two awards in each division for projects focused on polymer materials and Circular Economy design principles. The winning project will take a future-facing look at expanding the long-term benefits of polymer technologies in areas such as recycling/reuse, energy efficiency and outreach. Solutions based on chemistry, environmental science and engineering will be considered.

Research Projects Related to The Webb Law Firm
The Webb Law Firm will award two students for projects that demonstrate creative ideas resulting in new and functional processes or devices. Projects in Engineering/Robotics, among others, will be considered.

Research Projects Related to the Impacts of Thermo Fisher Scientific
Thermo Fisher Scientific will present awards to projects whose finding and knowledge thereof could have impact in making the world healthier, cleaner, or safer. Subject matters may be related (but are not limited) to laboratory work in the fields of biology, chemistry, water quality, or safety for consumer or industrial markets.

Research Projects Related to Thiel College
Thiel College will present awards to projects in the fields of Behavioral and Social Science, Biology, Environment, and Medicine & Health
Appendix 6 Recommended Chemistry Resources

Covestro PRSEF Chemistry Category Judges’ Preferred Bibliographic Resources

Charles B. Greenberg, Ph.D., Category Co-chair

A. About the “Science Enterprise” Generally


B. Intermediate School Chemistry
See Senior Chemistry below too and explore to your grade-appropriate comfort level for each subject. For example, the Encyclopedia Britannica, which is listed as reference #7 for Senior Chemistry, will also often serve Intermediate School Chemistry. So, do not hesitate to browse, and then move on to the next resource.

1. American Chemical Society, Chemistry for Life: http://www.middleschoolchemistry.com. [Protons, Neutrons and Elements; Finding Volume; Why Does Water Dissolve Salt?; The Periodic Table; Molecules in Motion]


CBGreenberg, Ph.D. 08/17/14 Senior Chemistry Category Co-chair


6. Museum of Science & Industry, Chicago, *Online Science, including goReact; Analyze Candy Using Chromatography; See the Colors in Leaves; Create Gas; Make Ice Cream; Make Recycled Paper; Make Slime:* [https://www.msichicago.org/experiment/hands-on-science/candy-chromatography/](https://www.msichicago.org/experiment/hands-on-science/candy-chromatography/).

7. Smithsonian Science Education Center, *Middle School Teaching Resources:* [https://ssec.si.edu/](https://ssec.si.edu/). [Subjects include electricity, energy, optics, properties of matter, weather and climate.]

**C. Senior Chemistry (but not excluding Intermediate Level resources)**


7. Encyclopedia Britannica, *Chemistry:* [https://www.britannica.com/science/chemistry](https://www.britannica.com/science/chemistry). [Broad coverage; if you are not a subscriber, just ignore the ads, which are the price for free access to the site.]


14. Miodownik, Stuff Matters, Houghton Mifflin Harcourt, Boston (2014). [About various materials such as steel, glass, paper, textiles and more.]


17. National Science Digital Laboratory: https://nsdl.oercommons.org/ [Browse the resource categories.]


19. Sandia National Laboratories, Energy and Climate: http://energy.sandia.gov. [Renewable Systems such as fuel cells and biomass, as well as the Combustion Research Facility, are linked.]


Appendix 7 A General Guide for Scientific References

Students are required to list at least 5 (five) major references (e.g. science journals, books, articles, internet sites will be checked and must be well documented) in their research plans. Referencing sources correctly is crucial for purposes of academic integrity and of students’ future success in higher educational pursuits.

Below are examples of what types of information to include in references, descriptions of what that information entails and how to find it, and formatting requirements for those references.

**Basic Reference Structure:**

Author(s), title, journal name, journal identifying information (year date, volume, issue, page(s)), web address (if any), date accessed (if web based)

**Anatomy of a reference:**

*Author:* The names of the people who wrote the reference. If this is an anonymous publication, such as a report from a government agency, you would list the government agency.

*Title:* the name of the article. If this was a report from a government agency, the name of the report. If this was a news item, even from web source, this is the headline. If this is a web item, it’s the title at the beginning.

*Journal name:* the name of the book or journal. If this was a news item, it would be the newspaper, or the web-based news site, with the date.

*Web address:* If the source was obtained from the web, then this is the exact URL which would bring up the content cited. If this is a print journal or a print newspaper which you are viewing on-line, then you don’t need to reference the web address, because this exists on paper.

*Date accessed:* This is the date on which you viewed the material you are citing. This is important because information on websites can be edited at any time.

**Examples of different types of sources:**


**Journal Article:** Ormerod, R. J. (1998). Beyond internal OR groups. *Journal of Operational Research Society, 49*(4), 420-429. N.B., If an article is from a print journal, you don’t need to add a URL, even if you read the article on line.


NOTES:

Listing only a URL is never acceptable.

Wikipedia is not an acceptable academic reference; however, Wikipedia uses standard references, which you can use in your literature search. While Wikipedia is often accurate, it may contain information or references which are not reliable.

Academic references should be of high quality and should be peer reviewed. Please check [http://flinders.libguides.com/evaluate](http://flinders.libguides.com/evaluate) for information about how to evaluate a source and its legitimacy.
Appendix 8 Project Categories

Individuals and team projects of the same scientific discipline will compete in the same category. Students will select a project category and type (individual/team) during registration. A team consists of 2 or 3 members who are all in grade levels which allow them to compete in the same division. For example, a seventh grader and an eighth grader would both be in the intermediate division and may work together; however, a sixth grader and a seventh grader would be in two different divisions and may not work together.

Junior Division - New Categories (Grade 6)

**Behavioral and Consumer Sciences** These projects will explore consumer products and the science of how people respond to the world around them. The areas include: Consumer Related (Consumer Product Testing, Consumer Product Design and Enhancements, Comparisons and Evaluation of Commercially Available Products), Behavioral Science Related (Psychology, Human and Animal Behavior, Learning and Perception, Educational and Testing, Surveys),

**Biological Sciences** These projects will explore living things, including plants, animals and humans, and the things which affect them. The area includes: Life Science Related (Biology, Botany & Zoology, Photosynthesis, Plant Growth, Biochemistry, Genetics & Inherited Traits), Health Related (Nutrition, Human and Animal Behavior, Allergies, Exercise, Studies of Animal/Human Health)

**Chemistry** These projects will explore chemistry, which includes study of any kinds of chemicals. These areas include: Chemistry Related (Organic & Inorganic Chemistry, Chemical Compounds, Household Chemicals (chemistry focus, not functional emphasis), Chemical Engineering) **Note**: If the project focuses on the biological impact/effect of the chemical, then the project should be placed in the biological category.

**Physical Sciences & Engineering** These projects will explore physics which includes our mechanical world, and engineering, which includes building things and solving problems: **Physics Related** (States of Matter, Optics and Photography, Sound and Acoustics, Heat, Cold and Thermal, Conductivity, Pressure and Vacuum, Electricity and Magnetism, Friction, Inertia, Gravity, Density), **Engineering Related** (Mechanical Engineering, Transportation, Buildings and Bridges, Planes, Trains, Boats and Cars, Sports, Robotics, Computers, Energy Production, Conversion and Storage, Alternative Energy, such as Wind and Solar)

Intermediate Division - (Grade 7, 8)

**Behavioral and Social Science**: human and animal behavior, social and community relationships - psychology, sociology, anthropology, archaeology, ethnology, ethnology, linguistics, learning, perception, urban problems, reading problems, public opinion surveys, educational testing, etc.

**Biology**: botany, zoology, genetics, biochemistry, including hormones, molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, food chemistry, etc.

**Chemistry**: inorganic, organic, physical materials, plastics, fuels, pesticides, metallurgy, etc.
Consumer Science: projects in the areas of consumer product testing and design.

Computer Science/Math: development of computer hardware, software engineering, Internet, simulations; statistics, calculus, geometry, abstract algebra, number theory, probability, etc.

Earth / Environment: pollution and sources of control, ecology, geology, mineralogy, oceanography, meteorology, climatology, geology, seismology, etc.

Engineering / Robotics: technology; projects that apply scientific principles to manufacturing and practical uses - civil, mechanical, aeronautical, chemical, heating and refrigerating, transportation, electrical, photographic, sound, automotive, marine, etc.

Medicine & Health/Microbiology: bacteriology, virology, fungi, bacterial genetics, etc.; study of diseases and health of humans and animals - dentistry, pharmacology, pathology, ophthalmology, nutrition, sanitation, pediatrics, dermatology, allergies, speech and hearing, etc.

Physics and Astronomy: solid state, optics, acoustics, particle, nuclear, plasma, superconductivity, fluid and gas dynamics, magnetism, quantum mechanics, biophysics, astronomy etc.

Senior Division (Grades 9, 10, 11, 12)

Behavioral and Social Science: human and animal behavior, social and community relationships - psychology, sociology, anthropology, archaeology, ethnology, ethnology, linguistics, learning, perception, urban problems, reading problems, public opinion surveys, educational testing, etc.

Biology: botany, zoology, genetics, biochemistry, including hormones, molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, food chemistry, etc.

Chemistry: inorganic, organic, physical materials, plastics, fuels, pesticides, metallurgy, etc.

Computer Science / Math: development of computer hardware, software engineering, Internet, simulations; statistics, calculus, geometry, abstract algebra, number theory, probability, etc.

Earth / Environment: pollution and sources of control, ecology, geology, mineralogy, oceanography, meteorology, climatology, geology, seismology, etc.

Engineering / Robotics: technology; projects that apply scientific principles to manufacturing and practical uses - civil, mechanical, aeronautical, chemical, heating and refrigerating, transportation, electrical, photographic, sound, automotive, marine, etc.

Medicine & Health / Microbiology: bacteriology, virology, fungi, bacterial genetics, etc.; study of diseases and health of humans and animals - dentistry, pharmacology, pathology, ophthalmology, nutrition, sanitation, pediatrics, dermatology, allergies, speech and hearing, etc.

Physics / Astronomy: solid state, optics, acoustics, particle, nuclear, plasma, superconductivity, fluid and gas dynamics, magnetism, quantum mechanics, biophysics, astronomy, etc.
Appendix 9 Using Statistics

As a tool to strengthen the use of statistical techniques in science fair projects, students should consider using the following statistical techniques (only if statistics are applicable) in presenting and analyzing data collected for their projects:

Junior Division

Graphical Presentation:
- Multiple samples
- Plotting data on graphs
  - X-Y charts
  - Pie charts
  - Bar charts

Intermediate Division

Statistical Analysis:
- Measure with dot plot
- Non-linear plots
- Numerical summaries
  - Median, mean
  - Percentiles, standard deviation

Senior Division

Hypothesis Testing:
- Z-test, T-test, Chi Square and when to use each
- Normal Distribution
- Linear Regression
- Least-squares curve fit

Statistical Advice for a Project

- Your library will have several references on statistics and statistical techniques to help you with your project.
- A general rule for sample size is 10 minimum per case. When comparing 2 groups use at least 8 samples each. Seek a minimum of 4 samples per group when comparing many groups.
- Present the all of the raw data obtained from the experiment and use statistical techniques to analyze them. Present the results of the analysis. Draw conclusions based upon the results of the analysis.
- Describe and explain any experimental data you obtained but that you chose not to use. Explain why you chose not to use the data.
- Using computer programs to plot and analyze data is acceptable. However, make sure that you know how the programs analyze data – a judge may ask you to explain it.
Appendix 10 Electronic Devices Policy

Electronic Devices Policy
Pittsburgh Regional Science & Engineering Fair

The Pittsburgh Regional Science & Engineering Fair embraces the respectful use of technology; in particular mobile phones.

We believe that respectful and responsible usage involves:

- Having your phone on silent mode or turned off during the judging process - 10:00 am – 12:30 pm and 2 pm – 3:45pm;
- Only using mobile phones and other electronic devices before judging, at lunch and after 3:45pm;
- Keeping mobile phones and MP3 players in pockets or with belongings under the exhibit table.
- Using common courtesy to others - do not let your mobile phone interrupt conversations or judging

Inappropriate usage involves:

- Taking pictures or recordings without consent; and
- Using your mobile phone during judging.

Covestro PRSEF personnel may choose from a range of consequences:

- Warning;
- Disqualification from Covestro PRSEF; and/or
- Placing mobile phone or electronic device at Covestro PRSEF information hub for designated time.

Students are responsible for own items if lost or damaged.
Appendix 11 Category Award Selection Procedure

Although there are many ways to reach a decision on category award winners, the following two procedures are simple and avoid the issue of disparity in judges' numerical scoring.

1. Judges review abstracts and view project boards without the student being present.
2. Judges revisit project boards and interview students.
3. After interviews are completed, all of the judges that have evaluated a group of projects meet to decide which are the best 1 or 2 projects in their group. If the judges feel that none of the projects in their group are worthy of an award, they should discuss this with their co-chair. Likewise, the judges may feel that there are more than 2 projects in their group which deserve further consideration. This too should be discussed with the co-chair.
4. The top 1 or 2 projects from each group are then presented to the whole group for final award judging. Between 6 and 9 projects should be advanced to be judged by all of the category judges in the group. This number will depend on the number of awards available to be awarded.
5. Each judge records the selected project numbers on the Award Selection Form. See Appendix 7 Award Selection Form.
6. As a group, all of the judges for the category visit the 6 to 9 selected projects without the student present. At this time, one of the judges shall present each project to the panel for discussion. Not all projects advanced will be recognized with an award.
7. When revisiting is completed, each judge ranks the projects, giving their first choice 1 point, the second 2 points and so on. Discussion is encouraged.
8. The ranking scores from each judge are added and the award winners are determined based on the composite scores. The first place winner is the project with the lowest score, second place to the next lowest and so on.
9. Judges caucus to discuss the results and confirm that the project with the lowest score is the one which the group agrees is the best project. They repeat that procedure for the other award winners. Co-chair judges shall resolve ties if the selection appears to be at an impasse.
10. Based on the number of entries in each category, multiple second, third and 4th place awards may be awarded. Only one first place will be awarded in each category. Judges will follow the Final Category Ranking form to determine how many awards to select. See Appendix 8 Sample Final Category Ranking Form.

Alternate Procedure

7. After the projects have all been presented to the group, the best of the category shall be chosen by a vote. The group discusses each of the projects and, via a show of hands, asks who among the judges feels that this particular project is worthy of 1st place. The project receiving the most votes is the 1st place selection for the category.
8. The group discusses each of the remaining projects and, via a show of hands, asks who among the judges feels that what projects are worthy of 2nd place, 3rd place and 4th place. Based on the number of entries in each category, multiple second, third and honorable mention awards may be awarded. Only one first place will be awarded in each category. Judges will follow the Final Category Ranking form to determine how many awards to select.
Appendix 12 Judging Rubrics

These rubrics were developed in order to provide constructive feedback to the students. These will be used by Category Judges to determine winners in each category. Please note that this will only be one judge’s assessment of the strengths and weaknesses of the student’s work given in order to improve future projects. It will not indicate how well the student performed with respect to other Covestro PRSEF participants. Each student will be interviewed by at least two category judges.

Some rubrics are tailored for specific applications. Point scores are used as a judging tool. Rubrics less the point values will be provided to the students’ teachers after Covestro PRSEF. The Category Judge Selection Procedure (See Appendix 11) has been designed to ensure all projects are evaluated on a consistent basis and ranked appropriately with regard to receiving awards. The decisions of the judges, determined on the day of the fair, are final.
### Senior/Intermediate Division Rubric

**Project # __________ Feedback Form – Senior/Intermediate Division**

The purpose of this form is to provide one judge’s assessment of the strengths and weaknesses of the presenter’s work in order to improve future projects. It does not indicate how well the presenter performed with respect to other PRSSE participants.

<table>
<thead>
<tr>
<th>Judging Criteria</th>
<th>Outstanding</th>
<th>Above expectations</th>
<th>At Expectations</th>
<th>Areas for Improvement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific thought</strong></td>
<td>- Hypothesis is relevant, testable, and novel</td>
<td>- Hypothesis is relevant, testable, and approached in a new way</td>
<td>- Hypothesis is relevant, testable, new to the student, research beyond simple internet search</td>
<td>- Conclusion is largely supported by data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Conclusion is fully supported by data</td>
<td></td>
<td></td>
<td>- Conclusions may overstate what is supported by the data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Define variables and provide controls</td>
<td></td>
<td></td>
<td>- Provide data that support the conclusion</td>
<td></td>
</tr>
<tr>
<td><strong>Experimental methods</strong></td>
<td>- Variables and controls clearly defined &amp; complete</td>
<td>- Variables and controls defined &amp; complete</td>
<td>- Variables and controls defined but may be incomplete</td>
<td>- Define variables and provide controls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Multiple trials, with multiple samples, performed</td>
<td>- At least 2 independent trials with multiple samples performed</td>
<td>- Single trial with multiple samples performed</td>
<td>- Perform multiple trials with multiple samples</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Well planned, documented, &amp; carefully executed</td>
<td>- Well planned &amp; carefully executed</td>
<td>- Appropriate but execution incomplete</td>
<td>- Use an experimental method that is appropriate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Thorough work notebook</td>
<td>- Adequate work notebook</td>
<td></td>
<td>- Prepare and present a notebook</td>
<td></td>
</tr>
<tr>
<td><strong>Analytical approach</strong></td>
<td>- Data completely supports conclusions</td>
<td>- Data adequate to support conclusion</td>
<td>- Data consistent with conclusions but not convincing</td>
<td>- Present data that support conclusions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Data limitations defined</td>
<td>- Data limitations not fully understood</td>
<td>- Limitations of data not addressed</td>
<td>- Understand and describe the limitation of the data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Statistical analysis is appropriate &amp; correctly executed</td>
<td>- Statistical analysis correctly executed</td>
<td></td>
<td>- Apply correct and appropriate statistical analysis</td>
<td></td>
</tr>
<tr>
<td><strong>Visual Presentation</strong></td>
<td>- Primary graphs or tables, scientific question, conclusions, &amp; brief descriptions of methods</td>
<td>- Text and visually displayed</td>
<td>- Text outweighs visually displayed information</td>
<td>- Revise the poster to balance text and visually displayed information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Data presentation is clear and concise</td>
<td>- Proper use of graphs/tables for data presentation</td>
<td>- Some use of graphs/tables for data presentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Material is well organized and reader needs no assistance</td>
<td>- Material is organized and reader can navigate with help</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oral Presentation</strong></td>
<td>- Well prepared, reflects a deep understanding of the question and relevance to a broad audience</td>
<td>- Well prepared, reflects a deep understanding of the question</td>
<td>- Well prepared, reflects an adequate understanding of the question</td>
<td>- Provide a complete description of the question</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Responds readily to questions</td>
<td>- Familiarity of background appropriate to experience level</td>
<td>- Limited familiarity of background material</td>
<td>- Become more familiar with the background material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Can reason from findings independently to suggest further investigations</td>
<td>- Can reason from findings, with help, to suggest further work</td>
<td></td>
<td>- Provide at least one suggestion for further research</td>
<td></td>
</tr>
</tbody>
</table>

**Judge’s Constructive Comment/Suggestion.**

**Judge’s Initials**

---

If TEAM Project, include comments on TEAMWORK:
# Junior Division Rubric

<table>
<thead>
<tr>
<th>Judging Criteria</th>
<th>Outstanding</th>
<th>Above expectations</th>
<th>At Expectations</th>
<th>Areas for Improvement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept Formation</strong></td>
<td>Concept independently developed</td>
<td>Concept independently developed</td>
<td>Concept developed with some assistance</td>
<td>Student should develop concept based upon personal interests</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Hypothesis original, stated clearly, and reinforced by scholarly references</td>
<td>Hypothesis stated clearly and reinforced by additional research</td>
<td>Hypothesis stated clearly</td>
<td>State hypothesis more clearly, reinforce with additional research</td>
<td></td>
</tr>
<tr>
<td><strong>Conduct of Experiment</strong></td>
<td>Student independently recognized need for controls, used them correctly, and recognized additional controls</td>
<td>Data presented clearly with limitations indicated</td>
<td>Data presented clearly</td>
<td>Learns more about experimental control and correct use</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Conclusions are based on multiple experiments with many replications</td>
<td>Conclusions are based on a single experiment with few replications</td>
<td>Data presented</td>
<td>Perform more replications in experiment and gather additional data</td>
<td></td>
</tr>
<tr>
<td><strong>Validation of Hypothesis</strong></td>
<td>Data more than adequate to support the conclusions and clearly presented</td>
<td>Data more than adequate to support conclusions</td>
<td>Data just adequate to support conclusions</td>
<td>Obtain additional data to better support conclusions</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Interpreted data correctly, clearly described interpretation, and applied appropriate statistical techniques</td>
<td>Interpreted data correctly and clearly described interpretation</td>
<td>Interpreted data correctly</td>
<td>Review data and reconsider the interpretation, clarify interpretation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recognizes limitations of data and options to improve</td>
<td>Recognizes limitations of data</td>
<td>Presented data with minimal consideration of limitations</td>
<td>Review data collection method and describe limitations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Describes a well-organized plan for further research in field studied</td>
<td>Citations several examples for further research in field studied</td>
<td>Citations one example for further research in field studied</td>
<td>Consider opportunities for further research in field studied</td>
<td></td>
</tr>
<tr>
<td><strong>Visual Presentation</strong></td>
<td>Primary graphs/tables, hypothesis, conclusions, and brief description of methods</td>
<td>Test and visually displayed information are balanced</td>
<td>Test and visually displayed information</td>
<td>Test outweights visually displayed information</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Extensive use of graphs/tables for data presentation which are clear and concise</td>
<td>Extensive use of graphs/tables for data presentation</td>
<td>Some use of graphs/tables for data presentation</td>
<td>Use graphs/tables to present data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Material is well organized and reader needs no assistance to understand</td>
<td>Material is organized so reader can navigate with help</td>
<td>Material is organized so reader can navigate with help</td>
<td>Organize material to assist reader</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Student can clearly and spontaneously discuss the project and the hypothesis, procedure, and conclusions</td>
<td>Student can discuss the project and explain the hypothesis, procedure, and conclusions</td>
<td>Student can discuss the project and explain the hypothesis, procedure, and conclusions</td>
<td>Become more familiar with the project's hypothesis, procedure, and conclusions</td>
<td></td>
</tr>
<tr>
<td><strong>Oral Presentation</strong></td>
<td>Handles all questions well, leads judge through the discussion</td>
<td>Handles most questions well, leads judge through the discussion</td>
<td></td>
<td>Student handles most questions well, follows the judge's lead through the discussion</td>
<td></td>
</tr>
</tbody>
</table>

Judge's Constructive Comment/Suggestion: ____________________________

Judge's Initials: ____________________________

If TEAM Project, Include comments on TEAMWORK: ____________________________
# Engineering and Robotics Senior Division Rubric

## Project #

### Engineering/Robotics Feedback Form – Senior & Intermediate Division

The purpose of this form is to provide one judge’s assessment of the strengths and weaknesses of the presenter’s work in order to improve future projects. It does not indicate how well the presenter performed with respect to other PRSEF participants.

<table>
<thead>
<tr>
<th>Judging Criteria</th>
<th>Outstanding</th>
<th>Above expectations</th>
<th>At Expectations</th>
<th>Areas for Improvement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineering Approach</strong></td>
<td>⬜ Problem scope is well-defined and serves a clear purpose.</td>
<td>⬜ Problem limited in scope and serves a purpose.</td>
<td>⬜ Problem scope too limited or broad with no clear purpose.</td>
<td>⬜ Clarify and limit the problem scope.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Proposed solution is novel.</td>
<td>⬜ Proposed solution represents a new approach to an old design</td>
<td>⬜ Proposed solution is new to student.</td>
<td>⬜ Propose a solution that has not been tried before.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Project addresses all aspects of the problem.</td>
<td>⬜ Project addresses most aspects of the problem.</td>
<td>⬜ Project addresses only one aspect of the problem.</td>
<td>⬜ Review the project to more clearly address the problem.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Can reason from findings to suggest further work.</td>
<td>⬜ Can reason from findings, with help, to suggest alternative solutions</td>
<td>⬜ Not able to suggest modifications to current plan.</td>
<td>⬜ Become familiar with limitations of the solution and how they relate to limits of the design.</td>
<td></td>
</tr>
<tr>
<td><strong>Procedural Plan</strong></td>
<td>⬜ Design process appropriate &amp; thorough.</td>
<td>⬜ Design process appropriate, expert advice would improve.</td>
<td>⬜ Design process appropriate but is incomplete.</td>
<td>⬜ Review the design process to more clearly address design limitations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Design process well-supported in notebook.</td>
<td>⬜ Design process documented in notebook.</td>
<td>⬜ Design notebook includes minimal data to support design.</td>
<td>⬜ Prepare and present the design notebook.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Construction feasible and cost effective.</td>
<td>⬜ Construction is feasible or cost-effective.</td>
<td>⬜ Construction feasible but not cost effective.</td>
<td>⬜ Revise the construction to be more appropriate and adequate.</td>
<td></td>
</tr>
<tr>
<td><strong>Analytical Approach</strong></td>
<td>⬜ Rationale for solution is clear and appropriate.</td>
<td>⬜ Rationale for solution is clear and appropriate.</td>
<td>⬜ Rationale for solution provided, but lacks clarity and appropriateness.</td>
<td>⬜ Revise the rationale for the solution to be more clear and appropriate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Mathematical approach included, appropriate statistical analysis correctly executed and well understood</td>
<td>⬜ Mathematical approach is included, appropriate statistical analysis correctly executed</td>
<td>⬜ Mathematical approach limited in scope, but is included.</td>
<td>⬜ Describe the mathematical approach.</td>
<td></td>
</tr>
<tr>
<td><strong>Visual Presentation</strong></td>
<td>⬜ Poster is primarily graphs or tables, scientific question, conclusions, &amp; brief descriptions of methods.</td>
<td>⬜ Text and visually displayed information balanced on poster</td>
<td>⬜ Text overweights visually displayed information.</td>
<td>⬜ Revise the poster to balance text and visually displayed information.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Clear and concise data presentation.</td>
<td>⬜ Proper use of data presentation (graphs/tables).</td>
<td>⬜ Some use of graphs/tables for data presentation.</td>
<td>⬜ Use graphs and tables for presenting data.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Material is well organized and reader needs no assistance</td>
<td>⬜ Material is organized so the reader can navigate through it with help.</td>
<td>⬜ Material is organized so the reader can navigate through it with help.</td>
<td>⬜ Organize the material to assist the reader.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Documentation reflects comprehensive understanding of design limitations.</td>
<td>⬜ Documentation reflects understanding of design limitations.</td>
<td>⬜ Documentation reflects incomplete understanding of design limitations.</td>
<td>⬜ Provide documentation.</td>
<td></td>
</tr>
<tr>
<td><strong>Oral Presentation</strong></td>
<td>⬜ Well prepared, reflects a deep understanding of underlying engineering principles and relevance to a broad audience.</td>
<td>⬜ Well prepared, reflects a deep understanding of the question</td>
<td>⬜ Prepared, reflects an understanding of the question.</td>
<td>⬜ Become more familiar with the question and provide a more complete presentation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Responds readily to questions on engineering principles.</td>
<td>⬜ Familiarity with engineering principles</td>
<td>⬜ Limited familiarity with engineering principles.</td>
<td>⬜ Become more familiar with the engineering principles and the rationale for the selected design.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⬜ Understands how the project can be useful and the difficulties that might be encountered in construction</td>
<td>⬜ Understands how the project can be useful but may not appreciate the difficulty of construction</td>
<td>⬜ Believes the project could be useful</td>
<td>⬜ Provide an example of an application.</td>
<td></td>
</tr>
</tbody>
</table>

**Judge’s Constructive Comment/Suggestion:**

**If TEAM Project, include comments on TEAMWORK:**

---

_Engineering/Robotics 2013_
## Engineering Junior Division Rubric

### Engineering Feedback Form – Junior Division

The purpose of this form is to provide one judge’s assessment of the strengths and weaknesses of the student's work in order to improve future projects. It does not indicate how well the student performed with respect to other PRSEF participants.

<table>
<thead>
<tr>
<th>Judging Criteria</th>
<th>Outstanding</th>
<th>Above expectations</th>
<th>At Expectations</th>
<th>Areas for Improvement</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineering Approach</strong></td>
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<td>Project scope</td>
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<td>and novel</td>
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<td>Solution stated clearly</td>
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<td>and reinforced by</td>
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<td>scholarly references</td>
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<td>Design process</td>
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<td>Construction feasible</td>
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<td>and cost-effective</td>
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<td>Rationale for</td>
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<td>solution clear,</td>
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<td>Mathematical approach</td>
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<td>included, appropriate</td>
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<td>statistical analysis</td>
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<td>well understood</td>
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<td>Visual Presentation</td>
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<td>Primary images (or</td>
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<td>schematics) graphs</td>
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<td>or tables, problem</td>
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<td>statement, solution,</td>
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<td>and brief description</td>
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<td>of methods</td>
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<td>Student can clearly</td>
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<td>and spontaneously</td>
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<td>discuss the project</td>
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<td>and explain the</td>
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<td>problem, procedure,</td>
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<td>and solution</td>
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<td>Oral Presentation</td>
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<td>handles all questions</td>
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<td>well, leads judge</td>
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<td>through discussion</td>
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<td>Handles most questions</td>
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<td>well, leads judge</td>
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<td>through discussion</td>
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<tr>
<td>Judge's Constructive</td>
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<tr>
<td>Comment/Suggestion:</td>
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</tbody>
</table>

**PRSEF USE ONLY**

**Student Name:**

**Teacher:**

**School:**

**Judge’s Initials:**

**Judge’s Comments:**

**TEAM Project, Include comments on TEAMWORK:**

EngAJo 2017
Computer Science Senior and Intermediate Division Rubric

Project #__________ Computer Science Feedback Form – Senior & Intermediate Division

The purpose of this form is to provide one judge’s assessment of the strengths and weaknesses of the presenter’s work in order to improve future projects. It does not indicate how well the presenter performed with respect to other PRSEF participants.

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<thead>
<tr>
<th>Judging Criteria</th>
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<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific thought</td>
<td>□ Objective is clear, ambitious and practical</td>
<td>□ Objective is clear and practical</td>
<td>□ Objective is clear but limited</td>
<td>□ Clarify and limit the objective</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>□ Approach to problem is novel</td>
<td>□ Approach to problem is new to the student</td>
<td>□ Approach to problem is well-understood</td>
<td>□ Reevaluate the approach to the problem to prevent potential failures</td>
<td></td>
</tr>
<tr>
<td>Programming methodology</td>
<td>□ Appropriate choice of computer language and effective use of language features</td>
<td>□ Appropriate choice of computer language and language features sometimes used to advantage</td>
<td>□ Appropriate choice of computer language but language features not used to advantage</td>
<td>□ Improve the choice of computer language and improve use of features of computer language</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>□ Program and data structure well-fitted to problem</td>
<td>□ Program and data structure adequate for the problem</td>
<td>□ Program and data structure sufficient to solve the problem</td>
<td>□ Redesign the program or data structures to prevent failures</td>
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<tr>
<td></td>
<td>□ Coding standards and conventions used</td>
<td>□ Coding standards and conventions used</td>
<td>□ Code commented adequately and with good variable naming</td>
<td>□ Comment the code and use descriptive variable names</td>
<td></td>
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<tr>
<td>Analytical approach</td>
<td>□ User interface is effective</td>
<td>□ User interface is inadequate</td>
<td>□ User interface is weak</td>
<td>□ Redesign the user interface to prevent confusion</td>
<td>20</td>
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<tr>
<td></td>
<td>□ Processing algorithms correct and efficient</td>
<td>□ Processing algorithms correct with limited attention to efficiency</td>
<td>□ Processing algorithms correct but no consideration for efficiency</td>
<td>□ Correct the processing algorithms to produce expected results</td>
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</tr>
<tr>
<td>Visual Presentation</td>
<td>□ Poster contains concise summary of algorithms, results, and sample input and output, including special cases</td>
<td>□ Poster contains adequate information</td>
<td>□ Poster contains too much or too little detail</td>
<td>□ Clarify the poster</td>
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<tr>
<td></td>
<td>□ Algorithms are described</td>
<td>□ Algorithms are not sufficiently described</td>
<td>□ Algorithms are not sufficiently described</td>
<td>□ Present the algorithms and correctly describe them</td>
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<tr>
<td></td>
<td>□ Complete diagrammatic description of program structure</td>
<td>□ Limited diagrammatic description of program structure</td>
<td>□ Limited attempt at description of program structure</td>
<td>□ List input and output conditions with samples</td>
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<td></td>
<td>□ Material is well organized and reader needs no assistance</td>
<td>□ Material is organized and reader needs minimal assistance</td>
<td>□ Material is organized so the reader can navigate with help</td>
<td>□ Describe the program structure</td>
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<tr>
<td>Oral Presentation</td>
<td>□ Well prepared, reflects a deep understanding of the program and how objective satisfied</td>
<td>□ Well prepared, reflects a deep understanding of the program</td>
<td>□ Well prepared, with a superficial understanding of the program</td>
<td>□ Organize the material to assist the reader</td>
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<td></td>
<td>□ Responds readily to questions</td>
<td>□ Become more familiar with the background material</td>
<td>□ Limited familiarity with background appropriate</td>
<td>□ Provide a complete description of the program</td>
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<tr>
<td></td>
<td>□ Can reason from experience to suggest further improvements and extensions</td>
<td>□ Can suggest further improvements</td>
<td>□ Suggestions for improvements are very simple</td>
<td>□ Suggest at least one potential improvement</td>
<td></td>
</tr>
</tbody>
</table>

Judge’s Constructive Comment/Suggestion:

If TEAM Project, include comments on TEAMWORK:

Initials

Computer 2013
# Mathematics Senior and Intermediate Division Rubric

## Project Feedback Form – Senior & Intermediate Division

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<tr>
<td><strong>Scientific thought</strong></td>
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<td>20</td>
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<tr>
<td>Objective is clearly-stated with mathematical content</td>
<td>Objective is clearly-stated with mathematical content</td>
<td>Objective is clearly-stated with mathematical content</td>
<td>Choose an objective that is at or above the grade level of the student and correct the objective</td>
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<tr>
<td>Appropriate mathematical language</td>
<td>Appropriate mathematical language</td>
<td>Appropriate mathematical language</td>
<td>Use mathematical language that is appropriate</td>
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<td>Supporting evidence</td>
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<tr>
<td>Results placed in historical context</td>
<td>Results placed in historical context</td>
<td>Results placed in historical context</td>
<td>Provide historical background</td>
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<tr>
<td>Counter examples show argument fails if hypotheses are omitted</td>
<td>Counter examples show argument fails if hypotheses are omitted</td>
<td>Counter examples show argument fails if hypotheses are omitted</td>
<td>Provide examples to illustrate result</td>
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<tr>
<td>Analytical approach</td>
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<tr>
<td>Step-by-step argument without gaps</td>
<td>Step-by-step argument with only minor gaps</td>
<td>Step-by-step argument with only minor gaps</td>
<td>Revise the argument to support conclusions</td>
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<tr>
<td>Appropriate references to the literature</td>
<td>Appropriate references to the literature</td>
<td>Appropriate references to the literature</td>
<td>Provide references</td>
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<td>Visual Presentation</td>
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<tr>
<td>Poster contains concise summary of results, steps of argument and illustrations of supporting evidence</td>
<td>Poster contains sufficient summary of results, steps of argument and illustrations of supporting evidence</td>
<td>Poster contains sufficient summary of results, steps of argument and illustrations of supporting evidence</td>
<td>Revise the poster to summarize the results and steps of the argument and to provide supporting evidence</td>
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<tr>
<td>Material is well organized and reader needs no assistance</td>
<td>Material is well organized and reader needs no assistance</td>
<td>Material is well organized and reader needs no assistance</td>
<td>Provide a complete example illustrating the argument</td>
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<td>Oral Presentation</td>
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<tr>
<td>Well-prepared, reflects a deep understanding of the question and relevance to a broad audience</td>
<td>Well-prepared, reflects a deep understanding of the question and relevance to a broad audience</td>
<td>Well-prepared, reflects a deep understanding of the question and relevance to a broad audience</td>
<td>Become more familiar with the question and provide a more complete presentation</td>
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<tr>
<td>Responds readily to questions</td>
<td>Responds readily to questions</td>
<td>Responds readily to questions</td>
<td>Become more familiar with the question and provide a more complete presentation</td>
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<tr>
<td>Judge’s Constructive Comment/Suggestion:</td>
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</table>

If TEAM Project, include comments on TEAMWORK.