Santa Clarita Christian School
3rd Annual STEM Expo

April 26, 2019

Dear Students and Parents,

SCCS is excited to host the third annual STEM Expo on Friday, April 26, 2019! Last year over 60 students in grades 3 through 7 participated in our second annual STEM Expo. We had the most innovative and creative experiments, inventions, and creations we have ever seen, and we are hoping to build upon this. We are very excited to see and hear what you discover, build, or design! Our hope is that this STEM Expo will pique your interest in the important areas of science, technology, engineering, and mathematics.

This packet will guide you through the process of preparing for the STEM Expo. We hope to come alongside you each step of the way, providing guidance and insight as you create your project. Each STEM Expo category is explained in detail in the following pages. Ideas, resources, and instructions are included. You will also find your "milestone" check-in pages that will need to be turned in at each one of the check-in days. Through the help of STEM Parents, we intend to make this a fun learning process for all students involved. We have built in checkpoints so that questions can be answered along the way.

Each project type has a specified structure and set of steps that students should follow in developing their projects.

Part of what we want students to learn is how to take a big project and break it down into a set of smaller, solvable problems that can be worked systematically to complete the larger project. The creative aspects of their projects should be applied to the product itself, not the steps used to accomplish.

The internet, including www.discoveryeducation.com and even YouTube, is FULL of examples and ideas. You can design and build your project without having to spend a lot of money! Be creative and resourceful!

Happy Creating!

Mrs. Trosper and Mrs. Kistler

STEM Expo Chairpersons

SCCS Science, Technology, Engineering, Mathematics (STEM) Expo Project Overview

Purpose: Expose students in grades 1st – 8th to STEM-related project-based, hands-on learning for the purpose of getting them excited about and interested in STEM. Students will learn a variety of important skills in the process of creating, designing, organizing, and presenting their projects.

Participation: Each student in grades 1st – 8th will be encouraged to participate in the STEM Expo by developing a project and completing it consistent with the key project milestones listed below. Although some teachers may allow for a small amount of classroom time to be used to develop the projects, most of the project development will be outside of the classroom. Students should plan to spend 30-45 minutes a week on the project from February to April. This should be adequate to complete an appropriately scoped project.

Key Project Milestone Dates:

Date	**Milestone**
February 15	Students need to **verbally** inform teacher of their plans for involvement in STEM Expo (send email)
March 15	Project Milestone #1 - selection and proposal complete and approved by STEM volunteer and teacher Milestone #1 page due
April 12	Project Milestone #2 - Technical check-in review with STEM volunteer (specific milestones for this requirement depend on the project type selected) Milestone #2 page due
April 26	Project complete and ready for Expo and judging

The project milestones will be evaluated in class or at the Expo on the specified days. At the STEM Expo event, the students will have to opportunity to describe and show their project to a judge and will receive feedback on the project from the judge.

Project Categories:

Next is a list of the project types we will be allowing at the STEM Expo this year. Students are encouraged to choose any category and project that **interests** them. If a student has participated in the Expo before, we encourage them to try a project from a different category to expand their understanding of other project development types. Students should make sure to select a project that can be completed in the 6 weeks available for its development once the proposal is complete in February. The STEM volunteers will assist in helping scope the projects at the first key project milestone.

1.	**Invention**	The Invention category provides a general area for an innovative solution to a problem, or a new single item invention. Students who select the invention category will be required to describe and illustrate the invention's design, describe and understand the invention's use and benefits, and build a prototype version of the invention for the Expo.
2.	**Reverse Engineering**	The Reverse Engineering category is intended to provide a means of discovery of engineering concepts and methods. (This is an excellent category for some of our younger students participating in the Expo.) Students who select the reverse engineering category must take something apart, learn how it works, and then be able to write down and describe how it works for the Expo.
3.	**Robotics & Computer Science**	The Robotics and Computer Science category provides a way to apply practical engineering, technology and math concepts to designing a robot with a purpose. Students who select the Robotics & Computer Science category will design and build a robot with a computer that completes a task either autonomously, semi-autonomously, or by remote control. The robot will be demonstrated at the Expo. Students may also design a computer program using code.
4.	**Rube Goldberg**	The Rube Goldberg Category is intended to provide a means of discovery of physics and engineering concepts and methods. Students who choose the Rube Goldberg category will design and build a Rube Goldberg machine. A Rube Goldberg machine is a device, apparatus, or invention that is deliberately over-engineered to perform a very simple task in a very complicated fashion, usually including a chain reaction. The student will need to describe the device purpose, the sequence of steps it

		performs to enact the purpose, and build the device / apparatus for the Expo.
5.	**Scientific Inquiry**	Scientific Inquiry is the basic experimentation category and provides a category most consistent with standard science fair entries. Students who select the Scientific Inquiry category will be required to utilize the scientific method to acquire knowledge about something. The scientific method involves research, hypothesis, experiment design, data collection and analysis**.**
6.	**Engineering Development**	Engineering development provides a generic category for engineering projects which do not fit into any other category. These projects can relate to mechanical, civil, chemical, aerospace, environmental, electrical, of other engineering areas. Students who select the Engineering Development category will be required to utilize the engineering development methodology of generating requirements, developing a design, building the design, and testing the design.

General Requirements for All Projects

Students should select a single project that fits into one of the project categories. During project development, the student will follow the project process steps and milestone requirements specific to their project type.

The space for the full presentation at the Expo is limited. All projects (except Rube Goldberg) should fit into a 16" x 46" space. Rube Goldberg projects should fit into 30" x 47" space if they are table displays. A small number of floor spaces will be available for larger Rube Goldberg machines. These will be limited to 4'x7' in dimension.

Posters should be made on tri-fold foam or cardboard, so they can stand up on their own on a table. Poster size and color can vary but must meet total project space requirements when combined with the

rest of the display. The student's name and grade must be clearly labeled on the project and poster.

  - Example: https://www.amazon.com/Elmers-Tri-Fold-Premium-Display-Board/dp/B00753IXV8/ref=sr_1_1?ie=UTF8&qid=1483563426&sr=8-1&keywords=36+x+48+trifold+display+board

Safety considerations should be taken for all projects.
A few key safety items:

  - No hazardous substances may be used.
  - Wiring must be properly insulated -- nails, tacks, uninsulated staples must not be used to fasten wiring.
- Electrical power is available but must be requested in advance.
- Entrants are encouraged to use technology where beneficial as part of their project display and documentation (e.g. computers, videos, animations, etc.

Judging

Judging will be completed at the STEM Expo based on the Judging Rubrics included in this package. *There are some changes to the judging process this year based on recommendations from last year. The focus of the judging will be on the project itself and the depth of penetration into scientific and engineering concepts. Additionally, the judges will ask the student a few questions to evaluate the level of understanding the student has developed as a result of completing the project.

Please refer to the judging rubrics in this packet (there is one for each category type) to understand the criteria being judged and the weighting of those criteria. The judging rubrics will be returned to the students after the Expo so they can understand what they did well and what to improve upon for the next year.

The students will also be interviewed as part of the judging process. They will need to be able to give a brief explanation of their project.

Grade level winners will be selected by the judges based on scores and interview with judges. There will be one first place ribbon awarded per grade level. Second place, third place, and honorable mentions will also be awarded.

Students will not receive a classroom grade on their projects but will receive a reward for participation.

WHAT'S NEXT?

After reviewing the information in this STEM Expo packet, each student should:

1. Select the project category (e.g. Invention, reverse engineering, etc.) of interest to you for your project.

2. Study the section of the guidelines related to your project type to understand the possible types of projects, project process, and requirements.

3. Determine what specific project you would like to do and let your teacher know your plan by Friday, Feb. 15.

4. Find the Milestone #1 page for your project type in this package and fill out the requested information in preparation for Milestone #1 Interview discussion on March 15.

5. Let your teacher know if you have any questions AND ENJOY!!!!!

INVENTION CATEGORY

The Invention category asks students to provide an innovative solution to a problem. Students who select the invention category will be required to describe and illustrate the invention's design, describe and understand the invention's use and benefits, and build a prototype version of the invention for the Expo.

Required Project Contents:

1. A presentation display poster describing the problem, proposed solution, background research, design of the invention, and data acquisition and analysis completed to determine if the invention is effective.

2. A 'mock-up', prototype, or construction of all or part of the invention.

Additional/Optional Project Contents:

A descriptive paper or video may be provided to show additional information including:

---Description of the design process that occurred in the creation of the invention, including any problems encountered and their solutions

---Drawings or descriptive text that describes the construction process and any materials required

---Any further steps taken beyond initial concept, including competitor research, publicity, etc.

INVENTION PROJECT STEPS

Step 1) Identify a Problem
Step 2) Conduct Background Research
Step 3) Suggest a Solution
Step 4) Design and Build the Solution
Step 5) Collect Data
Step 6) Analyze Data and Report Results

INVENTION CATEGORY MILESTONE #1: PROJECT DESCRIPTION (March 15)

Name_____ Teacher_____

1. IDENTIFY A PROBLEM: This is the problem I want to solve:_____

2. CONDUCT BACKGROUND RESEARCH: The people who need this invention are

   _____

---

3. SUGGEST A SOLUTION: I think what could fix the problem is

   _____

---

4. DESIGN AND BUILD THE SOLUTION: My basic idea for the design is

   _____

The materials I will need are

_____

---

5. COLLECT DATA: I will measure/track the following things to see if my invention works:

---

6. ANALYZE DATA AND REPORT RESULTS: What data will I record? What will it show and what will the results be?

   _____

INVENTION CATEGORY MILESTONE #2: TECHNICAL CHECK-UP (APRIL 12)

Name_____ Teacher_____

Summarize your status on the steps of the invention project:

1. Identify a Problem: Are there any updates to your problem statement since Milestone #1?_____
_____
2. Conduct Background Research: Is your background research complete or do you have more to do? What additional research is left to do and how long do you think it will take?_____
_____
_____
3. Suggest a Solution: Are there any updates to your solution since Milestone #1?_____
_
_____
4. Design and Build the Solution: Is your design complete? If not, what additional design aspects do you need to complete? How much time and work is associated with completing this?_____
_____
Have you completed building your invention? If not, what work is left to do?
_____
_____
Are you having any problems you are working through? What are they? How have you solved them?_____
_____
5. Collect Data: What tests have you completed to determine if your invention works? Do you have more tests to complete? If so, which ones?
_____
_____
6. Analyze Data and Report Results: Does your invention work and solve the problem? How did you determine this? If you aren't sure yet, what else needs to be done to determine this?_____
_____
_____

INVENTION CATEGORY MILESTONE #3: JUDGING RUBRIC (APR. 26)

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Display and Documentation	Score (5=highest)	Req'd by:
The problem is clearly identified and described	1 2 3 4 5 NA	All
Target audience or users of invention are identified and shown to have a valid need	1 2 3 4 5 NA	All
The solution and its design is described along with the materials needed to build it	1 2 3 4 5 NA	All
Description of the data acquired and analyzed to determine if invention was a success is described along with the results	1 2 3 4 5 NA	Grades 3 - 5
Prototype or mock-up is well built and complete enough to show important aspects of the invention	1 2 3 4 5 NA	Grades 6 - 8

ADDITIONAL INVENTION CATEGORY RESOURCES

Here are a few ideas of inventions created by students:

- a device that cleans gutters
- a plastic product that holds a book while you eat
- a rain poncho designed for use when riding a bicycle
- a lunch-box alarm that goes off when an unauthorized person opens the box
- a bird feeder that protects feed from wind and rain
- a new board game
- a newly designed bottle opener
- a toothpaste cap that minimizes waste and mess
- a device that prevents blisters from forming on hands when raking, shoveling, or sweeping
- a billfold that organizes money by denomination for people with visual impairments
- a new candy bar
- a new type of swing set
- clothing tags to help match and coordinate clothes
- a dog collar that lights up at night
- a bedspread that zips down the middle
- safety suspenders that light up at night for joggers or bikers
- a lock for a folding door
- a new type of ice cream container that minimizes mess
- a new type of rake that allows you to pick up leaves without bending over
- an infant support that prevents a very young baby from falling over
- a robot that distributes and collects student papers
- a glove with a light for signaling turns when riding a bike at night
- a better, more comfortable swing set
- a device to hold objects for disabled people who use a walker
- a computer program that includes graphics and music for entertaining children aged 3 months to 4 years
- a child's seat that fits a shopping cart
- a hearing-aid guard
- a mailbox alert device that signals when mail has been delivered to a roadside mailbox
- a leg cast sock to keep toes warm
- tapeless wrapping paper
- a comforter for cats
- an outside house light that flashes to signal police, firemen, or other helpers as to which house made a call for assistance
- a computer program that catalogs videotapes
- an eyeglass defogging device
- a device that makes it easier to swallow pills
- a drying rack for gloves
- a liquid that covers fade marks on blue jeans
- a light switch for young children
- a chocolate-candy device that prevents ice cream cones from dripping
- a bus-stop night light

Ideas and steps for invention projects

Discovery Science – for Invention (and Scientific Inquiry)

- http://school.discoveryeducation.com/sciencefaircentral/Science-Fair-Projects

Eduplace

- https://www.eduplace.com/science/invention/resources/real_inventions.html

- 5th grade Kids showing and describing their inventions
  - https://www.youtube.com/watch?v=Ct5VRPO2Aps

REVERSE ENGINEERING CATEGORY

Reverse Engineering Project Overview

The Reverse Engineering category is intended to provide a means of discovery of engineering concepts and methods. Students who select the reverse engineering category must take something apart, learn how it works, and then be able to write down and describe how it works for the Expo.

Required Project Contents:

1. Poster describing the product and the disassembly process along with each component and its function.
    - The poster should also describe in your own words how the device works and at least one key physical principle required for its operation.

2. Physical display (can be mounted on poster board) of the components
    - They should be labeled with their name and function and arranged such that they properly describe the function of the product

Additional/Optional Project Components:

• Draw an illustration of how the components fix together
• Draw a set of diagrams and instructions for how to disassemble the product

Reverse Engineering Project Steps

1) Select and acquire at least one product to reverse engineer.
2) Identify and collect the tools required to disassemble the products.
3) Disassemble the product and document the steps taken during disassembly.
4) Identify the name and function of each component that was disassembled from the unit. Also include what material each component is made of (e.g. plastic, rubber, etc).
5) Mount all components on a poster board. Label with name and function.
6) Describe in your own words how the product works and what physical principles are required for it to work.

Reverse Engineering Milestone #1: Project Description (MAR. 15)

Step 1) Select and acquire at least one product to reverse engineer: What product have you selected? What are its primary functions?

_____
_____
_____

Step 2) Identify and collect the tools required to disassemble the products: What tools will you need for disassembly? How long do you think it will take to disassemble? _____
_____
_____

Step 3) Disassemble the product and document the steps taken during disassembly – **not required for Milestone #1**

Step 4) Identify the name and function of each component that was disassembled from the unit. Also include what material each component made of (e.g. plastic, rubber, etc). - **not required for Milestone #1**

Step 5) Mount all components on a poster board. Label with name and function - **not required for Milestone #1**

Step 6) Describe in your own words how the product works and what physical principles are required for it to work - **not required for Milestone #1**

Reverse Engineering Milestone #2: Technical Check-Up (APR. 12)

Step 1) Select and acquire at least one product to reverse engineer: Has anything changed on your product selection since Milestone #1?_____

Step 2) Identify and collect the tools required to disassemble the products: Has anything changed on your tools or time estimates since Milestone #1?_____

Step 3) Disassemble the product and document the steps taken during disassembly: How far have you gotten in the disassembly?_____

_____

Did you encounter any problems? _____

_____

How did you get around them?_____

_____

Step 4) Identify the name and function of each component that was disassembled from the unit. Also include what material each component made of (e.g. plastic, rubber, etc.): What do you think is the most interesting / useful component of the product? Why?_____

Step 5) Mount all components on a poster board. Label with name and function: What do you have left to do on your display?_____

_____

How long do you think it will take you to complete it?_____

Step 6) Describe in your own words how the product works and what physical principles are required for it to work: Talk about how the product works? Was there anything surprising that you learned?_____

_____

_____

_____

_____

Reverse Engineering Milestone #3: Judging Rubric (APR. 26)

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Display and Documentation	Score (5=highest)	Req'd by:
Display identifies the product clearly.	1 2 3 4 5 NA	All
Display describes the disassembly process and tools used.	1 2 3 4 5 NA	All
Display describes each component, the material it is made of and it's function	1 2 3 4 5 NA	All
Display describes how the device works	1 2 3 4 5 NA	All
At least one physical principle is identified and described that is needed for product to work	1 2 3 4 5 NA	All

Additional Resources for Reverse Engineering Category

Examples of things to reverse engineer (or take apart!):

- Mechanical Toy (e.g. Jack-in the box)
- Toy Remote Control Car
- Toy Remote Control Helicopter
- Curling Iron or Hot Rollers
- Wrist watch
- Hair Dryer
- Bicycle and / or bicycle hub
- Can opener
- Clock Radio
- Coffee Maker
- CD or DVD player
- Record player
- Music Box
- Mechanical Clock
- Model electric train car
- Cell phone or computer charger
- Old cell phone or rotary phone
- Wind-up toy
- Keyboard and mouse
- Shower Head
- Weed eater
- Go Cart
- Push lawn mower

Resources:

- Khan Academy for electronic device reverse engineering: https://www.khanacademy.org/science/electrical-engineering/reverse-engin:
  - Alarm Clock: https://www.khanacademy.org/science/electrical-engineering/reverse-engin/reverse-engineering/v/what-is-inside-an-alarm-clock-radio-1
  - Tap Light: https://www.khanacademy.org/science/electrical-engineering/reverse-engin/reverse-engineering/v/what-is-inside-a-tap-light
  - Coffee Maker: https://www.khanacademy.org/science/electrical-engineering/reverse-engin/reverse-engineering/v/what-is-inside-a-coffee-maker
  - College student describing toaster reverse engineering project
  - https://www.youtube.com/watch?v=nx0dBRaJ6fc

ROBOTICS, CIRCUITS, & COMPUTER SCIENCE CATEGORY

Robotics, Circuits, and Computer Science Project Overview

The Robotics, Circuits, and Computer Science category provides a way to apply practical engineering, technology, and math concepts to designing a circuit, robot and/or software with a purpose. Students who select the Robotics & Computer Science category will design and build a robot with a computer that completes a task either autonomously, semi-autonomously, or by remote control. The robot will be demonstrated at the Expo. Another option is to build a basic, functioning circuit. Students may also choose to create or code a basic computer program, using coding software.

Note: Robot kits and programming apps/websites are acceptable (While some programming apps are free, some kits and programs can be very expensive. Student must perform work and understand and describe concepts behind the robot and/or software's operation.

Required Project Contents

1. A circuit, robot and/or software package that has been built by the student that performs a specific task or set of tasks. The robot may include sensors, microprocessors / processor, software, and/or user interface for operation. The software package can run on any computer and must have a designed user interface. The circuit will include electronics that perform a task.

2. A poster describing the circuit, robot and/or software package's construction, key components, key functions and logic

Additional/Optional Project Contents

1. Description or additional logic that can be added to the robot to accomplish additional tasks
2. Detailed user's manual for how to operate the robot
3. A description of how to alter the operation by varying operational parameters

Project Steps for Robotics/Circuits

Step 1) Determine the type of robot or circuit you would like to build
Step 2) Find (or develop) instructions for building robot or circuit
Step 3) Gather materials for building the robot or circuit
Step 4) Diagram the functions, logic and tasks of the robot or circuit (see Computer science project steps for any software components of your robot)
Step 5) Build the robot or circuit
Step 6) Test the robot or circuit with a variety of inputs, environments, and operational parameters
Step 7) Document results

Project Steps for Computer Science

Step 1) Determine what type of task your program will perform
Step 2) Determine what programming platform and language you will use
Step 3) Diagram the code functions and logic
Step 4) Program the code to perform the functions utilizing appropriate logic
Step 5) Test the program with a variety of inputs and operational parameters
Step 6) Document results

Robotics, Circuits, & Computer Science Milestone #1 – Project Description (MAR. 15) – 1 of 2

Name_____ Teacher_____

Robotics / Circuits

Step 1) Determine the type of robot or circuit you would like to build: What is the function, robot or circuit you will be building?

_____

_____

Step 2) Find (or develop) instructions for building robot or circuit: How will you develop the design for the robot or circuit? (e.g. are you using a kit, are you designing it yourself?)_____

_____

Step 3) Gather materials for building the robot or circuit: What materials will you need for your robot or circuit?_____

_____

Step 4) Diagram the functions, logic and tasks of the robot or circuit (see Computer science project steps for any software components of your robot) – **not required for Milestone #1**

Step 5) Build the robot or circuit – **not required for Milestone #1**

Step 6) Test the robot or circuit with a variety of inputs, environments, and operational parameters – **not required for Milestone #1**

Step 7) Document results – **not required for Milestone #1**

Robotics, Circuits, & Computer Science Milestone #1 – Project Description (MAR. 15) – 2 of 2

Computer Science

Step 1) Determine what type of task your program will perform: What task / function will your program perform?_____
_____

Step 2) Determine what programming platform and language you will use:

- What language and platform (program) will you be using for your project? _____
- Why / how did you choose the language and platform?_____
  _____

Step 3) Diagram the code functions and logic: What are the functions and logic your program needs?_____
_____

Step 4) Program the code to perform the functions utilizing appropriate logic – **not required for Milestone #1**

Step 5) Test the program with a variety of inputs and operational parameters– **not required for Milestone #1**

Step 6) Document results– **not required for Milestone #1**

Robotics, Circuits, & Computer Science Milestone #2 – Technical Check-up (APR. 12) – 1 of 2

Robotics / Circuits

Step 1) Determine the type of robot or circuit you would like to build: Have you changed your project plan at all since Milestone #1?

_____

_____

Step 2) Find (or develop) instructions for building robot or circuit: Have you acquired and/or completed the directions for the design and assembly of your robot and/or circuit? If not, what's left to do? How long will this take?_____

_____

Step 3) Gather materials for building the robot or circuit: Do you have all of the materials for your robot or circuit? If not, what is left to acquire? How long will this take?_____

Step 4) Diagram the functions, logic and tasks of the robot or circuit (see Computer science project steps for any software components of your robot): List the key functions and logic included in your robot or circuit._____

Step 5) Build the robot or circuit: What work do you have remaining to build your robot or circuit? How long do you think it will take?_____

_____

Have you encountered any problems while building your robot or circuit? How did you work around them?_____

_____

Step 6) Test the robot or circuit with a variety of inputs, environments, and operational parameters: What tests will you perform to check your robot or circuit? How long will this take?_____

_____

Step 7) Document results – **not required for milestone #2**

Robotics, Circuits, & Computer Science Milestone #2 – Technical Check-up (APR. 12) – 2 of 2

Computer Science

Step 1) Determine what type of task your program will perform: Has your program's task or function changed since Milestone #1?_____
_____
_____

Step 2) Determine what programming platform and language you will use: Has your language or platform changed since Milestone #1?_____

Step 3) Diagram the code functions and logic: Have the functions / logic changed since Milestone #1?_____

Step 4) Program the code to perform the functions utilizing appropriate logic – **not required for Milestone #1**
How much of the function / logic programming have you completed? What's left? How long will it take you?

_____
_____

Step 5) Test the program with a variety of inputs and operational parameters– **not required for Milestone #1**
What kind of tests will you run on your program?_____

Step 6) Document results– **not required for Milestone #2**

Robotics, Circuits, & Computer Science Milestone #3 – Judging Rubric (APR. 26)

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Robotics, Circuits, and Computer Science Display and Documentation	Score (5=highest)	Req'd by:
Display clearly describes primary function of robot, circuit, and/or software and summary of how that is accomplished	1 2 3 4 5 NA	All
Display includes logical and complete description of all robot, circuit, and/or software functions and logic	1 2 3 4 5 NA	All
Display adequately describes design and assembly or development process for the robot, circuit, and/or software	1 2 3 4 5 NA	All
Display describes all verification tests performed on the robot, circuit, and/or software and the test results. (including how varying the test parameters impacts the robot or circuit behavior)	1 2 3 4 5 NA	All
Robot, circuit, and/or software mock-up is well built and performs the desired function(s)	1 2 3 4 5 NA	All

Robotics, Circuits, & Computer Science Category Additional Resources

Robots

- Science buddies website – Great robot ideas for beginning, intermediate and advanced
  - http://www.sciencebuddies.org/science-fair-projects/Intro-Robotics.shtml?from=Blog
  - Kids Activities website with links to robots kids can make:
  - http://kidsactivitiesblog.com/68530/16-robots-kids-can-actually-make

Circuits

- PBS Kids learning has references to several circuit learning and building projects:
  - http://ca.pbslearningmedia.org/resource/phy03.sci.phys.mfe.lp_electric/electric-circuits/
- Simple Circuit Project
    - Video of kids making a door alarm

  http://ca.pbslearningmedia.org/resource/phy03.sci.phys.mfw.zalarm/designing-electric-circuits-door-alarm

Computer Science / Software

- MIT's programming language for kids ages 8 – 16 with lots of project ideas: https://scratch.mit.edu
- For more advanced students (requires download of software if you don't have it):
  - Python language Tutorial and information: https://www.python.org
  - Java Tutorial: https://docs.oracle.com/javase/tutorial/
  - C++ Tutorial: https://www.cplusplus.com/doc/tutorial/
- Simple Programming Project
  - Simple Dance Party video programmed using scratch: https://scratch.mit.edu/projects/10128067/
  - Beginner java programming projects: http://www.roseindia.net/java/beginners/

Rube Goldberg Category

Rube Goldberg Project Overview

The Rube Goldberg Category is intended to provide a means of discovery of basic physics and engineering concepts and methods. Students who choose the Rube Goldberg category will design and build a Rube Goldberg machine. A Rube Goldberg machine is a device, apparatus, or invention that is deliberately over-engineered to perform a very simple task in a very complicated fashion, usually including a chain reaction. The student will need to describe the device purpose, the sequence of steps it performs to enact the purpose, and build the device or apparatus for the Expo.

Required Project Contents

1. A display that includes a complete diagram of the project from the initial step to conclusion with a description of each step and the physical force(s) or mechanism used to accomplish that step
2. A constructed partial or complete device or apparatus showing the sequence of events and demonstrating some or all of the steps

Additional/Optional Project Contents

1. A video of a complete, successful run from a previous run
2. Videos of problems you had while building your project showing how you fixed them

Rube Goldberg Project Steps

Step 1) Determine what the simple task is that you want your Rube Goldberg machine to perform (e.g. the final action)
Step 2) Determine the types of and how many cause and effect steps (including branching and merging) you want to include in your project. Also identify the initialization step.
Step 4) Draw a diagram of the the sequence from initial step to conclusion. Include as part of the diagram a description of each type of machine and/or force (including direction) you are using to execute each step
Step 5) Determine how much of the sequence you will build
Step 6) Gather materials for and build your mock-up
Step 7) Test your mock-up
Step 8) Document results

Rube Goldberg Milestone #1 – Project Description (MAR. 15)

Name_____ Teacher_____

Step 1) Determine what the simple task is that you want your Rube Goldberg machine to perform (e.g. the final action): What is the simple task your machine will perform?

_____

_____

Step 2) Determine the types of and how many cause and effect steps (including branching and merging) you want to include in your project. Also identify the initialization step.
How many steps and what types of machines and forces will your machine have?_____

_____

_____

_____

What is your initialization step?_____

Step 3) Draw a diagram of the the sequence from initial step to conclusion. Include as part of the diagram a description of each type of machine and/or force (including direction) you are using to execute each step – **not required for Milestone #1**

Step 4) Determine how much of the sequence you will build for your mock-up: How much of the sequence will you build? How long do you think this will take?_____

_____

_____

Step 5) Gather materials for and build your mock-up – **not required for Milestone #1**

Step 6) Test your mock-up – **not required for Milestone #1**

Step 7) Document results – **not required for Milestone #1**

Rube Goldberg Milestone #2 – Technical Check-Up (APR. 12)

Step 1) Determine what the simple task is that you want your Rube Goldberg machine to perform (e.g. the final action): Has anything changed since Milestone #1 about your machine's primary simple task?_____

Step 2) Determine the types of and how many cause and effect steps (including branching and merging) you want to include in your project. Also identify the initialization step.
Has anything changed since Milestone #1 about your machine's cause / effect steps and initialization step?_____

Step 3) Draw a diagram of the the sequence from initial step to conclusion. Include as part of the diagram a description of each type of machine and/or force (including direction) you are using to execute each step: Have you completed your diagram? If not, how much work is left to do on this? How long will it take?_____

_____

Have you identified all of the forces and/or machines?_____

Step 4) Determine how much of the sequence you will build for your mock-up : How much of the sequence will you build? How long do you think this will take?_____

Step 5) Gather materials for and build your mock-up: Do you have all the materials required to build your mock-up? If not, what else do you need to get? How long do you think it will take to build?_____

_____

Did you experiment with the materials to make sure they do what you expect them to?

Step 6) Test your mock-up: What tests do you plan to execute to see if your mock-up works?

_____

_____

How many times will you need to set up you project to complete the testing? How much time will this take? _____
How reliable is your machine?_____

_____

Step 7) Document results – **not required for Milestone #2**

Rube Goldberg Milestone #3 – Judging Rubric (APR. 26)

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Rube Goldberg Display and Documentation	Score (5=highest)	Req'd by:
Primary task and set of cause and effect steps used to perform it are clearly described in display	1 2 3 4 5 NA	All
Diagram of the sequence of steps along with an explanation of the machine / force used at each step is properly represented in display in adequate detail to understand project	1 2 3 4 5 NA	All
Mock-up is well built and executes the required sequence of events properly	1 2 3 4 5 NA	All
Description of assembly process for the mock-up is included in the display	1 2 3 4 5 NA	All
Description of the testing process for the mock-up is included in the display	1 2 3 4 5 NA	All

Additional Resources for the Rube Goldberg Category

- Build a set of simple machines using natural physical forces
  - Simple machines include lever, wheel and axle, pulley, incline plane, screw, and wedge.
  - Physical forces include inertia, gravity, friction, stored energy, combustion, etc. (note that no flames are allowed on site, combustion should only be used diagrammatically).
  - Websites describing how to build rube goldberg machines:
  - http://www.connectionsacademy.com/blog/posts/2014-04-25/Build-Your-Own-Rube-Goldberg-Machine.aspx
  - http://www.wikihow.com/Build-a-Homemade-Rube-Goldberg-Machine

- Simple Tasks for your machine*: (*from Connections Academy blog)
  - Turn a light off
  - Crush a pop can
  - Drop a bottle in a recycling bin
  - Water a plant
  - Plant seeds in a pot of soil
  - Pop a balloon
  - Fill a glass with water
  - Shut a door
  - Squeeze toothpaste onto a toothbrush
  - Turn off an alarm clock

Elementary School Rube Goldberg to open cabinet
https://www.youtube.com/watch?v=lCUX4gn9-bY

Elementary School Rube Goldberg Balloon popping project
https://www.youtube.com/watch?v=f7hb-aiU894

Largest Rube Goldberg Machine in the world used to turn on Christmas Lights
https://www.youtube.com/watch?v=RBOqfLVCDv8

SCIENTIFIC INQUIRY CATEGORY

Scientific Inquiry Project Overview

Scientific Inquiry is the basic experimentation category and provides a category most consistent with standard science fair entries. Students who select the Scientific Inquiry category will be required to utilize the scientific method to acquire knowledge about something. The scientific method involves research, hypothesis, experiment design, data collection and analysis.

Required Project Contents

1. A project display that described how the scientific method was utilized to investigate a question and hypothesis.

2. A project display that includes the test results from the experiment or investigation and the resulting conclusions drawn from the investigation

Additional/Optional Project Contents

1. Videos of experiments being executed
2. Additional hypothesis and tests completed on a related question based on results of initial inquiry

Scientific Inquiry Project Steps

1. Ask a testable question
2. Do background research related to your question
3. Construct a hypothesis about the outcome based on your research and knowledge
4. Design an investigation to test your hypothesis
5. Conduct the investigation and collect data
6. Analyze and make sense of the data
7. Document conclusions and report results

Scientific Inquiry Milestone #1 – Project Description (MAR. 15)

Name_____ Teacher_____

1. Ask a testable question: What is your question?
   _____
   _____

2. Do background research related to your question: What type of background research have you done or will you do?_____
   _____
   _____

3. Construct a hypothesis about the outcome based on your research and knowledge: What do you think the answer to your question is and why?_____
_____
_____

4. Design an investigation to test your hypothesis: What type of experiment or investigation will you do?
   _____
   _____

---

5. Conduct the investigation and collect data
   - **Not required for Milestone #1**

6. Analyze and make sense of the data
   - **Not required for Milestone #1**

7. Document conclusions and report results
   - **Not required for Milestone #1**

Scientific Inquiry Milestone #2 – Technical Check-Up (APR. 12)

1. Ask a testable question
   - Has your question changed since Milestone #1?

_____
_____

2. Do background research related to your question
   - Have you completed all of your background research?

_____
_____

3. Construct a hypothesis about the outcome based on your research and knowledge
   - Has your hypothesis changed since Milestone #1?

_____
_____

4. Design an investigation to test your hypothesis
   - Has your experiment / investigation changed since Milestone #1?

_____
_____

5. Conduct the investigation and collect data
   - Have you completed your experiment(s)? If not, how much more do you have to do? Did you run into problems with your experiment? Does it answer the question you thought it would?

_____
_____
_____

6. Analyze and make sense of the data
   - What kind of data have you acquired? What is the data telling you?

_____
Do you have any confusing data? How can you clarify that data? _____
_____
_____

7. Document conclusions and report results
   - **Not required for Milestone #2**

Scientific Inquiry Milestone #3 – Judging Rubric (APR. 26)

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Display and Documentation	Score (5=highest)	Req'd by:
The project clearly describes how the scientific method was utilized to answer the question	1 2 3 4 5 NA	All
Adequate research is completed and described such that hypothesis is reasonable	1 2 3 4 5 NA	All
Investigation / experiment is well described and appropriate to ascertain the accuracy of the hypothesis	1 2 3 4 5 NA	All
Data is represented and interpretation of the data is described in enough detail to understand conclusion	1 2 3 4 5 NA	All
Conclusion is clearly stated and appropriate for the data that was acquired	1 2 3 4 5 NA	All

Additional Resources for the Scientific Inquiry Category

- Science Buddies website that will help you find a project based on your interests:
  - http://www.sciencebuddies.org/science-fair-projects/project_ideas.shtml
  - Science Buddies website support for science fair projects:
  - http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml
- Discovery Education website to help you find an idea for your project:
  - http://school.discoveryeducation.com/sciencefaircentral/Science-Fair-Projects/Choose-a-Science-Fair-Project-Idea.html

- Discovery Education website support for science fair projects:
  - http://school.discoveryeducation.com/sciencefaircentral/Science-Fair-Projects.html

- Projects at elementary school science fair at Davidson Elementary School
  - https://www.youtube.com/watch?v=WQlWf746OUM

- Does air occupy space science fair project
  - https://www.youtube.com/watch?v=V6ak8OLsVX4

ENGINEERING DEVELOPMENT CATEGORY

Engineering Development Project Overview

The engineering development category provides a generic category for engineering projects which do not fit into any other category. These projects can relate to mechanical, civil, chemical, aerospace, environmental, electrical, of other engineering areas. Students who select the Engineering Development category will be required to utilize the engineering development methodology of generating requirements, developing and building a design, and verifying and validating the design.

Required Project Contents

1. An engineering design that has been built by the student that is show to meet the requirements of the design through a verification and validation process. The design may be anything that can be developed using the engineering methodology. (e.g. bridge, rocket ship, roller coaster, over, water purifier, …the possibilities are endless.)

2. A poster describing the steps of the engineering process and key outputs: requirements, design description, verification results, and validation results.

Project Steps for Engineering Development

Step 1) Identify a basic concept for what you what to build.
Step 2) Define the functional requirements that the concept needs to meet. What detailed things do you want it to do?
Step 3) Identify and perform any calculations you need to do to determine the key aspects of the design. (for grades 6-8)
Step 4) Develop and diagram a design that meets the requirements.
Step 5) Identify materials needed to build the design
Step 6) Build the design
Step 7) Test the design (and fix if needed)-
Step 8) Document the results.

Engineering Development Project Milestone #1 – Project Description– MAR. 15

Name_____ Teacher_____

Engineering Development

Step 1) In a few sentences, describe what you are going to build and what it's primary function is?

_____

_____

Step 2) Define the functional requirements that the concept needs to meet. Make sure to include quantitative requirements when possible. You should identify at least 1 **functional** requirement for your project. Try to specify the functions you want first before you develop the design…

_____

_____

_____

_____

Step 3) Identify and perform any calculations you need to do to determine any aspects of the design. (for grades 6-8)

_____

_____

_____

Step 4) Develop and diagram a design that meets the requirements.

_____

_____

_____

Step 5) Identify materials needed to build the design._____

Engineering Development Project Milestone #2 – Technical Check-up– APR. 12

Engineering Development

Step 1) In a few sentences, describe what you are going to build and what it's primary function is? Did this change since Milestone #1? If so, how?

_____
_____

Step 2) Define the functional requirements that the concept needs to meet. Make sure to include quantitative requirements when possible. You should identify at least 1 **functional** requirement for your project. Try to specify the functions you want first before you develop the design… Did this change since Milestone #1? If so, how?

_____
_____
_____
_____

Step 3) Identify and perform any calculations you need to do to determine any aspects of the design. Did this change since Milestone #1? If so, how? (for grades 6-8)

_____
_____
_____
__

Step 4) Develop and diagram a design that meets the requirements. Did this change since Milestone #1? If so, how?

Step 5) Identify materials needed to build the design. Did this change since Milestone #1? If so, how?

_____
_____
_____

Step 6) Build the design: How far along are you on building your design? Have you had any problems you'd like to discuss?

_____
_____
_____

Step 7) Verify and validate the design. How are you planning on testing that each of your requirements are met? How will you show the your overall design meets the original intent in a realistic scenario?

_____
_____
_____
_____
_____
_____

Step 8) Document results – Not required for Milestone #2.

For final project make sure your display includes the results of the verification of requirements and validation of overall function. Does it work? Would you change anything?

_____
_____
_____
_____
_____
_____

Engineering Development Project Milestone #3 – Judging Rubric

General: Presentation Display	Score (5=highest)	Req'd by:
Attractive, easy to read, and layout is in appropriate logical order	1 2 3 4 5 NA	All
Visual aids promote understanding	1 2 3 4 5 NA	All
Shows project in appropriate detail for understanding by audience	1 2 3 4 5 NA	All

Engineering Development Project	Score (5=highest)	Req'd by:
Display clearly describes the basic concept for the design and what it's primary function is	1 2 3 4 5 NA	All
Display clearly shows functional requirements on the design and they are reasonable and appropriate for the concept	1 2 3 4 5 NA	All
Any calculations required to determine what the design needs to be to meet the requirements are described and accurately completed (grades 6-8)	1 2 3 4 5 NA	All
Overall design is described and key design components are diagrammed accurately.	1 2 3 4 5 NA	All
Process for verification and validation of requirements and results are described and shown.	1 2 3 4 5 NA	All
Design meets the requirements	1 2 3 4 5 NA	All

Engineering Development Additional Resources (Example)

Model rocket info:
http://www2.estesrockets.com/pdf/2844_estes_math_of_model_rocketry_tn-5.pdf

Roller Coaster info:
http://www.raftsac.org/ideas/Roller%20Coaster%20Math.pdf