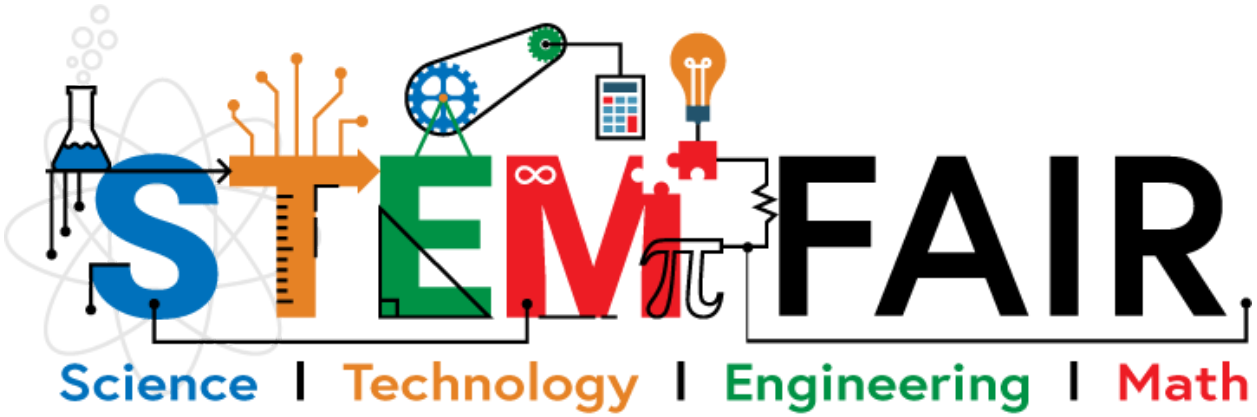
PGCPS Elementary Student STEM Fair Journal

Name: _____

Teacher: _____

Grade: _____

School _____



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PGCPS

PRINCE GEORGE'S COUNTY PUBLIC SCHOOLS
BOARD ACKNOWLEDGEMENT

PGCPS

The Division of Academics extends sincere gratitude to the Board of Education for their support and commitment to advancing educational excellence. We recognize and appreciate the ongoing efforts to provide the necessary resources, guidance, and leadership that enable our department to develop and implement curriculum initiatives that meet state and/or national standards. Together, we strive to ensure that every student has the opportunity to achieve their full potential and succeed in their academic journey.

Prince George's County Public Schools Board Of Education Website

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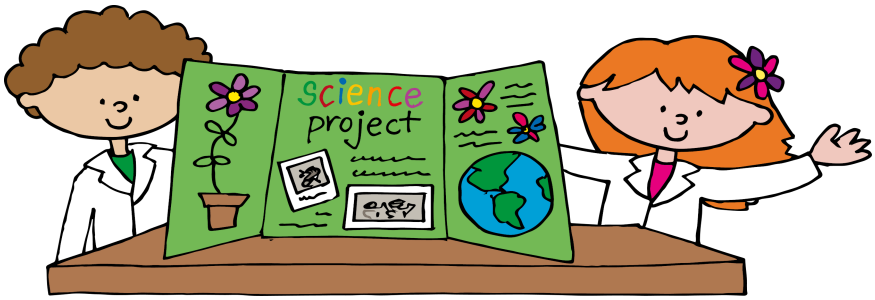
It's STEM Fair Time!



Overview

STEM stands for **S**cience, **T**echnology, **E**ngineering, and **M**athematics. Over the next few months, you will choose a research project that contains STEM elements. You will conduct an investigation to seek the evidence to your project's question. This long-term, at home project will enable you to combine reading, writing, math, data analysis, and scientific inquiry all on a topic that you have chosen!

This handbook provides you with examples and models of each step of the STEM process. There is space available to take notes and draft the elements of your project. Both you and your family, along with your teacher, will all use this book to write, edit, comment and keep track of your work on each component of the STEM Fair process.

STEM Fair Project Timeline

Your teacher will give you specific due dates for each phase of your project. Use the space below to write down your due dates. Then, turn the page and begin to brainstorm topics you might consider for your project.

Suggested Timeline for the STEM Fair Project

Component	Due Date	Teacher Initials	Student Initials
Project Title			
Choosing a Topic			
Question			
Prediction/Hypothesis			
Variables			
Materials			
Procedures			
Data Collection Tool			
Results: Actual/Investigation-Collected Data			
Results: Graph of Data			
Results: Written Explanation			
Conclusion			
Research Plan			
Research Paper			
Digital Presentation			
Display Board to School			

Getting Started:

Choosing a Topic and Project

Choosing a STEM Fair topic means you should be thinking about something that interests you, not something your teacher has chosen for you. There are many ways to choose a STEM Fair topic. You can start by observing the world around you, searching the internet, and exploring books in your school or library.

When choosing your STEM Fair Project, choose a project that is interesting, impacts your community or even the world! Think about the following when selecting a project idea: think about the world around you, questions you might have about how things work, why they react the way they do and how these elements interact with each other.

When selecting a STEM Fair Project, here are some guidelines to follow.

- You **CANNOT** conduct experimental testing on vertebrates (people, other mammals, birds, reptiles or amphibians).
- However, you may conduct observations on vertebrates providing there is **NO** interaction between the vertebrate and the observer. **(Refer to ISEF Safety Review Approval Request page).**
- You may conduct testing on invertebrates (worms, mollusks, insects) provided there is no injury to the animal.
- You **CANNOT** grow bacteria of any kind.
- You **CANNOT** make a model that only displays information or shows how something works. (lava lamps, volcanoes, solar system, cells, etc.)

*As you begin to narrow down your interests to one idea, you can consider some of the project ideas listed on the next couple of pages. This list might help you narrow down your ideas.

*For all projects, you must ensure you have a written **Safety Review pre-approval**. This pre-approval will be handled by the school's STEM Fair Coordinator.

More Things to Consider:

• Do I have time to effectively conduct an experiment with **at least three trials**?

• Do I have an adequate amount of space (inside/outside) to conduct this experiment?

• Can I easily find and afford to purchase all of the materials for my experiment?

• Will I need to build anything and, if so, can I do it by myself or do I need assistance?

Example STEM Fair Project Ideas

Environmental:

- What kind of soil is best for water retention?
- What is the effect of acid rain on plant growth?
- What effect does fertilizer have on algae growth?
- Does rain or hail create more erosion on a slope?
- Does vegetable waste (banana peels, apple cores, etc) decompose faster in soil with earthworms?
- Which soil cover prevents the most soil erosion (grass, mulch or bare soil)?
- How are different oil types affected by erosion?
- Which food group decomposes the quickest?
- Does the external color of a structure affect the internal temperature of the structure?
- Impervious vs. Natural surfaces - Which filters water best?
- Solar, Wind, or Hydroelectric - Which renewable resource provides the greatest amount of energy?

Robotics:

- Ideas can stem from various things, such as thinking about the following …
- What can you create or design that can perform a task or activity?
- Examples: Designing a trash grabber, designing a soda machine, designing a dog poop flashlight, etc.

Engineering:

- Does the design of a bridge affect its weight-bearing capacity?
- What levee construction will hold the most water?
- Which truss design will withstand the most weight?
- Which building design best withstands an earthquake?
- Which catapult design will launch an object the farthest?
- Does the shape of the nose cone affect how far a rocket will fly?
- Does the shape of a windmill's blades affect the amount of energy it produces?
- Does the area/material/shape of a parachute affect how fast it falls?
- Does the size/shape of the boat's hull affect how much weight it can carry?
- Does the bow of a ship influence water resistance?
- How does the diameter of the building affect its strength?
- Does the size/shape of a boat sail affect how fast it travels?
- Does the design of a trench affect the flow of water?
- Which pulley system will lift the most mass with the least amount of work?

STEM Fair Project Ideas

Physical Science:

- What variable affects the swing of a pendulum (length of string or mass of pendulum)?
- Is there a relationship between the size and strength of a magnet?
- What types of surfaces produce the greatest or least amount of friction?
- What variables affect the flight of an airplane (materials, weight, shape, or angle of launch)?
- Which shape of windmill blade is most efficient?
- How does the length of a rotor affect helicopter flight?
- Does the size, shape, or angle of a parachute affect its flight?
- Does the size of a bouncy ball affect how high it bounces?

Computer Science:

- How does the file size change as more letters (or characters) are added to a file?
- Does the color of the surface determine whether an optical mouse works?
- Does temperature (both hot and cold) affect how well a computer performs on a given task?
- What materials can block a Wifi signal?
- Does the image format change the file size of a picture saved to a computer?

Mathematics:

- Can the Fibonacci Sequence be found in nature?
- Does the wing angle of a paper airplane change the distance it flies?
- Is there a relationship between geometric shapes and patterns?
- Does a sports team's winning percentage deviate from the Pythagorean relationship?
- Does thicker liquid evaporate quicker than thinner liquid?

Material Sciences:

- How does the packaging affect the ripening of fruit?
- How is the bond of adhesive tape affected by temperature?
- Which is stronger . . . a wooden dowel, I-beam, U beam, etc. of a certain length and weight?

Selecting a Category

If you chose a project from this journal, you already know which category your project falls under. If you chose a project outside of this journal, use the chart and descriptions below to determine which STEM Fair Category your project falls under.

❑ BEHAVIORAL AND SOCIAL SCIENCES

The science or study of the thought processes and behavior of humans and other animals in their interactions with the environment is studied through observational and experimental methods.

- **Clinical and Developmental Psychology:** The study and treatment of emotional or behavioral disorders. Developmental psychology is concerned with the study of progressive behavioral changes in an individual from birth until death.
- **Cognitive Psychology:** The study of cognition, the mental processes that underlie behavior, including thinking, deciding, reasoning, and to some extent motivation and emotion.
- **Neuroscience:** Studies of the neural basis of cognitive processes, including learning and memory, language and thought, perception, attention, and affect. It investigates the human brain, from the functional organization of large-scale cerebral systems to microscopic neurochemical processes.
- **Physiological Psychology:** The study of the biological and physiological basis of behavior.
- **Sociology and Social Psychology:** The study of human social behavior, especially the study of the origins, organization, institutions, and development of human society.

❑ BIOLOGICAL SCIENCES

This category does not include Plants. Plants are in their own separate category. Studies that include all aspects of animal/human life interactions with one another or with their environment. Studies of microorganisms, including bacteria, viruses, fungi, prokaryotes, and simple eukaryotes as well as antimicrobial and antibiotic substances.

- **Animal Behavior:** The study of animal activities that includes observing animal interactions within and between species or an animal's response to environmental factors.
- **Cellular Studies:** The study of animal cells involving the use of microscopy to study cell structure and studies investigating activity within cells such as enzyme pathways, cellular biochemistry, and synthesis pathways for DNA, RNA, and protein.
- **Development:** The study of an organism from the time of fertilization through birth or hatching and into later life. This includes cellular and molecular aspects of fertilization, development, regeneration, and environmental effects on development.
- **Ecology:** The study of interactions and behavioral relationships among animals, and animals and plants, with their environment and with one another.
- **Genetics:** The study of species and population genetics at the organismal or cellular level.
- **Nutrition and Growth:** The study of natural, artificial, or maternal nutrients on animal growth, development, and reproduction including the use and effects of biological and chemical control agents to control reproduction and population numbers.
- **Physiology:** The study of one of the 11 animal systems. This includes structural and functional studies, system mechanics, and the effect of environmental factors or natural variations on the structure or function of a system. Similar studies conducted specifically at the cellular level should select the cellular studies subcategory.
- **Systematics and Evolution:** The study of animal classification and phylogenetic methods including the evolutionary relationships between species and populations. This includes

morphological, biochemical, genetic, and modeled systems to describe the relationship of animals to one another.

- **Antimicrobials and Antibiotics:** The study of a substance that kills or inhibits the growth of microorganisms.
- **Applied Microbiology:** The study of microorganisms having potential applications in human, animal or plant health or the use of microorganisms in the production of energy.
- **Bacteriology:** The study of bacteria and bacterial diseases and the microorganisms responsible for causing a disease.
- **Environmental Microbiology:** The study of the structure, function, diversity and relationship of microorganisms with respect to their environment. This includes the study of biofilms.
- **Microbial Genetics:** The study of how microbial genes are organized and regulated and their involvement in cellular function.
- **Virology:** The study of viruses and viral diseases.

❑ BIOMEDICAL AND HEALTH SCIENCES

This category focuses on studies specifically designed to address issues of human health and disease. It includes studies on the diagnosis, treatment, prevention or epidemiology of disease and other damage to the human body or mental systems.

- **Nutrition and Natural Products:** The study of food, nutrients and dietary needs in humans, and the effects of food and nourishment on the body. These studies may include the effects of natural or supplemental nutrients and nutrition.

❑ CHEMISTRY

Studies exploring the science of the composition, structure, properties, and reactions of matter not involving biochemical systems.

- **Analytical Chemistry:** The study of the separation, identification, and quantification of the chemical components of materials.
- **Computational Chemistry:** A study that applies the discipline and techniques of computer science and mathematics to solve large and complex problems in Chemistry.
- **Environmental Chemistry:** The study of chemical species in the natural environment, including the effects of human activities, such as the design of products and processes that reduce or eliminate the use or generation of hazardous substances.
- **Inorganic Chemistry:** The study of the properties and reactions of inorganic and organometallic compounds.
- **Materials Chemistry:** The chemical study of the design, synthesis and properties of substances, including condensed phases (solids, liquids, polymers) and interfaces, with a useful or potentially useful function, such as catalysis or solar energy.
- **Organic Chemistry:** The study of carbon-containing compounds, including hydrocarbons and their derivatives.
- **Physical Chemistry:** The study of the fundamental physical basis of chemical systems and processes, including chemical kinetics, chemical thermodynamics, electrochemistry, photochemistry, spectroscopy, statistical mechanics and astro-chemistry.

❑ COMPUTER SCIENCE and SYSTEMS SOFTWARE

The studies that focus on the techniques of computer science, and the development of software, information processes or methods to demonstrate, analyze, or control a process/solution

- **Algorithms:** The study or creation of algorithms - step-by-step procedure of calculations to complete a specific task in data processing, automated reasoning and computing.
- **Cybersecurity:** Studies involving the protection of a computer or computer system against unauthorized access or attacks. This can include studies involving hardware, network, software, host or multimedia security.
- **Databases:** Studies that create or analyze data organization for ease of access, management and update.
- **Human/Machine Interface:** Software application that presents information to a user about the state of a process and to accept and implement the operator's control instructions.
- **Languages and Operating Systems:** Studies that involve the development or analysis of artificial languages used to write instructions that can be translated into machine language and then executed by a computer or system software responsible for the direct control and management of hardware and basic system operations of a computer or mobile device.
- **Mobile Apps:** A study involving a software application developed specifically for use on small, wireless computing devices. These studies may include front-end development techniques, such as user interface design and cross-platform support, and/or back-end development techniques, such as data services and business logic.
- **Online Learning:** Studies that focus on utilizing electronic technologies to access educational curriculum outside of a traditional means. Studies explore the design of learning activities and programs with online technologies, as well as the effective use of e-learning systems.

❑ EARTH and ENVIRONMENTAL SCIENCES

Studies of the environment and its effect on organisms/systems, including investigations of biological processes such as growth and life span, as well as studies of Earth systems and their evolution.

- **Atmospheric Science:** Studies of the earth's atmosphere, including air quality and pollution and the processes and effects of the atmosphere on other Earth systems as well as meteorological investigations.
- **Climate Science:** Studies of Earth's climate, particularly evidential study of climate change.
- **Environmental Effects on Ecosystems:** Studies of the impact of environmental changes (natural or as a result of human interaction) on ecosystems, including empirical pollution studies.
- **Geosciences:** Studies of Earth's land processes, including mineralogy, plate tectonics, volcanism, and sedimentology.
- **Water Science:** Studies of Earth's water systems, including water resources, movement, distribution, and water quality.

❑ EMBEDDED SYSTEMS

Studies involving electrical systems in which information is conveyed via signals and waveforms for purposes of enhancing communications, control and/or sensing.

- **Circuits:** The study, analysis, and design of electronic circuits and their components, including testing.
- **Internet of Things:** The study of the interconnection of unique computing devices with the existing infrastructure of the Internet and the cloud.
- **Microcontrollers:** The study and engineering of microcontrollers and their use to control other devices.
- **Networking and Data Communications:** The study of systems that transmit any combination of voice, video, and/or data among users.
- **Optics:** The use of visible or infrared light instead of signals sent over wires. The study and development of optical devices and systems devoted to practical applications such as computation.
- **Sensors:** The study and design of devices that transmit an electrical response to an external device.
- **Signal Processing:** The extraction of signals from noise and their conversion into a representation for modeling and analysis.

❑ ENERGY: CHEMICAL and PHYSICAL

Studies involving biological and chemical processes of renewable energy sources, clean transport, and alternative fuels. Studies of renewable energy structures/processes including energy production and efficiency.

- **Alternative Fuels:** Any method of powering an engine that does not involve petroleum (oil). Some alternative fuels are electricity, methane, hydrogen, natural gas, and wood.
- **Computational Energy Science:** A study that applies the discipline and techniques of computer science and mathematics to solve large and complex problems in Energy Science.
- **Fossil Fuel Energy:** Studies involving energy from a hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from living matter of a previous geologic time and used for fuel.
- **Fuel Cells and Battery Development:** The study, analysis and development of fuel cells and batteries that convert and/or store chemical energy into electricity.
- **Microbial Fuel Cells:** The study of fuel cells that use or mimic bacterial interactions found in nature to produce electricity.
- **Solar Materials:** The study of materials used to convert and store solar energy through chemical changes. This includes topics such as thermal storage and photovoltaic materials.
- **Hydro Power:** The application of engineering principles and design concepts to capture energy from falling and running water to be converted to another form of energy.
- **Nuclear Power:** The application of engineering principles and design concepts to capture nuclear energy to be converted to another form of energy.
- **Solar:** The application of engineering principles and design concepts to capture energy from the sun to be converted to another form of energy.
- **Sustainable Design:** The application of engineering principles and design concepts to plan and/or construct buildings and infrastructure that minimize environmental impact.
- **Thermal Power:** The application of engineering principles and design concepts to capture energy from the Earth's crust to be converted to another form of energy.
- **Wind:** The application of engineering principles and design concepts to capture energy from the wind to be converted to another form of energy.

❑ ENGINEERING MECHANICS

Studies that focus on the science and engineering that involve movement or structure. The movement can be by the apparatus or the movement can affect the apparatus.

- **Aerospace and Aeronautical Engineering:** Studies involving the design of aircraft and space vehicles and the direction of the technical phases of their manufacture and operation.
- **Civil Engineering:** Studies that involve the planning, designing, construction, and maintenance of structures and public works, such as bridges or dams, roads, water supply, sewer, flood control and, traffic.
- **Computational Mechanics:** A study that applies the discipline and techniques of computer science and mathematics to solve large and complex problems in Engineering Mechanics.
- **Control Theory:** The study of dynamical systems, including controllers, systems, and sensors that are influenced by inputs.
- **Ground Vehicle Systems:** The design of ground vehicles and the direction of the technical phases of their manufacture and operation.
- **Industrial Engineering-Processing:** Studies of efficient production of industrial goods as affected by elements such as plant and procedural design, the management of materials and energy, and the integration of workers within the overall system. The industrial engineer designs methods, not machinery.
- **Mechanical Engineering:** Studies that involve the generation and application of heat and mechanical power and the design, production, and use of machines and tools.
- **Naval Systems:** Studies of the design of ships and the direction of the technical phases of their manufacture and operation.

❑ ENVIRONMENTAL ENGINEERING

Studies that engineer or develop processes and infrastructure to solve environmental problems in the supply of water, the disposal of waste, or the control of pollution.

- **Bioremediation:** The use of biological agents, such as bacteria or plants, to remove or neutralize contaminants. This includes phytoremediation, constructed wetlands for wastewater treatment, biodegradation, etc.
- **Land Reclamation:** The application of engineering principles and design techniques to restore land to a more productive use or its previous undisturbed state.
- **Pollution Control:** The application of engineering principles and design techniques to remove pollution from air, soil, and/or water.
- **Recycling and Waste Management:** The extraction and reuse of useful substances from discarded items, garbage, or waste. The process of managing, and disposing of, wastes and hazardous substances through methodologies such as landfills, sewage treatment, composting, waste reduction, etc.
- **Water Resources Management:** The application of engineering principles and design techniques to improve the distribution and management of water resources.

❑ MATERIALS SCIENCE

The study of the combination of various materials forms in systems, devices, and components that rely on their unique and specific properties. The scientific study of the properties and applications of materials of construction or manufacture (such as ceramics, metals, polymers, and composites)

- **Biomaterials:** Studies involving any matter, surface, or construct that interacts with biological systems. Such materials are often used and/or adapted for a medical application, and thus

comprise whole or part of a living structure or biomedical device which performs, augments, or replaces a natural function.

- **Ceramic and Glasses:** Studies involving materials composed of ceramic and glass.
- **Composite Materials:** Studies involving materials composed of two or more different materials combined together to create a superior and unique material.
- **Computation and Theory:** Studies that involve the theory and modeling of materials.
- **Electronic, Optical and Magnetic Materials:** The study and development of materials used to form highly complex systems, such as integrated electronic circuits, optoelectronic devices, and magnetic and optical mass storage media. The various materials, with precisely controlled properties, perform numerous functions, including the acquisition, processing, transmission, storage, and display of information.
- **Nanomaterials:** The study and development of nanoscale materials; materials with structural features (particle size or grain size, for example) of at least one dimension in the range 1-100 nm.
- **Polymers:** The study and development of polymers; materials that have a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins.

❑ MATHEMATICS

The study of the measurement, properties, and relationships of quantities and sets, using numbers and symbols. The deductive study of numbers, geometry, and various abstract constructs, or structures.

- **Algebra:** The study of algebraic operations and/or relations and the structures that arise from them. An example is given by (systems of) equations that involve polynomial functions of one or more variables.
- **Analysis:** The study of infinitesimal processes in mathematics, typically involving the concept of a limit. This begins with differential and integral calculus, for functions of one or several variables, and includes differential equations.
- **Combinatorics, Graph Theory, and Game Theory:** The study of combinatorial structures in mathematics, such as finite sets, graphs, and games, often with a view toward classification and/or enumeration.
- **Geometry and Topology:** The study of the shape, size, and other properties of figures and spaces. Includes such subjects as Euclidean geometry, non-Euclidean geometries (spherical, hyperbolic, Riemannian, Lorentzian), and knot theory (classification of knots in 3-space).
- **Number Theory:** The study of the arithmetic properties of integers and related topics such as cryptography.
- **Probability and Statistics:** Mathematical study of random phenomena and the study of statistical tools used to analyze and interpret data.

❑ PHYSICS AND ASTRONOMY

Physics is the science of matter and energy and of interactions between the two. Astronomy is the study of anything in the universe beyond the Earth.

- **Atomic, Molecular, and Optical Physics:** The study of atoms, simple molecules, electrons and light, and their interactions.
- **Astronomy and Cosmology:** The study of space, the universe as a whole, including its origins and evolution, the physical properties of objects in space and computational astronomy.

- **Computational Physics and Astrophysics:** A study that applies the discipline and techniques of computer science and mathematics to solve large and complex problems in Physics and Astrophysics.
- **Condensed Matter and Materials:** The study of the properties of solids and liquids. Topics such as superconductivity, semiconductors, complex fluids, and thin films are studied.
- **Instrumentation:** Instrumentation is the process of developing means of precise measurement of various variables such as flow and pressure while maintaining control of the variables at desired levels of safety and economy.
- **Magnetics, Electromagnetics and Plasmas:** The study of electrical and magnetic fields and of matter in the plasma phase and their effects on materials in the solid, liquid or gaseous states.
- **Mechanics:** Classical physics and mechanics, including the macroscopic study of forces, vibrations and flows on solid, liquid and gaseous materials. Biological physics is the study of the physics of biological processes.
- **Nuclear and Particle Physics:** The study of the physical properties of the atomic nucleus and of fundamental particles and the forces of their interaction.
- **Optics, Lasers, and Masers:** The study of the physical properties of light, lasers and masers.
- **Quantum Computation:** The study of the laws of quantum mechanics to process information. This includes studies involving the physics of information processing, quantum logic, quantum algorithms, quantum error correction, and quantum communication.
- **Theoretical Physics:** The study of nature, phenomena and the laws of physics employing mathematical models and abstractions rather than experimental processes.

❑ PLANT SCIENCES

Studies of plants and how they live, including structure, physiology, development, and classification. Includes plant cultivation, development, ecology, genetics and plant breeding, pathology, physiology, systematics and evolution.

- **Agriculture and Agronomy:** Application of the various soil and plant sciences to soil management and agricultural and horticultural crop production. Includes biological and chemical controls of pests, hydroponics, fertilizers and supplements.
- **Ecology:** The study of interactions and relationships among plants, and plants and animals, with their environment.
- **Genetics and Breeding:** The study of organismic and population genetics of plants. The application of plant genetics and biotechnology to crop improvement. This includes genetically modified crops.
- **Growth and Development:** The study of a plant from earliest stages through germination and into later life. This includes cellular and molecular aspects of development and environmental effects, natural or manmade, on development and growth.
- **Pathology:** The study of plant disease states, and their causes, processes, and consequences. This includes effects of parasites or disease-causing microbes.
- **Plant Physiology:** The study of functions in plants and plant cells. This includes cellular mechanisms such as photosynthesis and transpiration, and how plant processes are affected by environmental factors or natural variations.
- **Systematics and Evolution:** The study of classification of organisms and their evolutionary relationships. This includes morphological, biochemical, genetic, and modeled systems.

❑ ROBOTICS AND INTELLIGENT MACHINES

Studies in which the use of machine intelligence is paramount to reducing the reliance on human intervention.

- **Biomechanics:** Studies and apparatus that mimic the role of mechanics in biological systems.
- **Cognitive Systems:** Studies/apparatus that operate similarly to the ways humans think and process information. Systems that provide for increased interaction of people and machines to more naturally extend and magnify human expertise, activity, and cognition.
- **Control Theory:** Studies that explore the behavior of dynamical systems with inputs, and how their behavior is modified by feedback. This includes new theoretical results and the applications of new and established control methods, system modeling, identification and simulation, the analysis and design of control systems (including computer-aided design), and practical implementation.
- **Machine Learning:** Construction and/or study of algorithms that can learn from data.
- **Robot Kinematics:** The study of movement in robotic systems.
- **Pre-Clinical Studies:** These studies of potential drugs or therapies would include testing the intervention in platforms such as cultured cells or animal models of disease. The investigations could be directed toward determining factors such as potential drug permeability, efficacy and/or toxicity. These studies could also investigate the best route of drug administration.

Safety Review Approval Process

Will you ask people questions? Experiment on yourself? Experiment with other people in any way?

→ **Yes**

If your project ONLY requires the **observation** or **measurement** of human subjects (no harm or risks to subjects), you must have approval from the School Safety Review Board. Complete the School Safety Approval Request.

If your experiment requires touching humans then **STOP**! You need to think of another project.

↓ **No**

Does your project involve your **pet** or any other animals that have **back bones (vertebrates)**?

→ **Yes**

If your project ONLY requires the **observation** of vertebrate animals, you must have approval from the School Safety Review Board. Complete the School Safety Approval Request.

If your experiment requires touching or manipulating the vertebrate then **STOP**! You need to think of another project.

↓ **No**

Does your project involve **mold**? **fire?** potentially **hazardous substances?**

→ **Yes**

You must have approval from the School Safety Review Board. If a project involves the growth of mold, testing **must** be done in a sealed environment at all times. Complete the School Safety Approval Request.

↓ **No**

Does your project involve using bacteria in any way?

→ **Yes**

STOP! You need to think of another project to do.

↓ **No**

Does your project involve

- any chemical such as household cleaning agents, solvents, metals or organic chemical?
- Sharp objects or potentially dangerous tools? Use of an oven?

→ **Yes**

You must have approval from the School Safety Review Board. Complete the School Safety Approval Request.

↓ **No**

You do not need School Safety Review Board pre-approval. Write your specific question for your project.

School Safety Approval Request

Approval by the School Safety Review Board is **required** before experimentation. Fill in **all** of the information below and submit this form to your science teacher. The School Safety Review Board or the PGCPS Safety Review/Steering Committee reserves the right to deny any project due to safety concerns.

Student's Name _____ **Grade** _____

1) Describe the purpose of your investigation and the reason you responded to a yes on the **pre-approval key**. If a survey or questionnaire is being used, please attach.

2) Describe any potential risks or areas of concern that need to be addressed and approved before Experimentation.

3) Describe the procedures that will be used to minimize risk; safety measures taken; disposal procedures that will be followed (when applicable); and sources of safety information.

Safety Review Board SIGNATURES

1) **Science Teacher:** _____ _____

Print name **Signature**

2) **STEM Fair Coordinator:**_____ _____

Print name **Signature**

3) **Steering Committee:** _____ _____

Print name **Signature**

To be completed by Parent/Guardian:

Yes	No	
☐	☐	I have read and understand the conditions, risks, and I consent to my child participating.
☐	☐	Project testing/trials will be supervised by an adult at all times.
☐	☐	I have reviewed any survey or questionnaire that will be used.

_____ _____ _____

Parent/Guardian's Name (Please Print) **Parent/Guardian's Signature** **Date**

Developing A Question

A **question** is the specific problem you plan to investigate. The results and answer to your question can only be found by conducting a hands-on investigation/experiment.

An Acceptable Example of a Question:

• Does the design of a bridge affect its weight-bearing capacity?

Rationale: This question is acceptable because it aligns with what you will be investigating specifically.

Unacceptable Examples of a Question:

• Can a bridge hold weight?

• Are bridges essential for people?

Rationale: These questions are unacceptable examples because they are yes/no questions. Also, these questions do not require an investigation/experiment to occur in order to get an answer.

My question is:

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☐ Your question is approved! Next, start working on your Hypothesis/Prediction.

☐ Your question is not approved. Use my comments to rewrite it. Your new due date for your question is: _____.

Teacher Comments:

_____

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

My revised question is: _____

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☐ Your question is approved! Next, start working on your Hypothesis/Prediction.

☐ Your question is not approved. Use my comments to rewrite your question. Your new due date for your question is: _____.

Teacher Comments:

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

My revised question is: _____

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☐ Your question is approved! Next, start working on your Hypothesis/Prediction.

☐ Your question is not approved. Use my comments to rewrite it on a separate piece of paper. **Your final due date for your question is: _____.**

Teacher Comments:

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Teacher Signature: _____ Date: _____

Parent Signature: _____ Date: _____

Hypothesis/Prediction

A synonym for **hypothesis** is **prediction**. After you know your question, try to predict what the results will be based on your own background knowledge from either research or everyday observations. You must always include a real-world reason to support your hypothesis/prediction.

Model Question: Does the design of a bridge affect its weight-bearing capacity?

An Acceptable Example of a Hypothesis:

• I predict the design of a Warren Truss Bridge has the best weight-bearing capacity. Based on research, this bridge design allows the load to evenly distribute its weight across the entire bridge. In addition, this design increases the stability of the bridge because the bridge design is stronger than the Pratt Truss bridge design. A bridge with a stronger design is able to support more weight-bearing capacity, such as cars, trucks, etc.

Rationale: This hypothesis is acceptable because it includes specific information based on research done by the student as well as a real-world connection/reason.

An Unacceptable Example of a Hypothesis:

• I predict the bridge will be able to hold weight. I know this because bridges can hold cars.

Rationale: This hypothesis is unacceptable because the prediction is not specific, it's not supported by research and it doesn't provide a real-world connection/reason.

My hypothesis is: _____

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☐ Your hypothesis is approved! Next, start working on your Variables.

☐ Your hypothesis is not approved. Use my comments to rewrite your hypothesis. Your new due date for your hypothesis is: _____.

Teacher Comments:

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

My revised hypothesis is: _____

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☐ Your hypothesis is approved! Next, start working on your Variables.

☐ Your hypothesis is not approved. Use my comments to rewrite it. Your new due date for your hypothesis is: _____.

Teacher Comments:

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

My revised hypothesis is: _____

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☐ Your hypothesis is approved! Next, start working on your Variables.

☐ Your hypothesis is not approved. Use my comments to rewrite your hypothesis on a separate piece of paper. **Your final due date for your hypothesis is:** _____.

Teacher Comments:

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Variables

All experiments have three types of **variables**. A **variable** is something in your experiment that you change on purpose, something that may change, or something that you keep the same on purpose.

1. Independent Variable (You will **change this on purpose**)**:** You, as the scientist, change this variable in your experiment on purpose. Sometimes it is called the **manipulating variable**. You can **only have one (1) variable per experiment**.

2. Dependent Variable (You **wonder if this will change**)**:** This is what might change in your experiment based on your independent variable. Sometimes it is called the **responding variable** because it acts in response to what the independent variable did.

Experiment Question: Does studying longer improve test scores?

- **Independent Variable:** Time spent studying (2 hrs, 4 hrs, or 6 hrs)
- **Dependent Variable:** Test score
- **Controlled Variable:** Same test is given to everyone

The **test score** is the dependent variable because it may change depending on how long the student studies.

Definition: The **dependent variable** is what you **measure or observe** to see if it changes as a result of the independent variable.

If you have a well-written question, your independent variable and dependent variable are already identified.

3. Controlled Variables (You will **keep this the same on purpose**)**:** These are parts of the investigation you keep the same, so they don't "interrupt" what the independent variable is doing and how the dependent variable is reacting.

Model Question: Does the design of a bridge affect its weight-bearing capacity?

Model Variables:

• **Independent Variable:** Bridge design (Warren and Pratt Truss designs)

• **Dependent Variable:** Weight each bridge could handle, where, and how the bridge breaks

• **Controlled Variables:** The material to make the bridges, span of the bridge, and width of the bridge.

Suggestion: Use your materials list and your procedures to help you generate the controlled

variables. There will be a different amount of controlled variables for different experiments.

Variables are:

- **Independent Variable:** _____
- **Dependent Variable:** _____
- **Controlled Variables:** _____

_____

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☐ Your variables are approved! Next, start working on your Materials.

☐ Your variables are not approved. Use my comments to rewrite them. Your new due date for your variables is: _____.

Teacher Comments:

_____

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

My revised variables are:

- **Independent Variable:** _____
- **Dependent Variable:** _____
- **Controlled Variables:** _____

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Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Materials

Your **materials** are a list of the items you will need to conduct your experiment. As you develop your procedures on the next pages, you may need to add to this list.

Suggestion: Always list specific amounts/quantities for all items and **only use metric measurements.** Some metric measurement units are listed below to help you.

Metric Measurements Chart

Measurable Item	**Metric Unit**	**Abbreviation**
distance / length / height	millimeter centimeter meter kilometer	mm cm m km
time	seconds or minutes	sec / min
mass	milligrams grams kilograms	mg g kg
temperature	celsius	C
capacity	milliliter liter kiloliter	ml l kl
volume	cubic centimeter cubic meter	$cm3$ $m3$

Model Question: Does the design of a bridge affect its weight-bearing capacity?

An Acceptable List of Materials:

*Quantity	Description
3	2.54 cm x 10.16 cm x 40.64 cm balsa wood
84	gusset plates (squares measuring 5.08 cm on each side)
1	hot glue gun
20 - 25	glue sticks (depending on the size of the glue gun)
1	utility knife
600	craft sticks or tongue depressors
1	roll of masking or duct tape
2	bricks
1 - 20	weights (bottled water, sand, books, blocks, or flat and heavy objects
1	7.57 liter bucket
1	scale
1	metric ruler
1	box of medium/large binder clips
1	timer
1	camera
1	journal

*Quantity should be enough for at least 3 trials.

Rationale: This is an acceptable list of materials because specific amounts are provided for each item. Also, specific types of weights are mentioned. In addition, all measurements are recorded/written using metric measurements.

An Unacceptable Materials List:

Description
1” x 4” x 16” balsa wood
gusset plates (squares measuring 2 on each side)
hot glue gun
glue sticks (depending on the size of the glue gun)
utility knife
craft sticks or tongue depressors
roll of masking tape
bricks

Rationale: This is an unacceptable list of materials because no specific amounts are provided for each item. Also, all materials that were used to conduct the investigation are not listed. In addition, all measurements are recorded/written using standard/conventional (English) measurements.

☐ Your materials list is approved! Next, start working on your Procedures.

☐ Your materials list is not approved. Use my comments to rewrite your list on a separate piece of paper. **Your final due date for your materials list is:** _____.

Teacher Comments:

_____

_____

Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Procedures

Procedures are a detailed list of step-by-step directions of how to conduct your experiment. Using specific details are very important to procedures – using the exact amount of materials, the time it will take for parts, etc. The goal for procedures is for someone to follow the experiment exactly as you meant for it to be conducted without having you there to explain the directions. Remember, you must **repeat the activity/trial a minimum of three (3) times**! The more trials you conduct the more consistent your results.

Example Question: Does the design of a bridge affect its weight bearing capacity?

Acceptable Example for a List of Procedures:

1. Draw the Warren and Pratt bridge truss designs on graph paper.
2. Use 100 popsicle sticks and 14 gusset plates to design the bridge.
3. Use a ruler to measure the distance and length to make sure they remain the same throughout the design.
4. Use the utility knife to cut the balsa wood into 14 squares measuring 5.08 cm on each side. Make sure a trusted adult helps you cut the balsa wood.
5. Tape 7 gusset plates to your work surface.
6. With the help of an adult, hot glue the popsicle sticks to the gussets. After you glue a joint, clamp the joint with a binder clip and keep the binder clip on it for 30 minutes until the glue in the joint is completely dry.
7. Flip over the truss and attach popsicle sticks to the other side for double strength.
8. Build the second truss the same way.
9. Attach an extra popsicle stick at the long top and bottom members of the truss (chords) and where the slanted members tie the chords together (webs).
10. Let glue dry for 30 minutes.
11. Weigh the bridge and record the weight.
12. Place the bricks on your work surface 10.16 cm apart and make certain the long sides are parallel. Stand each truss vertically against a brick, and tape 3 of its web members to the brick.
13. Glue the struts and braces across the top and bottom. Add braces across either end of the bridge.
14. Let glue dry for 30 minutes.
15. Place the bricks 35.56 cm apart on the floor.
16. Place the ends of your bridge on the bricks.
17. Test the strength of your bridge by putting a 7.57 liter bucket on top of the bridge and start adding weight (bottled water, sand, books, or wooden blocks) slowly and incrementally until the bridge collapses. Continue until the bridge breaks.
18. Record how much weight each bridge could handle, where, and how the bridge breaks.

19. Repeat steps #2 through #18 for the Pratt Truss. Follow the design of a Pratt truss while using the same amount of materials and following the same span and width.
20. Repeat the process to complete three trials for each bridge model.

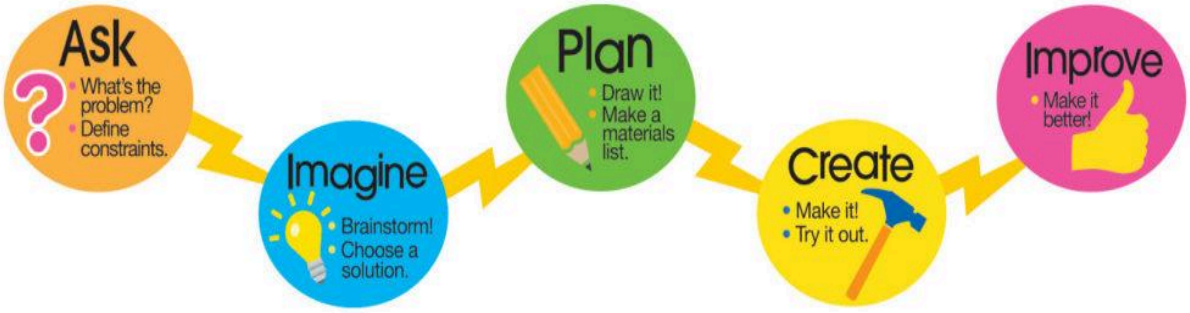
Notes: In your notebook, keep track of the challenges you came across and hypotheses you may have about how well each bridge will work. Also, it's a good idea to take photographs of your bridges before you begin to add weights. Then, continue to take pictures throughout the remainder of your experimentation.

Rationale: This list of procedures is acceptable because all of the steps are numbered, detailed, and they explain what you specifically need to do for each step.

Unacceptable Example for a List of Procedures:

1. Gather your materials and ask mom for permission to work in the kitchen.
2. Tie one stick onto the end of the other stick.
3. Glue the sticks together and put the weights on.
4. Write down your answer.
5. Do it all over again until you have used all of the weights.

Rationale: This list of procedures is unacceptable because the steps are incomplete. The steps do not clearly state specifically what needs to be done in order to build the bridge designs. Also, this list does not assist the reader with the necessary information/details in order to recreate the experiment/investigation.



My Procedures (You may need more or less lines. If you need more, attach another piece of paper.)

1.

_____

2.

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3.

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12.

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☐ Your procedures list is approved! Next, start working on your Data Display.

☐ Your procedure list is not approved. Use my comments to rewrite your procedures on a separate piece of paper. **Your new due date for your list is:** _____.

Teacher Comments: _____

_____

_____

Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Data Collection Tool

A **data collection tool** is what you will use to write down your data results as you conduct your investigation for each trial and make your observations. Your collection tool can be a table (an example has been provided below) and must include the following items:

- a title
- labels to describe the columns or rows
- space for repeated trials (a minimum of three; more is better!)
- space for the a calculation of the median of the data and the mean (average) of the data, if required by your teacher
- all data is collected in metric units (see Materials for a reminder)

* If you are not collecting numerical data but rather making observations, you still need to design a chart or keep a journal in which you can record your detailed notes.

Title of Data Table

Independent Variable	**Results**			**Average**
	Trial One	**Trial Two**	**Trial Three**	

My Data Collection Tool

(Use this space to design your own data collection tool or use examples from the appendix.)

☐ Your data collection table is approved! Next, start working on your Experiment.

☐ Your data collection tool is not approved. Use my comments to recreate your data collection on a separate sheet of paper. **Your new due date for your list is** _____.

Teacher Comments:

_____

_____

Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Results and Data from Experiment

Now, you are ready to conduct your experiment! All of the work you have done up to this point has prepared you for a thorough investigation on your topic. Before you begin your experiment, remember to:

- Gather all the materials you listed on your materials list.
- If your experiment requires adult supervision, you must have an adult present!
- Follow all the procedures you listed. If something needs to be added or changed, make sure you record it, so you can update your procedures accordingly.
- Keep accurate records of your **results** by filling in your data chart as you go.

REMEMBER!

- If you are growing something (plants, mold) plan to allow a minimum of two weeks (approximately 14 days) for everything to grow enough for you to have a meaningful amount of data.
- If you are freezing something, plan to allow a minimum of four hours for liquids to freeze completely so a meaningful amount of data can be collected.
- If you are melting something, plan to allow an appropriate amount of time depending if you are melting the item in an oven or just by natural, room temperature.
- If you are using an oven, remember to have an adult present.

  Do not begin graphing your data until your teacher has approved the data you collected in your table.

Data Table

☐ Your experiment data is approved! Next, start working on your Results, Graphics and Display.

☐ Your experiment data is not approved. Use my comments to recreate it. **Your new due date for your experiment data is: _____.**

Teacher Comments: _____

_____

_____

Teacher Signature: _____ **Date:** _____

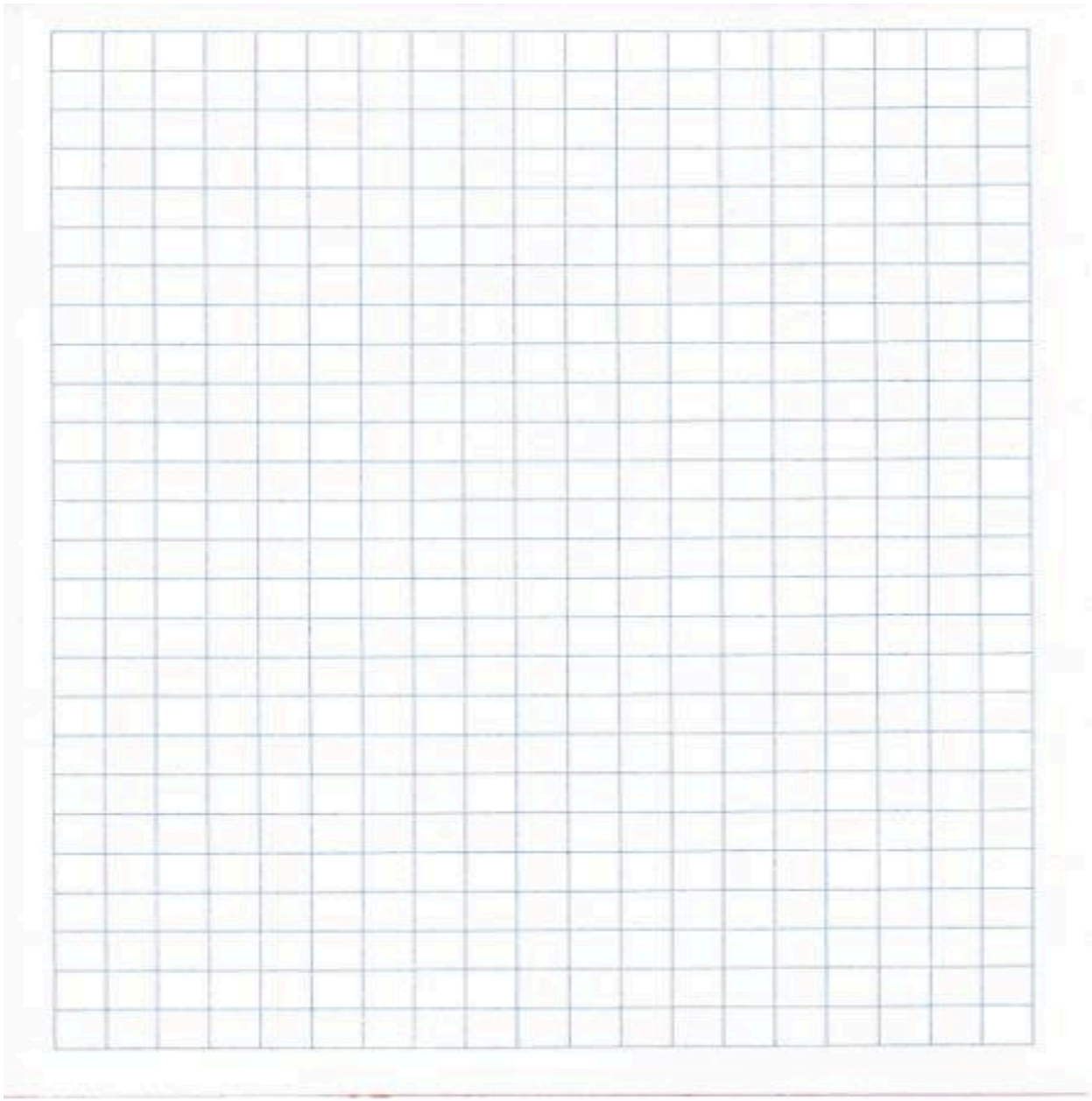
Parent Signature: _____ **Date:** _____

Results, Graphic Display

Once your teacher has approved the data you have collected in your table and you have summarized the data by finding the median, mean or some other method of highlighting the important results, you are ready to **graph your data**. Here are the steps to organize your material:

- You must choose the correct type of graph to display your results.
  - Line graph should be used to display continuous data – information that changes over time.
    - temperature changes (not just a final, ending temperature)
    - growth changes
    - time changes
  - Bar graph should be used to display data that is separate or distinct from other pieces of data in your activity.
    - height of bouncing or falling objects
    - distance objects travel
    - survey results
    - Pie charts, line plots and stem/leaf plots are not usual graphical displays in STEM projects. Please check with your teacher first if you are considering one of these types of displays.
- All graphs need to include the following information:
  - Title – this can be the same as your data collection table
  - Independent variable – this goes on the horizontal (x-axis); you can use what you have on the data collection table
  - Dependent variable – this goes on the vertical (y-axis); use the same description as the data collection table
- All of your data can be presented in a graphic display. However, you **must** present another graphic display for your summary data too.
- If you choose to only present one graphic display, you must present the summary data.
- You may use the graphing paper on the next page or select a graphing tool of your own.
  - On the provided graph, space has been left around the perimeter for all of the labels and used in portrait or landscape style.
  - Computer generated graphs are allowed but be sure they contain all of the information listed above.

Graph Paper



Sample Results (Graphic Display)

Data Table 1

Data Table 1: Weight Bearing Capacity (grams)								
Trial	**Bridge Type**	**Mass of Bridge**	**Mass of Load that Broke Bridge**	**Strength-to-Mass Ratio**	**Bridge Type**	**Mass of Bridge**	**Mass of Load that Broke Bridge**	**Strength-to-Mass Ratio**
1	Warren	89	30,190	339	Pratt	96	22,730	237
2	Warren	90	30,111	335	Pratt	87	16,531	190
3	Warren	88	28,900	328	Pratt	99	22,300	225
	Average	89	29,734	334	**Average**	94	20,520	217
	Strenght-to-Weight Ratio= Mass of Load that Broke Bridge/Mass of Bridge							

Data Table 2

Data Table 2: Strength-to-Mass Ratio by Trial (grams)				
Bridge Type	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
Warren	339	335	328	334
Pratt	237	190	225	217

Rationale: These two graphic displays are acceptable because both tables show you specific results from conducting the experiment. This is known as your data results. Both tables have titles. Also, the independent and dependent variables are labeled on the graphs with specific corresponding data.

Results and Written Explanation

A **written explanation** gives a brief analysis of the data you collected in your table. The results are displayed visually in your table. The length of results should be at least one paragraph long. The paragraph must summarize the data shown in the table and graph. It can include patterns or trends you noticed while analyzing your data, if any, but it should not be a conclusion.

Model Question: Does the design of a bridge affect its weight bearing capacity?

Acceptable Written Results Explanation Example:

> The data shows that the results varied by trial based on the bridge type. The results were very consistent as the Warren Truss bridge was always stronger than the Pratt Truss bridge. The Warren design could hold 30,190 grams during Trial 1 while the most the Pratt Truss bridge design could hold was 22,730 grams during the same trial.
>
> Observations during each trial showed that the Warren Truss bridge was very strong. The Warren Truss design was not only able to hold a greater amount of weight; it was able to hold the weight for a long period. While the bridge was showing signs of stress by leaning and some cracks, the bridge still could take on more weights. The Pratt Truss bridge design broke quickly and when they broke there were several pieces that almost exploded at once. The Warren Truss bridge broke by only a few pieces of the bridge breaking away.

Unacceptable **Written Results Explanation Example:**

> The data shows that the results varied by trial based on the bridge type. The results were very consistent as the Warren Truss bridge was always stronger than the Pratt Truss bridge.
>
> Observations during each trial showed that the Warren Truss bridge was very strong. The Warren Truss design was not only able to hold a greater amount of weight; it was able to hold the weight for a long period.

Here is the written explanation of my results.

This explanation summarizes the data by only mentioning the shortest and longest piece of data. There is an attempt to discuss a trend to the data even though a trend isn't completely clear. This explanation just states in words exactly what the table says. It doesn't summarize the most important data nor is there any brief discussion of a possible trend. Stating that you "can't tell if there is a trend" is not an analysis.

My Results and Written Explanation

(Use this space to write your results and written explanation)

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☐ Your Results and Written Explanation is approved! Next, start working on your Conclusion.

☐ Your Results and Written Explanation is not approved. Use my comments to recreate it on a separate piece of paper. **Your new final due date for your Results and Written Explanation is:** _____.

Teacher Comments:_____

_____

_____

Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Writing Your Conclusion

The **conclusion** tells what you learned about the topic after completing the experiment. It contains many parts. Use the question prompts below to organize your ideas. Then, join them together into multiple paragraphs to create your final conclusion.

What is the answer to the question you asked?

Reread your hypothesis. Was it correct?

What can you infer about your results?

How can this information help you, others or even companies in the real-world?

Did you have any problems as you conducted your investigation?

If you kept the same topic, what different idea would you test next year?

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☐ Your Conclusion draft is approved! Next, start working on combining your Conclusion statements into one final product.

☐ Your Conclusion draft is not approved. Use my comments to recreate it on a separate piece of paper. **Your new due date for your conclusion is: _____.**

Teacher Comments: _____

_____

_____

Teacher Signature: _____ **Date:** _____

Parent Signature: _____ **Date:** _____

Final Draft of Conclusion

(Use this space to write your final draft for your conclusion)

Research Paper Guidelines (*Optional, Not Required*)

The **research paper** is an important part of any good STEM fair project. The research paper gives you an opportunity to learn more about your topic and should be closely related to the investigation you have chosen for the STEM fair. It is recommended that students complete a research paper to support students' writing skills. **PLEASE NOTE:** The research paper is ONLY mandatory for students that are entering the Kids for Science STEM Fair (KFS).

1. **Title Page** – includes the title of your project, your name, school, grade, teacher, and the date the project is due.

2. **Acknowledgements** – a personal thank you to anyone who helped you with the project. It could include parents, teachers, siblings, librarian, scientist and any other person who assisted you with any part of your project.

3. **Question** – the specific question you ask for your experiment. This can be placed on its own page or right before beginning the research portion of your research paper.

4. **Background Research** –
   a. Start by brainstorming topic ideas. Think of other questions you have about your topic and make a list.
   b. Use books from the library and the internet to find out interesting and relevant information about your topic.
   c. Rewrite the information you find in your own words. Do not copy from the book or print pages from the internet. This is PLAGIARISM and it is illegal. If you need help, ask an adult for assistance.
   d. Make sure to keep track of all the books, websites and articles you used to get your information so you can list your sources in your bibliography.
5. **Sources/Bibliography** – an alphabetical listing of books, articles, and other sources, including websites that you used when researching your topic. **Visit http://classbrain.net for an explanation of how this should be written.**

6. Follow the directions provided by your teacher to complete http://easybib.comyour research project.

Appendix: STEM Fair Resources

The remaining pages of this journal have been divided into several sections. These appendices are designed to provide additional information to help students with the STEM fair project. Items that may be helpful in finding a topic, project ideas, writing a research paper, creating the display, how the STEM fair project will be judged, sample scoring sheets for teachers and a summary of acceptable and non-acceptable projects may be found in these sections.

The following information is included in each appendix:

Appendix A: STEM Fair Oral Presentation Scoring Guide

Appendix B: STEM Fair Display Board Scoring Guide

Appendix C: STEM Fair Research Paper Scoring Guide

Appendix D: Tips for Creating Display Board

Appendix E: Tips for Creating Digital Projects

Appendix F: Sample Research Paper

Appendix G: Blank Data Collection Tools

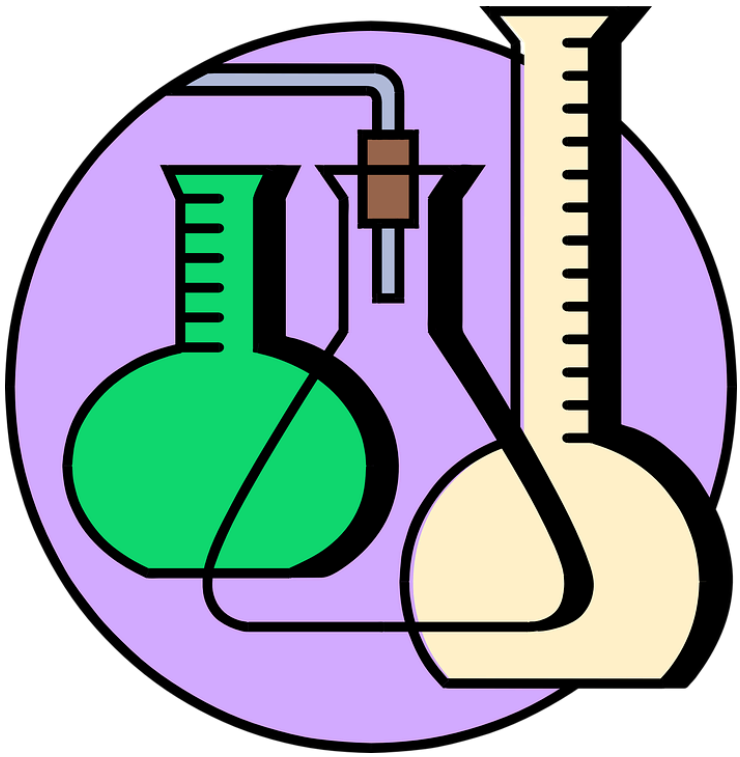
Appendix H: STEM Fair Project Overview Plan Document

Appendix A: STEM Fair Oral Presentation Scoring Guide

Student Name: _____ Grade Level:_____

Project Title:_____

Category	Possible Points	Points Earned	Comments
Eye Contact – Students are not reading from the display board and maintain eye contact with class the majority of the time.	**10**		
Projection of Voice – Students are clearly heard by all in the audience.	**10**		
Preparation – Students should appear to have practiced their presentation.	**10**		
Organization – Students are presenting information in a logical order.	**10**		
Knowledgeable About Their Project – Students do not depend on the display board, research paper and/or research plan.	**10**		
Introduction About Project – Student provides a summary about their project. This information can come from their research plan. (Note: The research plan is not the research paper, the plan summarizes the STEM fair project.)	**10**		
Question and Hypothesis – Students state their question and explain why they chose this topic.	**10**		
Materials – Students explain the materials they chose for their experiment.	**10**		
Procedures – Students summarize how they did their experiment, being sure to mention how many times the experiment was repeated.	**10**		
Data/Results/Conclusion – Student summarizes the results giving a few examples of numeric data collected.	**10**		
Total	**100**		**Final Grade:_____**



Appendix B: STEM Fair Display Board Scoring Guide

Student Name: _____ Grade Level:_____

Project Title:_____

Category	Possible Points	Points Earned	Comments
Overall Appearance and Organization: • All parts of the project are included, clearly labeled and in sequential order (title, question, hypothesis, materials, procedures, results, conclusion. Size of boards meets requirements: no smaller than 36" x 48" open and 36" x 24" closed and no larger than 100 cm wide and 95 cm high • Display board is neat and attractive.	**15**		
Question: • Question led to an investigation, not a report, demonstration or model. • A creative approach to problem solving was used to formulate the question.	**10**		
Hypothesis/Prediction: • Prediction must state a possible outcome of the experiment with an accompanying explanation. • Should show students background knowledge.	**10**		
Materials/Procedures: • Materials and equipment are listed with specific amounts using METRIC units. • All steps to conduct the experiment are described and in order.	**10**		
Variables/ Experimental Design: • Independent, dependent, and controlled variables are correctly identified and listed. • Adequate data were collected through repeated trials to justify the conclusion. • Sufficient sample size was used to support the conclusion (as necessitated by project).	**15**		
Results/Graphic Representation: • Data is presented in the form of a table with appropriate labels and titles. • An appropriate type of graph is accurately constructed (scale, labels and title) from the data on the table.	**15**		
Results/Written Explanation: • Explanation analyzes and summarizes the data to note patterns and trends. • Explanation interprets the graph.	**15**		

Conclusion: • Answers the original question being investigated. • Tells whether or not the hypothesis was correct, using specific data as a reference. • Additional questions to investigate are presented.	**10**		
Totals	**100**		**Final Grade:_____**

Appendix C: STEM Fair Research Paper(*Optional*) Scoring Guide

Student Name: _____ Grade Level:_____

Project Title:_____

Category	Possible Points	Points Earned	Comments
Organization – Information is very organized with well-constructed paragraphs and subheadings.	**15**		
All Parts Present – All five parts of the research paper are present and complete (Title Page, Acknowledgements, Question, Background Research and Bibliography).	**10**		
Amount of Information – All topics are accurately addressed and all questions answered with at least 5 sentences about each.	**20**		
Quality of Information – Information clearly relates to the main topic. It includes several supporting details and/or examples.	**20**		
Word Choice – The word choice makes the information very clear and informative.	**10**		
Mechanics – No grammatical, spelling or punctuation errors.	**15**		
Sources – All sources (information and graphics) are accurately documented in the desired format.	**10**		
Totals	**100**		**Final Grade:**

Appendix D: Tips for Creating A Display Board

SAFETY CAUTION: *DO NOT USE A STAPLER ON YOUR DISPLAY BOARD. THE STAPLES STICK OUT THE BACK OF THE DISPLAY BOARD THAT CAUSES INJURY!*

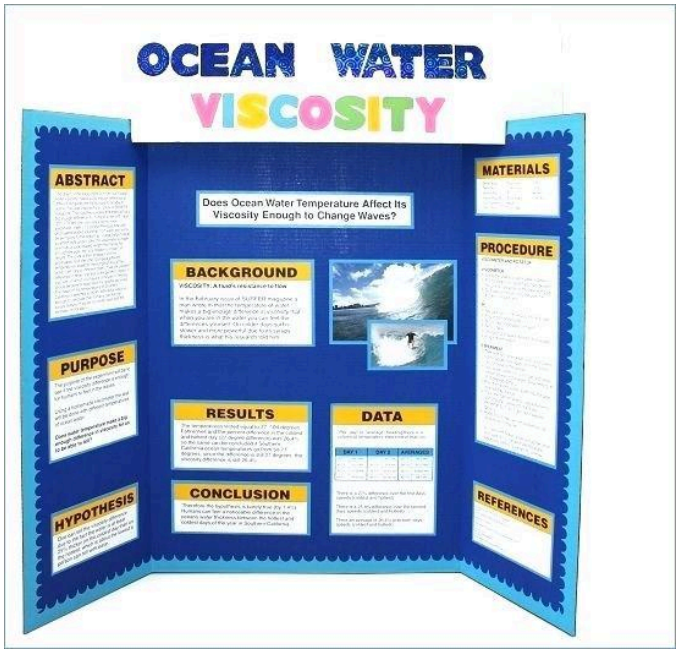
- **Select the Right Size* –** Choose a tri-fold display board that is no smaller than 36" x 48" open and 36" x 24" closed and no larger than 100 cm wide and 95 cm high.
- **Be Neat** – Avoid frayed or ripped edges of paper, glue globs, lots of cross outs or white outs etc. **Use Colors to Attract Attention** - Make sure colors are not too distracting.
- **Frame or Matte Your Work** – Use construction paper, or other materials, to provide a background for your written work and labels.
- **Choose a Good Title** – Titles should be short, catchy and related to your topic.
  - ★ For example, Cool Color Cubes is better than The Melting Rate of Different Colors of Ice Cubes
- **Writing Should Be Neat** – If possible, everything on your board should be typed, making sure that you use the same fonts and font sizes throughout. Do not go overboard with fonts, font colors or font sizes. Try to keep everything looking uniform. If you are handwriting, use a pen and write very neatly so that everything can be read. Cursive is not encouraged. ****We recommend that all information should be printed or type on paper before putting it on the board**.
- **Spelling Counts** – Have an adult check all of your spelling before printing.
- **Practice the Layout** – Before you glue anything to your board, lay it all out to make sure it fits. If items are too small make them larger, if items are too large make them smaller. You do not want things to overlap and you do not want too much white space.
- **Do Not Glue Any Materials From Your Project*** – Only paper and photographs are allowed on your board. If you want to put a material on your board, take a picture of it and glue that on your board.
- **Do Add Photos, Drawings and Images –** This is the best way to clearly show what you did during your investigation. If you use photos, drawing or image from online, make sure you cite where you retrieved it including the site link. (example: This picture was retrieve from Discovery Education site)
- **Research Papers Should be Placed on the Table in Front of Your Board – DO NOT attach the research paper to your backboard.**

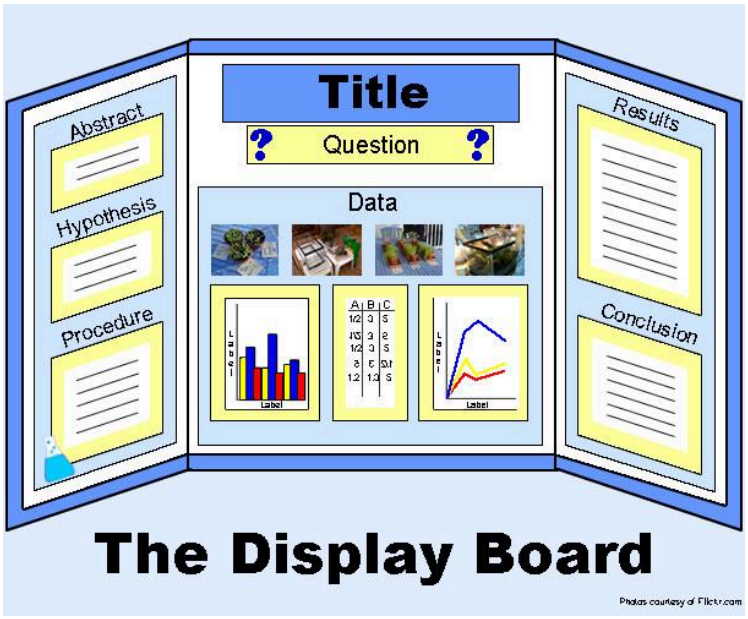
***Denotes a requirement for the county fair, Kids for Science. If you are invited to the fair your board must follow this tip.**

Sample Display Boards

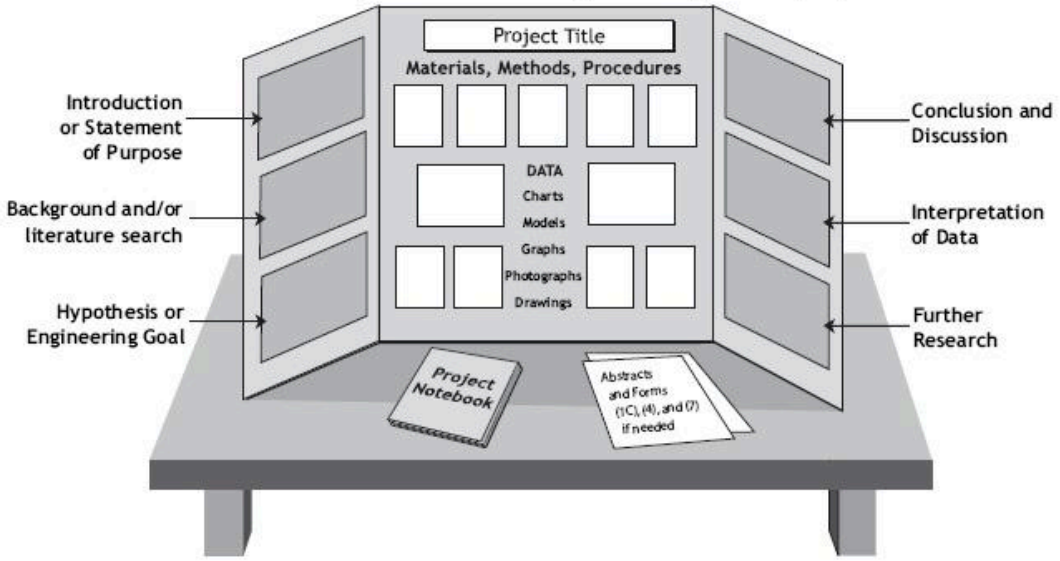
Question State your question here. **Hypothesis** State your hypothesis here. (Remember to do this BEFORE your experiment takes place.) **Materials List** List all materials you needed to complete the experiment. If you used it, list it.	**PROJECT TITLE** **Procedures** Explain what you did for your experiment in such a way that someone else could recreate the experiment again. (include pictures)	**Data** This includes a table where information is recorded during the experiment and an appropriate graph that shows the data in a visual form. **Analysis** Briefly tell what the data shows and what you found out. **Conclusion** State whether your hypothesis was right or wrong.

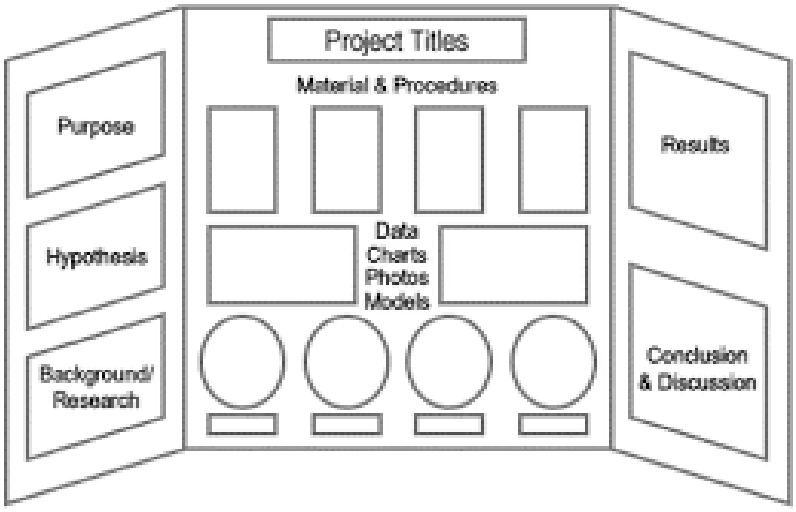
Have your science journal available for review.

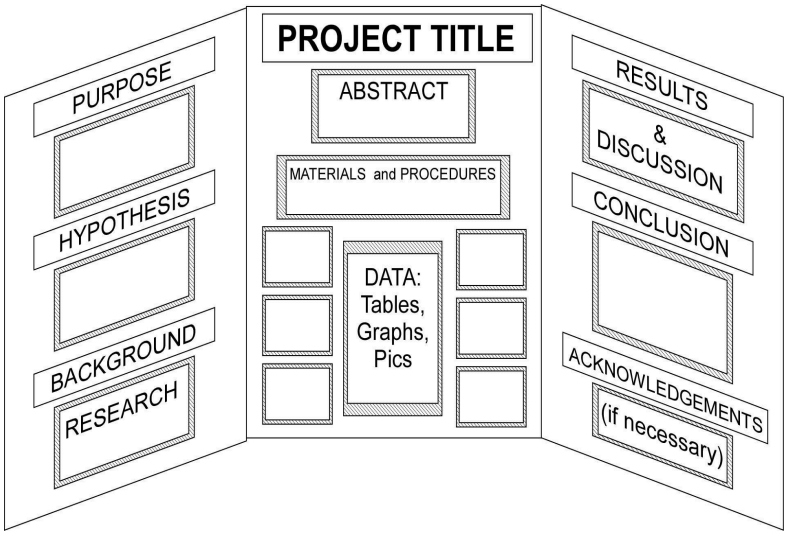


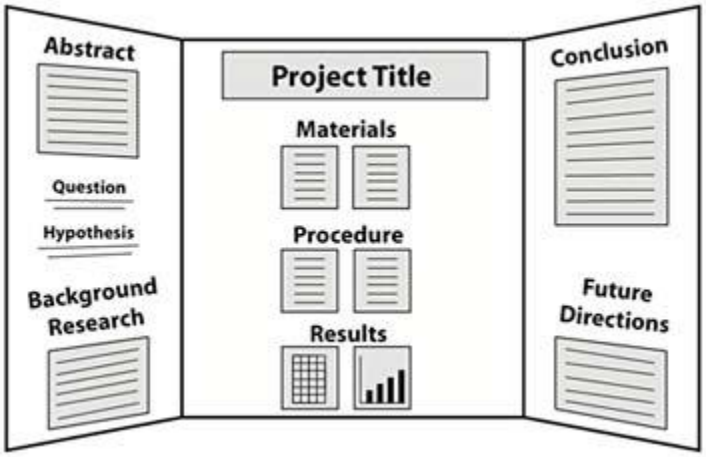


Material Normally Included on a Typical Project Display Board

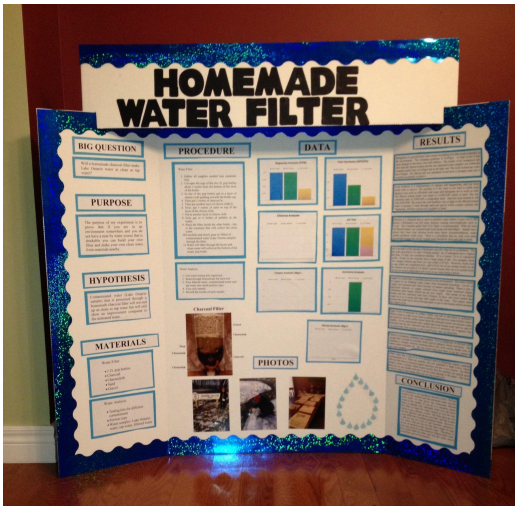


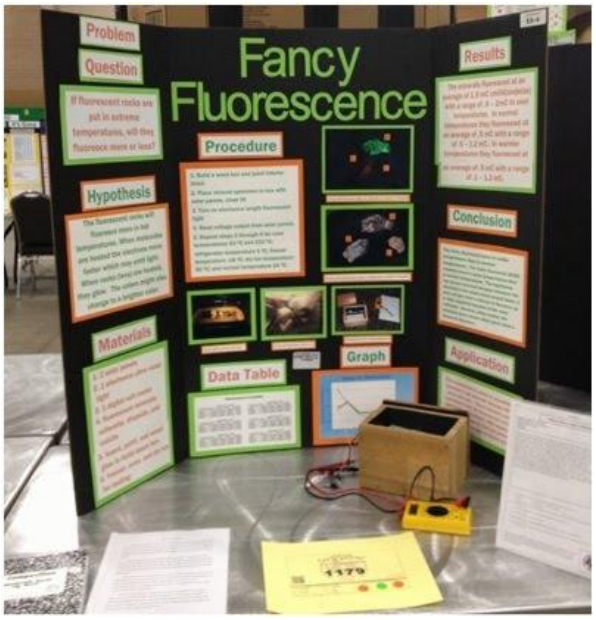

Project Titles
Material & Procedures
Purpose
Hypothesis
Background/ Research
Data Charts Photos Models
Results
Conclusion & Discussion

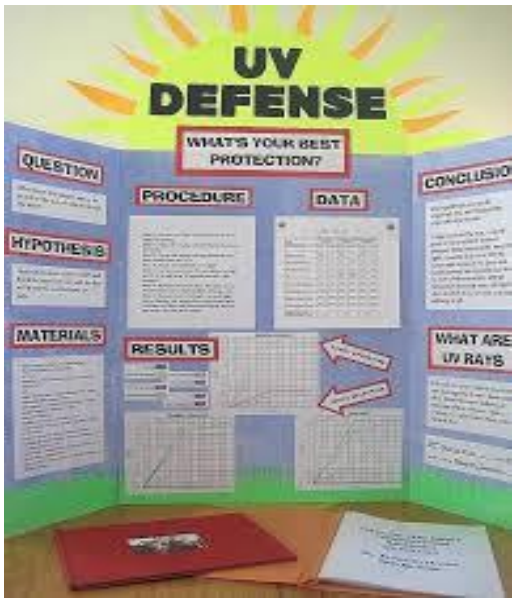

PROJECT TITLE
ABSTRACT
MATERIALS and PROCEDURES
DATA: Tables, Graphs, Pics
PURPOSE
HYPOTHESIS
BACKGROUND RESEARCH
RESULTS & DISCUSSION
CONCLUSION
ACKNOWLEDGEMENTS (if necessary)


Abstract
Question
Hypothesis
Background Research
Project Title
Materials
Procedure
Results
Conclusion
Future Directions

3
How Color Influences Taste
Abstract
Hypothesis and Variables
Methods and Materials
Research
Results


HOMEMADE WATER FILTER
BIG QUESTION
PROCEDURE
DATA
RESULTS
PURPOSE
HYPOTHESIS
MATERIALS
PHOTOS
CONCLUSION


Problem
Question
Fancy Fluorescence
Results
Procedure
Hypothesis
Conclusion
Materials
Data Table
Graph
Application


UV DEFENSE
WHAT'S YOUR BEST PROTECTION?
QUESTION
PROCEDURE
DATA
HYPOTHESIS
MATERIALS
RESULTS
CONCLUSIO
WHAT ARE UV RAYS

Appendix E: Tips for Creating Digital Projects

Digital projects are not accepted into the county-wide Kids for Science STEM Fair. Digital projects must be placed on a display board.

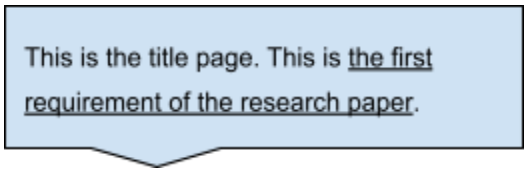
- **Be Neat** – Avoid using different types of fonts in various sizes. Find what you like and use it throughout the whole presentation.
- **Use Colors to Attract Attention** – Use no more than three colors in your presentation. Too many colors can be distracting.
- **Presentation Theme** – Select one theme that is appropriate for your topic and use it throughout the entire presentation.
- **Plan Your Slides*** – Before you begin, make sure you have planned each of your slides. Plan to have 13 or less slides, including slides for the title, question, prediction, materials, procedures, variables, graphic representation of results, written explanation of results, conclusion and acknowledgements.
- **Add Photos and Drawings –** This is the best way to clearly show what you did during your investigation.
- **Add A Brief Video*** – Consider adding a video of you conducting your experiment. It should be less than two minutes long. Do not add any other video clips.
- **Be prepared** – Bring a hard copy of your presentation just in case the computers don't work.
- **Research Papers Should be Placed on the Table in Front of Your Board – DO NOT attach the research paper to your presentation.**

  ** Denotes a requirement for the county fair, Kids for Science (KFS). If you are invited to the fair, your board must follow this tip.*

  **A video is not required for the KFS, but if you add a video it must be less than two minutes.*

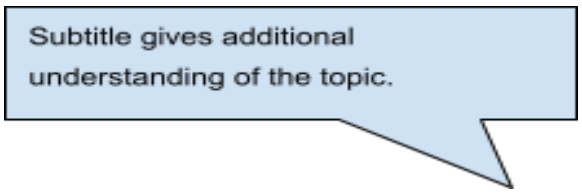
Appendix F: Sample Research Paper (*Optional*)

Below are sample research papers written by Chesapeake Math and IT Elementary School students. These samples are meant to help illustrate the 5 parts included in most research papers. Notes inside of balloons or in *italics*, are added to the papers to highlight special parts of the paper. These notes and highlighted areas should not be duplicated into your own papers. The contributions of Brandon Milline (5th grade) are greatly appreciated. They generously donated their research papers to be used in this journal.



Carry the Load

(Sample Research Paper)



Warren vs. Pratt Truss Bridge

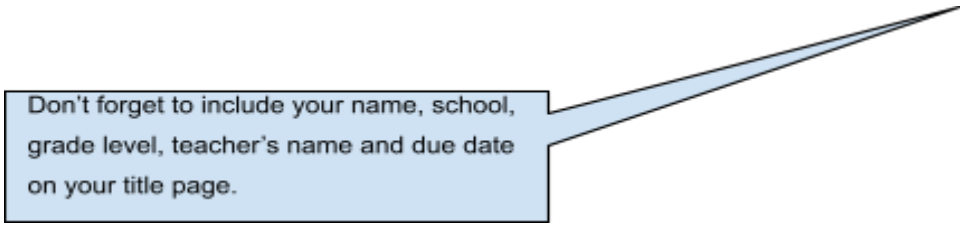
Student First and Last Name

Chesapeake Math and IT Elementary School

Fifth (5th) Grade

Teacher Name

April 17, 2018



This is the acknowledgements page. It is the second requirement of the research paper.

Acknowledgements

I would like to thank my mom for helping me with this project and typing the information, because it was taking me forever. Special thanks to Ms. G and Ms. McCain for encouraging me to do the project and for checking over my work. Thank you for not letting me quit even when I wanted to change projects because things were not working out the way I wanted them to.

Be sure to be specific when thanking people and say exactly how they helped you.

The question can either get its own page or be on the same page as the research.

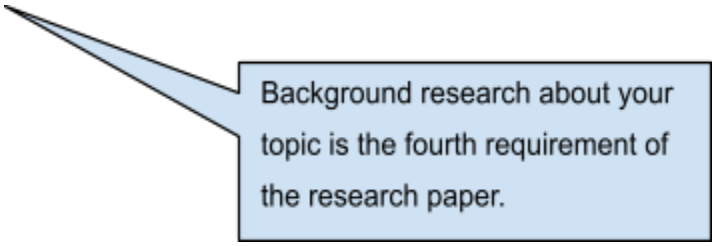
The question is the third requirement of the research paper.

Question

Does the bridge design affect its weight bearing capacity?

Background Information Research

Good built bridges have to be built keeping in mind how they can hold weight without the danger of collapsing. When bridges are built to accommodate cars, trucks, and even trains, the weight capacity must be considered. The design of the bridge is extremely important to determine the capacity of weight it holds.



Introduction

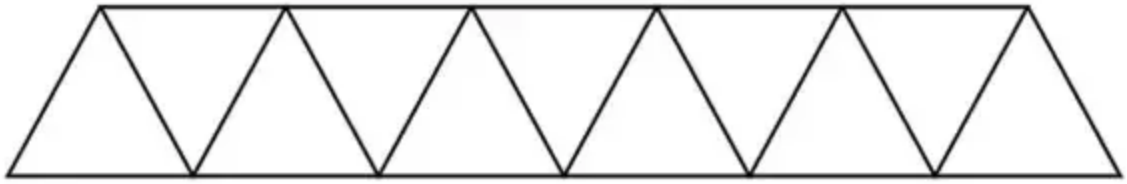
"Carry the Load" is a STEM Fair project and research paper that will give a better understanding of why different bridge designs are important, specifically the Warren and Pratt truss bridge styles, why they are used, and constructed with comparable and similar sizes, which is able to hold the most weight. A "truss" bridge is a bridge with "any of various structural frames based on the geometric rigidity of the triangle and composed of straight members subject only to longitudinal compression, tension, or both: functions as a beam or cantilever to support bridges, roofs, etc. (*Civil Engineering*, *Building Trades)*.

The purpose of this project is to determine if the way the bridge is built has an effect on the bridge's weight bearing capacity. Does the bridge design affect its weight bearing capacity? Does using the same type of material equal the weight bearing capacity?

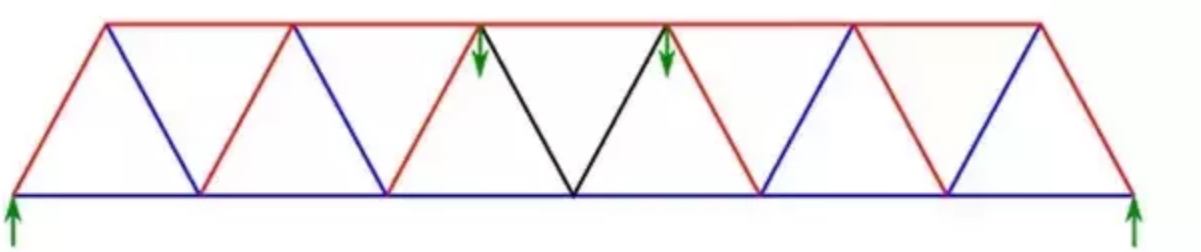
Good built bridge has to be built keeping in mind how they can hold weight without the danger of collapsing. This project is important because when designing and building a bridge, it is important that the bridge is built for safety and will not collapse during use because of the weight it needs to bear.

With steel as a building material, different types of trusses have different advantages and disadvantages; these are usually properly considered while choosing a shape. Other than strength and stability, the economy and ease of construction and fabrication also affect the choice.

1. ***Warren truss***
   - It is composed of equilateral or isosceles triangles.
   - The design is as shown.



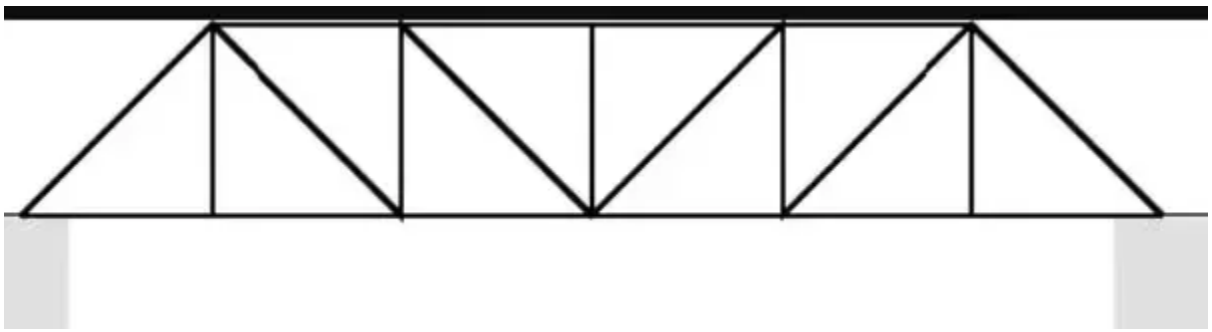
- The tension and compression members are as shown.



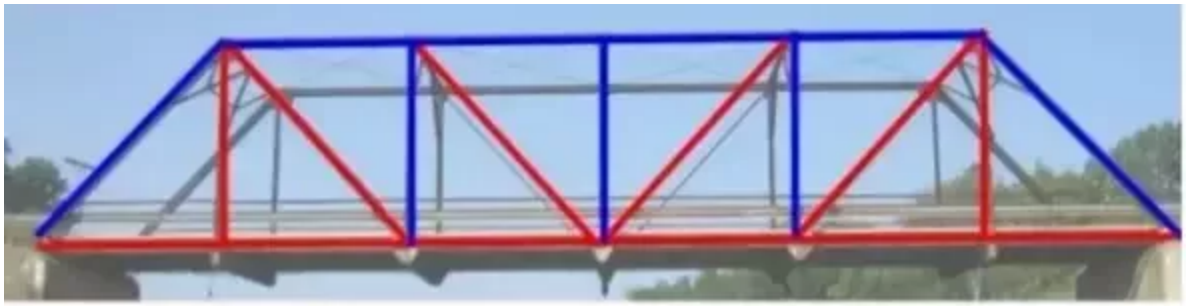
- Blue : tension
- Red : compression
- Equal lengths of tension and compression members is a disadvantage as steel buckles easily in compression hence short members for compression are preferable.
- It is easy to fabricate, assemble and inspect because of its simple design.

2. ***Pratt truss***

- It is composed of alternate vertical and inclined members
- It has diagonal members that slant down towards the middle
- The design is as shown



- The tension and compression members are as shown.



- Blue : compression
- Red : tension
- Green : 0 force
- It places compression on shorter vertical members and tension on longer diagonal members which is advantageous for steel.
- It places comparatively larger stress on top and bottom chord members hence larger section members are required for top and bottom.’

Data

By creating model bridges out of popsicle sticks using the Warren and Pratt bridge designs as the independent variable. A testing structure was created. A bucket of water with different amounts of liquid was used as weights to test the bridge capacity.

For analyzing the data, two models of bridge types were built and tested (Warren and Pratt Truss). The mass of weight the designs were able to bear ranged from _____ liters? to ____ liters? As each measure of weight was tested on each bridge, the ability to accommodate the weight without breaking was noted.

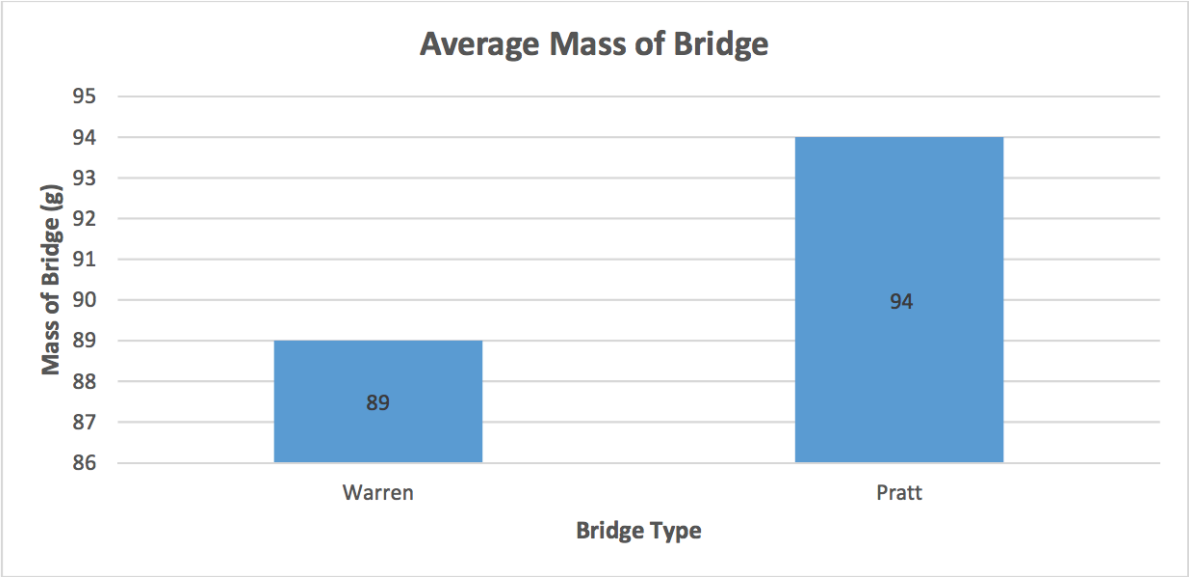
Data Table 1

Data Table 1: Weight Bearing Capacity (grams)								
Trial	**Bridge Type**	**Mass of Bridge**	**Mass of Load that Broke Bridge**	**Strength-to-Mass Ratio**	**Bridge Type**	**Mass of Bridge**	**Mass of Load that Broke Bridge**	**Strength-to-Mass Ratio**
1	Warren	89	30,190	339	Pratt	96	22,730	237
2	Warren	90	30,111	335	Pratt	87	16,531	190
3	Warren	88	28,900	328	Pratt	99	22,300	225
	Average	89	29,734	334	**Average**	94	20,520	217
	Strenght-to-Weight Ratio= Mass of Load that Broke Bridge/Mass of Bridge							

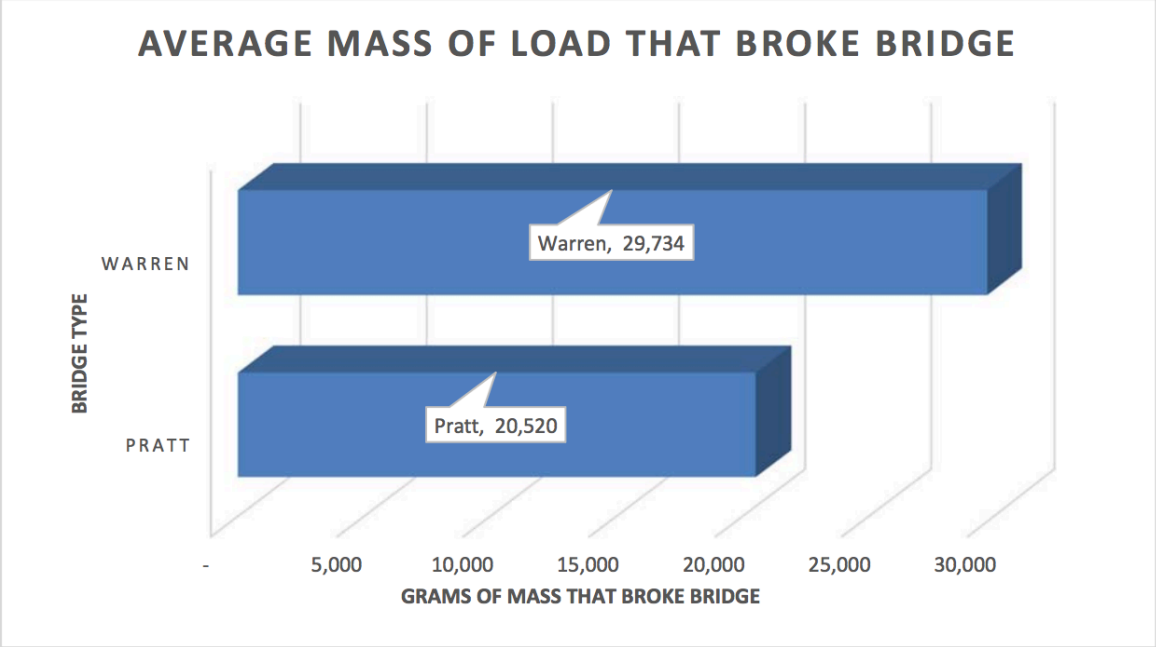
Data Table 2

Data Table 2: Strength-to-Mass Ratio by Trial (grams)				
Bridge Type	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
Warren	339	335	328	334
Pratt	237	190	225	217

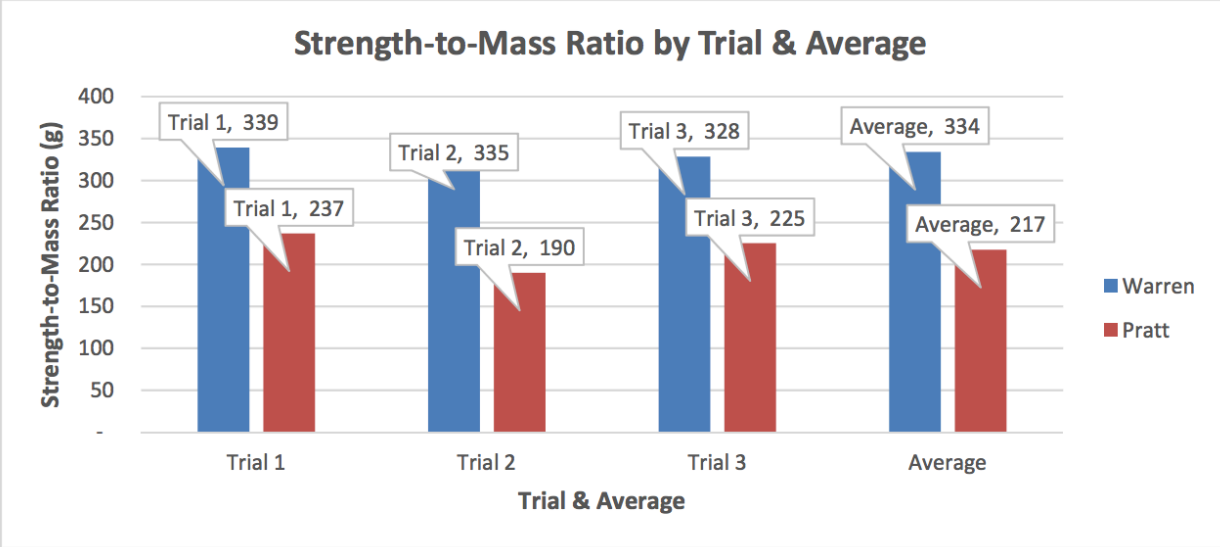
Bar Chart 1



Bar Chart 2



Bar Chart 3



Statement of Relationship

The Data Table 1 shows the data collected during the entire experiment. This table also shows the Mass-to-Strength ratio for each bridge type by trial. The table also averages all the data for the entire experiment. The Data Table 2 shows just the Mass-to-Strength ratio for each trial and the average of the data. The Bar Chart 1 shows the average mass of each bridge type. The Bar Chart 2 shows the average mass that broke the bridge by bridge type for the entire experiment. Bar Chart 3 Shows the data for each bridge type and the average of the data for the entire experiment.

Written Results

The data shows that the results varied by trial based on the bridge type. The results were very consistent as the Warren bridge was always stronger than the Pratt Truss bridge. The Warren design could hold 30,190 grams during Trial 1 while the most the Pratt bridge design could hold was 22,730 grams during the same trial.

Observations during each trial showed that the Warren bridge was very strong. The Warren Truss design was not only able to hold a greater amount of weight; it was also able to hold the wait for a long period. While the bridge was showing signs of stress by leaning and some cracks, the bridge still could take on more weights. The Pratt Bridge design broke quickly and when they broke there were several pieces that almost exploded at once. The Warren bridge type broke by only a few pieces of the bridge breaking away

Conclusion

Make sure your conclusion wraps everything up for the reader. The reader should not be left with many, if any, questions.

This research paper and STEM project taught me a lot about why different bridges are built. I see that it is important to have different types of bridges that can support the amount of cars that travel. After creating model bridges out of popsicle sticks using the Warren and Pratt bridge designs as the independent variable, and testing the amount of weight that each could hold, a determination was made that the _____ bridge design was the strongest. My hypothesis was proven _____. The way that the _____ part of the _____ bridge was made, it was designed in a way to hold the greatest capacity of weight.

I would extend this research to determine which type of bridge should be built for playground bridges, _____, and _____. I would like to extend this project to either another wooden structured bridge or using a different material to conBy creating model bridges out of popsicle sticks using the Warren and Pratt bridge designs as the independent variable, a determination was made on which bridge design was the strongest. I could further extend this project to construct two bridges with different materials that can serve a

stronger capacity.

Bibliography

NOTE: *The All sources should be listed in bibliography is the fifth and final alphabetical order by author's last requirement for the research paper.name. Any research paper WITHOUT a Bibliography is considered PLAGIARISM. For assistance writing your bibliography, visit http://easybib.com. Try to use a variety of sources including both books and websites.)*

Truss.(2018).Dictionary.com. Retrieved from http://www.dictionary.com/browse/truss?s=t

Gurstelle, W. (2015, May 22). Make a Warren Truss Bridge with Popsicle Sticks | Make:. Retrieved from https://makezine.com/projects/make-36-boards/make-warren-truss-bridge-popsicle-sticks/

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Latham, D., & Vaughn, J. (2012). *Bridges and tunnels: Investigate feats of engineering*. White River Junction, VT: Nomad Press.

Popsicle bridge. (n.d.). Retrieved from https://wesee.wikispaces.com/popsiclebridge

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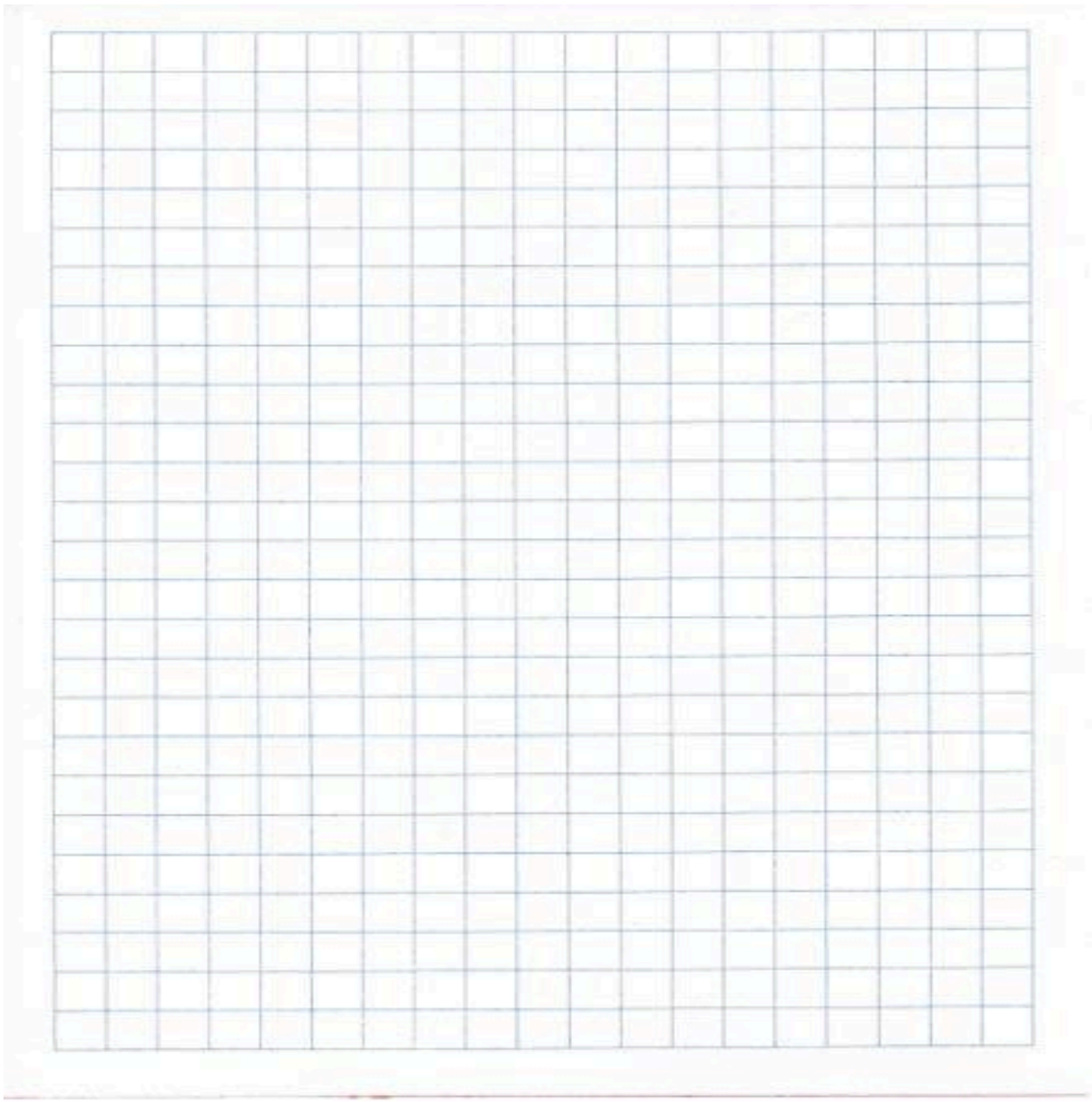
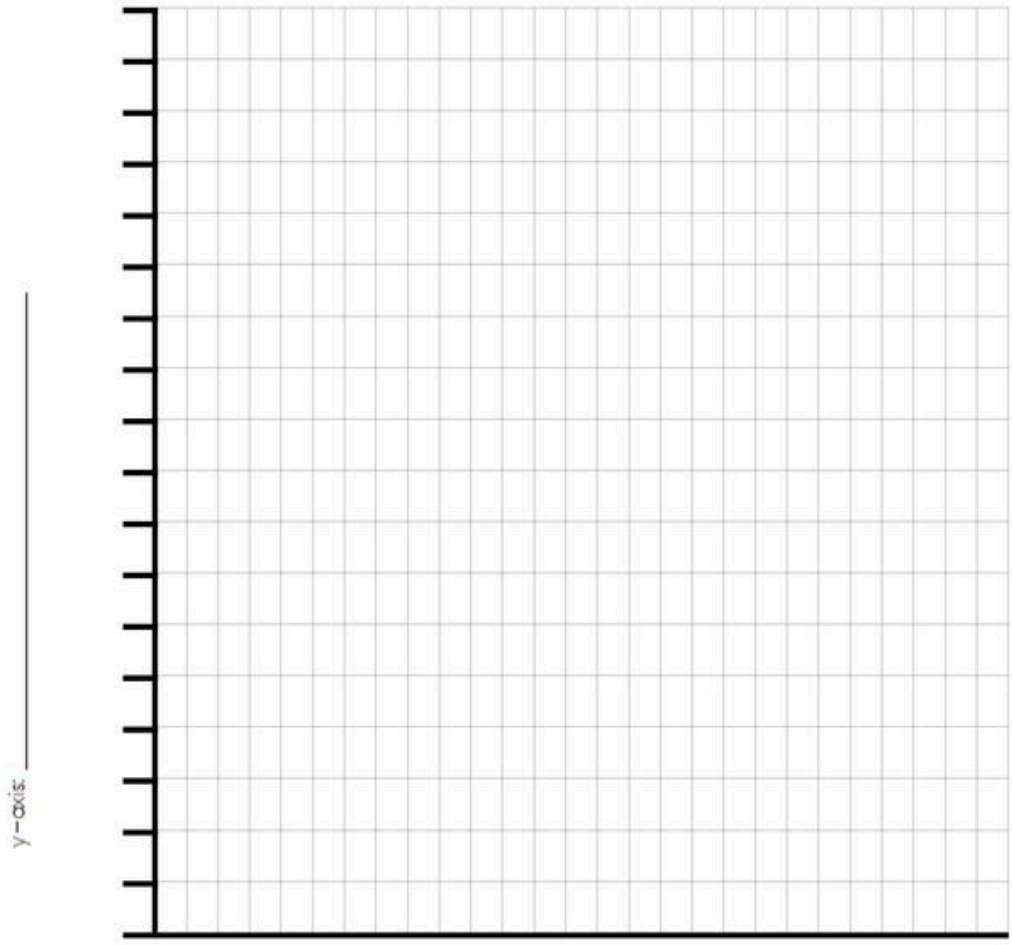
Appendix G: DATA COLLECTION TOOLS



Name: _____ Blank Bar Graph

Title: _____



x-axis: _____

Appendix H: STEM Fair Project Overview Plan Document

Name:_____ **Grade Level:**_____

Elementary Science STEM Fair Project Overview Plan ***(THIS IS NOT A RESEARCH PAPER)***
All students completing a STEM Fair Project MUST complete this form. This document will be needed for students that enter the Kids For Science STEM Fair (KFS)

Project Title: _____

Explain the reason you chose your STEM Fair project.

What is the question or problem you are investigating for your STEM Fair Project?

What is your hypothesis? What do you expect to learn from your investigation and research?

Does your project have any risks and safety precautions? Explain below.

Describe the procedures you will use to analyze the data/results.

Did you use human participants, animals or any hazards such as bacteria or chemicals during your investigation? Provide an explanation.

Name two sources that you used to help you with your research.