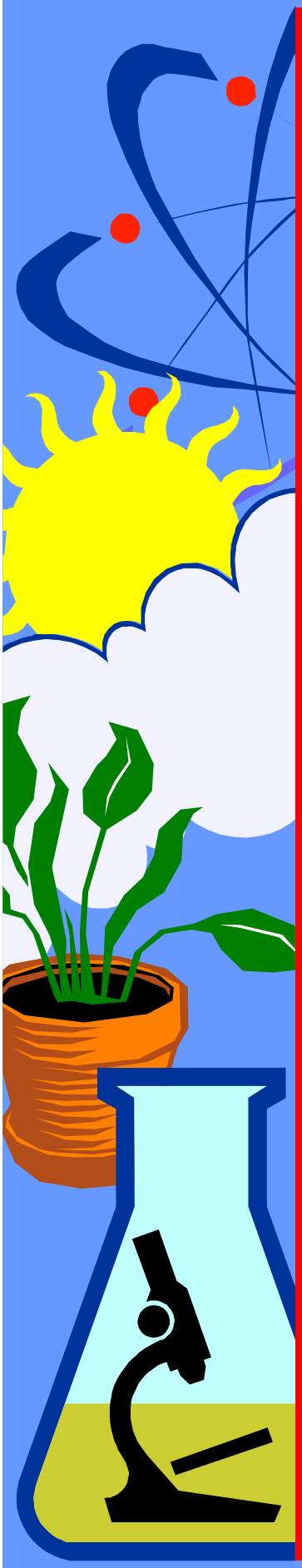

STEM Fair

Student Journal

Name: _____

Teacher: _____

Grade: _____

_____

(Name of School)

PRINCE GEORGE'S COUNTY PUBLIC SCHOOLS | PGCPS

PGIN 7690-3634

Board of Education of Prince George's County, Maryland

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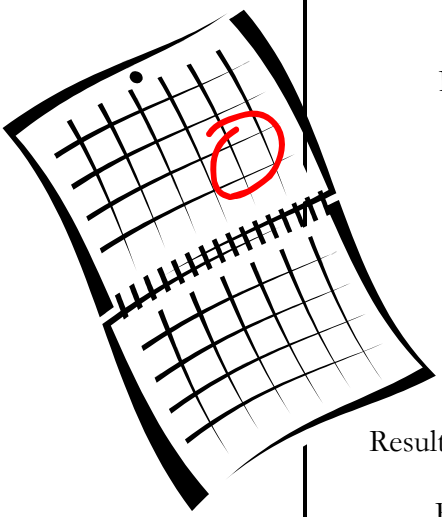
It's STEM Fair Time!!

STEM stands for Science, Technology, Engineering, and Mathematics. Over the next few months, you will choose your own research project that contains one or all of the STEM elements and conduct an investigation to seek the answer 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 is meant to provide you with examples and models of each step of the STEM process. There is also a place where you will 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 process.

Your teacher will give you specific deadlines 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.

Timeline for the STEM Fair Project



Component	Due Date
Question	
Prediction/Hypothesis	
Variables	
Materials	
Procedures	
Data Collection Tool	
Results, Actual Investigation	
Results, Graph of Data	
Results, Written Explanation	
Conclusion	
Research Paper	
Display Board to School	

Choosing a Topic

This STEM project is meant to be something that interests you, not something your teacher has chosen for you. To select a topic, think about the world around you and questions you might have about how things work, why they react the way they do or how elements interact with each other.

When considering a topic, here are some guidelines to follow.

- You may not conduct testing on vertebrates (people, other mammals, birds, reptiles or amphibians)
    - You may use vertebrates only if you are making observations of them and there is **no** interaction between the vertebrate and the observer.
- You may conduct testing on invertebrates (worms, mollusks, insects) provided there is no injury to the animal.
- You may not grow bacteria of any kind.
- You may not make a model that only displays information or shows how something works. (volcanoes, solar system, cells)
- You may conduct an investigation using mold or fire provided you have the written approval of an adult in your household and the approval of your STEM Fair teacher.

For all projects, you must ensure you have a written Safety Review pre-approval (pp. 6-7).

Getting Started

There are many ways to choose a STEM Fair topic. You can start by:

- observing the world around you
- searching the internet
- looking at books in your school library
- looking at books in your public library

You can also use the list below to determine a category of STEM inquiry that interests you. This might help you narrow down your ideas.

Earth / Environment	Chemistry	Physics	Life / Biology	Engineering	Mathematics
• weather • rain • climate • erosion • wind speeds • water filtration • recycling processes • composting	• freezing • melting • burning • rusting • heat	• speed • force • friction • gravity • magnets • electricity • elasticity • weight/mass • density	• plant growth (based on: water, temperature, sunlight, soil type) • invertebrates	• bridge design • building design • machine design	• probability • number relationships • frequency analyses

As you develop your project idea, consider the following questions with your family:

- Do we have time for this project or should we choose something that is shorter?
- Do we have the space (inside or outside) for this project?
- Can we purchase all of the items for this projects or are some too expensive or too hard to find?
- Will we need to build anything and, if so, can we do it?

As you narrow down your interests to one of the categories above, consider some of the project ideas listed on the next page.

STEM Fair Project Ideas

Physical Science:

What variables affect 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 determine the strength of an electromagnet (number of wire wraps, wire gauge, the diameter of nail)?
What variables affect the flight of an airplane (materials, weight, shape, angle of launch)?
How does the bounce height of a ball related to the drop height?
What variables affect the efficiency of parachutes (size, shape, materials)?
Which shape of windmill blade is most efficient?
How does the length of a rotor affect helicopter flight?
Does the length of a ramp (inclined plane) affect the amount of force needed to pull a load up a ramp?
Does the temperature of the air affect air pressure?
What effect does air pressure have on the bounce of a ball?
Does mass affect how fast objects of equal volume will fall through a liquid?
How does the size of a wheel affect the rate at which it lifts a load?
What is the effect of mass on rocket trajectory?
How does temperature affect the bounce height of a ball?
Does the angle of launching affect how far a paper airplane flies?
What variables affect the distance a balloon rocket will travel (amount of air, nozzle shape, angle of ascent, different pathways)?
Which type of material conducts sound the best?
Do different types of string or string lengths affect the efficiency of a paper cup or tin can telephone?
Do different watt light bulbs produce different amounts of heat?
What effect does temperature have on buoyancy?
Does color affect the rate in which an ice cube melts?
What effect does color have on temperature?
What material makes the best heat insulator?
Which type of container keeps liquids hotter longer?
What effect does temperature have on the elasticity of a rubber band?
Do suction cups stick equally well to different surfaces?
Does the amount of stretch of a rubber band affect the distance a rubber band will travel?
What design shape supports a bridge the best?
What shape of container allows for greater rates of evaporation?
How is the strength of a magnet affected by glass, cardboard and plastic?
What is the relationship between temperature and amount of carbonation in soft drinks?
Do basketballs that are fully inflated bounce better than flatter ones?
Do all liquids freeze at the same rate?
Does the depth of a pan affect how water freezes?
Do different types of liquids have an effect on the rate of oxidation?
Does viscosity (thickness) of a liquid have an effect on the rate of evaporation or the boiling/freezing point?
Does iron rust faster in salt or fresh water?
What coating inhibits rust formation the best?
Does hot water freeze at a different rate than cold water?
Which will food coloring mix into faster - hot, medium, or cold water?
Which chemicals slow the browning of apples or other fruits?
What food dry cells (tomato, potato, or apple) will produce the highest amount of energy measured in voltage?
What effect does temperature/packaging have on the ripening of bananas?
Does temperature have an effect on solubility? Does the color of water have an effect on evaporation rate?
Does temperature affect the growth of sugar or salt crystals?
What materials melt an ice cube most efficiently?
How does temperature affect the reaction rate of Alka Seltzer?
Do heavier objects fall faster than lighter ones?
Does the density of wood affect how much weight different pieces of wood will hold in water?
Do water purifiers really work?
How well do different types of wood absorb water?
What type of metal, steel, copper, or bronze, will rust faster?
What liquid works best in making invisible ink?
Do watches keep the same time?

Mathematics:

What are the most common sums of two dice when rolled?
What is the relationship between height and arm length?
What is the probability of reaching into a bin and selecting a particular color of M&M candy? Can statistics be used to predict the contents of edible consumer products such as fruit snacks, a bag of jelly beans or M&Ms?
Which juice box manufacturer has the largest volume of juice and uses the least amount of packaging material?
How do the dimensions of a rectangular prism change with respect to each other?
Does the probability of drawing a particular card from a deck depend upon the number of that type of card in the deck?

Computer Science:

Does the font style of the letters (or characters) in a file change the size of the file?
How does the file size change as more letters (or characters) are added to a file?
How do snow crystals grow?

STEM Fair Project Ideas

Life Science:

Do different colors of light affect the growth of plants?
Do seeds germinate at different rates?
Does the placement of a seed when planted affect the growth of the seed?
Do vitamins or fertilizers affect the growth of plants?
Does acid rain have an effect on the germination of seeds?
Does temperature affect the growth of seeds or plants?
Which fruits or orange drinks have the most vitamin C?
Which plants and vegetables make the best dye?
Does the type of water affect the growth of plants?
Is soil necessary for plant growth? (hydroponics study)
Does music affect plant growth?
Does a plant grow best in sunlight or artificial light?
Can plants deprived of sunlight recover?
Can newspaper be recycled to be used to fertilize plants?
How does the concentration of salt in water affect seed germination?
Do beans grow better in clay, sand or potting soil?

Environmental:

What kind of soil is best for water retention?
Does recycled paper break down faster than new paper?
How does the clarity of a body of water change over time?
Are there differences in the amount of air pollution inside vs. outside a building?
What kinds of garbage break down the fastest in a landfill?
What is the effect of acid rain on plant growth?
What effect does fertilizer have on algae growth?
Which environmental pollutant, motor oil or used antifreeze, has the greatest effect on plants?
Does using gray water (bath or hand washing) effect plant 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 soil types affected by erosion?
Which food group decomposes the quickest?
How does water collected while bathing, washing a car, or animal affect plant growth?
Do temperatures change when materials are composted?
What items are recycled the most in your home or community?
How many plastic bags does your family collect on a monthly basis?
What is the average number of plastic bags collected by 10 families in your community in a period of time (week, month)?
How much garbage does your family produce over a month and what percentage is recycled or could be recycled?

Earth Science:

Are there differences in temperature in shaded versus non-shaded areas during the day and at night?
How accurate are local forecasters?
Do weather conditions affect the broadcasting of AM radio stations?
What materials or methods work best for cleaning up oil spills?
Are different sizes and shapes of sand dunes formed by differing wind speeds?
How quickly does a creek change water temperature in comparison with air temperature?
How well does charcoal filter water?
Which material absorbs heat most efficiently, sand, soil, or rocks?
Do different types of soils have different percolation rates?
What effects do the changes in the length of day and night have on household plants?
Will the size of a crater be greater when the impact object is bigger? Or travels faster?
How accurate are long-range weather forecasts?
Is rainwater absorbed at the same rate in different kinds of soil?
How accurate are homemade weather instruments?

Engineering:

What factors affect the top speed of a radio-controlled car?
Does the material of a parachute affect how fast it drops?
What levee construction will hold the most water?
Which folded paper structure will support the most stress?
Which truss design will withstand the most weight?
Will the amount of material that will be eroded change as the slope angle increases?
Does the area of a parachute affect how fast it falls?
Which building design best withstands an earthquake?

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. Go to p. 7 and 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. Go to p. 7 and 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. Go to p. 7 and 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 chemicals?
- sharp objects or potentially dangerous tools? use of an oven?

Yes → You must have approval from the School Safety Review Board. Go to p. 7 and complete the School Safety Approval Request.

No ↓

You do not need School Safety Review Board pre-approval. Continue to p. 8 and write your specific question for your project

School Safety Approval Request

Fill in the information required for your project and submit it to your teacher. Approval by the School Safety Review Board is required before experimentation. The School Safety Review Board or the PGCPS Safety Review 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) STEM Coordinator: _____ _____
print name signature and date

2) Science Teacher: _____ _____
print name signature and date

3) School Administrator: _____ _____
print name signature and date

To be completed by Parent/Guardian:

Yes	No	
☐	☐	I have read and understand the conditions and risks above and consent to the participation of my child.
☐	☐	Project testing/trials will be supervised by an adult in our home at all times.
☐	☐	I have reviewed any survey or questionnaire that will be used. (if applicable)

_____ _____
parent/guardian's name (please print) parent/guardian's signature and date

Question

Your Question is the specific problem, topic or question you plan to investigate. The results or answer for your question can only be found by a hands-on investigation.

Good Example:

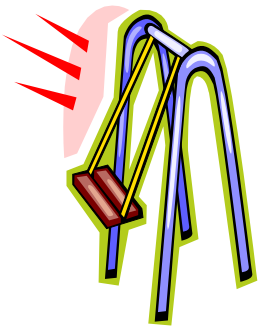
- Does weight affect how fast a pendulum swings?

This is a good example because you begin your question with a very basic wondering.

Bad Example:

- How does weight affect how fast a pendulum swings?

This is a poor example because when you use the word "how" you already assume you can change the pendulum's speed.



My question is: _____

_____

_____

_____

_____

☐ Your question is approved! Next, go to p. 10 to work on your Hypothesis/Prediction.

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

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

My revised question is: _____

_____

_____

_____

_____

☐ Your question is approved! Next, go to p. 10 to work on your Hypothesis/Prediction.

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

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

My revised question is: _____

_____

_____

_____

_____

☐ Your question is approved! Next, go to p. 10 to work on your Hypothesis/Prediction.

☐ Your question is not approved. Use my comments to re-write your question on a separate piece of paper. Your new due date for your question is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Hypothesis / Prediction

Hypothesis is a synonym for a prediction. After you ask your question, you try to predict what the answer will be based on your own background knowledge from either research or everyday observations. You must always give a real-world reason for your hypothesis.

Model Question: Does weight affect the speed of a pendulum?

Model Hypothesis Example:

- I think weight does affect the speed of a pendulum because when my big brother and I are swinging, he always goes faster than I do and he weighs more than I do so weight can change the pendulum.

There is a reason for the hypothesis with a specific example from the student's own experience.

The student gives a definite answer to the question

Bad Hypotheses Examples:

- Weight might change the speed because I have seen swings moving at different rates.
- Weight can't change the speed of a pendulum because I have never seen it done before.

No definite prediction was made.

This reason doesn't prove the prediction "can't." Just because you haven't seen it doesn't mean it hasn't happened.

My hypothesis is: _____

_____

_____

_____

☐ Your hypothesis is approved! Next, go to p. 12 to work on your Variables.

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

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

My revised hypothesis is: _____

_____

_____

_____

_____

☐ Your hypothesis is approved! Next, go to p. 12 to work on your Variables.

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

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

My revised hypothesis is: _____

_____

_____

_____

_____

☐ Your hypothesis is approved! Next, go to p. 12 to work on your Variables.

☐ Your hypothesis is not approved. Use my comments to re-write your hypothesis on a separate piece of paper. Your new due date for your hypothesis is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Variables

A variable is something in your experiment that you change on purpose, wonder if it will change or if you force it to stay the same. All experiments have three (3) types of variables.

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

2. Dependent Variable: 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.

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

3. Controlled Variables: 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.

You will change this on purpose.

You wonder if this will change.

Model Question: Does weight affect the speed of a pendulum?

Model Variables:

- Independent Variable – weight of the pendulum; you will add or take away weight to the pendulum with each set of trials
- Dependent Variable – speed of the pendulum; you don't know if this will change as you add or take away the weight.
- Controlled Variables – length of string used; type of string used; amount of time for each set of swings; starting "drop point" of the pendulum

String and a stopwatch were listed in your materials so you need to explain how you will control their use.

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.

My variables are:

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

_____

_____

☐ Your variables are approved! Next, go to p. 14 to work on your Materials.

☐ Your variables are not approved. Use my comments to re-write your variables. Your new due date for your variables is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

My revised variables are:

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

_____

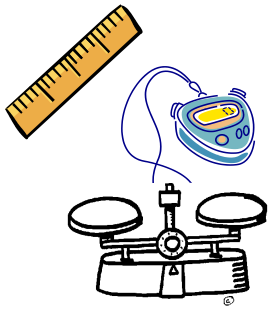
_____

☐ Your variables are approved! Next, go to p. 14 to work on your Materials.

☐ Your variables are not approved. Use my comments to re-write your variables on a separate piece of paper. Your new due date for your variables is: _____

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.

Remember to list specific amounts of items and to always use metric measurements. Some standard measurement units are listed below to help you.

Measureable Item	Metric Unit	Abbreviation
distance / length / height	millimeter centimeter meter kilometer	mm cm m km
time	seconds or minutes	sec / min
weight	milligrams grams kilograms	mg g kg
temperature	Celsius	C
capacity	milliliter liter kiloliter	ml l kl
volume	cubic centimeter cubic meter	cm^3 m^3

Model Question: Does weight affect the speed of a pendulum?

Model Materials Example

Quantity and Description	
5	plumbing washers of equal size for the weight
5 pieces, 35 cm each	twine or string
2	metric rulers
1	stopwatch
1 roll	masking tape
1	scissors

Specific amounts are provided; metric ruler is used; specific type of weight is mentioned.

Bad Materials Example

Quantity and Description
weights
pieces of string
stopwatch

No specific amounts are given nor is the type of measuring ruler listed. The list also leaves out materials that will be needed for the investigation.

My Materials List (You may need more or less lines. If you need more, attach a piece of paper.)

Quantity	Description
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____

☐ Your materials list is approved! Next, go to p. 18 to work on your Procedures.

☐ Your materials list is not approved. Use my comments to re-write them. Your new due date for your list is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Revised Materials List (You may need more or less lines. If you need more, attach a piece of paper.)

Quantity	Description
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____

☐ Your materials list is approved! Next, go to p. 18 to work on your Procedures.

☐ Your materials list is not approved. Use my comments to re-write them on a separate piece of paper. Your new due date for your list is: _____

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 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 a minimum of three (3) times!

Model Question: Does weight affect the speed of a pendulum?

Model Procedures Example:

1. Gather all materials.
2. Cut my sting into a piece that is 34cm long.
3. Tape one end of my string to a table so 30 cm are hanging off the side of the table.
4. Tie one plumbing washer to the free end of the string.
5. Lift the washer to the bottom of the table and release.
6. Start timing when the washer is released and continue timing until the pendulum has completed ten complete swings (back and forth).
7. Repeat 5 times and find the mean of the times. Record all data collect on the data chart.
8. Add one more washer to the string.
9. Repeat steps 4-7 with two, three, four and five washers on the string.
10. Compare the means of the data to draw conclusions.

Bad Procedures Example:

1. Gather your materials and ask mom for permission to work in the kitchen.
2. Tie one weight onto the end of the string.
3. Swing the pendulum 10 times and time how long it takes to swing.
4. Write down your answer.
5. Do it all over again until you have used all of the weights.

These procedures are not clear. The reader would not be able to recreate your experiment

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

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

9. _____

_____

10. _____

_____

☐ Your Procedures list is approved! Next, go to p. 20 to work on your Data Display.

☐ Your Procedures list is not approved. Use my comments to re-write them. Your new due date for your list is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Data Collection Tool

You will need a place to write down your data as you conduct your trials and make your observations. You collection tool can be a table 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 p. 14 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. This is most typical with projects that involve the growth or decay of something.

Model Question: Does weight affect the speed of a pendulum?

Model Data Collection Table

Independent Variable

Dependent Variable Summary

Effect of Weight on Speed of Pendulum

Weight of Pendulum	**Trials Recorded in Minutes and Seconds**					**Median Time for 10 Swings**	**Mean Time for 10 Swings**
1 weight							
2 weights							
3 weights							
4 weights							
5 weights							

Dependent Variable Individual Results

My Data Collection Tool

(Use this space to design your own data collection tool or use a table from appendix, pp. xx-xx)

☐ Your data collection table is approved! Next, go to p. 22 to work on your Experiment.

☐ Your data collection tool is not approved. Use my comments to re-create it on a separate piece of paper. Your new due date for your table is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Results, Data from Experiment

Now you are all 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 p. 16
- Have an adult present if your investigation requires it
- Follow the procedures just as you wrote them on p. 18
- Keep accurate records 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 temperature
    - If you are using an oven, remember to have an adult present.

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

☐ Your Experiment Data is approved! Next, go to p. 23 to work on your Results, Graphic Display.

☐ Your Experiment Data is not approved. Use my comments to re-create it on a separate table. Your new due date is: _____

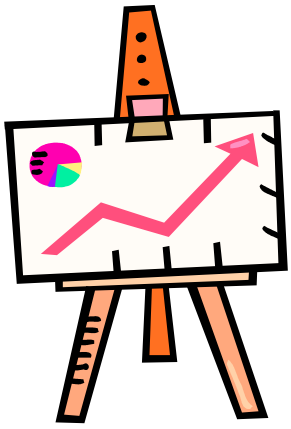
Teacher Signature:_____ Date: _____

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 graphs 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 graphs 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
- If you only present one graphic display, it must be the summary data (median, mean)
  - You can present a graphic display of all of your data but it must be in addition to the summary graph
- You may use the graphing paper on the next page or select a graphing tool of your own.
  - On the provide graph, space has been left around the perimeter for all of the labels and to use it portrait or landscape style.
  - Computer-generated graphs are allowed but be sure they contain all of the information listed above.



Results and Written Explanation

A written explanation gives a brief analysis of the data you collected in your table and displayed visually in your table. It should be about one paragraph and summarize the data shown in the table and graph. It can include trends you noticed in the data, if any, but it should not be a conclusion.

Model Question: Does weight affect the speed of a pendulum?

Model Written Results Explanation Example:

- The mean (average) time for 10 swings was approximately the same for all the weights. The longest time was with 2 weights at 28 seconds and the shortest time was with 5 weights at 24 seconds. However, since these times are close to each other and so are the other times, I would say the trend is that nothing really changes. When I look at the median data, the results are about the same – there is no real difference.

(This data was made-up just to demonstrate how to write an explanation.)

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.

Bad Written Results Explanation Example:

- My mean data was 1 weight at 26 seconds, 2 weights at 28 seconds, 3 weights at 27 seconds, 4 weights at 25 seconds and 5 weights at 24 seconds. I can't tell if there is a trend to this data.

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.

Here is the written explanation of my results.

☐ Your Results and Written Explanation is approved! Next, go to p. 29 to work on your Conclusion.

☐ Your Results and Written Explanation is not approved. Use my comments to re-create it on a separate piece of paper. Your new due date is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

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 your asked?

Re-read 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, go to p. 28 to work on your combining your Conclusion statements into one final product.

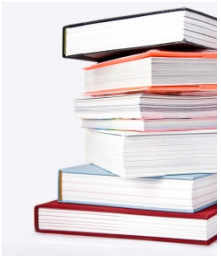
☐ Your Conclusion draft is not approved. Use my comments to re-create it on a separate piece of paper. Your new due date is: _____

Teacher Signature:_____ Date: _____

Parent Signature:_____ Date: _____

Final Draft of Conclusion

Research Paper Guidelines



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 STEM fair. The research paper is **MANDATORY** for anyone in grades four, five and six. The research paper is not complicated and only needs to include the following **five parts**:

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 **PLAGARISM** 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://easybib.com for an explanation of how this should be written.

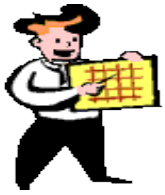
6. Follow the directions provide by your teacher to complete your research project.

Appendix: Student 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 Rubric
- **Appendix B:** STEM Fair Display Board Rubric
- **Appendix C:** STEM Fair Research Paper Rubric
- **Appendix D:** Tips for Creating an Outstanding Document
- **Appendix E:** Tips for Creating an Outstanding Digital Projects
- **Appendix F:** Sample Research Projects
- **Appendix G:** Blank Data Collection Tools



Appendix A: STEM Fair: Oral Presentation Rubric

Student Name: _____

Category	Possible Points	Points Earned	Comments
Eye Contact – Student is not reading from display board and maintains eye contact with class the majority or the time.	2		
Loudness of Voice – Students is loud enough for all members of the classroom to hear.	2		
Preparation – Student should appear to have practiced their presentation.	2		
Organization – Student is presenting information in a logical order.	2		
Enthusiasm – Student seems interested and excited about their topic.	2		
Title – Student states their title.	1		
Question – Student states their question and explains why they chose this topic.	3		
Hypothesis – Student states their hypothesis.	1		
Materials – Student explains the materials they chose for their experiment.	1		
Procedures – Student summarizes how they did their experiment, being sure to mention how many times the experiment was repeated.	3		
Results – Student summarizes the results giving a few examples of numeric data collected.	1		
Conclusion – Student tells whether or not their prediction was correct and summarizes conclusions that could be made based on the data collected. Student should also explain anything they might do differently if they were to do this investigation again.	3		
Research Paper – Student should explain something they found interesting in their research.	2		
Totals –	**25**		**Final Grade:** _____

Appendix B: STEM Fair: Display Board Rubric

Student Name: _____

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. • Display board is neat and attractive.	5		
Question: • Question led to an investigation, not a report, demonstration or model. • A creative approach to problem solving was used to formulate the question.	5		
Hypothesis/Prediction: • Prediction must state a possible outcome of the experiment with an accompanying explanation. • Should show students background knowledge.	5		
Materials/Procedures: • Materials and equipment are listed with specific amounts using METRIC units. • All steps to conduct the experiment are described and in order.	5		
Variables/ Experimental Design: • Independent, dependent, and controlled variables are correctly identified and listed. • Adequate dada were collected through repeated trials to justify the conclusion. • Sufficient sample size was used to support the conclusion (as necessitated by project).	5		
Results/Graphic Representation: • Data is presented in the form of a table with appropriate labels and title. • An appropriate type of graph is accurately constructed (scale, labels and title) from the data on the table.	5		
Results/Written Explanation: • Explanation analyzes and summarizes the data to note patterns and trends. • Explanation interprets the graph.	5		
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.	5		
Totals –	**40**		**Final Grade:** _____

Appendix C: STEM Fair: Research Paper Rubric

Student Name: _____

Category	Possible Points	Points Earned	Comments
Organization – Information is very organized with well-constructed paragraphs and subheadings.	5		
All Parts Present – All **five** parts of the research paper are present and complete (Title Page, Acknowledgements, Question, Background Research and Bibliography).	5		
Amount of Information – All topics are addressed and all questions answered with at least 2 sentences about each.	5		
Quality of Information – Information clearly relates to the main topic. It includes several supporting details and/or examples.	5		
Mechanics – No grammatical, spelling or punctuation errors.	5		
Sources – All sources (information and graphics) are accurately documented in the desired format.	5		
Totals –	**30**		**Final Grade:** _____

Appendix D: Tips for Creating Outstanding Display Boards

Be Neat – Avoid frayed or ripped edges of paper, glue globs, lots of cross outs or white outs etc.

Use Colors to Attract Attention – Use no more than three colors on your project board. Too many colors can be 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.

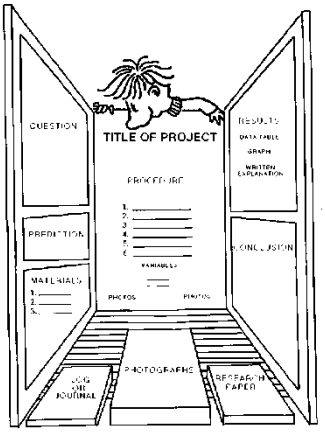
- For example, Cool Color Cubes is better than The Melting Rate of Different Colors of Ice Cubes

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 hand writing, use pen and write very neatly so that everything can be read. Cursive is not encouraged.

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 to 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 and Drawings – This is the best way to clearly shows what you did during your investigation.

Research Papers Should be Placed on the Table in Front of Your Board – DO NOT attach the research paper to your backboard.

Select the Right Size* – Choose a board that is no larger than 100cm wide and 95 cm high.

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

Appendix E: Tips for Creating Outstanding Digital Projects

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.

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

Spelling Counts – Have an adult check all of your spelling before printing.

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.

Do Add Photos and Drawings – This is the best way to clearly show what you did during your investigation.

Do 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.

Research Papers Should be Placed on the Table in Front of Your Board – DO NOT attach the research paper to your presentation.

Be prepared Bring a hard copy of your presentation just in case the computers don't work.

*** 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

Below are sample research papers written by William Beanes Elementary School students. These samples are meant to help illustrate the 5 parts to be included in the research paper. Notes inside of balloons, 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 Schntae Graham (4th grade) and Venetta Bronson (6th grade) are greatly appreciated. They generously donated their research papers to be used in this journal.

This is the title page. This is the first requirement of the research paper.

Truth Decay

(Sample Research Paper 1)

Subtitle gives additional understanding of the topic.

The Truth about Tooth Decay

Schntae Graham
William Beanes Elementary School
Fourth (4th) Grade
Teacher: Ms. Ward
February 19, 2002

Don't forget to include your name, school, grade level, teacher's name and due date on your title page.

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. Ward and Ms. Casbourne 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

Do different liquids affect the enamel of teeth (in this case the shell of an egg)? Will placing an egg in lemonade, Coca-Cola, Diet Coke, orange juice or water for seven days have any effect on the egg?

Research

Background research about your topic is the fourth requirement of the research paper.

Introduction

This research paper and STEM project taught me a lot about why my Mom always asks, "Did you brush your teeth?" I hear it every day. I see that it is important to brush your teeth, eat well and visit the dentist. That is why this project is titled, Truth Decay. This paper will give you a better understanding about why our teeth are important, how tooth decay begins, and how to prevent tooth decay.

Tooth decay can start at any age. While we are young, we should take good care of our teeth. I do not like to go to the dentist but my mom makes me go at least two times a year. My mom says it is important to go to the dentist, so when you get older you won't have a lot of problems with your teeth and spend a lot of money.

What are teeth made of?

This is a subheading. Subheadings help organize your research paper, so it is clear what will be discussed in each section.

The white covering of teeth is called enamel. The function of the enamel is to protect the tooth from pain and damage. Under the outer covering of enamel is a hard, yellow substance called dentin. Most of the tooth is made up of dentin.

What is tooth decay?

Tooth decay is a bacterial disease of the teeth. The decay is the primary source of tooth loss in people no matter what the age of the person.

Why do you get tooth decay?

Tooth decay happens when bacteria, sugary foods, and a target tooth surface work together or react against each other. Our mouths contain lots of bacteria. We eat a lot of different foods at different times of the day; therefore, the bacteria convert some of the sugary foods to acid. The bacterium that grows on our teeth is called plaque. Plaque is the sticky coat that forms on the outside of our teeth. When you do not clean or brush your teeth regularly, plaque will build. Bacteria eat through the outside of the teeth or what is called tooth enamel; this makes the tooth surface soft. Once the bacteria get through the enamel of a tooth, tooth decay can make a tiny hole in the tooth. You can tell you have a cavity when something cold (ice cream), hot (soup), or sugary (candy) may cause you to get a toothache or your teeth may feel tender. When this happens, tell a parent so you can go to the dentist.

Why was an egg used in this experiment?

A hard-boiled egg was used because this [illegible] to the egg during the experiment is in relation to the damage that can be done to your teeth.

It is important to make connections between your project and your research.

How do you prevent tooth decay?

To prevent tooth decay, it is important to brush your teeth regularly. Brushing is not just to make sure that your teeth are clean, but to remove plaque that builds up on your teeth and causes tooth decay. You should brush more than just once a day. Books and articles suggest that you brush after every meal. Use fluoride toothpaste. Fluoride helps protect your teeth from tooth decay. Visit the dentist at least twice a year. The dentist checks for problems. The dentist may

prevent small problems from getting out of control. Tooth decay may take several months to happen, but modern technology, like an x-ray, will show small problems.

Conclusion

Our teeth must last us a lifetime. One or two cavities may not seem like a big deal, but your teeth tell a lot about you. If you have rotten teeth, you may not smile a lot or it may cause you embarrassment. Now that you know what "Truth Decay" is, let's get busy and brush "Tooth Decay" away!

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

All sources should be listed in alphabetical order by author's last name.

The bibliography is the fifth and final requirement for the research paper. Any research paper WITHOUT a bibliography is considered **PLAGIARISM**.

Bibliography

Dr. Green website. 2000-2002. Online. 20 Jan. 2002. Available: http://www.drgreen.com.

Silverstein, Alvin and Silverstein, Virginia. Tooth Decay and Cavities. Danbury: Grolier Publishing, 1999.

Stay, Flora Parsa. DDS. The Complete Book of Dental Remedies. Garden City Park: Avery Publishing Group, 1996.

Ward, Brian R. Dental Care. New York: Franklin Watt, 1986.

Try to use a *variety* of sources including both books and websites.

For assistance writing your bibliography, visit http://easybib.com.

What is the Effect of Thermal Inversion on Air Pollution?

(Sample Research Paper 2)

Venetta L. Bronson
William Beanes Elementary School
Grade 6
Mr. Fishkin
February 19, 2002

Acknowledgements

Thanks Mom for all your help.

Thanks Ms. Casbourne for the STEM Fair "make and take."

Thanks Mr. Fishkin for helping me with my corrections.

Question

What is the Effect of Thermal Inversion on Air Pollution?

Background Information

Air and water are essential to life. Air pollution is caused when chemical substances are released into the atmosphere that are not normally found there. Polluted air can cause or lead to lots of health problems in people. It can also hurt animals.

Smog, the dark haze in air (smoke and fog), is the most common form of air pollution. It is a major problem for many cities around the world. Polluted air is dirty air. It can make the air smell bad and make things dirty. It can rise up into the atmosphere and be carried away for many miles by the wind. The atmosphere can be damaged by polluted air.

Many activities of human beings pollute the air. People pollute the air by allowing chemicals, poisonous gasses and tiny particles of dirt to get into the air.

My STEM Project

My STEM project is about the effect of thermal inversion on air pollution. A thermal inversion occurs when hot air is above cooler air. Hot air rises and cold air falls. If the cool air is nearer to the ground, there will be no mixing of air. This still air has no wind to carry away the pollution particles.

A thermal inversion traps the air near the ground. Pollution molecules build up in the air if there is no wind to carry them away from the city or rain to wash them out of the air. An example of how pollution and smog can be deadly is Donora, a small town in Pennsylvania. In October 1984, 6,000 people in a town of 14,000 got sick, and 20 died from pollution and smog that was so thick, people could not see across the street.

Smog is a combination of smoke and fog. A lot of pollution molecules you cannot see. However, sometimes you may see smoke combine with fog to produce smog. Estimates of deaths from pollution caused by still air, a build-up of smog, and pollution include 650 people in London in 1873, 400 people in New York City in 1963 and 4,000 again in London 1952 during 5 days of smog!

We cannot control the weather or prevent thermal inversions from occurring, but we can reduce the pollution that causes smog. We can drive more fuel-efficient cars. We can use devices to help stop pollution molecules from being released from cars, factories, and power plants.

Conclusion

This process of warm air rising and cold air falling keeps the air moving and helps carry pollution away from the source. A thermal inversion occurs when hot air is above cooler air. Hot air rises and cold air falls. If the cold air is nearer to the ground, there will be not mixing of air. This "still" air has no wind to carry away pollution particles. A thermal inversion traps air near the ground.

My hypothesis proved incorrect. I predicted that the hot air smoke would not rise out of the bottle. Instead, it would be trapped near the ground (stay in the bottom of the bottle) and the cold air would rise. I also predicted that a thermal inversion would have no effect on the air pollution at all.

In doing my experiment, I observed that the cold air smoke stayed in the bottom of the bottle for a long time instead of disappeared. At no time did it rise to the top. I was so sure that the hot air smoke would not rise; instead it would stay at the bottom of the bottle. However, it seemed once I dropped the match into the bottle with the hot air smoke, I saw the smoke rise out of the bottle and then it quickly disappeared. I did this experiment six times. Each time I got the same results. The only problem I remember was that sometimes the match would go out before I could get it to the bottle. I think this happened because I was scared of the fire. I was afraid I might get burned, but my mom said she wouldn't let it happen.

I'd like to try this experiment with a watch instead of a timer. I could check the amount of smoke in the bottles every minute to see if there was smoke in them or not.

Bibliography

Bender, David and Leone, Bruno. The Environment Opposing View Points. San Diego: Greenhaven Press Inc., 1996.

Chandler, Grey and Graham, Kevin. Protecting Our Air, Land and Water. New York: Henry Holt and Company Inc., 1996.

Stile, Darlene R. Air Pollution. Chicago: Children's Press, 1990.

Appendix G: Sample Data Collection Tools

				Median

				Mean

				Median

				Mean

						Median

						Mean

						Median	Mean