Science Fair Lessons and Activities

4-H Science Fair
Project Timeline

Step 1: (_____) Choose a scientific or engineering topic that interests you. Complete the Summary and Participant Registration Form and return them to your county 4-H Agent by the registration due date advertised. You are encouraged to turn in these items to your agent as soon as possible to provide the 4-H agent with an opportunity for feedback and project refinement prior to submission.

Step 2: (_____) Do a **research report** on the subject you have chosen. This should be written neatly and placed in a folder. It should include a list of books and authors you have read to find the information (Bibliography – APA or MLA format). The research report must be done **before** you do your experiment. This will help you to form your hypothesis.

Steps 3 – 9 (_____) These should be recorded in a **logbook**.

Step 3: PURPOSE: What do you want to find out? This should be in the form of a question. The answer to the question will be found by doing the experiment.

Step 4: HYPOTHESIS: What do you think will happen in your experiment? This is a prediction of the outcome based on what you learned in the research report and a possible reason(s) for this predicted outcome.

Step 5: MATERIALS: What do you need to complete the experiment? This should be in the form of a list.

Step 6: PROCEDURE: What will you do, step-by-step, to complete the experiment? As you develop your list of steps to take, write them down first on a separate piece of paper. Number them in the order you will complete them. Then, write them in final form. The procedures need to be written in enough detail to support someone else's exact reproduction of your experiment without you around to answer questions.

Step 7: If you are doing an **experimental project**, you will need to identify the **independent variables** in your experiment. (These are the things that you

can change that will affect the results of your experiment.) You may choose only one independent variable. Identify the **dependent variable** in your experiment. (This is the thing that changes because of the independent variable you changed.) Identify the variables that need to stay the same throughout all of your trials. These are the **controlled variables**.

Step 8: (_____) Conduct the experiment. Remember to do three or more trials. Record your results in the form of a chart. Keep good records. It is a good idea to record your progress using photographs.

Step 9: (_____) RESULTS: What happened? Display your data in the form of a chart or graph.

Step 10: (_____) WRITTEN RESULTS: Write an explanation of your chart or graph using the data. Be sure to mention any trends or unusual observations in your explanation.

Step 11: (_____) CONCLUSION: What did you learn? The conclusion should be a paragraph that explains the results. The paragraph should begin by stating whether or not your hypothesis was correct or incorrect. *The conclusion must be supported by details and/or data from the investigation.* The conclusion paragraph should conclude with an idea for further investigation (i.e. If you could do another experiment to learn more about this subject, what would you like to do?).

Step 12: (_____) Construct your backboard. Everything you have done in steps 2 – 10 will appear on the backboard. The backboard should be neat and colorful, with a catchy title. Remember, you may not bring anything to the STEM Fair except the backboard, your logbook, and your report. Be sure your name is clearly marked on the back of the backboard, and the front of your logbook and report.

Identifying a Good Question

For most students, the hardest part of completing a SET fair project is selecting a good question (topic). It is important that your question be one that you are interested in and can experiment with yourself.

A good question:
- must lead to an investigation (experiment) **not** a report, a demonstration or model. The question may ask about the **effect** of one thing upon another.
- should be one from which you can collect data (ideally measurements or direct observation) **rather than** opinions.
- should be specific rather than really broad.
- is one which the materials needed to experiment with are easy to find.

Examples of good questions:
How does temperature affect the bounce of a basketball?
What type of conditions do mealworms prefer? (wet/dry, light/dark, warm/cold)
What shape of container will allow water to evaporate the quickest? (shallow/deep)

Examples of poor questions:

Question:	How do volcanoes erupt?
Reason:	This project would be a model not an experiment, is too vague (broad), and will not involve data collection.
Question:	What are optical illusions and how do people see them?
Reason:	This question is not an experiment and asks for opinions not data.
Question:	What effect does caffeine have on the bloodstream?
Reason:	This project is one for which students would not have the materials necessary to test it OR would involve the ingestion of caffeine to observe reactions in a vertebrate animal (including humans) and would be disqualified.

Choose which one of the two questions would make a better SET fair project and circle it. On the line below the two questions, give a reason(s) why the one you did not choose would be a poor question for a SET fair project. The first one is done for you.

1. Why are there craters on the moon?

    ~~Does the drop height of an object affect the size of the crater it will make?~~

    The question 'Why are there craters on the moon is phrased as a report and doesn't allow for the collection of data.

2. What effect does temperature have on the growth of bean seeds?

    How do beans grow?

    _____

    _____

3. From what direction does the wind blow most frequently during one week?

    What makes the wind blow?

    _____

    _____

4. Does an apple contain water?

    How much of the weight of an apple is water?

    _____

    _____

5. Do showers or baths use more water?

    Is it better to take a shower or bath?

    _____

    _____

6. What makes a ball bounce?

    What effect does air pressure have on the bounce of a ball?

    _____

    _____

Answer Key

Choose which one of the two questions would make a better SET fair project and circle it. On the line below the two questions, give a reason(s) why the one you did not choose would be a poor question for a SET fair project. The first one is done for you.

1. Why are there craters on the moon?

   (Does the drop height of an object affect the size of the crater it will make?)

   The question 'Why are there craters on the moon?' is phrased as a report and doesn't allow for the collection of data

2. (What effect does temperature have on the growth of bean seeds?)

   How do beans grow?

   The question 'How do beans grow?' is phrased as a report and does not allow for the collection of data.

3. (From what direction does the wind blow most frequently during one week?)

   What makes the wind blow?

   The question 'What makes the wind blow?; is phrased as a report and does not allow for the collection of data.

4. Does an apple contain water?

   (How much of the weight of an apple is water?)

   The question 'Does an apple contain water?' is a yes or no question and does not allow for the collection of data.

5. (Do showers or baths use more water?)

   Is it better to take a shower or bath?
   The question 'Is it better to take a shower or a bath?' is phrased as an opinion and does not allow for the collection of data.

7. What makes a ball bounce?

   (What effect does air pressure have on the bounce of a ball?)

   The question 'What makes a ball bounce?' is phrased as a report and does not allow for the collection of data.

Understanding Variables

Variable – any factor in an experiment that can affect what happens in the experiment. Variables often include:

Length	Time	Amount (concentration)
Weight (mass)	Location	Size/shape
Height	Wind/weather	Speed
Temperature	Materials used	Test subject

- **Independent variable (manipulated variable)** – the factor that will be intentionally changed during the experimental procedure in order to find out what effect it has on something else. An example of an independent variable is using different lengths of string to construct a pendulum in order to observe the effect the length of the string has on the swing of the pendulum.

- **Dependent variable (responding variable)** – the factor that is observed and measured to see if it is affected by the change in the independent variable. An example of a dependent variable is the number of swings the pendulum makes when the length of string is changed.

- **Variables that are controlled** – the factors in the experiment that must be kept exactly the same to make sure that they are not having any effect on the dependent variable. Variables that would need to be controlled in the pendulum experiment would be the mass of the pendulum, the type of string, and the release height of the pendulum.

Examples:

Variables that can affect the growth of plants include:

Amount of light	Temperature	Direction of planting
Amount of water	Type of water	fertilizer

Variables that can affect the flight of a paper airplane include:

Wind speed	Weight of plane	Material used to build plane
Size of plane	Amount of thrust	Design of wings

A Well-Designed Investigation

Only **one** variable at a time should be changed by the investigator during an experiment. This ensures that the data collected (the dependent variable) are the results of the effect of the only variable that was changed (the independent variable). This is called a **"fair test."**

Demonstration for Independent, Dependent, and Controlled Variables

Materials Needed:

1 large tin pie plate

1 small tin pie plate

1 large fork or spoon

1 small fork or spoon

two student volunteers

Engagement:

Engage students by explaining that there will be an imaginary pie eating contest.

Exploration:

Have two volunteers come to the front of the room. Give the small pie plate and the large spoon or fork to one student. Give the large pie plate and the small spoon or fork to the other student. Explain that you have two different students who will be competing to finish their pie first.

Explanation:

Ask the class the following questions:
1. Who will win?
2. Is this a fair contest?
3. What can be done to make this a fair contest? Guide discussion until students realize that both contestants must have the same size pie and the same size fork or spoon. Emphasize that to be a **fair** contest the only difference allowed is the difference between the two contestants.

Elaboration/Evaluation:

This demonstration can then be related to a science experiment. Scientists must have only one difference in each experiment they conduct (the independent variable) to have a fair experiment. If more than one difference is allowed, they won't know what difference was responsible for their results. All other variables must be kept exactly the same (controlled) just as in the demonstration above. The dependent variable would be the time it took for each student to eat their pie. Students can then be asked to relate the idea of variables in an experiment to a hands-on science application. The sample backboard activities included in section three of this document provide ample opportunities for students to demonstrate their knowledge of variables.

Any other contest set up between two students that has several variables introduced (different size cups and straws or different conditions for finishing a foot race) would work equally well.

Know Your Variables

Jamal is going to complete an experiment beginning with the question and hypothesis below. Complete the activities to help him design his experiment correctly so that his results will be valid.

> **Question:** Will a skateboard roll farther on concrete or asphalt?
>
> **Hypothesis:** A skateboard will roll farther on asphalt because it is smoother.

1. What is the **independent variable** in this experiment? (What will be intentionally changed?)

   _____

   _____

2. What is the **dependent variable** in this experiment? (What will Jamal measure as a result of the change he made?)

   _____

   _____

3. Should Jamal use the same skateboard on the concrete and asphalt or a different one for the concrete and the asphalt? Why or why not?

   _____

   _____

4. Should Jamal just push the skateboard each time and then measure how far it goes? Why or why not?

   _____

   _____

5. Jamal has decided to use a ramp. He will put the skateboard at the top of the ramp and then release it. Is a ramp a good idea? Why or why not?

   _____

   _____

6. There are several cracks and puddles on the asphalt and concrete surfaces Jamal plans to use. Make a suggestion about what he should do when he rolls the skateboard.

_____

_____

7. Based on your answers to questions 3 – 6, make a list of the **variables that must be controlled** (kept the same) in Jamal's experiment.

_____

_____

_____

_____

8. Jamal plans to roll the skateboard down the ramp one time onto the concrete surface and one time onto the asphalt surface. He will measure the distance the skateboard travels on each surface and record the results on a chart. Knowing that scientists repeat their experiment in order to get valid results, explain what Jamal should do differently from what he had planned.

_____

_____

_____

_____

Challenge: On a separate piece of paper:

A. Write the steps of the procedure that Jamal must follow in his experiment. In your writing, be sure to mention the variables that must be kept controlled and how the dependent variable should be measured.

B. Design a data collection table that Jamal could use to record his results if he repeated his procedure on the concrete and on the asphalt surfaces four times each. Be sure to label all the columns and rows with headings and to include a place to record the average (mean).

Know Your Variables (Answer Key)

Jamal is going to complete an experiment beginning with the question and hypothesis below. Complete the activities to help him design his experiment correctly so that his results will be valid.

> **Question:** Will a skateboard roll farther on concrete or asphalt?
>
> **Hypothesis:** A skateboard will roll farther on asphalt because it is smoother.

1. What is the **independent variable** in this experiment? (What will be intentionally changed?)

The independent variable is the surface.

1. What is the **dependent variable** in this experiment? (What will Jamal measure as a result of the change he made?)

The dependent variable is distance the skateboard rolls.

2. Should Jamal use the same skateboard on the concrete and asphalt or a different one for the concrete and the asphalt? Why or why not?

Jamal should use the same skateboard because a different skateboard might not roll exactly the same. That is changing another variable that should be controlled.

3. Should Jamal just push the skateboard each time and then measure how far it goes? Why or why not?

Jamal would not be able to measure whether or not he pushed each time with the same amount of force. This is another uncontrolled variable.

4. Jamal has decided to use a ramp. He will put the skateboard at the top of the ramp and then release it. Is a ramp a good idea? Why or why not?

A ramp would be a good idea because Jamal would know that the skateboard would roll down the ramp the same way each trial.

5. There are several cracks and puddles on the asphalt and concrete surfaces Jamal plans to use. Make a suggestion about what he should do when he rolls the skateboard.

Jamal should find a place where the surfaces are as smooth and free of cracks as possible.

6. Based on your answers to questions 3 – 6, make a list of the **variables that must be controlled** (kept the same) in Jamal's experiment.

Same skateboard, length and height of the ramp, surfaces free of cracks and puddles.

7. Jamal plans to roll the skateboard down the ramp one time onto the concrete surface and one time onto the asphalt surface. He will measure the distance the skateboard travels on each surface and record the results on a chart. Knowing that scientists repeat their experiment in order to get valid results, explain what Jamal should do differently from what he had planned.

Jamal should do his experiment on each surface at least three times. He should then average the distances for each surface and compare the averaged data.

Writing a Hypothesis

A hypothesis is an informed statement that a scientist makes about what the outcome of the experiment will be. This statement should be based on some knowledge that the experimenter already has or some background research he or she may have done. A hypothesis is best written by thinking about the independent variable (factor that is changed on purpose in the experiment), the dependent variable (factor that is observed or measured to see what effect the change made), and making a statement about the relationship between the two. The hypothesis should also include the reason why you think the stated outcome will happen. Key words to use in a hypothesis are: **because, increase, decrease, stay the same, the greatest amount, the farthest, etc.**

When students get to sixth grade, are expected to be able to write their hypothesis using the **if/then** format:

If I change _____ **then** _____ will change.
    variable from question 3   variable from question 4

Example If/then Hypothesis:

If I increase the temperature of water, **then** the dissolving time of salt in water will decrease.

If I increase the height from which a drop of water is released, **then** the diameter of the splash will increase.

If I place water in containers with a greater surface area, **then** the evaporation rate of the water will increase.

Note: Students should understand that the hypothesis is a cause/effect statement. The student **causes** a change (**independent variable**). The results of the investigation (**dependent variable**) are the **effect** of that change.

Example:

Question:	Do different depths in a lake have different water temperatures?
Independent Variable:	Different depths of a lake
Dependent Variable:	Different water temperatures
Hypothesis:	The deeper you go in a lake the temperature of the water will decrease because it is further away from the sunlight.

Write a hypothesis for each of the following experiments.

1. **Question**: Does the amount of stretch of a rubber band affect the distance the rubber band will travel?
   Independent Variable: The stretch of the rubber band (will be increased)
   Dependent Variable: The distance the rubber band will travel

   Hypothesis: _____

   _____

2. **Question**: Will cups with different materials in them have different temperatures?
   Independent Variable: Cups with different materials (i.e., beans, bb's, and water)
   Dependent Variable: Temperature of the materials in the cup

   Hypothesis: _____

   _____

3. **Question**: Will the color of an insect help protect it from being eaten by a predator? (colored toothpicks will be used as model insects)
   Independent Variable: Different colored toothpicks (brown, green, yellow, blue, red)
   Dependent Variable: Number of each color of toothpick found

   Hypothesis: _____

   _____

4. **Question**: What effect does adding soap to water have on the number of drops that can be placed on a penny?
   Independent Variable: Soapy water instead of plain water
   Dependent Variable: Number of drops that stay on the penny

   Hypothesis: _____

   _____

5. **Question:** What kind of container will allow hot water to retain its heat longer?
   Independent Variable: Type of container
   Dependent Variable: Change in temperature

   Hypothesis: _____

   _____

6. **Question:** Does the length of a ramp (inclined plane) affect the amount of force needed to pull a load?
   Independent Variable: Length of ramp
   Dependent Variable: Amount of force
   Hypothesis: _____

   _____

7. **Question:** What effect do different surfaces have on how high a ball will bounce?
   Independent Variable: Different surfaces (wood, carpet, floor tiles, grass, cardboard)
   Dependent Variable: Height the ball bounces

   Hypothesis: _____

   _____

Example: *Answer Key*

Question:	Do different depths in a lake have different water temperatures?
Independent Variable:	Different depths of a lake
Dependent Variable:	Different water temperatures
Hypothesis:	The deeper you go in a lake the temperature of the water will decrease because it is further away from the sunlight.

Write a hypothesis for each of the following experiments.

1. **Question**: Does the amount of stretch of a rubber band affect the distance the rubber band will travel?
   Independent Variable: The stretch of the rubber band (will be increased)
   Dependent Variable: The distance the rubber band will travel

   Hypothesis: *I think the more I stretch the rubber band, the farther it will travel <u>because</u> stretching the rubber band gives it more energy.*

2. **Question**: Will cups with different materials in them have different temperatures?
   Independent Variable: Cups with different materials (i.e., beans, bb's, and water)
   Dependent Variable: Temperature of the materials in the cup

   Hypothesis: *I think that cups of different materials would all have the same temperature <u>because</u> they would all be in the same place.*

3. **Question**: Will the color of an insect help protect it from being eaten by a predator? (colored toothpicks will be used as model insects)
   Independent Variable: Different colored toothpicks (brown, green, yellow, blue, red)
   Dependent Variable: Number of each color of toothpick found

   Hypothesis: *I think the green insects would be protected from being eaten by predators <u>because</u> it would be harder to see in its natural environment.*

4. **Question:** What effect does adding soap to water have on the number of drops that can be placed on a penny?
   Independent Variable: Soapy water instead of plain water
   Dependent Variable: Number of drops that stay on the penny

   Hypothesis: *I think that adding soap to water would decrease the number of drops that can be placed on a penny <u>because</u> the soapy water would be slippery and would not stay on the penny.*

5. **Question:** What kind of container will allow hot water to retain its heat longer?
   Independent Variable: Type of container
   Dependent Variable: Change in temperature

   Hypothesis: *I think that a container made of plastic would allow hot water to retain its heat longer than other types of containers <u>because</u> a plastic container doesn't feel hot on the outside like glass or metal.*

6. **Question:** Does the length of a ramp (inclined plane) affect the amount of force needed to pull a load?
   Independent Variable: Length of ramp
   Dependent Variable: Amount of force
   Hypothesis: *I think the longer the ramp the larger the force needed to pull a load up the ramp <u>because</u> I know I get more tired when I climb a long hill than when I climb a smaller one.*

7. **Question:** What effect do different surfaces have on how high a ball will bounce?
   Independent Variable: Different surfaces (wood, carpet, floor tiles, grass, cardboard)
   Dependent Variable: Height the ball bounces

   Hypothesis: *I think the ball will bounce higher on the floor tiles and on other surfaces <u>because</u> floor tiles are smooth and hard and the other surfaces are less smooth or less hard.*

Writing a Procedure

Rebecca is planning to do a SET fair project to test the following question and hypothesis. Read the procedure that she will follow in her experiment and the hypothesis she has made.

Question: What food substances will cause yeast cells to produce the greatest amount of carbon dioxide gas?

Hypothesis: Flour will cause the yeast cells to produce the greatest amount of carbon dioxide gas **because** it is used in cakes that rise partly due to carbon dioxide.

Materials:

flasks	water	honey	salt	flour
balloons	sugar	syrup	spoon	

Procedure:

1. Fill each flask with water.
2. Add some of each kind of food to the water in each flask.
3. Add some yeast to each one of the flasks.
4. Place a balloon over the top of each bottle to trap the gas.
5. Let sit for a few days somewhere in the house.
6. Use a ruler to measure the width of each balloon and record on a chart.

In designing her experiment and writing her procedure, Rebecca has forgotten some important things that scientists must do each time they experiment.

Some of the things scientists must do to design a valid experiment are …

- State the exact amount of each material they use so other scientists can repeat their experiment.
- Control all variables in the experiment (keep them the same) except the one that they are manipulating (changing).
- Repeat the experiment more than one time or use more than one test object to see if they get consistent (similar) results.

On the next page, rewrite Rebecca's list of materials and her procedure so it is a valid experiment. Think carefully about amounts (measurements) and units you will use for each listed material. Be sure the steps of the procedure reflect what variables are being controlled (kept the same) in the experiment.

Question: What food substances will cause yeast cells to produce the greatest amount of carbon dioxide gas?

Hypothesis: Flour will cause the yeast cells to produce the greatest amount of carbon dioxide gas because it is used in cakes that rise partly due to carbon dioxide.

Materials:

_____   _____   _____
_____   _____   _____
_____   _____   _____
_____   _____   _____

Procedure:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Designing a Data Collection Table

Your data collection table should be designed before you begin your actual experiment. You will need the table to record data at the same time you collect it. You should try to collect data that can be measured, counted, or directly observed rather than people's opinions.

A data table should include a title that tells about the data. Tables are made up of columns that are drawn vertically (down) and rows that are drawn horizontally (across). To create a data collection table for a science experiment, you need to have spaces to record data related to the following ideas:

1. the **independent (manipulated) variable** (what you are changing);
2. the **dependent (responding) variable** (the results you will be measuring);
3. how many **tests (trials or subject)** will be conducted; and
4. the **average (mean)** of data related to the dependent variable.

Examples:

A data collection table for an experiment where a student rolls a marble down different height ramps to see how far the marble will travel might look like this:

Distance a Marble Rolls From Different Height Ramps **(Title)**

	Distance Marble Rolls **(Dependent Variable)**				
Height of the Ramp **(Independent Variable)**	Trial 1	Trial 2	Trial 3	Trial 4	Average (Mean)
10 cm					
20 cm					
30 cm					

A data collection table for an experiment to test how the number of drops of glycerin in a bubble solution affects the size of a bubble might look like this:

The Effect of Adding Glycerin to a Bubble Solution **(Title)**

	Number of Drops of Glycerin (**Independent Variable**)		
Size of Bubble **(Dependent Variable)**	**Two Drops**	**Four Drops**	**Six Drops**
Trial One			
Trial Two			
Trial Three			
Average (Mean)			

1. On a separate sheet of paper, design a data collection table that could be used to record data for an experiment to test the following question:

Question:	**What effect does cold have on the bounce of a ball?**
Independent variable:	**The ball will be tested at two temperatures—room temperature and after being in the freezer over night.**
Dependent variable:	**The rebound height of the ball will be measured.**
Trials:	**Three trials for each temperature of the ball.**
Average (mean):	**The average of the three trials will be calculated.**

2. On a separate sheet of paper, design a data collection table that could be used to record data for an experiment to test the following question:

|	
Question:	**Does the size of a parachute affect the amount of time it takes an object to fall 10 meters?**
Independent variable:	Three different size parachutes with an area of 100 sq. cm, 400 sq., and 900 sq. cm.
Dependent variable:	Amount of time object takes to hit the ground.
Trials:	Five trials for each size parachute.
Average (Mean):	The average of the five trials will be calculated.

Making a Bar Graph or a Line Graph

Bar Graph—bar graphs should be used to show data that reflect amounts (counted or measured) from separate groups. For example, the average number of bounces for different balls dropped from the same height would best be shown on a bar graph. The number of different types of birds visiting a bird feeder on the same day would also be best shown on a bar graph. The bars drawn on a bar graph must all be the same width and are separated by spaces between them.

Line Graph—line graphs are used to show relationships among data. In particular, line graphs show trends in data (increasing, decreasing, or staying the same). Experiments that are measuring time, temperature, or distance will usually produce data that should be graphed as a line graph. The amount of time a solid takes to dissolve in a different range of temperatures would be shown on a line graph. The height a ball will rebound when dropped from different heights would also be best represented on a line graph.

For both bar and line graphs in science, the independent variable is usually shown on the horizontal (x) axis of the graph and the dependent variable is shown on the vertical (y) axis.

TITLE OF GRAPH

vertical (y) axis (dependent Variable)

horizontal (x) axis
(independent variable)
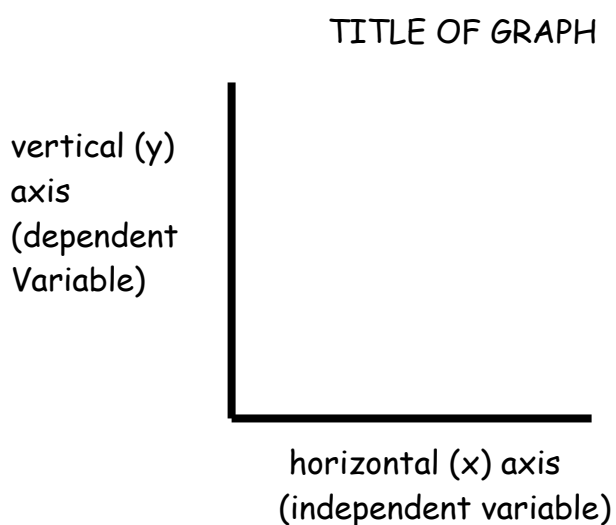
The graph should have:
- number of scales in even intervals (1's, 2's, 5's, 10's, 20's, 100's, 1000's, etc.);
- labels for both the horizontal (x) and vertical (y) axes; and
- a title that tells what is being represented on the graph.

Activity 1
Identify whether the data collected in the experiments described below should be graphed as a bar graph or a line graph.

a. The number of paper clips each type of magnet can pick up.
_____

b. The effect different amounts of salt have on the freezing point of water.
_____

c. The type of food that mealworms prefer.
_____

d. The measurement of the amount of erosion of a hill that is rained on over a three-week period.
_____

Activity 2
Decide whether the data collected in the experiment below should be represented in the form of a bar graph or a line graph. Use the grid below to construct the type of graph you have chosen for the data.

Question: How much of the garbage thrown out in the cafeteria in one school week could be recycled?

Total Amount of Weight of Each Type of Recyclable Garbage

Type of Garbage	Paper	Plastic	Glass	Aluminum
Weight in Kilograms	65 kilograms	40 kilograms	5 kilograms	10 kilograms

Decide whether the data collected in the experiment below should be represented in the form of a bar graph or a line graph. Use the grid below to construct the type of graph you have chosen for the data.

Question: Does the amount of salt in a salt water solution affect how an egg will float in the solution?

Distance From the Bottom of the Cup in Centimeters

Amount of Salt	Trial One	Trial Two	Trial Three	Average (Mean)
No salt	0 cm	0cm	0cm	0cm
10 grams	2cm	3cm	2cm	2.5cm
20 grams	4cm	4cm	4cm	4cm
30 grams	4cm	8cm	6cm	6cm

Drawing a Conclusion

Study the question, hypothesis, and results of the experiment below. Read the conclusion that has been written for the experiment. As you read, be sure to think about the four parts that are needed in a conclusion:

1. Reflecting back on the original hypothesis and stating whether it was supported by the results of the investigation or not.
2. Answering the original question that started the investigation and including the results that were used as the basis for that answer.
3. Stating any inferences that can be made from the results of the experiment.
4. Mentioning any additional questions that could be investigated or information that could be researched in the future.

Question: Does the amount of salt added to a solution affect the boiling point temperature of the solution?

Hypothesis: As the amount of salt added to a salt solution increases, the boiling point will stay the same because I think water always boils at the same temperature.

Results:

Boiling Point Temperature Using Different Amounts of Salt

Average Temperature at Which Boiling Starts	Amount of Salt in Solution
100 degrees Celsius	No Salt
101 degrees Celsius	10 grams of salt
102 degrees Celsius	30 grams of salt
103 degrees Celsius`	50 grams of salt

Conclusion:

My hypothesis was not supported by the results of my investigation. I thought that salt would not have an effect on the boiling point temperature of the solution. In my experiment I found out that as you added more salt to the solution, the boiling point of the solution increased. The average boiling point temperature was 100 degrees Celsius when there was no salt in the solution and was 103 degrees Celsius when 50 grams of salt were added. I think salt makes the solution denser (heavier) that I now know saltwater boils at a higher temperature. Next time, I would like to find out if salt has any effect on the freezing point of water.

1. **Pretend you have completed an experiment and collected the data shown on the chart below. Use the sentence starters to write a conclusion for the experiment.**

> My hypothesis was…. (supported or not supported)
> In this experiment, I found out that….
> The results (data) showed that…..
> One thing I can infer from my experiment is….
> I would also like to find out….

Question: Does the size of a solid affect how quickly it will dissolve in water?

Hypothesis: Smaller size solids will dissolve quicker than larger size solids because they have more surface area exposed to the water.

Results:

Time to Dissolve in Minutes

Sugar size	Trial One	Trial Two	Trial Three	Trial Four	Trial Five	Average (Mean)
Whole cube	5 minutes	4 minutes	5 minutes	5 minutes	6 minutes	5 minutes
Cube in half	3 minutes	3 minutes	4 minutes	3 minutes	4 minutes	3.4 minutes
Crushed cube	1 minute	1 minute	2 minutes	2 minutes	1minute	1.4 minutes

Conclusion:

_____

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2. **Pretend you have completed an experiment and collected the data shown on the chart below. Write a conclusion for the experiment. Use the sentence starters below if necessary.**

> My hypothesis was…. (supported or not supported)
> In this experiment, I found out that….
> The results (data) showed that…..
> One thing I can infer from my experiment is….
> I would also like to find out….

Question: What kind of soil will absorb the greatest amount of water?

Hypothesis: Sandy soil will absorb the greatest amount of water because the amount of space between the grains of sand can hold a lot of water.

Results:

Amount of Water Absorbed

Type of Soil	Trial One	Trial Two	Trial Three	Average (Mean)
Potting Soil	50 ml	47 ml	52 ml	49.7 ml
Soil w/humus	63ml	68ml	63ml	64.7ml
Clay	11ml	9ml	15ml	11.7ml
Sandy Soil	22m1	25ml	23ml	23.3ml

Conclusion:

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_____

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Question:

_____

_____

Hypothesis:

_____

_____

_____

Materials: (list specific amounts)

_____

_____

_____

_____

Variables:

Independent variable:_____

Dependent variable:_____

Controlled variables:_____

_____

Factors for Observation or Design:_____

_____

Procedures(s):

_____

_____

_____

_____

_____

_____

_____

_____

_____

Data collection: (data table)

Results: (graph, diagram, chart)

Written Explanation of the Data

_____
_____
_____
_____
_____
_____

Conclusion/Discussion:

_____
_____
_____
_____
_____

Real World Application:

_____
_____
_____

Bibliography/Research Reference Note Sheet

Title: _____

Author(s):_____

_____

Web Site:_____

Date Published: _____

Publisher: _____

Number of Pages:_____   **Pages Referenced:**_____

Notes:

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Title

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Question

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Hypothesis

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Materials

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Procedure

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Results (Data Table)

Res

Graph

Written Explanation of Data

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Results / Conclusion

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SET Fair Experiment Lessons

The following mini-backboard projects are included here to provide an opportunity for educators to pull together the previous lessons used to teach the individual components of a SET Fair project. The use of these activities provides an opportunity for the educator to model all of the steps needed to complete a SET fair project. It is suggested that the educator choose one of these activities to use as whole class instruction. It would be helpful if the educator also provided reading material to give the students an opportunity to do some research prior to completing the hypothesis. This gives the students the opportunity to "practice" doing investigations that reinforce the skills and processes involved in inquiry science.

Like any good SET Fair backboard, these are self-explanatory. Anyone reading a well-done SET Fair backboard should be able to recreate the investigation from the information provided on the backboard. Also, the layout of these activities mirrors the layout of a SET fair backboard. These activities can be completed on the worksheet (not recommended because of lack of space for response) or transferred to a manila folder (better option as it provides a better opportunity for the student to respond to each part of the activity and gives the student a way to "display" the practice project).

Question: What effect does adding soap to water have on the number of drops that can be placed on a penny?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: cup of plain water, cup of water with 10 drops of dishwashing liquid added, penny, two eyedroppers, paper towels

Procedure:
1. Place the penny on a paper towel. Place the cup of water and eye dropper nearby.
2. Practice using the dropper to make sure water drops are consistent in size. Try to hold the dropper at the same height from the table (between 2-5cm) each time you squeeze out a drop.
3. Using a dry penny, count the number of drops you can place on the top of a penny until a drop makes it spill over.
4. Record the results on the data chart.
5. Repeat the procedure two more times using the plain water. Make sure to dry the penny off between each trial.
6. Repeat steps 3-5 using a cup of water with 10 drops of dishwashing liquid added.
7. Average the data.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable (what you would change on purpose)

_____
_____

Dependent variable: (what would be affected)

_____
_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____
_____

Observations/Results:

Type of Water (Independent variable)	Number of Drops (Dependent Variable)		
	Trial 1	**Trial 2**	**Trial 3** Avg. (Mean)
Plain water			
Soapy water			

Explanation of Results

_____
_____
_____
_____

Average Number of Drops That Fit on a Penny
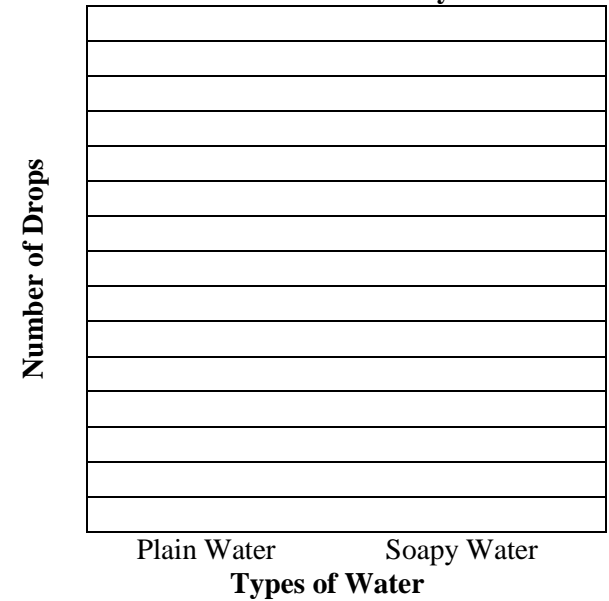
Number of Drops

Plain Water   Soapy Water
Types of Water

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
_____
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Question: Do the number of wraps of wire around a nail affect the strength of an electromagnet?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: one long, thin nail, 100 – 200 cm of thin insulated wire (amount needed may vary depending upon the gauge of the wire used), size D battery, paper clips or staples, scissors, wire strippers

Procedure:
1. Remove a short bit of the insulation at both ends of the wire with the scissors.
2. Leaving 10 cm of wire at one end free, wind the wire ten times around the nail neatly so that the wraps are touching each other.
3. Tape the two stripped ends of the wire firmly to the bottom and top (poles) of the battery.
4. Test the strength of the nail electromagnet by sticking the pointed end of the nail into a pile of paper clips or staples. Count the number of paper clips or staples that were picked up.
5. Continue until you have data for four more trials
6. Repeat the experiment using 20 wraps, 30 wraps, 40 wraps, and 50 wraps.
7. Average the data.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable (what you would change on purpose)

_____
_____

Dependent variable: (what would be affected)
_____
_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____
_____

Observations/Results:

Number of Wire Wraps (Independent variable)	Number of Paper Clips/Staples (Dependent Variable)				
	5 Trials				**Avg./Mean**
10 Wraps					
20 Wraps					
30 Wraps					
40 Wraps					
50 Wraps					

Explanation of Results

_____
_____
_____
_____

Results of Averages of Data for Number of Paper Clips/Staples
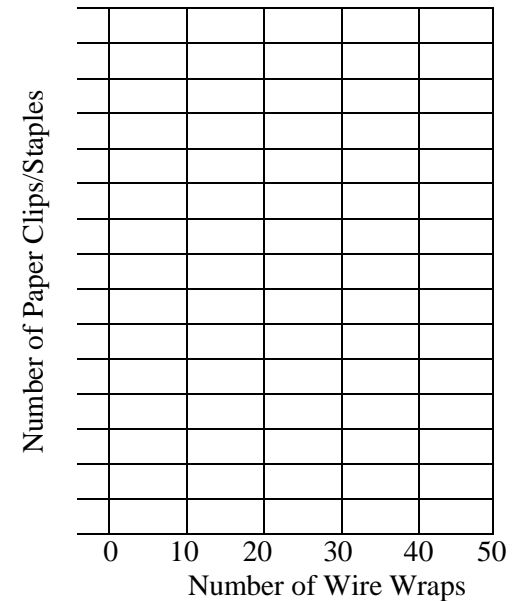
Number of Paper Clips/Staples (vertical axis)

0   10   20   30   40   50
Number of Wire Wraps

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
_____
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Question: Does the length of a pendulum affect the number of swings it makes in 10 seconds?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: one 45 cm length of string, tape, washers, paperclip, pencil, clock/watch

Procedure:
1. Tie the 45 cm length of string to your pencil and tape the pencil flat to the table so that the pendulum can swing freely from the edge of the table.
2. Tie a paperclip to the lower end of the string. Make sure there are 40 cm of string hanging from the pencil to the top of the paper clip. To get the right length of string wind the string around the pencil until you get the length you want.
3. Add one washer to the paper clip for weight.
4. Hold the string parallel to the table top and release.
5. Count how many complete swings (back and forth) the pendulum makes in 10 seconds.
6. Continue until you have data for four more trials.
7. Repeat the experiment for string lengths of 30 cm, 20 cm, and 10 cm.
8. Average the data.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable (what you would change on purpose)

_____
_____

Dependent variable: (what would be affected)

_____
_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____
_____

Observations/Results:

Length of Pendulum (Independent variable)	Number of Swings in 10 Seconds (Dependent Variable)					
	5 Trials					**Avg./Mean**
40 cm						
30 cm						
20 cm						
10 cm						

Explanation of Results

_____
_____
_____
_____

Results of Averages of Data of Pendulum Swings
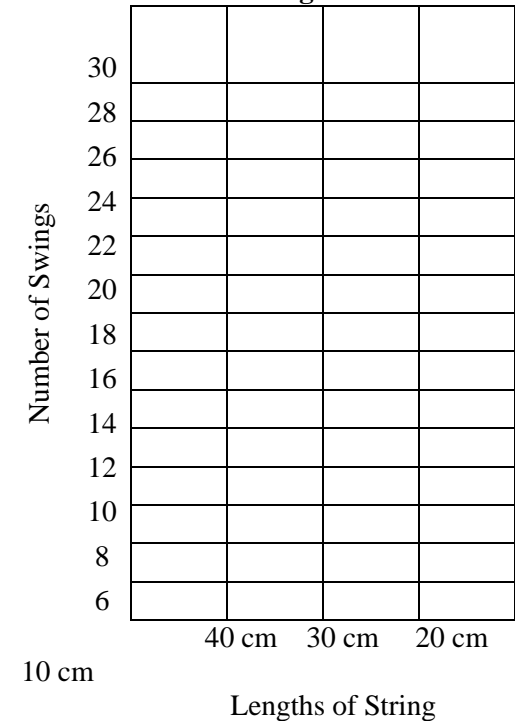
Number of Swings

30
28
26
24
22
20
18
16
14
12
10
8
6

40 cm   30 cm   20 cm
10 cm

Lengths of String

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

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Question: How is the bounce height of a ball related to the height from which the ball is dropped?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: one tennis ball, one meter stick

Procedure:
1. Tape the meter stick to a wall with the 0cm end down on the floor. Make sure that the floor underneath the meter stick is clear and flat so that nothing will interfere with the bounce of the ball.
2. Hold the bottom of the tennis ball even with the 20 cm mark.
3. Release the ball, observe, and determine the total bounce height in cm. (The total bounce height will be the distance from the floor to the highest point the bottom of the ball reaches as it bounces.)
4. Continue until you have data for four more trials
5. Repeat the entire experiment for drop heights of 30 cm, 20 cm, and 10 cm.
6. Average the data.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable (what you would change on purpose)

_____
_____

Dependent variable: (what would be affected)
_____
_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____
_____

Observations/Results:

Drop Height of Ball (Independent variable)	Total Bounce Height of Ball (Dependent Variable)				
	5 Trials				**Avg./ Mean**
20 cm					
40 cm					
60 cm					
80 cm					
100 cm					

Explanation of Results

_____
_____
_____
_____

Results of Averages of Data for Total Bounce Heights
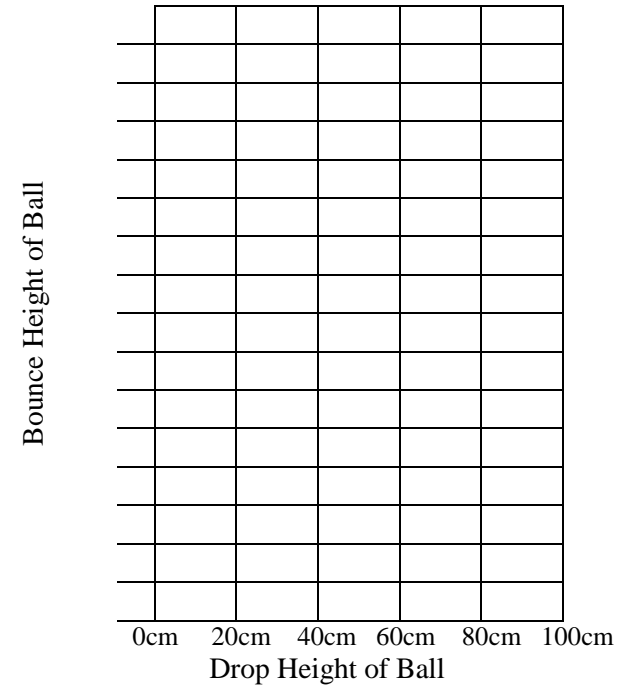
Bounce Height of Ball

0cm   20cm   40cm   60cm   80cm   100cm
Drop Height of Ball

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
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Question: Does the height of a ramp that a marble rolls down affect the distance the marble will roll?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
6

Materials: one glass marble, one grooved ruler, two 3x5 inch index cards, one meter stick or strip, three equal size books, tape

Procedure:
1. Place the two index cards on top of each other and tape them together. Fold the index cards in half into the shape of an A frame. This frame will catch and be moved by the marble at the bottom of the ramp.
2. Set up a ramp using one book and the grooved ruler. Measure the height from the top of the ramp to the table and record the height on the data collection table.
3. Place a piece of masking tape across the ruler at or near the top of the ramp. This will be the starting line.
4. Place the index card frame 2cm from the bottom of the ramp. Place a piece of tape to mark the spot where the frame will start but be sure not to place it where the marble will be rolling.
5. Hold the marble even with the front of the piece of tape (starting line) on the ramp and let it roll down the ramp into the index card frame.
6. Measure the distance that the index card frame was moved by the marble in centimeters.
7. Continue until you have data for 4 more trials.
8. Repeat the experiment for ramp heights built from two books and three books.
9. Average the data.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable (what you would change on purpose)

_____
_____

Dependent variable: (what would be affected)

_____
_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____
_____

Observations/Results:

Height of Ramp (Independent variable)	Distance Marble Rolled (Dependent Variable)				
	5 Trials				Avg./ Mean
1 book _____cm					
2 books _____cm					
3 books _____cm					

Explanation of Results

_____
_____
_____
_____

Results of Averages of Data for Distance Rolled

Distance Marble Rolled in Centimeters

Height of Ramp in Centimeters

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
_____
_____
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Question: Is the accuracy of a commercial weather forecast affected by the length of time prior to the actual weather event?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: long-range commercial weather forecasts from the Internet or newspaper, chart for organizing data

Procedure:
1. Beginning 5 days prior to the chosen target date, begin collecting and recording long-range weather forecasts from www.weather.com, www.noaa.gov, www.wbalchannel.com or another source.
2. Beginning on the target date, collect and record weather observations (i.e., sunny/cloudy, precipitation).
3. Collect data for 30 days.
4. Compare forecasts to actual data recording whether or not the forecast accurately predicted the weather for the target date.
5. Analyze data for trends.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Observations/Results:

Date of Weather Observation	Weather Source			
	Predictions			
	5Day Prior	3Day Prior	1Day Prior	Actual Weather

Explanation of Results

_____
_____
_____
_____
_____

Results of Accuracy of Advanced Weather Forecasts

Percent of Accuracy

| | | |
| 5Day Prior | 3Day Prior | 1Day Prior |

Number of Days Advance Prediction

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

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Question: How does friction produce static electricity?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
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_____
_____

Materials: balloon, wool material, stopwatch, notebook, pencil, graph paper

Procedure:
1. You will need one data table for each trial, so make at least three data tables for doing at least three separate trials.
2. Blow up the balloon and tie off the end.
3. Rub the balloon on the wool material once, in one direction.
4. Hold the balloon up on the wall, start the stopwatch and release. Does it stay on the wall? If not, stop your stopwatch and write "0" seconds in your data table.
5. Repeat steps 3 and 4, increasing the number of rubs each time, until the balloon sticks to the wall. Rub the balloon in the same direction each time.
6. When the balloon does stick to the wall, keep the stopwatch going until the balloon falls off the wall. When it does, stop the stopwatch and write the time in the data table next to the matching number of rubs.
7. Repeat step 6, increasing the number of rubs each time and recording the amount of time the balloon sticks to the wall with the stopwatch. Write the results in the data table each time.
8. Make a graph of your results.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable: (what you would change on purpose)

_____

Dependent variable: (what would be affected)

_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____

Trial 1 # Rubs	Stays on Wall Y/N	Time on Wall (secs)

Trial 2 # Rubs	Stays on Wall Y/N	Time on Wall (secs)

Trial 3 # Rubs	Stays on Wall Y/N	Time on Wall (secs)

Observations/Results:

Number of Rubs (Independent variable)	Amount of time on Wall (Dependent Variable)				
	3 Trials				Avg./ Mean
1 rub					
2 rubs					
3 rubs					
4 rubs					
5 rubs					

Graph Results
Left Side (Y Axis) – Number of Rubs
Bottom (X Axis) – Time in Seconds

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
_____
_____
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_____

Question: How do electrons flow through different materials?

Hypothesis: (an informed statement based on information gained from research and prior knowledge.)

_____
_____
_____
_____

Materials: materials to test (aluminum foil, paper clips, wood, plastic, rubber bands, penny, dime, safety pin), 6 volt battery, 3 wire leads with alligator clips at both ends, 6 volt light bulb with wire leads (radio shack 272-1140), flat insulating surface (cutting board)

Procedure:
1. Set up your circuit board that you will use to test your materials. You will need 3 pieces of wire with alligator clip at each end.
2. Attach Wire One clip to the (-) battery terminal.
3. Attach Wire Two clip to the (+) battery terminal.
4. Attach the other end of Wire One to one of the light bulb leads.
5. Attach Wire Three clip to the other light bulb lead.
6. You will connect your different materials between the free ends of Wire One and Wire Three.
7. Make a data table.
8. Place the first material into the circuit. Does the bulb light up? How bright is it? Write the results in the data table

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):
Variables: (Things that could change)
Independent variable: (what you would change on purpose)

_____

Dependent variable: (what would be affected)

_____

Other Experimental Variables: (These are things that could change and need to be kept the same or controlled.)

_____
_____

Type of Material	Source of Material	Brightness of Bulb

Observations/Results
Categorize the materials according to your results. Put materials with high brightness into the conductor category, materials with dim brightness into poor conductor category and off or no brightness into insulator category.

Insulators	Poor Conductors	Conductors

Conclusion:
The conclusion has four steps:
1. A hypothesis check: Was your hypothesis supported by the investigation or not?
2. A summary of the results that helped you reach the above conclusion.
3. Inference: What, if anything, can you infer from your results?
4. What problems did you experience? What new questions could you investigate in the future?

_____
_____
_____
_____
_____
_____

Question: How do resistors work in a circuit?

Hypothesis: (an informed statement based on
information gained from research
and prior knowledge.)

_____
_____
_____
_____

Materials: #2 pencils in lengths of 2 in, 4 in, 6
in, 8 in cut off at both ends;
insulated alligator clip set, 9 volt
battery, 9 volt battery connector,
small light bulb rated at 9 volt, small
light bulb holder, ruler, pencil
sharpener, popsicle stick

Procedure:
1. Set up your circuit board that you
will use to test your resistors. You
will need three pieces of wire with
an alligator clip at each end.
2. Take one wire and attach one end to
one terminal of the battery by
clipping the alligator clip securely to
one of the terminals.
3. Attach the other end of that wire to
one terminal of the light bulb holder
contact screw using the clip.
4. Using a new wire, attach one end to
the other contact screw of the light
bulb holder with the alligator clip.
5. Screw the light bulb into the light
bulb holder.
6. Before you start your experiment,
make sure your circuit works. Touch
the two ends of the empty alligator
clips together, holding on to the
insulated sleeve so that you do not
get a shock. Does your light turn
on? If it does, move on to # 7.

Title: (should be short and catchy)
The title briefly summarizes results.

_____
_____

Procedure (continued):

7. Make your pencil resistors to test
your circuit. Sharpen both ends of
the pencil.
8. Use a ruler to measure each piece of
pencil from tip to tip of the
sharpened pencil lead.
9. Place each pencil resistor one at a
time into the circuit between the
alligator clips by clipping onto the
pencil lead portion at the tip of each
end of the pencil. It is important to
make sure the clips are attached to
the graphite and not to the wood,
because wood is an insulator and is
not a conductive material.
10. Look at the light each time you
connect one of your pencil resistors
to the circuit. Make a record of your
observation. Use a number scale to
describe what you see. For example,
you might use a scale of 1 to 5,
where 1 is dark and 5 is bright.
11. Remember that piece of wire and
popsicle stick? These are your
control groups. Put them into your
circuit and rate them using the same
method and scale used to test the
pencils. The extra piece of wire is
the "positive control" and the
popsicle stick is the "negative
control".

Procedure (continued):
Variables: (Things that could change)
Independent variable: (what you would change
on purpose)
_____

Dependent variable: (what would be affected)
_____

Other Experimental Variables: (These are
things that could change and need to be kept the
same or controlled.)
_____
_____

Observations/Results:

Length of pencil (cm)				
Brightness of Light				

Conclusion:
The conclusion has four steps:
5. A hypothesis check: Was your
hypothesis supported by the
investigation or not?
6. A summary of the results that helped
you reach the above conclusion.
7. Inference: What, if anything, can you
infer from your results?
8. What problems did you experience?
What new questions could you
investigate in the future?

_____
_____
_____
_____
_____
_____

Notes:

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