



Intel ISEF Middle School Science Fair

A Guide for Teachers

By

Berk Moss

Bernadette Buxton

Rebecca Hall

Kathy Weeks

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Transparency
Package

SAMPLE

(A guideline on expectations for your Science Coaches and Science Fair Support Volunteers should be handed to them prior to their first visit to the classroom. Modify and add any of your school's policies to this list.)

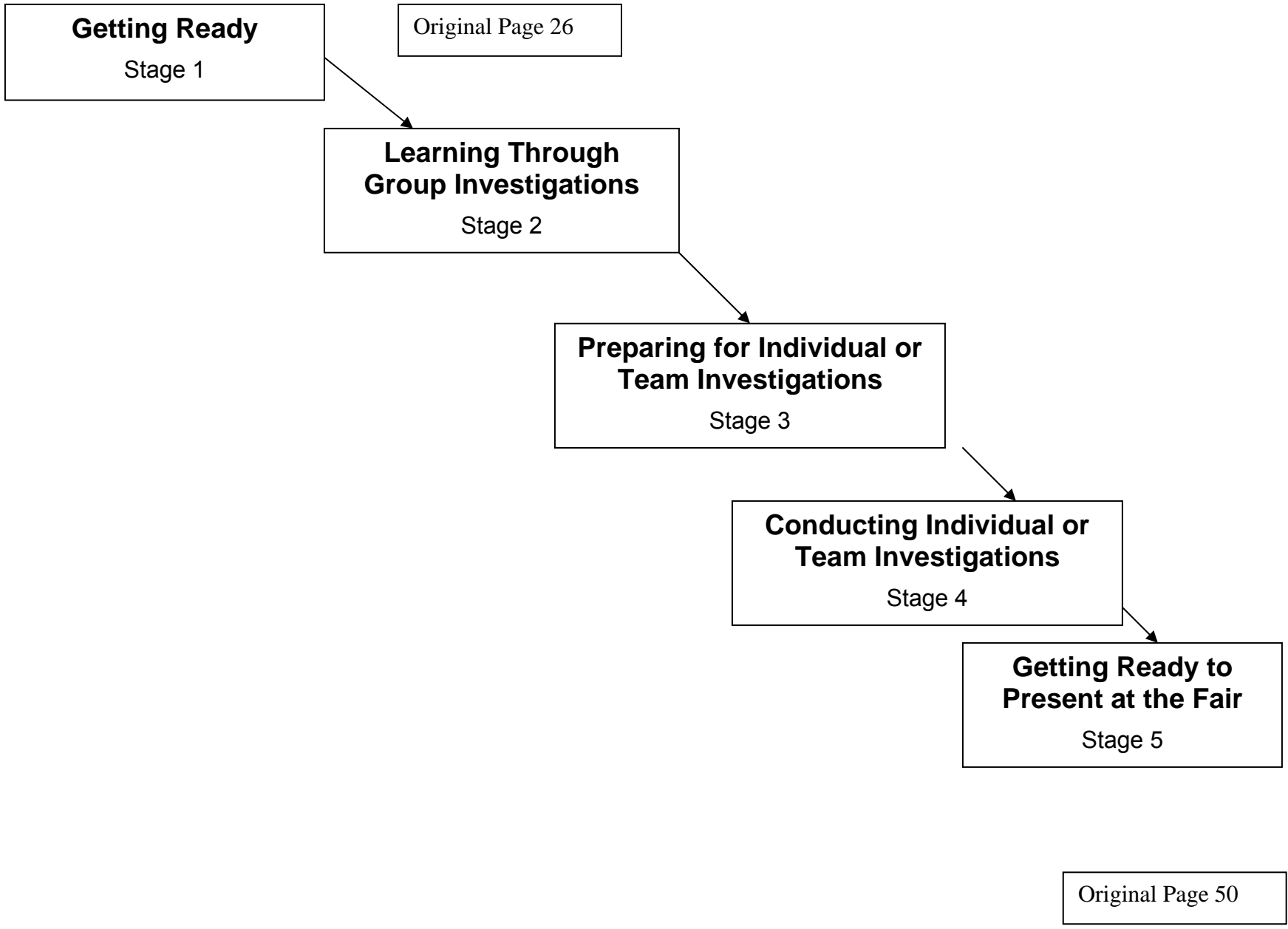
Guidelines for Volunteers

- Make sure you know and understand the school's policy about volunteers working with students and follow it. (e.g., Are you expected to check in at school office? Do you have to wear a visitor/volunteer nametag while in the school building?) Talk to the science teacher if you have any questions.
- Student confidentiality: Anything the student discusses with you should remain confidential. If something concerns you, raise it only with the teacher or school administrator. They will decide on any necessary action.
- Do not allow yourself to be alone in a closed room with a student. Always have a third person present. It's best to work in an open or community area.
- Avoid talking specifics about the student with their parents. This is the teacher's responsibility, and any comments or questions should be directed there. General positive comments are fine, however.
- Please be sensitive to and respectful of the diverse cultural backgrounds from which students may come.
- While it may seem helpful for a volunteer to want to assist a student outside school hours, *volunteers must not arrange to meet any student at times or locations other than the class or Club meetings* without prior approval of the teacher and/or administrator and parents.
- Be sure the investigation and display is the student's own work. Advising and coaching are appropriate. Becoming a co-investigator with the student is not.

Transparency - Notes on the four step Inquiry Model

The student Develops an inquiry question	The student Designs an Investigation	The Student Gathers and transforms data	The student prepares an analysis
Do Background Research	Write Clear Procedures	Plan Data Records	Identify patterns in results accurately.
What is an "Inquiry Question"	State Protocols (rules for repeatability and dealing with anomalies.)	Do a transformation that helps answer the question	Explicitly use results to answer the question
Use Operational Definitions (Clarifying the question)	Use concept of "fair test"		Discuss sources of error and limitations
<i>A great question foreshadows a good design</i>	<i>A great design leads to easy data gathering</i>	<i>A great data presentation makes the analysis leap out.</i>	

•



How does a lid on a cup affect the rate at which a hot liquid cools as compared to a cup without a lid?

Data Table:

Time (minutes)	Temp. with lid	Temp. without lid
0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
9.5		
10.0		

Four Question Strategy for Inquiry Question Development:

Student name: _____

Q1: A topic I can realistically investigate is:

_____.

Q2: A _____ usually acts in the following ways:

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

Q3: I can change the actions of the _____ by changing the:

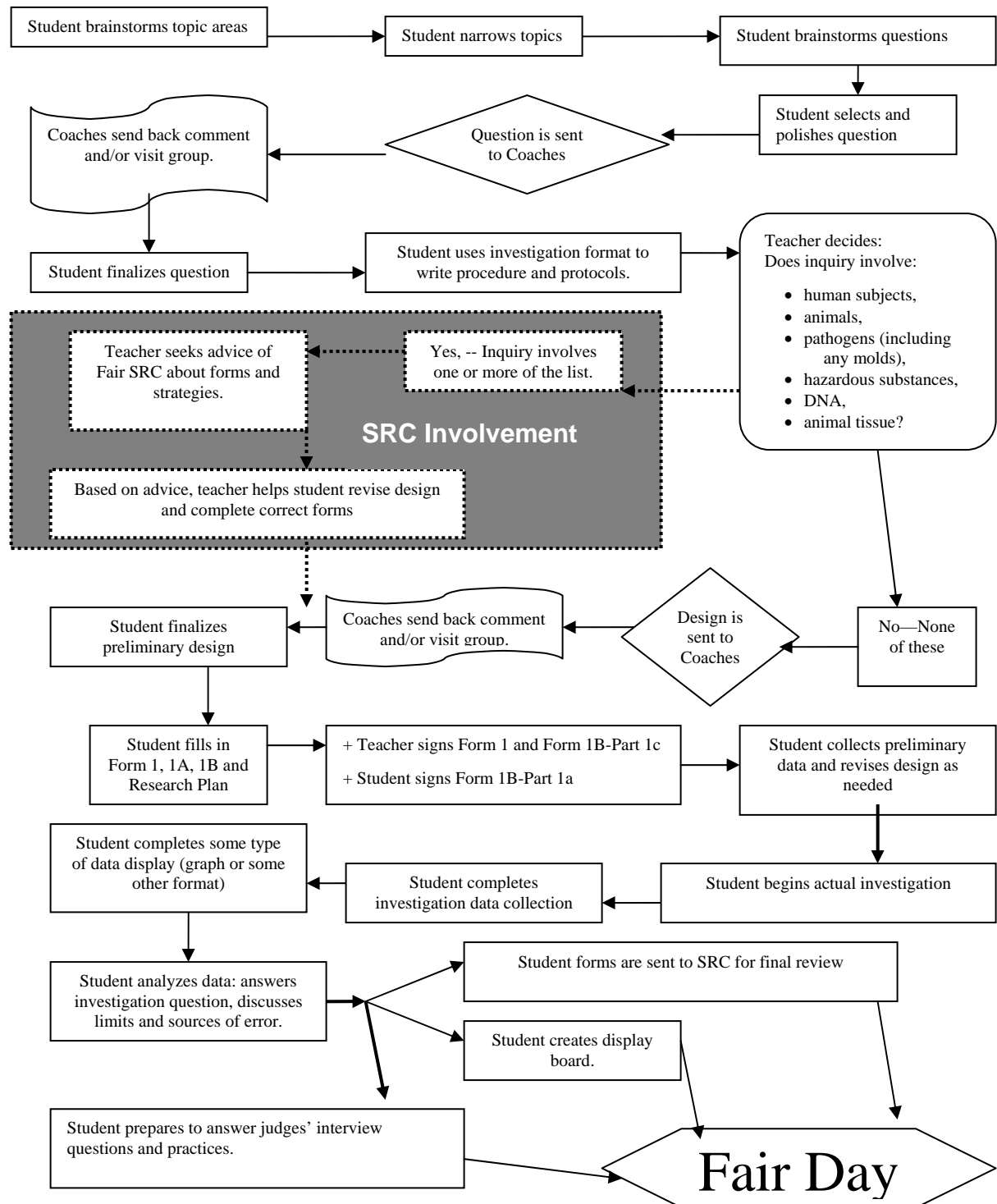
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

Q4: I can measure the change of the actions by using a _____ and the units _____.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

A question that I can investigate about _____ is:

Flowchart from topic idea to Fair day (and other events)



- Student Name _____

Brainstorming Topics and Generating Inquiry Questions

List four activities you enjoy doing outside of school:

- 1.
- 2.
- 3.
- 4.

Name at least two science investigations you have done that interested you:

- 1.
- 2.
- 3.

Circle all of the subjects below that interest you: (You may write in others.)

- Plants/Flowers Chemicals Electricity Animal Observations
 Cars/Ramps Pendulums Music
 Household Products Comparisons Weather

You can use any of the topics above to create an inquiry question for your Fair project. Use the chart below to narrow your topic to a question.

Topic From Above	I Wonder About	Materials Available	What I Might Measure

From today's activities, some questions I may want to investigate include:

1. _____
2. _____
3. _____

Four Question Strategy for Inquiry Question Development:

Student name: _____

Q1: A topic I can realistically investigate is:

_____.

Q2: A _____ usually acts in the following ways:

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

Q3: I can change the actions of the _____ by changing the:

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

Q4: I can measure the change of the actions by using a _____ and the units _____.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

A question that I can investigate about _____ is:

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Sample Student Questions: the good, bad and the ugly...

1. When did T-Rex live on earth?
2. Do plants grow better if a little vitamin C is added to their water?
3. How does a volcano work?
4. Which frozen liquid melts the fastest water, milk or Pepsi™?
5. Does your pulse rate increase or decrease after listening to different types of music?
6. How much does a cricket's blood pressure go up when it chirps?
7. How fast is the current of the Congo River (in Africa)?
8. How tall is the tallest mountain?
9. Which tree on our school campus will be first to lose all of its leaves in the autumn?

Variables and Measurement

Question: Does your pulse rate increase or decrease after listening to different types of music?

What is being changed?

What is being measured?

Question: How much of the liquid comes out if we use Coke[®] instead of Dr. Pepper[®] in our demonstration?

What is being changed?

What is being measured?

Question: How much of the liquid comes out if we use cold Dr. Pepper[®] rather than room temperature Dr. Pepper[®] in our demonstration?

What is being changed?

What is being measured?

Question: Which soil type absorbs the most water?

What is being changed?

What is being measured?

Question: Which type of leaf contains the most red coloring?

What is being changed?

What is being measured?

Question: Do Alka-Seltzer tablets dissolve faster in hot or cold water?

What is being changed?

What is being measured?

Look at this one -

Question: Are humid days more uncomfortable?

What is being changed? Humidity

What is being measured? People's rating of discomfort

Student Name _____ Teacher _____

Research Question Form

Fill in sections 1-3 below and return to science teacher.

1) What is your question?

2) What are you changing? (Independent variable)

3) What are you measuring? (Dependent variable)

leave the space below this line for science coaches to fill in

Science Coach comments:

Coach, can you suggest some key words to help with library or Internet research for science background on this question?

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Operational Definitions

Sample question:

At which angle do the cars roll off the ramp best?

Possible operational definitions for “roll off the ramp best”:

- Roll off the ramp without going over the side
- Roll off the ramp smoothest
- Roll off the ramp farthest
- Roll off the ramp fastest

An operational definition in your investigation design/procedure write-up might look like this:

I will operationally define “roll off the ramp best” to mean that the car rolls farthest from the bottom of the ramp until it stops moving.

Fill in your own operational definitions in this format:

I will operationally define “ _____ ”
to mean _____.

(You might have to use this format for more than one term.)

Categories of Variables

- Variables where you control the change –
“independent variable”
- Variables where you measure the change –
“dependent variable”
- Variables you work to keep the same –
“controlled variables”

<<< Dr. Pepper™ and Mentos™ Example>>>

Variables in this investigation

Things I will modify: I will use bottles of Dr. Pepper at different temperatures. (*This is the independent variable.*)

Things I will measure: I will measure the volume of liquid left in the bottle after the reaction. (*This is the dependent variable.*)

Things I will control: I will use the same size bottles of Dr. Pepper, the same flavor of Mentos™ and the same number of candies each time. (*These are the controlled variables.*)

<<<Cars and Ramps Example>>>

Variables in this investigation:

Things I will modify: I will modify the angle of the ramp by first using one book under the ramp then two and finally three.

Things I will measure: I will measure the distance the car rolls off the ramp.

Things I will control: I will use the same three cars each time at each angle. I will use the same books each time. I will be sure the surface the cars are rolling on is the same each time – tile floor not carpet. I will start the cars at the same point on the ramp each time. In comparing results, I will look at how each car did at each of the three angles.

Variables in my investigation

Things I will modify (independent variables)

Things I will measure (dependent variables)

Things I will control (controlled variables)

Materials table

Materials that will be used

Item	quantity	size
<i>Example:</i> Test tube	2	125mm x 10 mm

Which procedure style do you find easiest to follow?

Sentence style

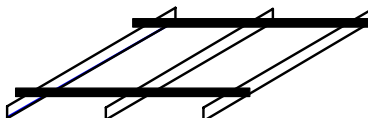
Get five craft sticks, and put three of them on the table running in parallel lines in front of you about 3 cm apart. Attach one of the other sticks in the slots provided along one end of the first three. Attach the last stick in the slots provided along the other end of the first three.

Step style

1. Get five craft sticks.
2. Lay three of them on the table running in parallel lines in front of you 3 cm apart.
3. Attach one of the other sticks in the slots provided along one end of the first three
4. Attach the last stick in the slots provided along the other end of the first three.

Diagram style

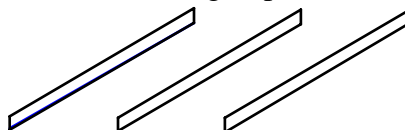
You are going to construct something that looks like this from five craft sticks:



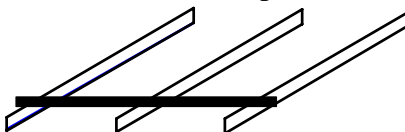
1. Get five craft sticks.
2. Lay three of them on the table running in parallel lines in front of you 3 cm apart.
3. Attach one of the other sticks in the slots provided along one end of the first three.
4. Attach the last stick in the slots provided along the other end of the first three.

Step-by-Step Diagram style

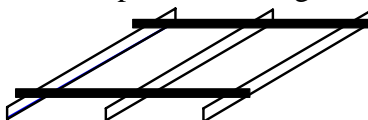
1. Get five craft sticks.
2. Lay three of them on the table running in parallel lines in front of you 3 cm apart.



3. Attach one of the other sticks in the slots provided along one end of the first three.

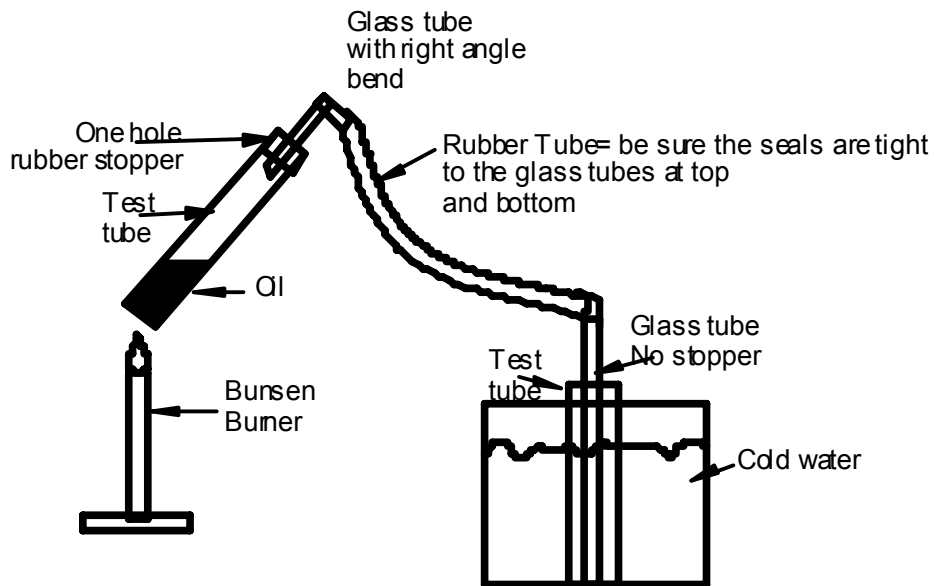


4. Attach the last stick in the slots provided along the other end of the first three.



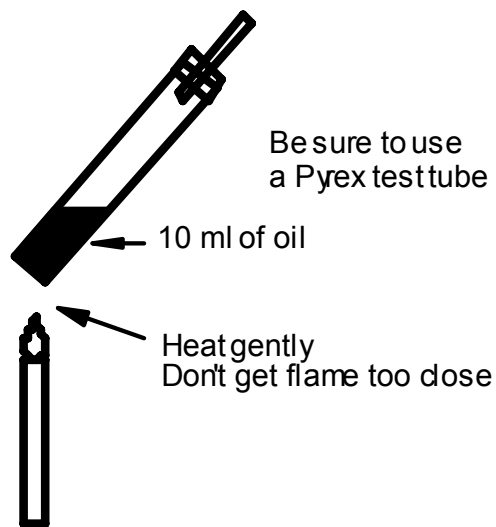
[Notice that your diagrams do not have to show the unimportant details of the actual sticks. These diagrams don't show all the notches in the sticks or the rounded ends because they are not important to the project. Also, we've shaded two of the sticks so they show up better in the diagram.]

Using Annotated Diagrams

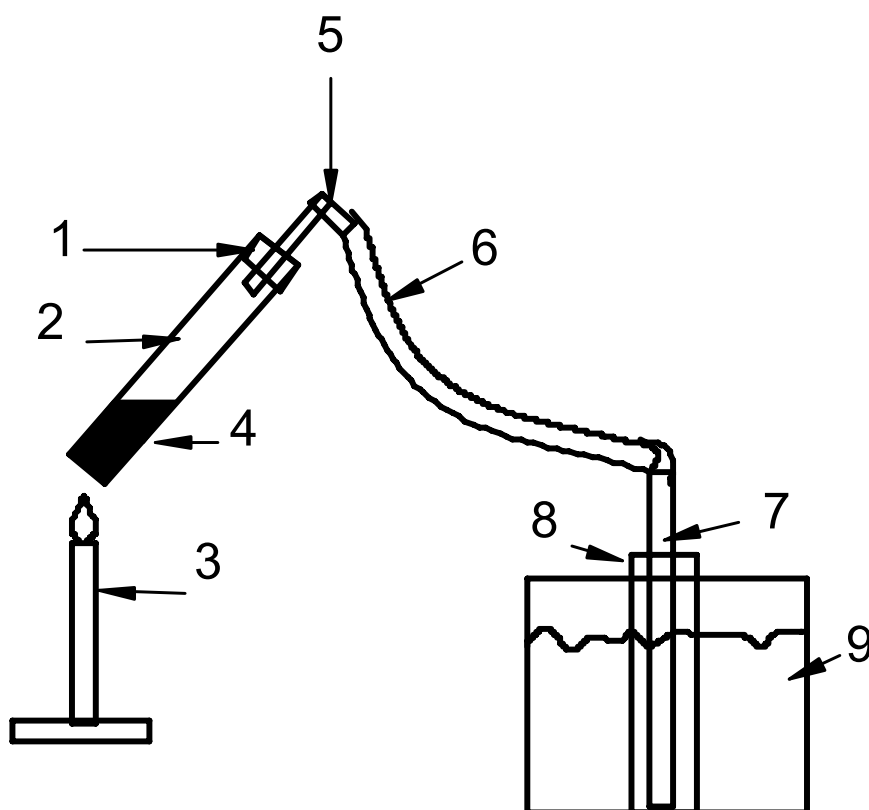


Distillation Apparatus

An annotated diagram can help you explain how your apparatus is set up or how you used it. Be sure your diagram is large enough for your notes to fit easily. Sketch everything out before you start to work on your final copy. Don't try to use too many notes. If you need to, use a second diagram with additional notes.



You also can use numbers to connect to your notes:



Distillation Apparatus

1. One-hole rubber stopper – be sure to have tight seals
2. Pyrex test tube
3. Bunsen burner – heat gently. Don't get flame too close.
4. 10 ml of oil
5. Right angle bends of glass tube
6. Rubber tubing – be sure to have a tight seal at top and bottom.
7. Glass tube – no rubber stopper
8. Receiving test tube
9. Cold water

Notice how you can put more detail in numbered notes, but they may not be quite as easy to read and understand because the reader has to jump back and forth between the notes and the diagram.

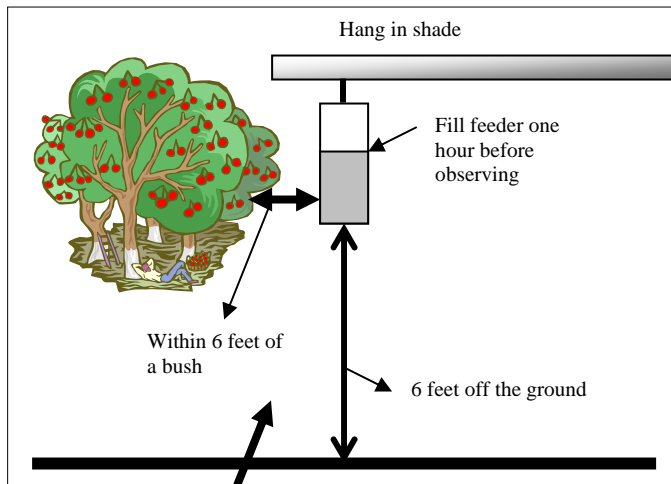
A sample of one student's procedure write up.

A. Organize the data takers

1. Contact friends and family across the country to set up feeders and observe hummingbirds.
2. Give each data taker the same instructions for building the feeder and for data recording.
3. Design a data sheet.

B Build the feeders

1. Use a clear plastic bottle with a stopper and tube.
2. Mail the feeders to the data takers.
3. Fill the bottle with a sugar water mixture. Do not add any coloring.
4. Hang in the shade 6 feet above the ground within 6 feet of nearby bushes.



C Take the data

1. Observe the feeder for 15 minutes each day between 9 AM and 11 AM.
2. Do at least three observations per week for four weeks.
3. Record on the data sheet the start time, stop time and number of hummingbirds visiting the feeder in the 15 minute period.

Diagrams add clarity

Notice that numbered steps were used

D Unusual situations

1. Do not count any observation time where people or cats are within 30 feet of the feeder.
2. Do not count any observation time if it is actually raining during the observation.
3. Fill the feeders at least one hour before doing any observation.

Protocols for unusual situations are covered.

Original Page 106

All trials

Butterfly observations:

After sitting down in the garden chair, wait 3 minutes before starting to count. This is to allow the butterflies to resume normal behavior after I've walked through the garden.

Cars and Ramps:

For every test, start the cars with the rear bumper at the top edge of the ramp.

Weather observations:

After emptying the rain gauge each week, dry the inside with a paper towel.

Special situations:

Butterfly observations:

If there is any loud noise or anyone walks in the garden, wait 3 minutes before restarting your count.

Cars and Ramps:

If a car goes off the edge of the ramp before reaching the bottom, replace the car at the starting point and run the test again. Do not record any data.

If, after leaving the ramp, the car curves, measure the distance in a straight line from the center of the ramp to the stopping point.

Weather observations:

If hail falls during the week, do not count the total rainfall that week.

Student Name _____ Teacher _____

One of the Coaches plans to come to advise this student.

1. Operational Definitions

- The terms in the question will need clarification with operational definitions.
- Good - There is no problem with unclear terms. Everything is well-defined.

2. Independent Variables

- Current design has too many independent variables.
Advice=

- Current design doesn't have a sample size that will support an answer to the question.
Advice=

- Good – The independent variables are fine.

3. Dependent Variables

- Advice on measurements indicated in the design=

- Advice on need for a self-designed rating scale=

- Good – The dependent variables are fine.

4. Help designing controls

- Advice on factors that need to be held constant from trial to trial=

- Advice on how to hold _____ constant =

- Good – The controlled variables are fine.

5. Help with equipment

Advice on finding equipment =

Advice on building equipment =

Advice on using equipment =

Good – This design should not have any problems with equipment.

6. General advice

Advice on ideas of whom to contact for further suggestions =
(Please give specifics, if possible.)

Please revise this design and send back.
(If possible, please provide an e-mail address to which student can send design revisions.)

7. Notes to teacher

This student probably will need substantial help in collecting preliminary data.
(Please elaborate, if possible.)

This design probably will need significant revision after preliminary data collection.
(Please elaborate, if possible.)

One of the Coaches plans to come to help with preliminary data collection.
(Please contact the Coach at _____ to give date and time of that meeting.)
(Coach's phone number)

This design looks strong and probably won't need much revision after preliminary data collection.

Additional comments: _____

Student Name _____ School _____
Date _____

SRC Feedback On Preliminary Design

- Some SRC's use standard paragraphs in e-mails or forms such as this one to give feedback to students. We are adding this form so that teachers have an idea of the types of responses that are typical.

If the project is approved without condition,

- This project is approved based on the research plan submitted.

If the project is approved with specific conditions,

- This project is approved if the changes in the research plan listed below are made.

If the project is not yet approved and advice must be given,

- This project is yet to be approved. Please make the changes indicated below or contact an SRC member, and then resubmit the project for SRC approval.

Original Page 114

If the project involves human subjects, check one of the following:

If the SRC, the teacher, and the school administrator agree that the project involves minimal risk to subjects and no informed consent will be required,

- This project has been approved by the IRB and the top box pertaining to risk level on Form 4 has been marked. No additional informed consent forms are required.

If the SRC, the teacher and the school administrator all agree that the project involves minimal risk and informed consent will be required,

- This project has been approved by the IRB and the middle box pertaining to risk level has been marked on Form 4. Each subject will be required to sign Form 4 in the lower left box. If the subjects are minors, their parent will need to sign in the lower right box.

If the SRC, the teacher and the school administrator agree, the project is approved with more than minimal risk,

- This project has been approved by the IRB and the lowest box pertaining to risk level has been marked. You will need to involve a Qualified Scientist (see Glossary starting on page **Error! Bookmark not defined.** in this *Guide* for details) and have that person sign Form 2 before experimentation begins. Each subject will be required to sign Form 4 in the lower left box. If the subjects are minors, their parent will need to sign in the lower right box.

If the project involves non-human vertebrate animals and only involves passive observation of pets, or farm, wild or zoo animals check the following:

If the project is observational only,

- This project has been approved by the SRC and has been marked on Form 5A. The “observational study only” box will be marked.

If the project involves non-human vertebrate animals and involves more than passive observation of pets, or farm, wild or zoo animals check the following:

- This project must take place in a registered research facility licensed by the USDA. The research will be conducted under the certificate issued by that institution’s Institutional Animal Use and Care Committee. Submit a copy of that certificate along with Forms 1C, 2,3 and 5B. With these forms the SRC will sign the right hand box on form 1B.

The Importance of Data Transformation

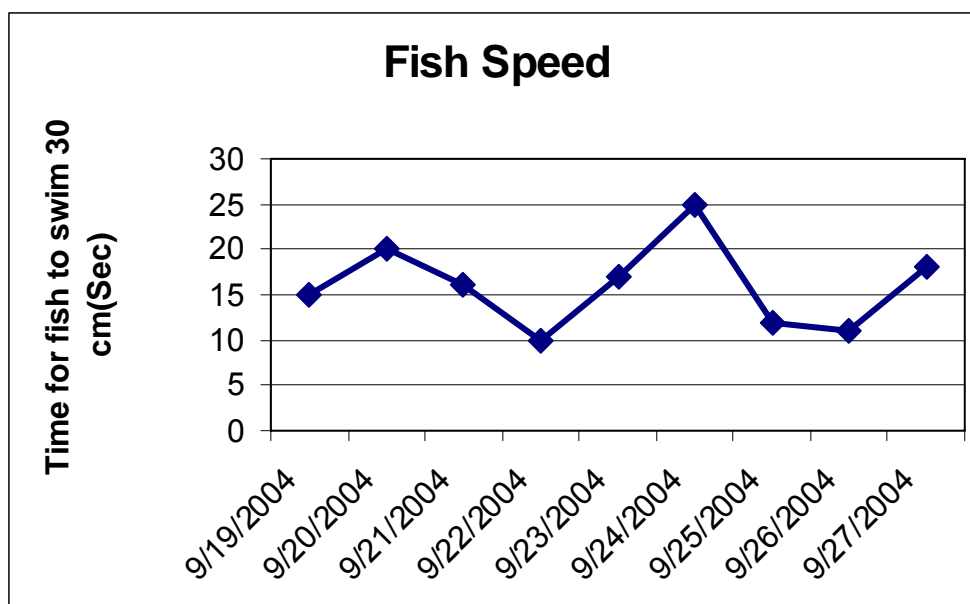
Data as recorded by the student:

Speed of fish between two points 30cm apart

	date	fish time seconds	fish speed cm/sec	water temperature ° C
3:45 PM	9/19/2004	15	2.0	15
7:45 AM	9/20/2004	20	1.5	10
8:15 AM	9/21/2004	16	1.9	11
5:45 PM	9/22/2004	10	3.0	22
2:15 PM	9/23/2004	17	1.8	14
6:00 AM	9/24/2004	25	1.2	5
9:00 AM	9/25/2004	12	2.5	18
8:30 AM	9/26/2004	11	2.7	18
7:30 AM	9/27/2004	18	1.7	12

Do you see any pattern that answers the question, "Do fish swim faster at higher temperatures?"

The student used the computer to "make a graph:"



Original Page 125

Same data -- rearranged from lowest temperature to highest

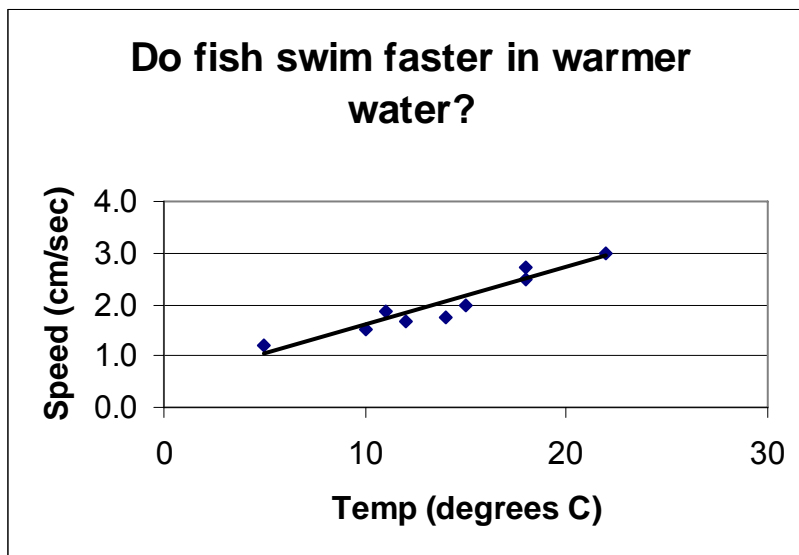
Speed of fish between two points 30cm apart

Sorted by temperature

	date	fish time seconds	fish speed cm/sec	water temperature ° C
6:00 AM	9/24/2004	25	1.2	5
7:45 AM	9/20/2004	20	1.5	10
8:15 AM	9/21/2004	16	1.9	11
7:30 AM	9/27/2004	18	1.7	12
2:15 PM	9/23/2004	17	1.8	14
3:45 PM	9/19/2004	15	2.0	15
9:00 AM	9/25/2004	12	2.5	18
8:30 AM	9/26/2004	11	2.7	18
5:45 PM	9/22/2004	10	3.0	22

Do you see any pattern that answers the question, "Do fish swim faster at higher temperatures?"

The student graphed the transformed data:



Is the pattern even more clear?

Original Page 126

Parts of an abstract:

- the purpose of the experiment
- the procedures used
- the results
- the conclusions

Sample Abstract

I read that oil from outboard boat motors kills plants along rivers. I wanted to see if typical plants from the Willamette River were affected.

I went to some riverside marsh lands and collected two samples each of five types of plants. My reading told me that engine exhaust contained about 2% oil, so I prepared some water mixed with 2% oil and I tried to grow one of each type of plant in that. I tried to grow the other plant of each type in pure water.

For three weeks, I grew the plants and photographed them every week. At the end of the time I measured the height of the plants and then dried them and measured their weight. All of the plants grown in the oil mixture either died or were much smaller than those grown in pure water.

I can see from my results that for the five types of plants I used, oily water kills or reduces growth. It would be interesting to try other plants (such as trees) and use a longer growing time to see if the results are similar.

Developing Your Abstract

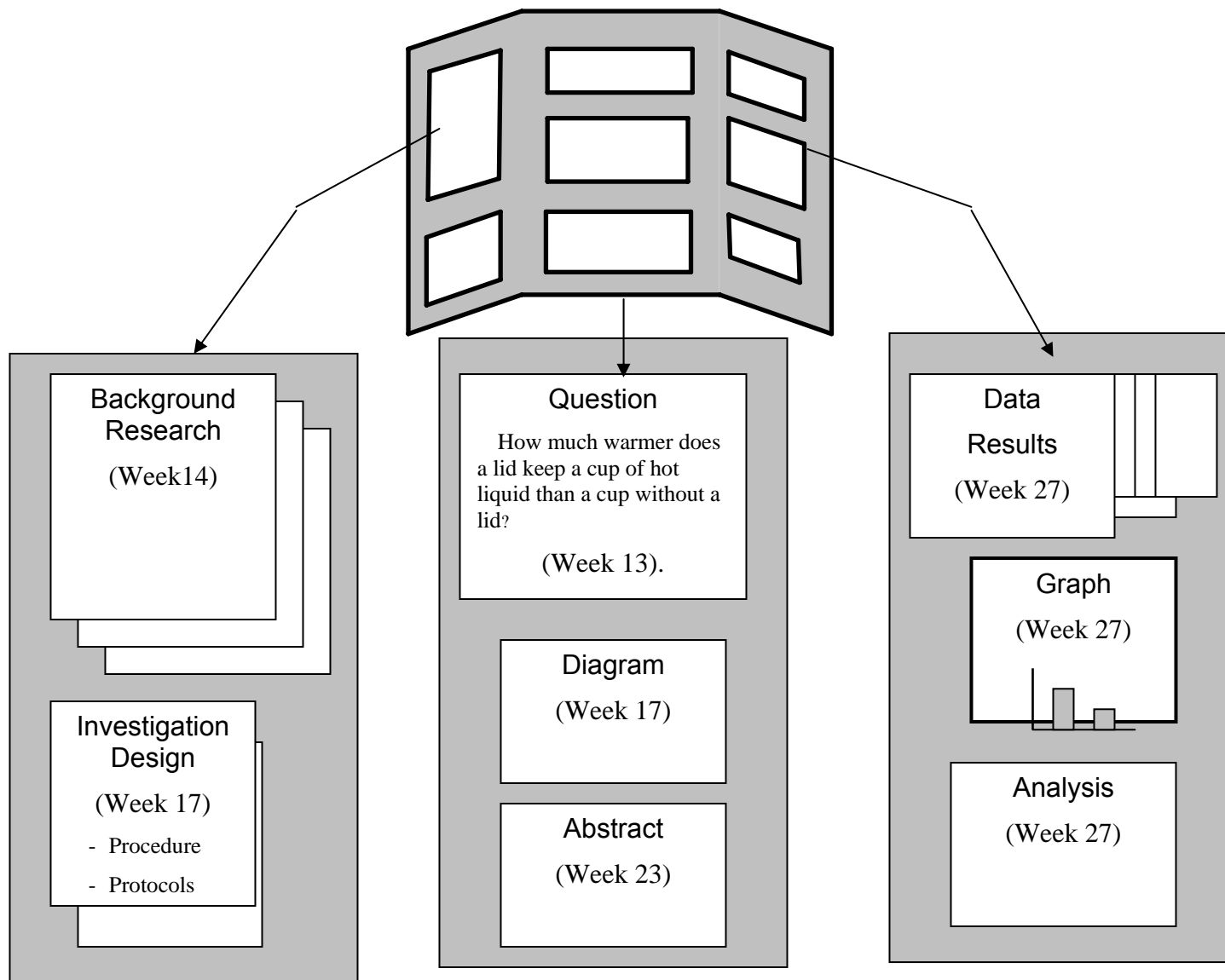
The student in our example did a good job writing her abstract. In the first paragraph she has a very short description of the problem. Take a moment and write a sentence or two about your investigation. What did you study? What did you want to find out? Write your **purpose statement** here:

From our sample abstract, we see the next part is to briefly explain your method of investigation (**procedure**). Don't give all the details here, but do tell the basics of what you did, what you worked to control and what you measured.

The next step is to briefly discuss your **observations and results**. Be especially careful to include results that led you to the conclusion you draw in the last part of your abstract. Tell just the general trends of your results here, not many specifics. Don't use tables or graphs right now, rather just mention the important generalities.

The last part of the abstract is your **conclusion**. You set out to answer a question; now use your results to answer it. If you can think of some extensions of your investigation, mention them - even if they aren't something that would be practical for you to do yourself. (The student in the example didn't expect to plant trees herself. She just said that it would be interesting if someone did.)

A Sample Display Board



Tips for Volunteers

Helping Students with Presentations

Students will need the most help with the following:

- Making short notes on index cards - Be brief; notes should give just enough information to jog memory about what student wants to say
- Using and referring to their board as they talk - The students should talk in sequence *as it appears on their board*. If they have arranged their work non-sequentially, then they should consider numbering their display components to help the flow of their presentation.
- Eye contact and voice projection
- Keeping their presentation to a reasonable length

After the students have conducted a brief presentation, you should ask questions from the “Sample Judging Questions.”

Most Judges will ask these two questions and others (Students will expect something like these two)

“Why is your research important? How could your findings be used?”

And,

“How would you expand your research? What questions would you investigate next?”

Finally,

- Ask students what they thought they did well and what could be improved.
- Give some positive feedback!

Sample Judging Questions

Below are listed some sample questions that a judge might ask during an interview with a student. (Please note that not all of these questions will be relevant to all projects.)

Framing the Question:

What prompted you to choose this topic?
What is the question that you wanted to answer?
What type of research did you have to do before you began the experiment?
Did you make any initial observations or do any other experiments before you began?
How/Where did you research the scientific principals that your project is based on?
Do you have a hypothesis?

Designing the Investigation:

Please describe for me what you did for this project.
What are your controls? What are your variables?
What materials did you used? Did you have to purchase or make any of your equipment?
Did you have to modify your procedure as you did the experiment?
How did you deal with unusual situations while taking data?

Collecting and Presenting Data:

How did you organize the information/data that you collected?
Why did you choose this type of graph/chart to represent your data?
How long did you spend gathering data?
How many trials (tests of the same experiment) did you run?
Was there any “weird” data that seemed out of ordinary? Did you choose to include it?
If so, how do you explain it? If not, why did you choose to not include it?
How did you measure your data? What units of measurement did you use?

Analyzing and Interpreting Results:

Did you make any calculations using your data?
Could you see any patterns in your data?
What did you learn as a result of this project?
Does your data support your conclusion?
What were your sources of data?
What could you do to eliminate sources of error if you were to do this project again?
Did you discover something that you would like to learn more about?
Were there any results that surprised you?
If you could continue this project, what would you do next?