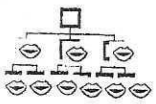
A scientist systematically studies the universal rules and laws that govern our universe. He or she uses powers of observation, analysis, and synthesis of ideas to describe the nature of the world around us. Scientists look for and develop ??? about the origin, function, and interrelation of forces, elements, materials, systems, etc., of the natural world. Scientists develop hypotheses about what they see. Using the scientific method, a scientist can test his or her hypothesis to develop a theory.



- ✓ Scientific inquiry
- ✓ Inference
- ✓ Observation
- ✓ Hypothesis
- ✓ Variables
- ✓ Control
- ✓ Manipulated variable
- ✓ Responding variable
- ✓ Data
- ✓ Theory
- ✓ Law

Think Like a Scientist:

Science Fair

Research and Experimentation

Choose a topic that is of interest to you.

Develop a set of research questions based on things you have observed or learned.

Research your topic, using your questions as a guide.

Make inferences about , forces, , and relationships within your topic.

Develop a hypothesis.

Design an experiment to test your hypothesis.

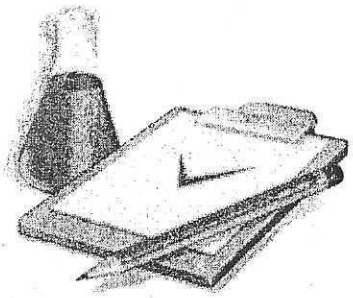
Conduct your experiment with careful observation and data collection.

Report your findings in a professional manner.

- ✓ Hypothesis
- ✓ Experiment
- ✓ Documentation
- ✓ Research
- ✓ Report
- ✓ Charts
- ✓ Graphs
- ✓ Presentation

- ✓ Pose questions
- ✓ Make observations
- ✓ Make inferences
- ✓ Develop hypotheses
- ✓ Design experiments
- ✓ Make measurements
- ✓ Collect data
- ✓ Interpret data
- ✓ Draw conclusions
- ✓ Develop models
- ✓ Report findings

Science Fair Checklist



_____1. Choose a topic

Topic: _____

Question: _____

_____2. Develop a set of research questions based on things you have observed or learned.

_____3. Research your topic, using your questions as a guide.

_____A. Encyclopedias

_____B. Books

_____C. Databases

_____D. Other Sources (interview, magazine, video, etc.)

_____4. Make inferences about , forces, , and relationships within your topic.

_____5. Develop a hypothesis in "If..then" format.

Hypothesis: _____

_____6. Design an experiment to test your hypothesis.

_____7. Conduct your experiment with careful observation and data collection.

_____A. Establish controls for your experiment

_____B. Determine manipulated variables

_____C. Determine responding variable

_____D. # of Trials _____

_____8. Report your findings in a professional manner.

_____A. Research Paper

_____B. Science Board or Powerpoint

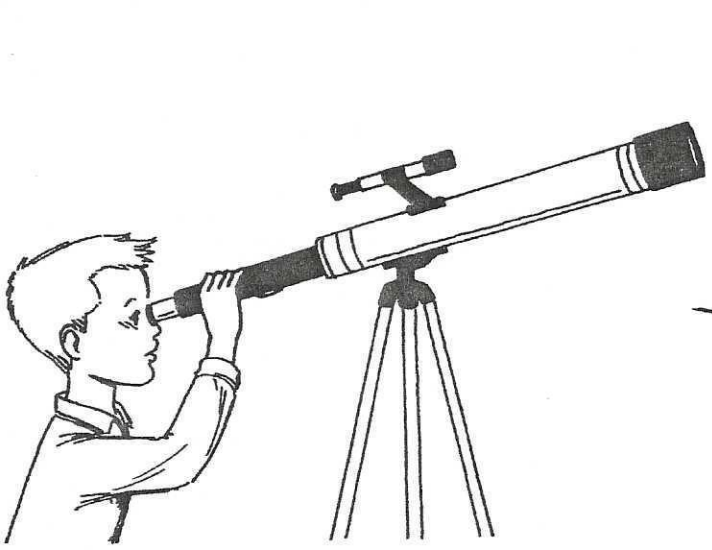
_____C. Science Fair

CHOOSING A TOPIC

Students are often glad to do science investigation projects because they are tired of **"learning about"** facts and concepts and look forward to actually **"doing"** science. Completing a science investigation project can be a very exciting and enjoyable experience if you pick a topic that interests you! Since selecting the right topic is so important to the success of the project, you should explore your science interests before deciding on a topic to investigate.

Things That I Wonder About (Science Interest Survey)

In today's world, science is a part of most of the things we experience. In sports, you may use scientific methods to compare the action of two different golf balls in a physics experiment. In a biology experiment, you might compare the effect of different water temperatures on the blood pressure of swimmers immediately following a race. Almost any topic that you can think of uses at least some science.



Science is sometimes divided into two main areas: the physical and the life sciences. The **physical sciences** concentrate on nonliving matter and involve subjects such as physics, chemistry, geology, meteorology, and astronomy. As you probably know, the **life sciences** (also known as **biology**) concentrate on all kinds of organisms, such as bacteria, molds, worms, plants, sponges, fish, birds, and humans. Life science subjects include molecular biology, microbiology, botany (plants), zoology (animals), ecology, and animal behavior. The subject of psychology may also be thought of as a life science, since it deals with the living organism you are most interested in—man. The subjects under the physical and life sciences make up the **basic science categories**. These science categories are a good place to begin your science interest survey.

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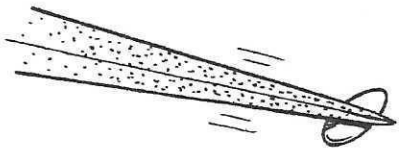
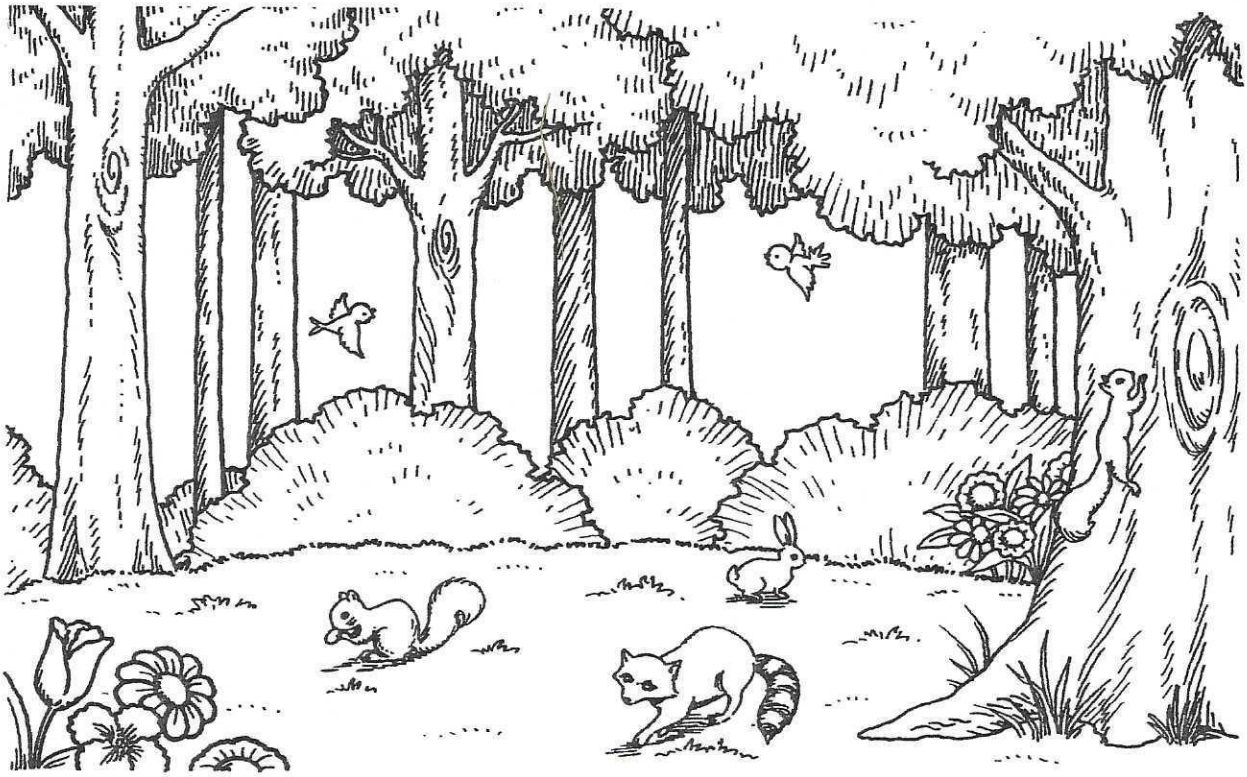


Even if the effect of nicking the seed coat of honey locust has been determined and described, your question might be changed to include other factors or combinations of factors. A search of the books and articles about seed germination should reveal that many seeds require nicking (officially called **scarring**) before they will germinate. This results in a large number of unscarred seeds that will form a seed bank for the production of future trees. The fact that acid from the stomachs of animals that eat certain fruits and seeds can increase the germination rates of seeds that have passed through the digestive systems of these animals is also known. Another good but more complex science investigation question would be to ask about the combined effects of scarring and acid on honey locust seed germination. It is less likely that the combined effects of these two factors (scarring and acid) have been worked out, so your question might be considered **original** and **creative**. (A word of caution: You must be very careful not to pick a question that is too complicated and too difficult to answer by a single science investigation.)



Name _____ Date _____

Student Exercise

1. Write down two things from the physical sciences that you are interested in but cannot fully explain.

   a. _____

   _____

   b. _____

   _____

2. What basic physical science categories are your two answers for question one included within? (Circle one.)

   a. physics chemistry geology
   meteorology astronomy other:

   b. physics chemistry geology
   meteorology astronomy other:

3. Write two things from the life sciences that you are interested in but cannot fully explain.

   a. _____

   _____

   b. _____

   _____

4. What basic life science categories are your answers for question three included within? (Circle one.)

   a. molecular biology microbiology botany zoology
   medicine and health ecology animal behavior
   psychology other:

   b. molecular biology microbiology botany zoology
   medicine and health ecology animal behavior
   psychology other:

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Name _____ Date _____

5. Are you more interested in the physical or life sciences? Why?

6. If you had to choose one basic science category as your favorite, which one would it be?

7. Can you think of a recent television show or movie that deals with your basic science category? Name and describe this show or movie.

8. Name two professions or jobs that deal with your favorite basic science category.

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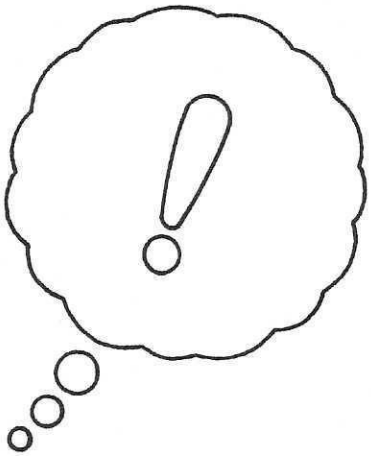
MAKING A HYPOTHESIS AND DESIGNING A STUDY



Turning My Question Into a Hypothesis

Five examples of topic questions for student science fair projects are listed below.

1. What effect does water temperature have on the size of soap bubbles?

2. What effect does hot water have on the germination of geranium seeds?

3. What effect does the color of light have on the growth of radish seedlings?

4. Which type of seeds do house finches like best?

5. Does the life of a light bulb depend on wattage?

Even though many forms of the scientific method are used, all science investigations are based on hypotheses that are tested in order to answer questions about the material world. A **hypothesis** is essentially a topic question that has been reworded into a form that can be tested. In the example below, question one has been restated in the form of a hypothesis.

A. Hypothesis: Warmer water will produce larger bubbles than cooler water.

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Choosing a Topic

The world of science is limitless, and so are your choices of topics to investigate through the science fair.

The scientific method begins with **QUESTIONS**.

Ask yourself:

What am I curious about?

What do I wonder about?

Keep a journal or list of topics that inspire your curiosity.

Develop:

1. *questions of origin,*
2. *questions of function,*
3. *questions of interrelation,*
4. *questions of application, and*
5. *questions of extension.*

based on the topics.

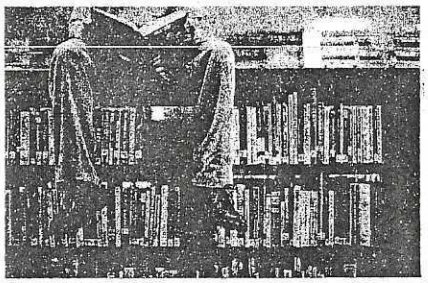
Science can be the study of...

chemical effects of light	actinology
blood vessels and lymphatics	angiology
bees	apiology
arachnids	arachnology
the search for extraterrestrial life	astrobiology
atoms	atomology
bacteria	bacteriology
physical life	biology
heart function and disease	cardiology
whales	cetology
climate	climatology
the universe	cosmetology
the skin and related diseases	dermatology
interactions in environments	ecology
insects	entomology
animal behavior	ethology
the earth; earth's crust and strata	geology
reptiles	herpetology
water	hydrology
mammals	mammalogy
climate and weather	meteorology
microscopic life	microbiology
fungi	mycology
clouds	nephrology
brain	neurology
ancient animals	paleozoology
disease	pathology
rocks	petrology
medicines	pharmacology
plants	phytology
fire	pyrology
earthquakes	seismology
caves	speleology
poisons	toxicology
volcanoes	vulcanology
extraterrestrial life	xenobiology

Choose the question that most fascinates you as the basis for your science fair project.

Conducting Your Research

Research is the most important first step in any scientific endeavor. It is important to know not only background relating to your topic, but you also want to know what other research and experimentation has been conducted in the field. There are many resources available to you to conduct your research, but it is a good idea to start with the basics.



Encyclopedias: This is a great place to start. Encyclopedias contain VOLUMES of information on just about every topic you can think of, and you can find them in EVERY library. Information in a general encyclopedia is pretty basic, but it can point you in wider directions for further research. Also, ask your librarian if your library has specialized encyclopedias for scientific research!

APA Format for Citing an Encyclopedia:

Author of the article. (Year). In *Title of encyclopedia* (Vol. 1, pp. 1-2). Publishing city: Publisher.

Manzo, K. (2008). In *The Encyclopedia of Research and Experimentation* (Vol. 12, pp. 500-534). El Paso: Manzo Publications.

Books: Both public and private libraries stock large collections of books on science, scientists, technology, and the natural world. Most school libraries use the Dewey Decimal System of classification. Under this system, science and technology are located in the 500's and 600's. Although you may use the library's computer catalog to locate books on a particular topic, it is often more fruitful to simply go to the stacks and peruse books according to their Dewey code. When you find a book of interest, check the index to see if it addresses some of the topics you are researching.

500 – Science
500 Natural sciences & mathematics
- 510 Mathematics
- 520 Astronomy & allied sciences
- 530 Physics
- 540 Chemistry & allied sciences
- 550 Earth sciences
- 560 Paleontology; Paleozoology
- 570 Life sciences
- 580 Plants
- 590 Zoological sciences

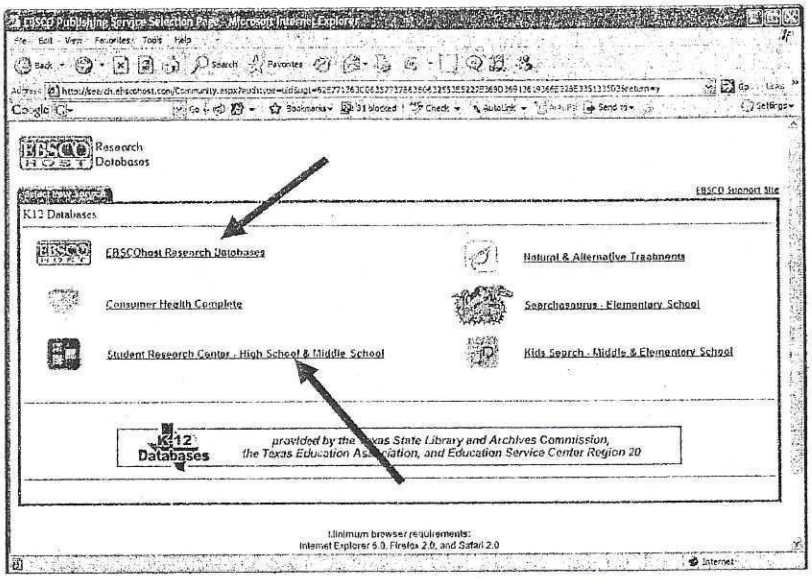
600 – Technology
- 600 Technology (Applied sciences)
- 610 Medical sciences; Medicine
- 620 Engineering & allied operations
- 630 Agriculture
- 640 Home economics & family living
- 650 Management & auxiliary services
- 660 Chemical engineering
- 670 Manufacturing
- 680 Manufacture for specific uses
- 690 Buildings

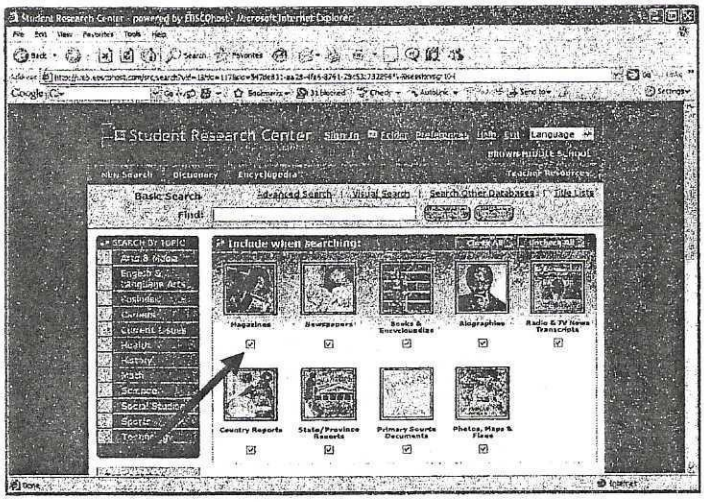
APA Format for Citing a Book:

Author, A. (Year). *Title of work: Use first letter capitalized for subtitle.* Publishing city: Publisher.

Manzo, K. (2008). *Complete book of research and experimentation.* El Paso: Manzo Publications.

Databases: Our school libraries provide all students access to databases full of information from journals, magazines, newspapers, and many, many other sources. A database is a very large collection of data stored electronically. The information provided in database articles is very detailed and in-depth. Don't make this your first stop, or you may become overwhelmed. Once you have gotten a handle on the basics of your topic, you will be ready to jump in and explore the databases.

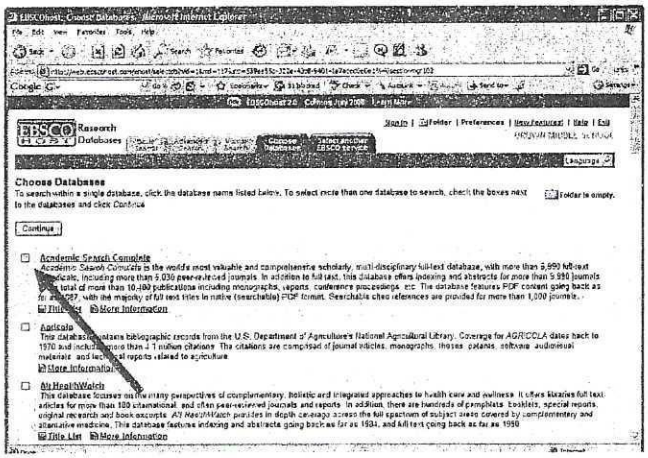




Start with the Student Research Center. From this database, you can search magazines, newspapers, books and encyclopedias, biographies, and more. Enter your search terms and get going! Remember – When you choose your search terms you want to be specific and concise.

Some of the articles here will provide citations for you, while others you will have to look for the information at the top of the article.

If you want to get more in-depth, try the EBSCO databases. These databases provide collections of scholarly articles from journals. Select one or two of the databases you want to search, and then hit "continue". You will be able to enter search terms here as well. Don't forget to select "Full Text" before you search!

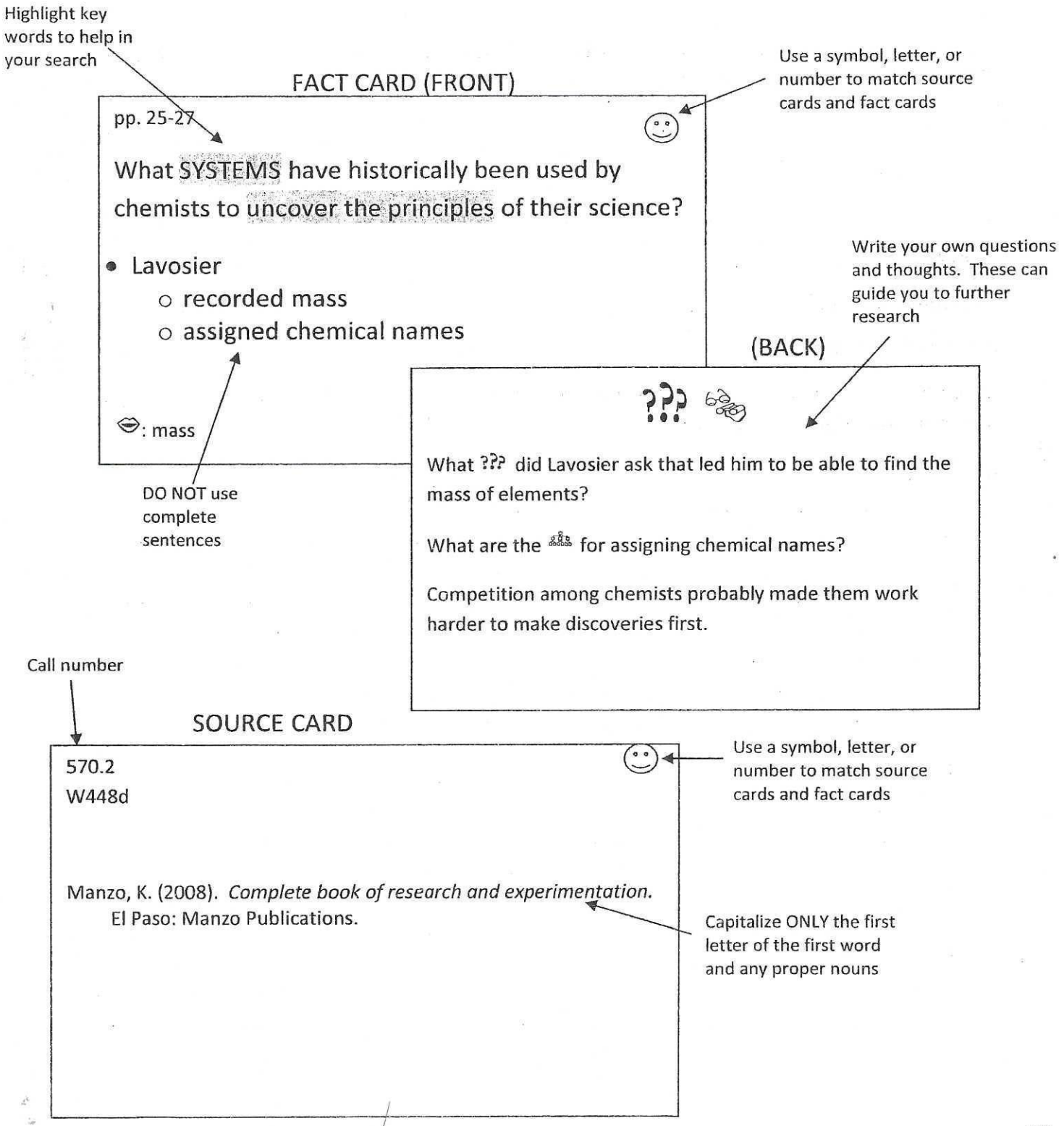


APA Format for Citing a Database Article:

Author, A. (Year). Title of Article. *Title of Journal, Vol(No.). Date retrieved, 2008, from EBSCO database.*

Taking Notes: Index Cards

Index cards can be a very useful tool for note taking. Using index cards allows you to be able to physically manipulate the information once you have collected it. When using index cards, you must use fact cards and source cards.



Works Cited MLA Style

Book:

_____. _____.
Author (Last Name, First Name) Title of Book (Underlined)

_____: _____. _____.
Place of Publication Publisher Date Published

Encyclopedia article with author: (If no author begin with title)

_____. "_____".
Author (Last Name, First Name) Title of the article

_____. _____.
Name of encyclopedia (underlined) Date Published

(IF ONLINE ALSO USE THE FOLLOWING)

_____. <वा>_____.
URL Address Date Accessed

Internet or Web Site:

_____. "_____".
Author (if any), last name first. Title of article

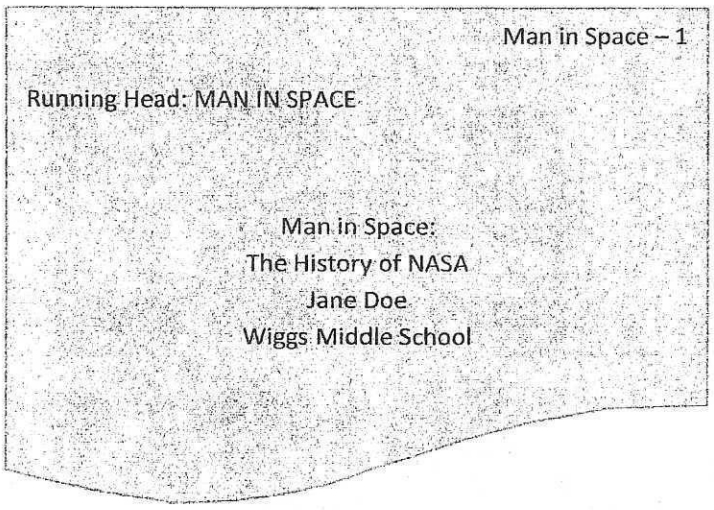
_____. _____.
Date of article URL address

_____.
Date you access the site.

Writing Your Research Paper

Academic conventions refer to the specific [illegible] that a writer must follow when writing professional or scholarly papers. The fields of science use the conventions, or [illegible], outlined by the American Psychological Association (APA) manual.

Title Page



- Page header in top-right
- Running head on the first line of the page, left justified; the words "Running Head:" followed by a colon and abbreviated title in all caps
- Type your full title in the upper half of the page, centered
- Beneath your title, type your full name
- Beneath your name, type the name of your school

Basic [illegible] for APA papers

- Double-space
- Set margins at 1 inch
- Use 10-12 inch font (Times New Roman or other serif font)
- Place a page header in the top right corner of each page, include first 2-3 words of title and page number
- Include the following sections, each beginning on a separate page: **title page, abstract, text, references, and appendices** (if applicable)

Abstract

An abstract is a 75-100 word paragraph that provides the reader with a quick overview of your paper. It should summarize 🏛 and key ❀. It should also summarize results and conclusions, as well as implications or applications of the research you will discuss in your paper.

An abstract is written after the report is completed, even though it is intended to be read first. If your instructor requires you to write an abstract for your research paper, it will be written on its own page, which will come after the title page. Center the word "Abstract" one inch from the top of the page.

The Text

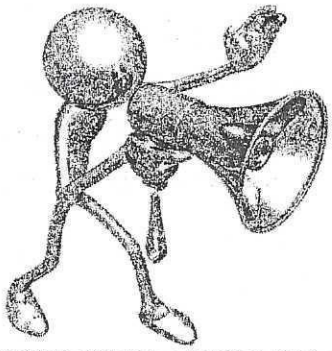
Introduction

The purpose of the introduction is to get the attention of the reader. You may choose to use a narrative, anecdote, description, facts and statistics, or a quotation. Before you decide how to write your introduction, you should ask yourself, "What interested ME in this topic in the first place?" and try to share that interest or excitement through your introduction.

For a science research paper, you should include such information as what you intend to do, and how you plan to structure your paper. The last sentence of your introductory paragraph will be your thesis statement. Your thesis statement should clearly state the purpose of your work.

Main Text (or Body)

The main text of your paper should discuss your research and project results in an organized fashion. Follow your outline to help keep your ideas together. Make sure to discuss not only background ❀, you must also summarize how you conducted your experiment and what results you found from your data sets.



Hints & Tips:

- Remember the 3 C's – clear, concise, and creative
- Your writing style should be formal, avoid slang or first or second person pronouns (I, me, you)
- Always write in active voice
- Cite your sources using the APA style of documentation
- Follow 🏛 for spelling, grammar, capitalization, and punctuation

Conclusion

The conclusion should leave the reader with a clear understanding of the importance of your research. You may use any of the following ideas in your conclusion:

1. Summarize the main points and draw a conclusion
2. Discuss how your research and experiment influenced your attitude toward the subject
3. Discuss what you learned throughout the project
4. Discuss the implications of your research
5. Point out directions for future research or ???
6. Link the ideas of the last and first paragraphs to come full-circle with your ideas

Reference Page

Your reference page will begin on a new page at the end of your paper. The reference page allows you to share your information sources for the reader so that he or she can try to duplicate or build on your work. Center the title "References" about one inch from the top of the page. Double space throughout your reference page. Follow these additional guidelines for your reference page:

- Use a hanging indent (first line is flush left and additional lines are indented five spaces)
- Alphabetize your entries by the last name of the first author or editor
- Italicize titles and subtitles of books and ONLY capitalize the first letter of the first word and proper nouns

- Make an argument – don't simply combine your source information in your own words
- Look for  ,  ,  , and form your own  based on the information that will answer your research question.
- Enclose borrowed language in quotation marks
- Provide signal phrases that include the author's name to prepare readers for a quotation
- Use ellipses (three spaced periods) to condense long quoted passages.
- If your quote is more than 40 words, set it apart by indenting one-half inch and do not use quotation marks.

Name: _____ Assignment 3d Due: _____

Teacher: _____ Period: _____ Score: ___ / 10 pts

Master Lab Materials List

List *all* of the materials you need to complete your experiment in the table below. Be sure to list multiples if you will need more than one item. For example: 10 straws.

Many science materials double as household items in their spare time. For each of the materials you have listed below, see if it is possible to find that material around your house. If it is, mark that box with a check. Things that you can't find around your house or apartment but you could purchase at a grocery, hardware, or speciality store, check those boxes as well.

	Qty.	*Material*	*Home*	*Grocery*	*Hardware*	*Other*
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

Science Materials Suppliers

Recommended Materials Suppliers

For every science lab you review there should be a list of materials you will need. Many of these are very easy to acquire. If you do not have them in your home already you will be able to find them at the local grocery or hardware store. For more difficult items we have selected, for your convenience, a small but respectable list of suppliers who will meet your needs in a timely and economical manner. Call for a catalog or quote on the item you are looking for and they will be happy to give you a hand.

Loose in the Lab
9462 South 560 West
Sandy, UT 84070
Phone 1-888-403-1189
Fax 1-801-568-9586
www.looseinthelab.com
General Science

Delta Education
80 NW Boulevard
Nashua, NH 03601
Phone 1-800-442-5444
Fax 1-800-282-9560
www.delta-ed.com
General Science

Flinn Scientific
PO Box 219
Batavia, IL 60510
Phone 1-800 452-1261
Fax 1-630-879-6962
www.flinnsci.com
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Educational Innovations
362 Main Ave
Norwalk, CT 06851
Phone 1-888-912-7474
Fax 1-203-629-2739
www.teachersource.com
General Science

Frey Scientific
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Mansfield, OH 44903
Phone 1-800-225-FREY
Fax 1-419-589-1546
www.freyscientific.com
General Science

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Phone 800-446-8767
Fax 1-970-484-1198
www.hubbardscott.com
General Science

NASCO
901 Jonesville Ave.
Fort Atkinson, WI 53538
Phone 1-414-563-2446
Fax 1-920-563-8296
www.nascofa.com
General Science

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Rochester, NY 14692
Phone 800-387-7822
Fax 1-716-334-6174
www.wardsci.com
General Science

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Burr Ridge, IL 60521
Phone 800-955-1177
Fax 1-800-955-0740
www.fisheredu.com
General Science

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Phone 1-800-728-6999
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www.edmundscientific.com
General Science

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Buffalo Grove, IL 60089
Phone 800-727-4368
Fax 1-800-676-2540
www.sargentwelch.com
General Science

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3823 Leanvenworth St.
Omaha, NE 68105
Phone 800-228-7117
Fax 1-402-346-2216
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Biology / Anatomy