STUDY Supplement

Experiment Reports

The rules for scientific writing style (see section on **Science Essays**) apply for experiment reports, too.

Experiment reports use the following format: **Title – Abstract – Introduction – Materials and Methods – Results – Discussion – References**. Each section should be preceded by the appropriate heading which is emphasized in some way (bold, underlined or capitalized), apart from the title, which is itself emphasized.

Title

The title should be clear, informative and as specific as possible, so that the reader can see at a glance what the report is about. Make sure you include:

- the name of the substance, organism, situation etc being studied
- the aim of the experiment

Abstract

An abstract is an at-a-glance summary for people who may not wish to read the whole report. It is usually only required at university level and beyond. As it is a summary, it is written last of all. The abstract should be short (no more than one paragraph) and not go into detail. The reader must be able to understand it without having to refer to anything else. It usually includes:

- a description of the topic
- a summary of the methods used
- a summary of the results
- and most importantly, a summary of the main conclusion

Introduction

In the introduction you should include:

- how the experiment is relevant to your broad topic of study
- what the aim of the experiment is. If the aim is to test a hypothesis, then state the hypothesis, the thinking behind it and the predictions that you are testing.
- any relevant assumptions you are making. For example, ***In investigating the acceleration due to gravity of a falling ball, I shall assume that air resistance is negligible***.
- any relevant background information on the topic. Cite and briefly discuss any important experiments carried out by others.

Materials and Methods

In this section you should describe what you actually did in the experiment without referring to the results. You need to write clearly and in detail. It should be possible for someone else to repeat the experiment simply from reading your description. Be sure to include information on:

- the materials and equipment you used
- how you used the materials
- sizes, measurements, concentrations etc

- any special reasons why you chose particular materials or methods
- any statistical methods you used to analyse the data
- the location and date, if it is a field study

Take care to:

- give only necessary details. For example, do not give the size of a beaker unless it is absolutely vital to an understanding of the experiment.
- avoid mentioning irrelevant matters such as how to clean up after the experiment or details specific to your circumstances such as "the assignment that our class was given".
- explain the reasons why you carried out a particular action. For example, you might write: ***In order to test whether..., I...***
- show how you made the experiment as accurate as possible. For example, an unexpected result may have prompted you to take extra readings.
- use the first person (***I***, ***we***) or the third person (***he***, ***she***, ***it***, ***they***). Using the second person (***you***) sounds as though you are giving instructions to the reader. You can also use the passive, eg ***a sample was taken*** instead of ***we took a sample***.
- write in the past tense. A report describes what you have actually done.

Results

In this section you should give the results of the experiment without referring to their significance regarding the aim of the experiment. Bear in mind the following:

- You must describe the main trends of your results. Refer in your description to the appropriate figures (diagrams, graphs, charts etc) and/or tables in the order in which they appear in the report.
- Figures and tables must be given a number followed by a title. They should be numbered separately; so, for example, if you had two figures and one table, they would be presented as: ***Figure 1***, ***Figure 2***, and ***Table 1***. Make sure that the title is clear and informative, enabling the reader to understand the figure or table on its own without having to read through the report. Position the number and title at the bottom of a figure and at the top of a table. Remember to give a scale for each figure, if appropriate. Each graph axis must be labelled with the measured variable and its unit (for example, ***length/m***).
- Do not repeat data in the text that you have already given in a figure or table. Instead refer in the text to the figure or table by its number; for example, either ***Figure 1 shows that...*** or ***...as shown in Figure 1*** or ***...is shown to fluctuate (fig.1)***.
- If you are able to quantify the errors associated with the collection of your data, then this information should appear on your graphs as error bars, and in your tables as, for example, ***length = 25cm (± 0.5)***.
- If you are making a statistical analysis, you must mention the level at which the trends were statistically significant.

Discussion

This section splits into two distinct elements – **Analysis** and **Evaluation**.

Analysis

Here you need to consider the evidence and analyse the results with regard to the aim of the experiment as stated in the Introduction. You should:

- explain the patterns and relationships exhibited by your results.
- explain to what extent the results support your hypothesis and/or predictions.

You may wish to:

- produce further figures, resulting from your analysis, that show the relationship between variables more clearly.

Evaluation

In this section you need to evaluate your experiment and discuss the soundness of the conclusions you have reached. You need to:

- discuss how your assumptions and analysis of errors might have an effect on your interpretation of the results.
- identify any anomalous results and give reasons for accepting or rejecting them.
- take into account alternative interpretations of your results which might be equally valid. What hypothesis or hypotheses other than your own might account for the results you obtained?
- explain to what extent the results have contributed towards an understanding of your broad topic of study.
- make recommendations, if any, for improved methods or further experiments which might help to resolve remaining difficulties in achieving the aim of the experiment or testing the hypothesis.

Science Essays

The basic principles of writing English essays apply to science essays too. Information and tips on good essay writing is provided in *Chambers Study Dictionary*.

In addition, scientific writing style has some rules of its own:

- Be particularly clear and concise.
- If you are writing about an organism, give the scientific name of that organism. If it also has a widely used common name, give both the scientific and the common names the first time you mention the organism, and afterwards give just the common name. Scientific names should be given in italics. The genus name begins with a capital letter and the species element begins with a small letter; for example, ***Homo sapiens***. Once the scientific name has been given in this way, you may then abbreviate the genus name; for example, ***H. sapiens***. Remember that scientific names behave like proper nouns: they are not preceded by the articles ***the*** or ***a***; for example, ***It has long been thought that Homo sapiens...***
- Make sure that any figures or tables you give follow the guidelines set out under **Results** in **Experiment Reports**, above.
- If you refer to a published work in the main body of your essay, give a paraphrase of the relevant information rather than an exact quotation. The precise words do not matter (as they might do in a literature essay); what matters is that you show you understand the material by presenting it in your own words.
- Use metric measurements always, and give the appropriate units in the standard abbreviations.
- Numbers below ten should be written out in words unless they are part of a measurement (for example, ***4g*** or ***5cm***)
- Avoid starting sentences with a number. Either write out the number in words or restructure the sentence. So, for example, a sentence beginning ***25 of those questioned said that...*** could be rewritten as ***Twenty-five of those questioned said that...*** or ***Of those questioned, 25 said that...***
- Take care to distinguish between singular and plural forms of nouns. Scientific terminology relies heavily on Latin-based words, in which the singular form is often shown by the ending ***-us***, ***-a***, ***-um*** or ***-is*** and the plural form by the ending ***-i***, ***-ae***, ***-a*** or ***-es***. For example, ***datum*** is singular and ***data*** is plural. Sometimes the same form is used for both singular and plural; for example, ***species***.

Theories

Big Bang Theory

A theory for the evolution of the universe which postulates that all matter and energy were once concentrated into an unimaginably dense state, from which it has been expanding after a gigantic explosion between 13 and 20 billion years ago. This explains why galaxies are seen to be moving away from each other. The main evidence in support of the theory is the cosmic background radiation (a relic of the early hot phase in the Big Bang universe) and the redshift of galaxies (in which the wavelength of light from galaxies is shifted closer to the red end of the spectrum the further away the galaxies are).

Chaos Theory

The theory that some systems, though governed by simple laws, are highly sensitive to starting conditions, which makes their behaviour extremely difficult to predict. Examples of chaotic systems are the weather and economics.

Collision Theory

A theory which explains how chemical reactions occur and which predicts the rate of reaction. For a reaction to take place the atoms in the reactants have to collide, which leads to the breaking and formation of bonds and thus to the creation of the product of the reaction. However, not all collisions lead to chemical change. If the reactants are made more concentrated and the temperature is raised, more collisions are brought about, increasing the rate of reaction.

Continental Drift

A theory put forward in 1912 to explain the distribution of the continents and oceans and the structural, geological and physical similarities between continents. The continents were believed to have been formed by the break-up of a single land mass hundreds of millions of years ago and to have then drifted apart. However, such movements could only be explained when plate tectonics began to be studied in the 1960s.

Darwinian Theory, Darwinism

See **Natural Selection**

Gaia Hypothesis

The theory that the Earth functions as a self-regulating living entity within the solar system. According to James Lovelock, who put forward the hypothesis in 1972, the Earth's living matter, air, oceans, and land surface form a complex system which can be seen as a single organism and which has the capacity to keep our planet a fit place for life.

Kinetic Theory

A theory which attempts to account for the physical properties of matter, especially gases, in terms of the movement of the atoms or molecules of which they are composed. In the simplest form of the theory, gas molecules are conceived as elastic spheres whose bombardment of the walls of the containing vessel causes the pressure exerted by the gas.

Lamarckism

One of the earliest theories of evolution, now discredited, which proposed that characteristics acquired during the lifetime of an organism could be transmitted from parent to offspring.

Natural Selection

Evolutionary theory, first proposed by Charles Darwin and Alfred Russel Wallace in 1858, which postulates the survival of those organisms that are best adapted to their environment. The characteristics which favour survival arise as random variations due to mutation and are then inherited.

Neo-Darwinism

The modern version of Darwin's theory of evolution by natural selection, incorporating the discoveries of modern genetics and laying particular emphasis on genetic mutations leading to variations in population.

Plate Tectonics

A geological theory, formulated in the 1960s, according to which the Earth's crust is composed of a small number of large plates of solid rock whose movements in relation to each other are responsible for continental drift, earthquake zones and volcanoes.

Quantum Mechanics

A theory that developed from the quantum theory and which is used in the interpretation of the behaviour of particles, especially subatomic ones.

Quantum Theory

A theory developed by Max Planck (1858–1947) and based on the principle that there is a minimum indivisible amount (a quantum) of certain physical properties, such as momentum, energy and electromagnetic radiation, that can exist. In particular, the theory postulates that the frequency of electromagnetic radiation is proportional to the energy associated with these quanta.

Relativity

Two theories of motion – Special Theory of Relativity (1905) and General Theory of Relativity (1916) – developed by Albert Einstein. They postulate that the speed of light in vacuo, **c**, is a fundamental constant, and go on to suggest that measurement of space, time and other physical properties is affected by the presence of mass and the position and motion of the observer.

Steady-State Theory

The theory that the universe has always existed and that it is constantly expanding and creating matter. The steady-state theory is now generally discredited and the Big Bang theory preferred.

String Theory

A theory in fundamental physics that attempts to construct a model of elementary particles from one-dimensional entities rather than the zero-dimensional "points" of conventional particle physics.

Unified Field Theory or Grand Unified Theory

The physicist's holy grail: a theory which simultaneously describes the four forces of nature (strong nuclear, weak nuclear, electromagnetic, and gravitational) as one. No such theory has yet been found.

General Prefixes and Suffixes

a-	without, opposite
ab-	away from, opposite
ad-	at, near
aer(o)-	air
anti-	against
arthr(o)-	joint
atmo-	vapour
auto-	self
bacteri(o)-	bacteria
bi-	two
bi(o)-	life
cary(o)-	nucleus
chlor(o)-	green; chlorine
chrom(o)-	colour; chromium
chromat(o)-	colour; chromatin
-cide	killer
com-, con-	together, with
-cyte	cell
cyto-	cell
-derm	skin
di-	double
ecto-	outside, outer
end(o)-	inside, inner
entomo-	insect
epi-	on, over
-escent	becoming
eu-	good, pleasant
exo-	outside, outer
gastr(o)-	stomach
-gen	producing
geo-	earth
-graphy	description
gymno-	bare, naked
hal(o)-	salt; halogen
h(a)em(o)-, h(a)ema-, h(a)emat(o)-	blood
hemi-	half
hetero-	different
hist(o)-	tissue
homo-	same
hydr(o)-	water; hydrogen
hyper-	over; excessive
hypo-	below; deficient
inter-	between
intra-	within
iso-	equal; isomer
kary(o)-	nucleus
leuc(o)-, leuk(o)-	white
-logy	study
-lysis	loosening
macr(o)-	large
mes(o)-	middle
meta-	change; after
-meter	measuring device
micr(o)-	small
mon(o)-	one, single
morph(o)-	form
multi-	many
myc(o)-	fungus
necr(o)-	death, corpse
neur(o)-	nerve
ocul(o)-	eye
olig(o)-	few
-oma	tumour
omni-	all
oo-	egg, ovum
oste(o)-	bone
ovi-, ovo-	egg, ovum
p(a)ed(o)-	child
pal(a)e(o)-	old, ancient
peri-	around
phag(o)-, -phage	eating, eater
-phore	bearer

General Prefixes and Suffixes

photo-	light
-phyl(l)	leaf
phyt(o)-, -phyte	plant
pleur(o)-	side; pleura
-pod	feet
poly-	many
pseudo-	false
pro-	before
rhiz(o)-	root
-scope	viewing instrument
-scopy	viewing
-sperm	seed
sperm(o)-, spermat(o)-	sperm; seed
-stat	device maintaining constancy
sub-	under
syn-	together
-taxis, -taxy	movement to or from
tel(e)-	distant
tel(o)-	end
therm(o)-	heat
trans-	across
tri-	three
trich(o)-	hair
troph(o)-, -trophy	nourishment
-tropism, -tropy	turning to
uni-	one
xer(o)-	dry
zo(o)-	animal

SI Prefixes

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{18}	exa-	E	10^{-1}	deci-	d
10^{15}	peta-	P	10^{-2}	centi-	c
10^{12}	tera-	T	10^{-3}	milli-	m
10^{9}	giga-	G	10^{-6}	micro-	μ
10^{6}	mega-	M	10^{-9}	nano-	n
10^{3}	kilo-	k	10^{-12}	pico-	p
10^{2}	hecto-	h	10^{-15}	femto-	f
10^{1}	deca-	da	10^{-18}	atto-	a

Using the Internet for Research

Where to Search

To begin your search through the Web, you have to decide which of the various search tools will best suit your purpose. There are three basic types of tool:

Search engine

A search engine will search its database of Web pages for a specific word and display a list of websites containing it. The database is compiled by a program which trawls the Web on the lookout for new sites. A search engine is therefore very comprehensive and useful for finding something specific and/or obscure.

Here are the addresses of some popular search engines:

- AltaVista – www.av.com
- Go – www.go.com
- Fast Search – www.alltheweb.com
- Google – www.google.com
- Lycos – www.lycos.com

These are just a few of the many available. You might want to try out some others as well (see **Recommended Websites** on page 15) and discover which you prefer.

Some search engines (for example, AltaVista and Google) also offer the facilities of a directory.

Directory

A directory is a selection of websites arranged according to subject. Unlike a search engine, the database of a directory is created by people not programs; consequently, you will find fewer sites featured. However, they will have been selected by the directory provider for their relevance and often a review of each site will help you to make your choice.

The sites in a directory are listed according to a branching system, starting with a general subject and branching into specific categories which then sub-branch into even more specific categories. This means that you can quickly find sites on a topic that interests you as well as seeing related sites on similar topics. You can also save time by first narrowing down your search to a particular category and then using the search engine within that category alone.

Here are the addresses of some directories:

- Yahoo – www.yahoo.com
- About.com – www.about.com
- Open Directory – http://dmoz.org

There are also more specialized directories which focus on particular subjects, some of them obscure. You can find these directories by looking in one of the following specialized directory guides:

- Directory Guide – www.directoryguide.com
- Gogettem – www.gogettem.com

Some specialized directories are called libraries. These are good for finding in-depth research material on specific subjects. Online libraries are generally compiled by academics, and so are often reliable and authoritative. Try:

- WWW Virtual Library – www.vlib.org

Bot

A bot (short for robot) collects and compares up-to-date information from a number of search engines and directories, carrying out so-called metasearches.

- MetaCrawler – www.metacrawler.com
- Search.com – www.search.com

Tip

The type of organization that maintains a website can be seen from the sequence of letters in its address. For example, *ac* or *edu* indicates that the site belongs to a university or college; *com* or *co* indicates a commercial enterprise; *gov* indicates a government department; *net* indicates a network provider; and *org* indicates a non-commercial organization.

How to Search

You might want to try searching first of all by using none of the above tools, but by simply guessing an address. This often works if you want general information about a company, organization or individual. Suppose you wanted information on a company named Huggle Helicopters plc. You could try typing www.hugglehelicopters.com (or www.hugglehelicopters.co.uk if it is a UK firm) or simply www.huggle.com into the address bar (called the location field in Netscape Navigator). If this does not produce a satisfactory result – perhaps because the company has an address that is nothing like its name or because it does not actually have a website – you will have to use a search tool.

Whether you are using a search engine, a directory or a bot, the searching process is similar. You type a keyword or keywords into the box provided and press return. You can also type in various signs and symbols which will help you to narrow down your search. The most important of these are:

- **AND** type this between two words and the search is restricted to sites containing both words
- **OR** type this between two words and the search is restricted to sites that contain either one word or the other, or both
- **NOT** type this in front of a word and the search is restricted to sites that do not contain that word
- **NEAR** type this between two words and the search is restricted to sites where the two words are fairly close (say within 20 words of each other)
- **+** use this in the same way as AND; it can also be used in front of a so-called stop word (a common word like "the", "of", "how" etc that is normally ignored in the search, or a single letter such as the initial in a name) and the stop word will then be included in the search
- **–** (minus sign) use this in the same way as NOT
- **" "** put quotation marks around a phrase and the search is restricted to sites containing exactly that phrase rather than the individual words
- **( )** use brackets instead of quotation marks in some search tools

So, for example, typing in **Issac Newton AND biography OR discoveries** will bring up sites about Issac Newton's life and sites about his discoveries, whereas typing in **Issac Newton AND biography AND discoveries** will only yield sites mentioning his life and his discoveries. However, the exact method of searching as well as the devices used can vary from search tool to search tool (for example, some use the signs **+** and **–** and some do not; some automatically include every word in the search,

making **AND** and **NOT** redundant) so it is worth spending a few a minutes reading the instructions given in each site under ***Help*** or ***Search tips*** or ***Refine your search*** or similar. You will usually also be given the option of an advanced search, which will allow you to restrict your search even more.

Tips on Searching

- Speed up your search by restricting your search to the UK Web (this is usually an option in search engines). On the other hand, if you cannot find what you want it may be because you are restricting your search to the UK Web instead of taking advantage of the whole Web.
- Speed up your search by restricting it, if appropriate, to one language.
- If you are unsuccessful with one search engine, try a different one. Some engines search more Web pages than others or have a different database.
- If one keyword doesn't yield the result you want, try a different one related to the same subject.
- If the links are slow, either be patient or try later when the system will hopefully not be so busy. It is a good idea to avoid the peak times in the USA. Mornings are a good time for UK users.
- If you do not want pictures on websites, then switch to text only. It will make it faster to download pages. To switch off pictures in Microsoft Internet Explorer, click on Tools, then Internet Options, then Advanced, then Show Pictures.
- Add sites that you like to your favourites menu (in Internet Explorer) or bookmark them (in Netscape Navigator), so that you can easily return to them by clicking on them.
- Save time and money by collecting Web pages so that you can read them later. Allow each page to download fully. It will then be saved as a temporary file which you can access via the History menu when offline.
- Print out or save to disk any Web pages you are really interested in.

A few points to remember:

- If you have a lot of searching to do you need to be patient. The slowness of some sites to download can sometimes test your patience.
- If you need information that is up to date, you are more likely to find it online than in a library of books that were printed years ago. However, not all websites are regularly updated, so some caution is required.
- There is no guarantee that the information in a site is correct. Of course, errors occur in printed works, too, but are less likely because the works go through an editing and proofreading process. It is therefore advisable to use reliable sites provided by those who have reputations to maintain: organizations, companies, universities and academics.
- Depending on the contract you have with your Internet service provider and telephone company, using the Web can cost money every time you log on, particularly if you use it during the daytime.

Recommended Websites

Some Useful ICT Websites

www.searchengineguide.com – a guide to search engines
http://foldoc.doc.ic.ac.uk/foldoc – dictionary of computing
www.whatis.com – IT encyclopedia
www.pceverything.co.uk – all about PCs
www.computerhistory.org – the Computer Museum History Center

Some Useful Science Websites

www.nature.com – advanced but very interesting site of the science magazine
www.sciseek.com – a science search engine with many links
www.newscientist.com – the science magazine online
www.chemicalelements.com – facts about all the elements
www.msim.org.uk – the Museum of Science and Industry in Manchester
www.nhm.ac.uk – the Natural History Museum
www.gsc.org.uk – the Glasgow Science Centre
www.exploratorium.edu/science-explorer/ – fun science activities from a San Francisco museum
www.star.le.ac.uk/edu/index.html – lots of information about space and astronomy
http://seds.lpl.arizona.edu/billa/tnp – detailed information on the solar system

Some Useful Geography Websites

www.georesources.co.uk – links geared towards school work
www.bbc.co.uk/education/gcsebitesize/geography
www.internetgeography.co.uk
www.pavilion.co.uk/dwakefield – resources for the curriculum, plus links
www.cia.gov/cia/publications/factbook – World Factbook: information on all countries
www.geographical.co.uk – Geographical Magazine site
www.nationalgeographic.com – National Geographic magazine site
www.rgs.org – Royal Geographic Society

Some Useful Mathematics Websites

www.bbc.co.uk/education/gcsebitesize/maths – revision tips and links
www.mathforum.org – US site with lots of information, including a "Dr Math" section