M.Sc., Chemistry **2019-2020**

	ELECTIVE-II	**Semester - II**
19CHP205A	**RESEARCH METHODOLOGY FOR CHEMISTRY**	**4H 4C**

Instruction Hours/week:L: 4 T:0 P:0 Marks: Internal:40 External: 60 Total:100

External Semester Exam: 3 Hours

Course objectives

The course enables the students to

- Understand how to do literature survey about a particular scientific problem.
- Understand about the digital sources available for the literature collection.
- Understand the methods of doing scientific research and how to write scientific papers.
- Understand about the chemical safety and ethical handling of chemicals.
- Understand about the data analysis.

Course outcomes (CO's)

1. Understood how do to the literature survey about a particular scientific problem.
2. Understood the digital sources available for the literature collection.
3. Understood the methods of doing scientific research and how to write scientific papers.
4. Understood about the chemical safety and ethical handling of chemicals.
5. Learned about the data analysis.

Unit I- Literature Survey

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, introduction to chemical abstracts and beilstein, subject index, substance index, author index, formula index, and other indices with examples.

Unit II – Digital and Information Technology and Library Resources

Web resources, E-journals, journal access, TOC alerts, hot articles, citation index, impact factor, H-index, E-consortium, UGC infonet, E-books, internet discussion groups and communities, blogs, preprint servers, search engines, scirus, Google scholar, chemindustry, Wiki-databases, chemspider, science direct, scifinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web.

Internet resources for chemistry. Finding and citing published information.

Unit III – Methods of Scientific Research and Writing Scientific Papers

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

Unit IV – Chemical Safety and Ethical Handling of Chemicals

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit V- Data Analysis and Electronics

Data Analysis: The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

Electronics: Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

SUGGESTED READINGS

1. Dean, J., Jones, A. M., Holmes, D., Reed, R., Jones, A., & Weyers, J. (2011). *Practical Skills in Chemistry* (II Edition). Harlow: Prentice-Hall.
2. Hibbert, D. B., & Gooding, J. J. (2006). *Data Analysis for Chemistry*. Oxford: Oxford University Press.
3. Topping, J. (1984) *Errors of Observation and Their Treatment* (IV Edition). London: Chapman Hall.
4. Harris, D. C. (2007). *Quantitative Chemical Analysis* (VII Edition). New York: W. H. Freeman and Company.
5. Levie, R. D. (2001). *How to Use Excel in Analytical Chemistry and in General Scientific Data Analysis*. Cambridge: Cambridge University Press.
6. IUPAC–IPCS. (1992). *Chemical Safety Matters*. Cambridge: Cambridge University Press.
7. M. B. Smith, (2005) *March's Advanced Chemistry* (VII Ediition). Beckam print Ltd, Delhi.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: I M.Sc CHEMISTRY COURSE NAME: RESEARCH METHODOLOGY IN CHEMISTRY

COURSE CODE :19CHP205A BATCH: 2019-2021

Unit I- Literature Survey

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, introduction to chemical abstracts and beilstein, subject index, substance index, author index, formula index, and other indices with examples.

All discoveries in the laboratory must be published somewhere if the information is to be made generally available. A new experimental result that is not published might as well not have been obtained, insofar as it benefits the entire chemical world. The total body of chemical knowledge (called the literature) is located on the combined shelves of all the chemical libraries in the world. Anyone who wishes to learn whether the answer to any chemical question is known, and, if so, what the answer is, has only to turn to the contents of these shelves. Indeed, the very expressions ‘‘is known,’’ ‘‘has been done,’’ and so on, really mean ‘‘has been published.’’ To the uninitiated, the contents of the shelves may appear formidably large, but fortunately the process of extracting information from the literature of organic chemistry is usually not difficult. In this appendix, we will examine the literature of organic chemistry.1 It is quite clear that The Literature can be divided into two broad categories: primary sources and secondary sources. A primary source publishes the original results of laboratory investigations. Books, indexes, and other publications that cover material that has previously been published in primary sources are called secondary sources. It is because of the excellence of the secondary sources in organic chemistry (especially Chemical AbstractsTM, SciFinder1, and

Beilstein) that literature searching is comparatively not difficult. The two chief kinds of primary source are journals and patents. There are several types of secondary source.

PRIMARY SOURCES

Journals

For well over 100 years, nearly all new work in organic chemistry (except for that disclosed in patents) has been published in journals. There are thousands of journals that publish chemical papers, in many countries and in many languages. Some print papers covering all fields of science; some are restricted to chemistry; some to organic chemistry; and some are still more specialized. Fortunately for the sanity of organic chemists, the vast majority of important papers in ‘‘pure’’ organic chemistry (as opposed to ‘‘applied’’) are published in relatively few journals, perhaps 50 or fewer. The concept of ‘‘pure’’ organic chemistry is not as useful because organic chemistry is now important in many areas. Literature that is important to an organic chemist is found in journals and patents that focus on bioorganic, organometallic, materials science, separation science, medicinal chemistry, pharmaceutical sciences, and medicine to name a few. The reader is therefore cautioned that the journals listed in this section have organic chemistry as their primary focus, but are by no means the only sources of information concerning organic chemistry. The literature is vast and many journals are published weekly, and some semimonthly. In addition to ordinary papers, there are two other types of publications in which original work is reported: notes and communications. A note is a brief paper, often without a summary (nearly all papers are published with summaries or abstracts prepared by the author). Otherwise, a note is similar to a paper.2 Communications (also called letters) are also brief and usually without summaries (though some journals now publish summaries along with their communications, a welcome

trend). However, communications differ from notes and papers in three respects:
1. They are brief, not because the work is of small scope, but because they are condensed. Usually, they include only the most important experimental details or none at all.
2. They are often of immediate significance. Journals that publish communications make every effort to have them appear as soon as possible after they are received. Some papers and notes are of great importance, and some are of lesser importance, but all communications are supposed to be of high importance. With modern computer technology, communications can often be published in a matter of weeks, and the on-line version (e.g., the American Chemical Society ASAP papers) can be found before the print version appears.
3. Communications are preliminary reports, and the material in them may be republished as papers at a later date, in contrast to the material in papers and notes, which cannot be republished.

Primary, Secondary, and Tertiary Sources

Sources of information or evidence are often categorized as primary, secondary, or tertiary material. These classifications are based on the originality of the material and the proximity of the source or origin. This informs the reader as to whether the author is reporting information that is first hand or is conveying the experiences and opinions of others which is considered second hand. Determining if a source is primary, secondary or tertiary can be tricky. Below you will find a description of the three categories of information and examples to help you make a determination.

Primary Sources

These sources are records of events or evidence as they are first described or actually happened without any interpretation or commentary. It is information that is shown for the first time or

original materials on which other research is based. Primary sources display original thinking, report on new discoveries, or share fresh information.

Examples of primary sources:

Theses, dissertations, scholarly journal articles (research based), some government reports, symposia and conference proceedings, original artwork, poems, photographs, speeches, letters, memos, personal narratives, diaries, interviews, autobiographies, and correspondence.

Secondary Sources

These sources offer an analysis or restatement of primary sources. They often try to describe or explain primary sources. They tend to be works which summarize, interpret, reorganize, or otherwise provide an added value to a primary source.

Examples of Secondary Sources:

Textbooks, edited works, books and articles that interpret or review research works, histories, biographies, literary criticism and interpretation, reviews of law and legislation, political analyses and commentaries.

Tertiary Sources

These are sources that index, abstract, organize, compile, or digest other sources. Some reference materials and textbooks are considered tertiary sources when their chief purpose is to list, summarize or simply repackage ideas or other information. Tertiary sources are usually not credited to a particular author.

Examples of Tertiary Sources:

Dictionaries/encyclopedias (may also be secondary), almanacs, fact books, Wikipedia, bibliographies (may also be secondary), directories, guidebooks, manuals, handbooks, and textbooks (may be secondary), indexing and abstracting sources.

The importance of writing a good title and abstract

The title and abstract are the most visible parts of your article.

During peer review, the title and abstract are used when we invite reviewers. Invited reviewers are asked to decide whether they wish to review the manuscript on the basis of the title and abstract alone.

If and when the manuscript is published, more people will read the title and abstract than the whole article. In fact, many people will only read the title and abstract, and may only try to read them once. It is thus important to catch the reader's attention by making the title and abstract as concise, accurate and readable as possible.

Most people rely on electronic search engines to find articles. Usually they search through databases that contain only the title, author list and abstract of articles, excluding any keywords attached to the article by its authors. This is the case, for example, for the National Library of Medicine's databases, including Medline and PubMed. It is therefore important to include in the title and/or abstract the words that potential readers of the article are likely to use during a search.

If you want to make sure that your article is found as a "Related Article" in PubMed searches, please bear in mind that the algorithm used for this functionality gives more weight to less common terms, words used more frequently within a document, and terms in the title.

Titles: The key to ensuring your article will be found

The title is an essential way to bring the article to potential readers' attention, especially in those cases where the database being searched does not include the abstract of the article. The title must therefore be as accurate, informative and complete as possible.

Some tips on titles

- Be as descriptive as possible and use specific rather than general terms: for instance, include the specific drug name rather than just the class of drug.
- Use simple word order and common word combinations: e.g. "juvenile delinquency" is more commonly used than "delinquency amongst juveniles".

- Avoid using abbreviations; they could have different meanings in different fields.
- Avoid using acronyms and initialisms: e.g. "Ca" for calcium could be mistaken for "CA", which means cancer.
- Write scientific names in full, e.g. Escherichia coli rather than E. coli.
- Refer to chemicals by their common or generic name instead of their formulas.
- Avoid the use of Roman numerals in the title as they can be interpreted differently: for instance, part III could be mistaken for factor III.

Abstracts: Selecting the most important information

The abstract must outline the most important aspects of the study while providing only a limited amount of detail on its background, methodology and results. Authors need to critically assess the different aspects of the manuscript and choose those that are sufficiently important to deserve inclusion in the abstract.

Once the abstract is ready it can be helpful to ask a colleague who is not involved in the research to go through it to ensure that the descriptions are clear. After the manuscript is written, the authors should go back to the abstract to check that it agrees with the contents of the final manuscript.

Abstract structure

Abstracts should have a structured format. This serves several purposes: it helps authors summarize the different aspects of their work; it makes the abstract more immediately clear; and it helps peer reviewers and readers assess the contents of the manuscript.

The abstract structure varies between journals and between types of article. Authors should check that the abstract of their manuscript is consistent with the requirements of the article type and journal to which the manuscript will be submitted. Please note that the abstract requirements differ between the biology and medical journals in the BMC series published by BMC, for example.

The abstracts of manuscripts submitted to the **biology journals in the BMC series** should be structured as follows:

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Background: This should place the study into the context of the current knowledge in its field and list the purpose of the work; in other words, the authors should summarize why they carried out their research.
Results: This section should describe the main findings of the study.
Conclusions: A brief summary of the content of the manuscript and the potential implications of its results.
The abstracts of manuscripts submitted to the **medical journals in the BMC series** should be structured as follows: Background, **Methods**, Results, and Conclusions. The Background, Results, and Conclusions are as for the biology journals, above. In addition, the Methods section should summarize how the study was performed and mention the different techniques employed. It should also include details of any statistical tests employed.

For further details on the requirements of any particular journal published by BMC, please check the relevant 'Instructions for Authors' page.

Some tips on writing abstracts

- Check the abstract length: Abstracts should not exceed 350 words. Abstracts that are too long lose their function as summaries of the full article, and excess words may be omitted by some indexing services.
- Include synonyms for words and concepts that are in the title: e.g. if referring to 'stillbirths' in the title mention 'perinatal deaths' in the abstract (if appropriate).
- As in the title, use simple word order and common word combinations.
- Make sure the salient points of the manuscript are included, but be consistent; the abstract should only reflect those points covered in the manuscript.
- Minimize the use of abbreviations.
- Avoid citing references.

A **monograph** is a specialist work of writing (in contrast to reference works) on a single subject or an aspect of a subject, often by a single author, and usually on a scholarly subject.

In library cataloging, monograph has a broader meaning, that of a nonserial publication complete in one volume (book) or a definite number of volumes. Thus it differs from a serial publication

such as a magazine, journal, or newspaper. In this context only, books such as novels are monographs.

The term "monographia" is derived from the Greek "mono" (single) and grapho (to write), meaning "writing on a single subject". Unlike a textbook, which surveys the state of knowledge in a field, the main purpose of a monograph is to present primary research and original scholarship ascertaining reliable credibility to the required recipient. This research is presented at length, distinguishing a monograph from an article. For these reasons, publication of a monograph is commonly regarded as vital for career progression in many academic disciplines. Intended for other researchers and bought primarily by libraries, monographs are generally published as individual volumes in a short print run.

In Britain and the U.S., what differentiates a scholarly monograph from an academic trade title varies by publisher, though generally it is the assumption that the readership has not only specialized or sophisticated knowledge but also professional interest in the subject of the work.

Introduction to the Beilstein System

This book is designed to both update the reader on the status of the Beilstein database and search system and derived electronic information, as well as provide the chemistry community with a comprehensive and up-to-date view of the overall activities and scope of the current Beilstein system. When the first ACS book on Beilstein was published in 1990 there was a renewed and growing interest in Beilstein, as it moved from its past environment of a print based German language reference, existing only as a very large series of books (which made up the Beilstein Handbuch der Organischen Chemie - or, in English, the Beilstein Handbook of Organic Chemistry). In the short time since 1990, the staff of Beilstein (first in the Beilstein Institute and now in Beilstein Information Systems) have continued their vast modernization program, which has resulted in many new chemistry data and information resources for the chemical community. This book is a tribute to Konrad Beilstein, the man who had the foresight to realize that high quality scientific chemical data and information would be a timeless resource for chemists.

Throughout the history of abstracting scientific literature in chemistry, the name Beilstein has had a unique position of quality and value to the chemist. As a young graduate student in organic chemistry I first came across Beilstein as part of my synthesis work on a bicyclic nitrogen ring system. In 1963 it took me a considerable amount of time to search for this class of compounds and translate the appropriate sections of the *Beilstein Handbook* into English; now those

activities take a few seconds, because the database is computerized and the information is essentially all in English. The transformation of this sleeping giant into a modern information resource is amazing and of great value to the ongoing progress of most of academic and industrial chemistry.

Beilstein Chronology

1838: Friedrich Konrad Beilstein was born in St. Petersburg, Russia

1865: Beilstein became Professor of Organic Chemistry, St. Petersburg

1866: Beilstein became the Chair of Chemistry at the Imperial Technical Institute in St. Petersburg

1881: First Edition of the Beilstein Handbook (2 volumes, 1500 compounds, 2200 pages)

1885: Second Edition (3 volumes, 4080 pages)

1906: Third Edition (8 volumes, 11,000 pages)

1906: Death of Friedrich Konrad Beilstein

1918: Fourth Edition (German Chemical Society, Berlin)

1984: Fifth Edition in English (480 volumes, 400,000 pages)

1988: Beilstein Online on STN

1989: Beilstein Online on DIALOG

1990: ACS Symposium Series book - The Beilstein Database

1995: CrossFire - Beilstein file in-house with ca. 6,000,000 organic compounds with properties data

1996: CrossFire Gmelin - Gmelin file in-house available with ca. 1,000,000 inorganic and organometallic compounds with properties data

1997: ACS Book - The Beilstein Database and Search System

Even though the Beilstein Handbook of Organic Chemistry covers Aonly@ organic chemistry, it has been a critical resource for most of the 20th century. As we approach the 21st century the management and leadership of Beilstein Information Systems GmbH has further developed this valuable resource into a number of practical, every-day, tools for the chemist. The purpose of this book, the successor to the ACS Symposium Series book entitled "The Beilstein Online Database - Implementation, Content, and Retrieval", is to demonstrate how the Beilstein database and associated software products have been evolving over the last 7 years since the first book was published.

With all the changes, remodeling, and reorganization of Beilstein in the past few years into two separate organizations, the Beilstein Institute and Beilstein Information Systems (explained in further detail later in this chapter) it is probably best to first answer the question - "What is Beilstein, now?" Perhaps the best way to begin to answer this question is to show what Beilstein was in the past. Beilstein is an enormous set of reference books that, although very well organized, occupied a great deal of space. It was relatively difficult to quickly locate information spread throughout the five different series composing the handbook.

The Library has a complete run of printed Chemical Abstracts (CA) from 1907 through 2002. We now rely on the electronic version available via SciFinder. Chemical Abstracts and the Collective Indexesis are shelved in the Reading Room (2nd floor) of the library, in reference ranges.

Chemical Abstracts

Parts of Print CA

- **Abstracts**

CA is published weekly, and there are 26 weekly issues per "volume". Each Abstract issue is divided into 80 Subject Sections. Each abstract appears in just one section, based on the novelty of the process or substance being reported in the literature. Each weekly issue contains indexes by author, subject keyword (not official headings), and patent number. Individual issue indexes

are superseded first by a volume index published every six months, and then by the Collective Index (see below). The Chemistry Library no longer subscribes to the print weekly issues.

- **Collective Indexes**

Every five years CAS publishes a Collective Index (CI), which supersedes the semi-annual indexes for the previous 5-year CI period. The 14th CI was published in 2002 and covers the years 1997-2001. The library has all Collective Indexes up to this point. They are divided into:

- **Author Index**, 1907-
- **Subject Index** 1907-71 (included chemical substance names through 1971)
- **Chemical Substance Index**, 1972- (includes all CA Index Names used during the specific index period)
- **General Subject Index**, 1972- (includes all subject and compound-class terms that are not systematic CA Index Names)
- **Formula Index**, 1920- (no formula indexes were compiled for 1907-19)
- **Patent Index**, 1907-

- **Index Guides**

The Index Guide for each Collective Index period provides cross-references from commonly used chemical names to official CA Index Names (with registry numbers) used in the corresponding Chemical Substance Index. It also serves as a thesaurus of all controlled-vocabulary subject headings used in the General Subject Index. The Index Guide should always be consulted before looking up a chemical name or subject term in the Collective Indexes.

- **Ring Systems Handbook**

The RSH leads you from a ring or cage structure to the CA Index Name and Registry Number of a ring parent compound, for searching in the Chemical Substance Index. Entries are in ring analysis order and are indexed by molecular formula and Index Name.

- **Registry Handbook**

The Registry Handbook - Number Section is a cumulative numerical listing of all registry numbers assigned to chemical substances from 1965 forward. If you have only a registry number

and need the CA Index Name for that compound, look it up here first and then use the name to consult the Chemical Substance Indexes. A corresponding Names Section (available on microfiche) provided registry numbers for several hundred thousand of the most-indexed common names.

CASSI

CASSI (Chemical Abstracts Service Source Index) is the comprehensive and retrospective list of sources that have been indexed by Chemical Abstracts since it began in 1907. It includes journals, books, conferences, and other series, arranged by CA abbreviation. This is the source you use to translate journal title abbreviations into full titles for searching in the library catalog and other finding aids. CASSI is published every five years and is located at the Circulation Desk.

Using CA

1. Select an appropriate Index volume based on the type of search you want to do (author, substance, or subject) and the time period desired.

Author: Entries are arranged by last name, then by first and second initials (not by first name). Qualifying text is the title of the document. Coauthors are cross-referenced to first author.

Formula: Entries contain only abstract numbers unless there is a large number of them, and no qualifying text. It's best to use the Formula Index to get the corresponding CA Index Name, then look up that name in the corresponding Chemical Substance or Subject (1907-71) index, where the entries are more detailed. Formulas are listed in Hill order.

Chemical Substance name: Start with the Index Guide to see if there's an entry for the name you have. If not, use the Formula Index or Ring Systems Handbook to get the name. In the CSI you must use only the specific CA Index Name for that CI period. There are no cross references to earlier or generic names. Names are arranged by "parent" (the structural skeleton) followed by substituents and modifications. Qualifying text in each entry indicates what the document is primarily about, followed by an abstract number. About 600 of the most frequently indexed compounds are called "Qualified Substances." Their document entries are grouped into seven categories: Analysis, Biological studies, Occurrence, Preparation, Properties, Reactions, Uses and miscellaneous.

Subject term: Always check the Index Guide first to find an appropriate term to look up in the Subject Index (1907-71) or General Subject Index (1972-). Classes of compounds (e.g. Carcinogens), undefined compounds and mixtures (e.g. Gasoline), processes, plant/animal species, and other general topical terms are found in this index, along with cross references and scope notes.

Patent number: Arranged by issuing country/organization, then by patent number. CA abstracts only the first member of a patent family, and links later equivalent patents to this parent patent. Equivalents are cross-referenced to the parent. Prior to 1981 the equivalents were listed in the Patent Concordance.

2. Note Abstract Numbers from the entries of interest. Abstract numbers prefixed "R" indicate a review; "P" indicates a patent.
3. Go to the corresponding Abstracts volume and look up the abstract by its number.
4. Repeat this process for earlier or later index periods. Remember that Index Names and subject headings changed over time, so consult the Index Guide for each CI period.

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CLASS: IM.Sc CHEMISTRY COURSE NAME:RESEARCH METHODOLOGY FOR CHEMISTRY

COURSE CODE: 19CHP 205A UNIT: I (Literature Survey) BATCH-2019-2021

S.NO	Questions	Opt-1	Opt-2	Opt-3	Opt-4	Answers
1	Research is	Searching again and again	Finding solution to any problem	Working in a scientific way to search for truth of any problem	looking new things	Working in a scientific way to search for truth of any problem
2	Which of the following is the first step in starting the research process?	Searching sources of information to locate problem	Identification of problem	Searching for solutions to the problem	Survey of related literature	Identification of problem
3	Action research means	A longitudinal research	An applied research	A research initiated to solve an immediate problem	A research with socio economic objective	A research initiated to solve an immediate problem
4	A reasoning where we start with certain particular statements and conclude with a universal statement is called	Deductive Reasoning	Inductive Reasoning	Abnormal Reasoning	Transcendental Reasoning	Inductive Reasoning
5	Which of the following variables cannot be expressed in quantitative terms?	Socio-economic Status	Marital Status	Numerical Aptitude	Professional Attitude	Numerical Aptitude
6	In the process of conducting research 'Formulation of Hypothesis" is followed by	Statement of Objectives	Analysis of Data	Collection of Data	Selection of Research Tools	Selection of Research Tools
7	A research paper is a brief report of research work based on	Primary Data only	Secondary Data only	Both Primary and Secondary Data	collection of data	Both Primary and Secondary Data

8	One of the following is not an open source software:	DSpace	Windows	Green-stone	Linux	Windows
9	Classification of all types of libraries has been made by-	IFLA	UNISIST	UNESCO	INSDOC	UNESCO
10	Informal self education is possible in what kind of library?	National Library	Public Library	Specific Library	College Library	Public Library
11	…… Is a process of information	CD-ROM	Books	computers	notes	CD-ROM
12	Feedback mechanism is a part of which service?	Reprography	CAS	Translation service	SDI	SDI
13	What is the collection of terms or records in MARC called?	System	Network	Website	Database	Database
14	What is Bibliometry?	Function of Library Network	Information Management Service	Information Management Tool	Library Service	Information Management Tool
15	Microchip was invented by…..	Microsoft	Intel	IBM	DELL	Intel
16	Information is…..	Raw Data	Processed Data	Organized data	Input data	Organized data
17	Conference proceedings are considered as.....documents.	Conventional	Primary	Tertiary	Secondary	Primary
18	RSS feed is a tool of :	Graphic design	Web 1.0	Web 2.0	Architecture	Web 2.0
19	An appropriate source to find out descriptive information is..... .	Bibliography	Directory	Dictionary	Encyclopedia	Encyclopedia
20	One of the following search engine is exclusively meant for	SCIRUS	Altavista	Yahoo	Google	SCIRUS

	scientific information :					
21	Technological Gatekeeper is :	A formal method of giving current awareness service	A method of technology assessment and evaluation	A process of transfer of technology	An informal mechanism of keeping user informed of relevant development	An informal mechanism of keeping user informed of relevant development
22	The Farmington plan is associated with :	Library Legislation	Library Cataloguing	Library Cooperation	Library Indexing Service	Library Cooperation
23	UNESCO assisted Model Public Library in India is located at :	Kolkata	Delhi	mumbai	Chennai	Delhi
24	When the first ACS book on Beilstein was published in	a) 1960	1970	1980	1990	1990
25	Shelf list facilitates..... .	Classification	Weeding out	Stock verification	shelf list	Stock verification
26	Questionnaire is a :	Research method	Measurement technique	tool for data collection	Data analysis technique	Tool for data collection
27	A periodical evaluation of an employee is done through..... .	Job rotation	Performance appraisal	Refresher course	Work guide	Performance appraisal
28	“Controlled Group” is a term used in..... .	Survey research	Historical research	Experimental research	Descriptive research	Experimental research
29	‘Noise’ in Information Retrieval is due to..... .	Precision	Recall	Relevant information	Redundant information	Redundant information

30	What is the relationship between ISBD and cataloguing codes ?	They are not related at all	Cataloguing codes will include bibliographic description	ISBD includes cataloguing rules	ISBD can replace cataloguing rules	Cataloguing codes will include bibliographic description
31	Abstract numbers prefixed "R" indicate a	Review	Research	Result	Reference	Review
32	A_____ is a specialist work of writing on a single subject.	Review	Abstract	Beilstein	Monograph	Monograph
33	Which of the following is not a “Graphic representation” ?	Pie Chart	Bar Chart	Table	Histogram	Table
34	The oldest and the largest Library Association in the world is..... .	ALA	LA	IFLA	IASLIC	ALA
35	Which of the following is not covered under Intellectual Property Rights ?	Copyrights	Patents	Trade Marks	Thesaurus	Thesaurus
36	Ontology is..... .	An Indexing Method	Classification of Internet based documents	Cataloguing of Internet based documents	Documentation service	Classification of Internet based documents
37	CA is published	a) Yearly	Daily	Monthly	Weekly	Weekly
38	The transmission of receiver’s reaction back to the sender is known as..... .	Noise	Feedback	Medium	Source	Feedback

39	Protocol means..... .	Interchange of data between two devices	Interchange of data between two computers	Linkage between two computers	Linkage between two devices	Linkage between two devices
40	Which of the following is an 'Acronym' ?	UNESCO	UNO	UNDP	UGC	UNESCO
41	A set of rules that govern overall data communications system is popularly known as..... .	Protocol	Agreement	Pact	Memorandum	Protocol
42	9. Every five years CAS publishes a	Author Index	Collective Index	Subject Index	Fo rmula Index	Collective Index
43	Which of the following is not true about e journals ?	They are distributed through digital methods	They also have editors or editorial boards	They are publications of serial nature	They are always free of cost	They are always free of cost
44	Whether Library is a system?	Yes, it has various sections as sub-systems coordinating each other forming a system	No, it cannot be a system	It is quite impossible	Library is separate from a system.	Yes, it has various sections as sub-systems coordinating each other forming a system
45	The secondary source of information comprised of:	monographs.	Subject periodicals and encyclopedias	Indexing and Abstracting periodicals	Bibliography and patents	Indexing and Abstracting periodicals
46	Article published in research journal are…	Reference sources	Secondary sources	Primary sources	Tertiary sources	Primary sources
47	Which is not the Thesaurus?	A collection of selected terminology	Synonymous terms	List of words	Dictionaries	Dictionaries

48	What is a Patent?	An agreement to the Government	Document of the library	An agreement between the inventor and the Government	An agreement between library and Publisher	An agreement between the inventor and the Government
49	World of learning is a what source of information	primary source	Documentary source	Secondary source	Tertiary source	Secondary source
50	Facts of File is weekly digest of	indian events	American events	World events	England events	World events
51	Compton year book contains	Political events	Cultural events	Outstanding events	Economic events	Outstanding events
52	Online Europa year book has coverage since	1965	1975	1984	1985	1985
53	Which of the following is a specialized information organization online tool?	Mamma	Dogpile	Vivisimo	Entireweb	Vivisimo
54	Research periodicals are which category of sources?	Primary	secondary	Tertiary	Non documentary.	Primary
55	Reference sources are those	Which are large in size?	Which are read at home easily?	Which used to obtain particular information?		Which used to obtain particular information?
56	Which part of new encyclopedia Britannica is useful for ready references?	Macropaedia	Propaedia	Micropaedia	Premedia	Propaedia
57	Year book are also known as	Hand book	Annual	Directory	Dictionary	Annual

58	What is India: A reference annual?	Year Book	Almanac	Gide book	Hand book	Year Book
59	What is Trade bibliography?	List of Author Bibliography	List of Special Bibliography	List of books in print or for sale compiled by a publisher	List of books of trade Library	List of books in print or for sale compiled by a publisher
60	What is the meaning of E-Documents?	All Documents other than printed	Non-Paper documents	In electronic form such as Cassettes, CD-ROMs, etc.	Audio visual tools	In electronic form such as Cassettes, CD-ROMs, etc.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: I M.Sc CHEMISTRY COURSE NAME: RESEARCH METHODOLOGY IN CHEMISTRY

COURSE CODE :19CHP205A BATCH: 2019-2021

Unit II – Digital and Information Technology and Library Resources

Web resources, E-journals, journal access, TOC alerts, hot articles, citation index, impact factor, H-index, E-consortium, UGC infonet, E-books, internet discussion groups and communities, blogs, preprint servers, search engines, scirus, Google scholar, chemindustry, Wiki-databases, chemspider, science direct, scifinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web.

Internet resources for chemistry. Finding and citing published information.

Electronic journal

Electronic journals, also known as ejournals, e-journals, and electronic serials, are scholarly journals or intellectual magazines that can be accessed via electronic transmission.

Some journals are 'born digital' in that they are solely published on the web and in a digital format, but most electronic journals originated as print journals, which subsequently evolved to have an electronic version, while still maintaining a print component. As academic research habits have changed in line with the growth of the internet, the e-journal has come to dominate the journals world.

An e-journal closely resembles a print journal in structure: there is a table of contents which lists the articles, and many electronic journals still use a volume/issue model, although some titles now publish on a continuous basis. Online journal articles are a specialized form of electronic document: they have the purpose of providing material for academic research and study, and they are formatted approximately like journal articles in traditional printed journals. Often a journal article will be available for download in two formats - as a PDF and in HTML format, although other electronic file types are often supported for supplementary material. Articles are indexed in bibliographic databases, as well as by search engines. E-journals allow new types on

content to be included in journals, for example video material, or the data sets on which research has been based.

With the growth and development of the internet, there has been a growth in the number of new journals, especially in those that exist as digital publications only. A subset of these journals exist as Open Access titles, meaning that they are free to access for all, and have Creative Commons licences which permit the reproduction of content in different ways. High quality open access journals are listed in Directory of Open Access Journals. Most however continue to exist as subscription journals, for which libraries, organisations and individuals purchase access.

Accessing Online Journals

There are two ways to access online journals...

One is to access the journal using authentication on UI Library's web site, then it will grant access to articles & abstracts.

Start by going to: Library Home Page

Then choose "Electronic Journals' under "Research Tools". From there you'll have to navigate to each journal.

The other is to install a VPN client on your computer. VPN stands for Virtual Private Network. It basically sets up an encrypted tunnel from your computer to campus, and then all your Internet traffic appears to originate from on-campus.

There are instructions for setting up the VPN client at: CITES VPN Overview

Be sure to use the profile named something like "Library access from off campus" to properly access journal sites.

ToC (Table of Contents) Alert

ToC (Table of Contents) Alert of a Publication - Notification of Table of Contents of newly published journal issue

Most Library-subscribed article databases provide **ToC Alert of a publication** so that **every time an issue of your desired journals is published, you can be informed of the table of contents of these new issues.**

After setting up a ToC alert, you will be notified of the articles from the new issues of the journals of your choice via E-mail or RSS.

This page assists you to set up **E-mail ToC alerts** and **RSS ToC alerts**.

Useful

The ToC Alert is an email message you will receive the minute a new issue is published online, and contains the article titles (with direct link), names of the author(s), DOI's and page numbers.

Fast

Signing up for the ToC Alert is extremely simple. All you will need to do is fill out your email address in the grey box on the right-hand side of this homepage.

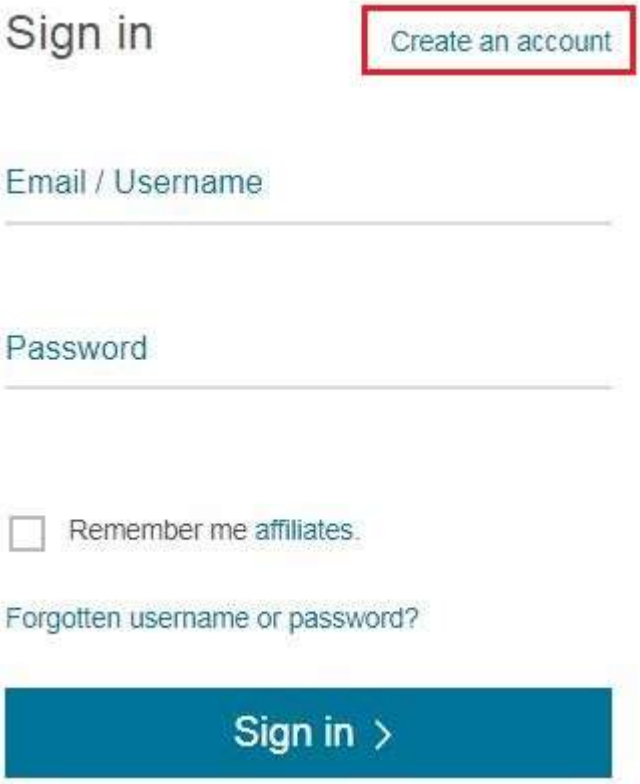
Confidential

You do not have to create an account. You will not become part of any other mailing list. Your information will not be shared with third parties. You can cancel this service at any moment.

How to set up e-mail ToC alerts?

The ways of setting up of ToC Alerts differ in different databases. Below are steps generally applicable to most databases.

Step 1: Most databases require you to log into your personal account to set up your ToC alerts. Register for a personal account with the database you use if you have not done so.



[from ScienceDirect]

Step 2: After you log into your account (if this is required), select "Volume alerts", "Issue alerts", "ToC alerts", "Journal alerts", "Issue notifications", "Publications", "Journals", etc., depending on the database you are using.

Step 3: Some databases only enable ToC alerts be created at the title level. Click "Publications" or "Journals" to find a journal. On the page of a desired journal title, select "Alerts", "ToC alerts", "Follow journal/book series/handbook" etc. to set up the ToC alert.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: I M.Sc CHEMISTRY COURSE NAME: RESEARCH

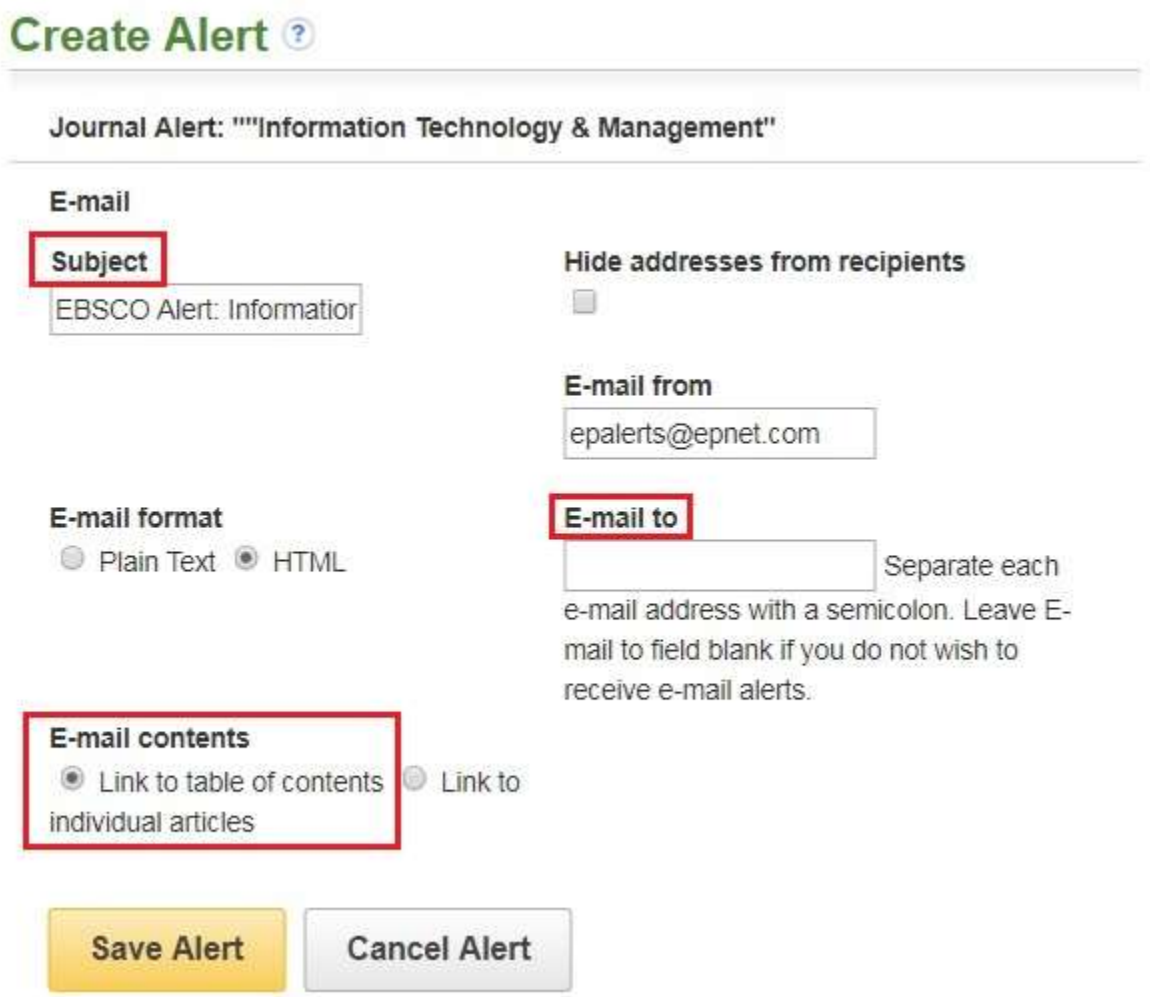
METHODOLOGY IN CHEMISTRY

COURSE CODE :19CHP205A BATCH: 2019-2021

[from ScienceDirect]

Some other databases only provide ToC alert services for selected journal titles only. If you are not able to find any links which direct you to create the ToC alert of a particular journal, it may be that this service is simply not available.

Step 4: Depending on the database you are using, you may be asked to i) change the subject of the e-mail message; ii) set up e-mail content; iii) set the alert period; iv) enter your e-mail address, etc. Then save your e-mail alert.



You will be notified of the new journal content every time a new issue of the selected journal is published.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: I M.Sc CHEMISTRY COURSE NAME: RESEARCH METHODOLOGY IN CHEMISTRY

COURSE CODE :19CHP205A BATCH: 2019-2021

How to set up RSS ToC alerts?

Steps taken to add an RSS ToC feed vary depending on the databases and the RSS reader/aggregator you are using. Below are some steps generally applicable to setting up RSS ToC alerts in most databases.

Step 1: Install an RSS reader/aggregator on your computer, or register at a web-based RSS reader, such as My Yahoo. For more about RSS, read the "RSS" page of this guide.

Then open or log into your RSS reader/aggregator.

Step 2: Click "Browse", "Publications", "Alerts", "RSS Alerts", etc., depending on the database you are using, to view a list of journal titles with RSS functionalities.

Step 3: Click "Create RSS feed", RSS or , next to the desired title(s).

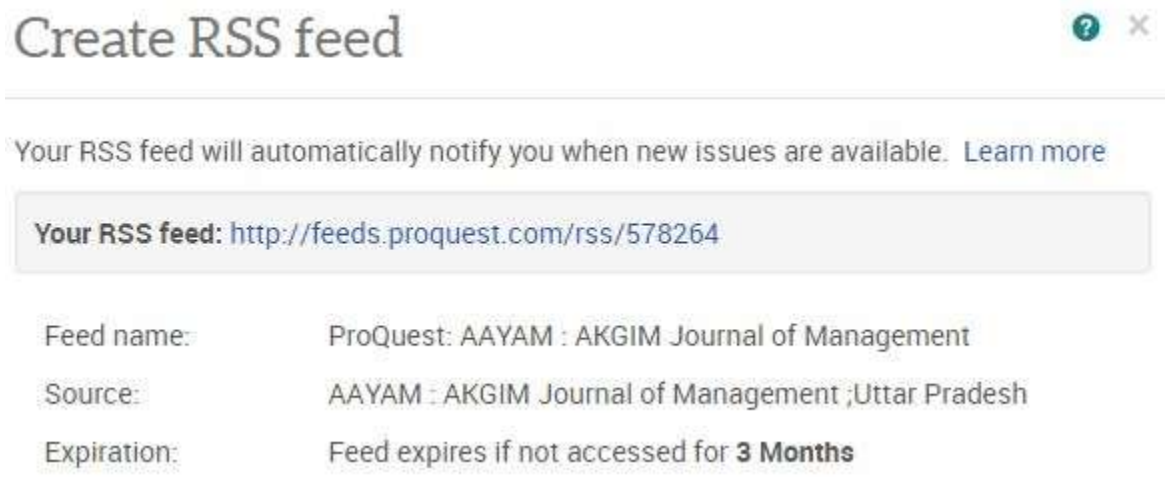
[from EBSCOhost]

You may also create RSS feeds from the page of individual journal titles. Click "Alerts", "RSS Alerts", "Create RSS feed" etc. on the journal page, depending on the database you are using.

[from ScienceDirect]

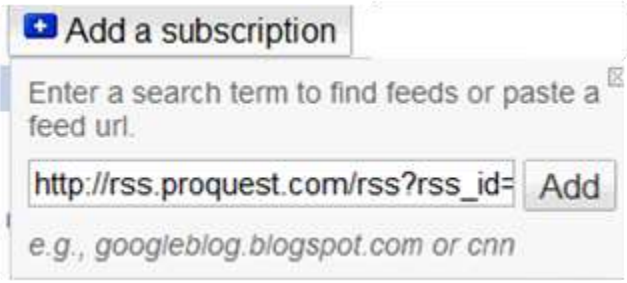
Note: Some databases only provide ToC alert services for selected journal titles only. If you are not able to find any links which direct you to create the ToC alert of a particular journal, it may be that this service is simply not available.

Step 4: You may then see a Syndication Feed link or a "Subscribe to this feed" link. The ways to add a feed vary depending on the article database and RSS reader/aggregator you use. You can copy the URL of the feed, or right-click on the "Subscribe to this feed" link and select "Copy Shortcut" for IE or "Copy Link Location" for Firefox from the popped up menu.



[from ProQuest]

Then paste the URL into your reader manually. You can change the feed title, if desired.



You will be alerted of the new journal content via your RSS reader once the new issue of your selected journal is published.

S.NO	Questions	Opt-1	Opt-2	Opt-3	Opt-4	Answers
1	Physical condition of the books should be property maintained. This is known as	Collation	Conservation	Shelf-arrangement	Organization	Conservation
2	_____ is an important record of books, which shows the position of any book on the shelves	Bay Guide	Authority File	Accession List	Shelf. .List	Shelf. .List
3	Three great achievements in U.S.A. were noticed i.e. enunciation of DDC classification scheme, formation of American Library Association and the publication of 1st Journal of the librarianship in the year	1857	1859	1876	1901	1876
4	Books lost from the library are known through _____	Stock verification	Charging and discharging	Shelf list	Accession Register	Stock verification
5	LA is the Library Association of	Manipur	Andhra Pradesh	Great Britain	Canada.	Great Britain
6	Of the following libraries in India, which one is the oldest library?	Asiatic Society Library, Bombay	Connemara Public Library, Madras	Delhi Public Library, Delhi	National Library of India, Calcutta	National Library of India, Calcutta
7	The first centre to use computer in the library and information activities in India is	DESIDOC	INSDOC	DRTC	UGC.	INSDOC

8	Abstracts should not exceed .....words	350	50	250	450	350
9	'Fair use' is the norm for determining the legality of	Producing the second edition of a book	Photocopying an entire book	Making available a book to another library on inter-library loan	Prescribing a book as a text book	Photocopying an entire book
10	Generally a reference service of a library in the conventional form is processed through the stages which are	Preparation, service, assimilation	Indexing, orientation, delivery of the query's reply	Orientation, user's study, photocopy supplied	Preparation, orientation, delivery of the query's reply	Preparation, service, assimilation
11	_____ is a process of helping employees in an organization to acquire new skills and competence on a continuing basis	Total Quality Management	Management Information System	Financial Resources Development	Human Resources Development	Total Quality Management
12	PR stands for	indian Press Registration	Intellectual Property Right	International Property Right	Indian Property Regulations	Intellectual Property Right
13	On which of the following technologies semantic web is not based?	RDF	Ontologies	Cloud seeding	URI	Cloud seeding
14	The concept of Artificial Intelligence (AI) belongs to _____	Second Generation Computers	Third Generation Computers	Fourth Generation Computers	Fifth Generation Computers	Fifth Generation Computers
15	Computer memory is measured in _____	Bytes	Kilobytes	Megabytes	All of the above	All of the above
16	What are three types of basic languages used in computer programming?	Zero, low and high levels	COBOL, BASIC and PROLOG	FOTRAN, PL/I and SNOWBOL	Machine, Assembly and high level lannguages	Machine, Assembly and high level lannguages

17	When CD-ROM was prepared and made?	1985	1982	1980	1977	1985
18	In how many ways the switching system can be established	Two	Three	Five	Seven	three
19	Which type of switching system is telephone network?	Circuit switching	Packet switching	Message switching	None of the above	Circuit switching
20	Which of the following software is useful for word processing?	DBASE	LIBSYS	WordStar	CDS/ISIS	WordStar
21	NICNET and INDONET are the networks of which category?	LAN	MAN	WAN	IN	WAN
22	What is a bug?	Computer Virus	Error in Computer Configuration	Error in a Programme	None of these	Error in a Programme
23	Which is not a programming language?	FORTRAN	BASIC	COBOL	ASCII	ASCII
24	ISO-9960 is related with?	Standard for encoding data on CD-ROM	Standard for Computer Hardware	Standard for Information Processing	Standard for Networking	Standard for encoding data on CD-ROM
25	ASCII has how many codes?	256	526	265	254	256
26	Raw, unevaluated, unprocessed and unorganized facts is known as:	Data	Information	Knowledge	Wisdom	Data
27	Information retrieval is fastest from	Floppy Disk	Magnetic Tape	Hard Disk	None of the above	Hard Disk
28	An University providing Open Access to Sanskrit dissertations through Internet	Jawaharlal Nehru University	Delhi University	Mahatma Gandhi University	University of Madras	Delhi University
29	In which of the following the term “Truncation” is used	Budgeting	Search Formulation	Coordination	Classified bibliography	Search Formulation

30	The CD alphabets in CDS/ISIS stands for	Computerized Documentation	Condensed Disk	Confirmed Disc	Compact Disc	Computerized Documentation
31	Electronic telecommunications system joining millions of computers together.	E-mail	Internet	US Mail	UPS	Internet
32	Following is not a social bookmarking site:	Digg	Delicious	Sqidoo	Facebook	Sqidoo
33	Following is not a network protocol:	HTTP	SMTP	TCP/IP	Z39.50	Z39.50
34	LOCKOSS (Software) is an international community initiative by:	MIT Libraries	Stanford University	University of Waikato	University of Southampton	Stanford University
35	Identify the odd one from the following:	Koha	VTLS	SLIM++	SOUL	Koha
36	Following is not a Web 2.0 tool:	Blog	Facebook	UGC-INFONET 2.0	RSS feeds	UGC-INFONET 2.0
37	Following is an example of microblogging:	Wordpress	Blogspot	Livejournal	Twitter	Twitter
38	Now-a-days how many types of Protocol are used ?	5	4	3	2	2
39	Which type of protocol is used by interface for public data network (PDN)?	X.25	X.12	X.13	X.20	X.25
40	In Which five year plan the INFLIBNET was established	Fourth five year plan	Fifth five year plan	Sixth five year plan	Seventh five year plan	Seventh five year plan
41	Resource sharing is a part of …	Library cooperation	Library administration	Library management	Library cataloguing	Library cooperation

42	Which one is a full text e-Resource?	JCCC	ISID	Science finder scholar	ACS	ACS
43	Which one is E-Bibliographic database?	Nature	Blackwell	ISID	Springer	ISID
44	Virtua accommodates Different version of the MARC Standard?	USMARC	UKMARC	CANMARC	SWEMARC/All of above	SWEMARC/All of above
45	Which is the journal of Library and Information Science?	Abacus	Actanumerica	Interlending and Document supply	All of above	Interlending and Document supply
46	The Electronic Library is.....	A Magazine	A Journal Name	A LIbrary	An Encyclopeadia	A Journal Name
47	Which two is a Library Management Software for small libraries?	Library Solution and Follet	Follet and MSN	MSN and Tar	LYCOS and Live Search	Library Solution and Follet
48	What is APS?	A Search Engine?	A Full-text e-resource	Bibliographic database	Library Management Software	A Full-text e-resource
49	Which one is Library and Information Science Journal name?	Reference Reviews incorporating ASLIB Book Guide	Reference Reviews incorporating ASLIB Book journals	Reference Reviews incorporating ASLIB Book Review	Reference Reviews incorporating ASLIB E-Book	Reference Reviews incorporating ASLIB Book Guide
50	Questionnaire is a :	Research method	Measurement Technique	Tool for data collection	All the above	Tool for data collection
51	The Dewey Decimal Classification divides human knowledge into	10 basic categories	100 basic categories.	1000 basic categories	10000 basic categories	10 basic categories

52	Call Number of a Book Means	Book Number	Class Number	Both (A) and (B) are true	None of the above	Both (A) and (B) are true
53	Accession Number means	Call Number of a book	Unique Number for a book inside a particular library.	Book Number	Class number	Unique Number for a book inside a particular library.
54	How many digits have in the ISSN	10	8	13	15	8
55	Main use of Shelf list is	Cataloging	Circulation	Stock Verification	Book Selection	Stock Verification
56	Posting the right person at the right place is called _____	Recruitment	Coaching	Deployment	Induction	Recruitment
57	TQM is a system of continuous improvement employing participative management and centered on needs of the _____	Customers	Staff	Organization	Government	Organization
58	Financial support given to libraries are of two types - Recurring and	Ad-hoc	Endowments	Annual	Non-recurring	Endowments
59	Principle of maximum aggregate benefit is concerned with__	Growth of library	Library use	Library service	Library fee	Library service
60	…….. takes items of expenditure for libraries as the working data for allocation of funds.	Method of details	Per capita method	Principle of economy	Library budget	Library budget

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: I M.Sc CHEMISTRY COURSE NAME: RESEARCH

METHODOLOGY IN CHEMISTRY

COURSE CODE :19CHP205A BATCH: 2019-2021

Unit III – Methods of Scientific Research and Writing Scientific Papers

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

GUIDELINES FOR PROJECT WORK AND LABORATORY EXPERIMENTS

PROJECT WORK

1. Objective

The objective of the project work is to help the student develop ability to apply the engineering

and technological concepts, tools and techniques to study and attempt to solve any engineering or system problem. Stress is given on quality of training for development of professional competence.

2. Prerequisite

Students pursuing Section B Examination can take up project work only after securing minimum grade 'C' in 5 (five) subjects in an engineering branch of Section B. Students are required to register for project work by filling the application form, as given at Appendix I, along with a demand draft of Rs. 3000.00 (US $ 200 in case of overseas students) in favour of 'The Institution of Engineers (India)' payable at Kolkata and return it to the headquarters of the Institution within the stipulated date.

3. Project Guide

On receipt of the application for project work with the prescribed fee, a letter giving the name and address of the project guide shall be issued to the students by the headquarters of the Institution. After receipt of the letter from the Institution, students are expected to contact the project guide within a week for their project work, carrying with them their Identity Card. In case designated project guide is not available due to any reason or change of address of the project guide or the student, thus affecting the facility of contact between them, the student is expected to contact the Chairman of the State/ Local Centre to which he is

attached for an alternate project guide. The Chairman of State/Local Centre, after being satisfied with the reason stated by the student, would allot him the alternate project guide within the jurisdiction of his State/ Local Centre, under intimation to the Director (EEA) at headquarters.

A 'Fellow' or a 'Member' of the Institution is only eligible to act as project guide. The project

guide shall be responsible for guidance in preparing synopsis of the project, project report and

monitoring the progress of work. He will also be responsible for guidance regarding problem formulation and methodology of the project selected by the student. In addition, the project guide shall evaluate the project work of the student.

4. Types of Project Work

The project work may be from any of the following types:

a) Comprehensive case study (covering any structure, industry or system);

b) Field-oriented analysis and/or design problems (such as design of engineering structures, industrial/engineering processes and systems);

c) Management-oriented study (such as evaluation, estimation, optimization, planning, and management, etc.);

d) Repair and maintenance of equipment, structures, etc.;

e) Any other project work a project guide may wish to allot to the student.

5. Synopsis of the Project

Synopsis of the project should be prepared in consultation with the project guide as per the format given in Appendix II. The synopsis should clearly state the objective and methodology of the proposed project to be undertaken. It should have full detail of the rationale, sampling instrument to be used, limitations, if any, and future direction of further study, etc as asked in the format. The synopsis of the project shall be approved by the Project Guide. Approved copy of the synopsis should be a part of the project report. Students are advised to retain an approval copy of the synopsis with them. After finalizing the topic and approval of synopsis of the project, the student should start the actual project work under the supervision of the project guide.

6. Project Report

A student is required to prepare 3 (three) neatly typed copies of his final project report as per the format given in Appendix II. One copy of the project report should be submitted to the project guide for internal evaluation; one copy of the project report, with signature of the Project Guide, is to be submitted to the Director (EEA), The Institution of Engineers (India), 8 Gokhale Road, Kolkata 700 020 for external evaluation; and one copy should be retained by the student with him/ her. The following points should

be noted regarding the final project report:

a) The project report shall contain the methodology, data/input, analysis, and the results/final outcome and comments of the project guide, if any.

b) Each project report must adequately explain the methodology adopted and the directions for future study;

c) The project report must also contain (a) Copy of the approved synopsis; and

(b) Certificate of originality of the work by the project guide.

d) The length of the report should not exceed 2500 words in double-spaced typed pages (excluding appendices and exhibits).

7. Time Limit for Project Work

Allotment of project guide for project work shall be done twice a year, i.e., May/June and December/January. For May/June term, the evaluation work shall be carried out in the month of August, whereas for December/January term, it would be in the month of February.

Minimum Time Limit

Students, having secured minimum grade 'C' or above in 5 (five) or more subjects after declaration of result of Winter term, must complete the project work and submit one copy of the same to the project guide and one copy to the Director (EEA) by August 10 of that year for internal and external evaluation. The project guide, in turn, shall submit his assessment report, along with the evaluated project report, to the Director (EEA) by August 20. Similarly, students, having secured minimum grade 'C' or above in 5 (five) or more subjects after declaration of result of Summer term, must complete the project work and submit one copy of the same to the project guide and one copy to the Director (EEA) by February 10 of the following year for internal and external evaluation and the project guide must send the assessment report by February 20.

Maximum Time Limit

Project work shall required to be completed within the stipulated period of 6 (six) years for a complete pass in Section B Examination. The term/session of declaration of result of Section B of a student shall

depend on the date of submission of project report. In case a student fails to obtain the required grade in the project work in one or more attempts, he shall be required to re-register again for the same with the prescribed fee of Rs. 3000.00/US $ 200.

8. Evaluation of the Project Work

Full marks for the project work will be 100 (one hundred). There will be internal as well as external evaluation of the project work. Minimum aggregate for passing project work will be grade 'B'.

Internal Evaluation

The internal evaluation will be carried out by the project guide, based on the project report submitted by the student to him. The project guide shall submit his assessment report on the prescribed proforma to be sent to him along with the letter of allotment. The assessment report must be accompanied with the evaluated project report (marks given on the content page and duly signed) as submitted by the candidate to the project guide for internal evaluation. Non-receipt of proforma should be informed to the headquarters on the address mentioned on page 5.

External Evaluation

External evaluation will be carried out by the examiner to be arranged by the Institution.

9. Important Notes while Preparing the Synopsis of the Project

The synopsis of the project should include the following:

o Rationale for the study.

o Objectives of the study.

o Methodology to be used for carrying out the study (detailed).

o The expected contribution from the study.

o Limitations, if any, and the direction for future study.

10. Important Notes while Preparing the Project Report

a) The Project Work should be submitted in A-4 size (29 cm x 20 cm), typed in double space, in a bound volume.

b) Before binding the project report, the student should ensure that it contains the following:

• Approved synopsis of the project work;

• Certificate of originality of work by the project guide; and

• Comments of the project guide on the project work, if any.

Students should submit a statement certifying that the work is an original one and has not been submitted earlier to any other Institution for fulfillment of the requirement of a course of study. The above certificate is required to be countersigned by the project guide. If any project report is received in the absence of the above, the same will be returned to the student for compliance.

c) The student should prepare 3 (three) typed copies of the final project report. One copy of the project work should be submitted to the project guide for internal evaluation; one copy to the Director (EEA) of the Institution at Kolkata by registered post/courier for external evaluation mentioning on top of the envelope "Project Report-ET" (name of the engineering discipline); and one copy should be retained with him. The project report submitted to the project guide or to the Director (EEA) of the Institution will not be returned to the student.

LABORATORY EXPERIMENTS

1. Objective

In order to equip students in pursuit of their cherished goal, a course on 'Laboratory Experiments' has been made compulsory in the syllabi of Section B examination. This

programme can produce best results if it is able to arouse the basic inquisitiveness, originality and intelligence in the minds of students.

2. Prerequisite

Students pursuing Section B examination can take up Laboratory Experiments only after securing minimum grade 'C' in 5 (five) subjects in an engineering branch of Section B. Students are required to register for laboratory experiments by filling the application form, as given at Appendix III, along with a demand draft of Rs. 7,000.00 (US $ 400 in case of overseas students) in favour of 'The Institution of Engineers (India)' payable at Kolkata. On receipt of the application with choice of engineering college/institute and fee, a student shall be intimated the name of the engineering college/institute where he shall be required to perform the laboratory experiments. The decision of the Institution regarding allotment of college/institute shall be final and binding upon the students.

3. College/Institute for Laboratory Experiments

On receipt of name of the college/institute from the Institution, the student is expected to contact the authorities of the concerned college/institute for performing the laboratory experiments on production of a copy of the letter issued by the Institution. Thereafter, authorities of the college/institute shall permit the student to use the facility of the concerned department for laboratory experiments.

The facility for performing laboratory experiments in a college/institute will be available twice a year, i.e., May/June and December/January. Students eligible for laboratory experiments after declaration of results of Summer examination can complete the laboratory experiments in December/January, whereas candidates for Winter examination can complete in June/July each year.

4. Number of Experiments

A student shall be required to perform 10 (ten) laboratory experiments, out of a list of 20 (twenty) experiments, prescribed for the branch of engineering in which he is pursuing Section B examination. Selection of 10 (ten) experiments shall be at the sole discretion of the concerned authority of the college/institute.

5. Certificate for Completion of Experiments

After completion of the required number of laboratory experiments, the college will issue a completion certificate to the student. The student, in turn, shall inform the Director (EEA) about the same, enclosing an original copy of the completion certificate, retaining a copy with him.

6. Evaluation of Laboratory Experiments

Full marks for the laboratory experiments will be 100 (one hundred). The evaluation shall be carried out by the concerned college/institute where the student shall perform the laboratory experiments. The prescribed proforma for an evaluation report shall be sent directly to the concerned college/institute by the Institution. In case of non-receipt, the college may inform the headquarters (address and phone number given on page 5). The filled-in proforma shall be sent to the Director (EEA), under confidential cover, directly by the college/institute. Minimum grade for passing laboratory experiments will be 'B'.

The evaluation work shall be carried out in the month of August for May/June term, whereas for December/January term, it would be in the month of February.

7. Hostel Accommodation Charges

The Institution is not liable to provide any hostel accommodation in the college/ institute during the period of performing laboratory experiments. However, some colleges/institutes may extend the facility of hostel accommodation on request of the students. Charges for lodging/boarding arrangements in the hostel shall be borne by the student separately. The student is not

required to pay any other fee directly to the college/institute.

8. Time Limit for Laboratory Experiments

Minimum Time Limit

Students, having secured minimum grade 'C' or above in 5 (five) or more subjects after declaration of result of Winter term, must complete all 10 (ten) laboratory experiments by August 10 of that year for evaluation. The authority of the concerned college shall submit the assessment report to the Director (EEA) by August 20. Similarly, for Summer term, laboratory experiments are required to be completed by February 10 of the following year and the concerned authority of the college shall submit the assessment report by February 20.

Maximum Time Limit

Laboratory experiments are required to be completed within the stipulated period of 6 (six) years for a complete pass in Section B Examination. The term/session of declaration of result of Section B of a student shall depend on the date of completion of laboratory experiments. In case a student is not able to complete required number of laboratory experiments and obtain grade 'B' in one or more attempts, he shall be required to re-register again for the same with prescribed fee (Rs. 7000.00/US $ 400).

Format of Synopsis

1. Title of the Project
2. Objectives of the study
3. Rationale for the study
4. Detailed Methodology to be used for carrying out the study
5. The expected contribution from the study
6. List of activities to be carried out to complete the project (with the help of a bar chart

showing the time schedule)

7. Places/labs/equipment and tools required and planning of arrangements

8. Problems envisaged in carrying out the project, if any.

Format of Final Project Report

1. Title of the Project

2. Objectives of the Study

3. Methodology of the Study

4. Statement of the Problem

5. Input Data/Structure/Questionnaire

6. Analysis/Solution/Description

7. Final Results

8. Conclusion

9. Scope of Future Study

POSTER DISPLAY PREPARATION

Poster Display is a method for authors to present research or to display original work. They also allow the author to meet with

interested attendees for in-depth discussion. Information should be displayed clearly and succinctly.

A poster must cover KEY points of a topic. A poster should:

1. attract attention of participants

2. provide a brief overview of your topic

3. encourage discussion and questions

Please be aware that a poster is not intended to be a reproduction of your paper in the proceedings. There will be tables available for

presenters to deposit printed materials related to their posters for meeting attendees.

POSTER PREPARATION GUIDELINES

 IMPORTANT! Posters must be complete and submitted electronically by August 7, 2017 in one of the pre-determined

templates (which will be made available to download within the online poster presentation portal).

 All posters must be in the English language and read from left to right and top to down OR from center to left and center to

right.

 Use of color to create emphasis or to draw the viewer to focal points may increase the appeal of your poster.

 Select colors wisely, remembering that not all attendees may be able to distinguish between red, green, and grey.

 Use pictures, diagrams, figures, etc., rather than text when appropriate, to best describe your work. Excessive use of text

should be avoided. The average poster has from 2-5 figures/diagrams.

 Your poster should be designed for the viewer. Please ensure that content is clear to the reader when you are not present at

the display.

 Research posters must include the purpose, description of the study, methodology, major findings, limitations, conclusions,

implications for practice or clinical relevance (if applicable), funding source (if applicable) and a disclosure statement (if

warranted). Acknowledgments are optional.

 Research posters involving human subjects must address protection of human subjects in keeping with International

Standards governing human research (IRB approval if applicable).

AWARDS

Posters will be judged from the electronic file submitted prior to the meeting for first, second, or third place poster awards. These

files will be blinded, peer reviewed and evaluated on the quality of the poster, content, and relevance to the field of vascular access.

The winners will be announced and presented with a certificate at the Annual Scientific Meeting. To qualify for the advance poster

awards, presenters must submit an image of their poster electronically through the online portal by August 7, 2017.

During the meeting attendees will be able to participate in voting for the “Peoples Choice” award. This award will be announced after

the Scientific Meeting on the AVA website and E-VAN.

First, second and third place awards will be granted for Oral Presentations. Award winners will be notified by email and results will

be announced after the Scientific Meeting on the AVA website and E-VAN. Presentations will be judged on the following criteria:

 Information provided by the speaker is presented in a clear, logical, and concise format that communicates the major focus

of the research or project and adheres to the AVA submission guidelines.

 The work is timely, innovative and represents a potentially significant scientific or educational contribution to the specialty

of vascular access and AVA priorities.

 If scientific research findings are presented, the presentation demonstrates scientific method, quality, design, methodology,

and data are presented to sufficiently support the conclusion(s).

ELECTRONIC CONTENT DISCLOSURE

Providing AVA with an electronic abstract, presentation and/or handouts constitutes agreement that AVA and its designated agent

are expressly authorized and granted the right to reproduce the presenter's electronic presentation or handout file(s) and include the

file(s) on the AVA 2017 ePoster Gallery, which will be provided to meeting participants as part of their registration package. AVA

attendees place great value and importance on receiving session handouts.

Poster presentations

Study guide

For a printer-friendly PDF version of this guide, click here

This guide presents a strategy for producing poster presentations that encourages clarity as well as creativity, helping you to make the most of your poster design.

Other Useful Guides: **Using visual aids** and **Presenting numerical data**.

Introduction

Posters are often used to share information and are an important part of many conferences, seminars and exhibitions. They may be used to present quite complex material, and so it is important that the information on them is well laid out, legible and attractively presented.

General points about posters

Poster presenters are usually offered a large area to display their material (typically $1m^2$ or 2m by 1m).

Posters are usually read at a viewing distance of more than one metre. You will need to make sure that your poster is legible and easy to scan at this distance so that your information is understood quickly.

The temptation to fill the space with as much material as possible should be avoided; poster presentations should never be as dense as a printed page.

Many seminar or workshops organisers supply guidelines suggesting suitable typeface styles and sizes, along with conventions for titles and subheadings. Use these to guide your basic poster design.

When making posters it is essential that you give careful consideration to their visual appearance as well as their content.

Methods of making posters

There are two popular approaches to making a poster.

Approach One - One-piece method

The presenter chooses to design the poster in one large piece (Figure 1). The design is prepared using a versatile software application such as Microsoft Powerpoint (see our guide on **Using Microsoft PowerPoint for posters**). It is designed and produced in A3 or A4 size and is then enlarged at the printout stage.
(Note: producing one-piece posters can take a little while to get used to. Make sure you start working on your first poster in plenty of time. Using a **template** could save you some time)

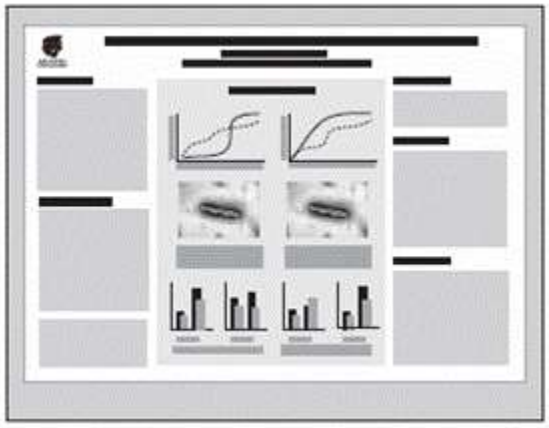


Figure 1:One-piece method

Approach Two - Panel method

The allocated poster area is divided up into a number of separate panels (Figure 2). These may consist of different elements such as text, pictures, tables or titles. Standard word-processor or presentation software (e.g.

Figure 2: Panel method

Microsoft Word or Powerpoint is used to prepare the panels which are then mounted onto a background. Laminating the individual elements can improve their appearance and robustness.

Choose the production method that is most appropriate to your needs, abilities and resources. The panel method allows for greater flexibility and can be adapted to changing layouts. The one-piece method can be very eye-catching, making your poster stand out from the rest.

Stages in producing a poster

Step One - Choosing content

The first step is to clarify the task that you have been set and the type of information that you will need to include on your poster. The following questions are useful reminders of the range of factors that you might need to consider before you start writing the text of your poster.

- What is the purpose of your poster - to report findings, present an argument, convince an audience or promote a product?
- Who will be looking at your poster - a specialist audience, the general public, other students?
- What will your audience be looking for - detailed information or a brief summary?
- Where will your poster be displayed - in a busy conference hall or in your department?
- Are there any guidelines governing the content of your poster? These might specify the nature and structure of the material to be displayed (as well as practical issues such as the size of the poster and the size and amount of text to be used).

The answers to these questions will influence the nature and amount of material that you display. If you think that you are including too much information in your display, think about what could be taken out; remember that ‘less’ is often ‘more’ in visual displays.

Step Two - Making a plan

Once you have decided on the content of your poster, you need to consider the way the information should be displayed. A useful starting point is to prepare an outline plan that will help you make the most effective use of the space available to you.

Structure

Your overall structure should be clear and logical so that the viewer's eye naturally follows the flow of information in your display. To help establish a clear sequence of information, think about planning your poster on a grid system as in the diagram on the following page (Figure 3).

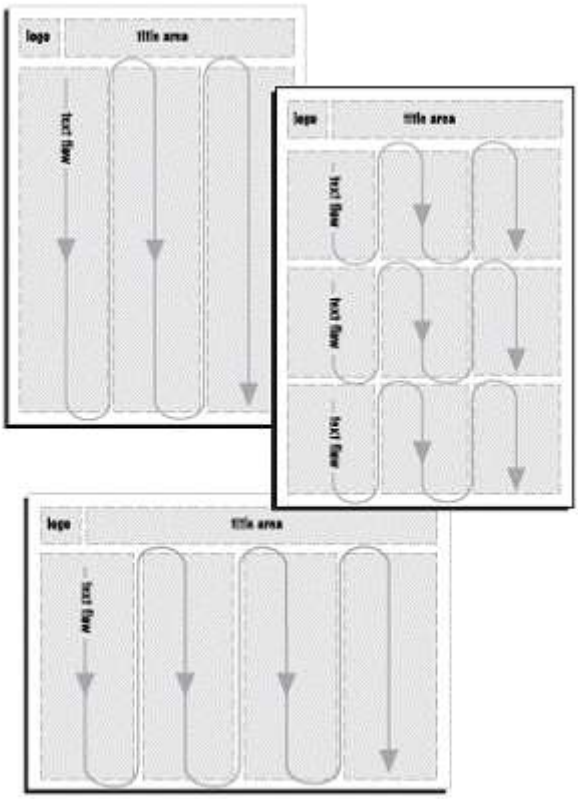


Figure 3: Grid systems

As you can see, the grids help break down the large space into convenient sized areas. Also, two main visual sequences become apparent: rows travelling across the page or columns travelling down the page. These natural 'pathways' can be used to structure your information in both panel and one-piece poster displays, guiding your reader's eye through your information in a logical and fluid way.

Using a grid system, try producing a rough sketch of your poster layout working in a reduced scale to get a feel for how you might assemble your information in the final display. Use a pencil and some scrap paper to help you think freely and experiment with different designs.

Developing your poster design

Once you have established a basic layout for your poster, try printing out rough versions of the text and use scissors and glue to move things around. This can be used to experiment with different sequences and spacings and will help you gauge the amount of information needed for an effective display.

Step Three - Preparing your final poster

When you have a fairly good idea of where you want things to go, you can start to prepare your final poster. If you are aware of a few design principles as you prepare your material, you are more likely to achieve good results. Sticking to the following rules will help you produce an effective poster. Once you have more experience of poster production you can become more adventurous.

Using text

Once you have written your text, you need to choose how to present it. There are five main variables to consider.

- **Font** - choose a font that is easy to read at a distance. Most of the standard fonts are fine for this (e.g. Helvetica, Palatino, Times). Avoid mixing too many fonts as this can look messy. Two is often ideal; one for the headings and one for the main text.
- **Type size** - remember that your poster will be read by someone standing at about a metre away so the text will need to be legible at a distance. Use large type sizes; the following examples are at 24 point and 36 point and

can be clearly read at a distance. Titles and headings will need to be larger than your main text. Developing a hierarchy of type sizes can help to differentiate between your main body text and the other text elements in your poster. Keep the number of type sizes to a minimum to avoid over-cluttering your poster. Apply your hierarchy to all aspects of your poster design to ensure consistency.

- **Line spacing or 'leading'** - using one and a half or double spacing between lines of text greatly increases the legibility of your poster design.
- **Alignment** - most word-processing packages give you the option of aligning your text in different ways on the page; the main choices are left, right, centre and justified. Avoid mixing alignments as this can look very awkward. Left aligned is the easiest to read, particularly when using large type.
- **Case** - text in UPPER CASE can be very difficult to read, even at close distances, and is best avoided.

Colour palette

Colour can add an extra dimension to your poster design, making a poster more attractive and giving you another method of highlighting particular aspects of your information. Choose colours that work well together so that they don't detract from the information in your display. It is sensible to use a small range of colours so that your poster doesn't look chaotic.

Diagrams

Displaying information on a poster gives you an opportunity to represent your data in an interesting and eye-catching way. Think about how your display can be enhanced through the use of illustrations, tables, charts or photographs. The inclusion of one carefully chosen image can be a very powerful way of drawing people's attention to your poster. The companion study guide
PRESENTING NUMERCIAL DATA offers advice and guidance on effective ways of
communicating numerical information in your poster presentations.

Step Four - Showing your poster

Poster presentations can take many forms. Sometimes you will be asked to stand next to your poster, talking to people as they browse and answering questions about your work. At other times, your poster will simply need to 'stand alone' as part of a general display. It might be useful to think about how you can help an interested

reader take information away from your poster: printing off A4 copies of one-piece posters or producing bullet-point summaries of panel posters are very effective ways of sharing your information.

Summary

Posters are a highly visual medium and can be a very effective way of communicating information to a wide audience. The challenge is to produce a poster design that is both pleasing to the eye and logical to the mind. Time taken to produce a coherent and creative display can produce stunning results.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: IM.Sc CHEMISTRY COURSE NAME:RESEARCH METHODOLOGY FOR CHEMISTRY

COURSE CODE: 19CHP 205A UNIT: III(Methods of Scientific Research and Writing Scientific Papers)BATCH-2019-2021

S.NO	Questions	Opt-1	Opt-2	Opt-3	Opt-4	Answers
1	"A systematic step-by-step Procedure following logical process of reasoning" called	Experiment	Observation	Deduction	Scientific method	Scientific method
2	Ethical Neutrality is a feature of	Deduction	Scientific method	Observation	experience	Scientific method
3	Scientific method is committed to …….	Objectivity	Ethics	Proposition	Neutrality	Objectivity
4	"One of the methods of logical reasoning process" is called	Induction	Deduction	Research	Experiment	Induction
5	An essential Criterion of Scientific study is	Belief	Value	Objectivity	Subjectivity	Objectivity
6	"Reasoning from general to particular "is called	Observation	experience	deduction	Induction	deduction
7	"Deduction and induction are a part of system of reasoning" – stated by	Caroline	P.V.Young	Dewey John	Emory	P.V.Young
8	A brief summary of content of manuscript and the potential implications of the results is	Conclusion	Abstract	Discusssion	Results and Discussion	Conclusion
9	Research is classified on the basis of …….. and methods	Purpose	Techniques	Methodology	Intent	Intent
10	Research undertaken for knowledge sake is	Pure Research	Action Research	Survey	Pilot study	Pure Research
11	Example for fact finding study is	Pure Research	Survey	Action Research	Long term	Survey

					Research	
12	Facts or information's are analyzed and critical evaluation is made in	Survey	Pilot study	Action research	Analytical research	Analytical research
13	Research conducted to find solution for an immediate problem is …….	Action Research	Analytical Research	Survey	Fundamental Research	Action Research
14	Fundamental Research is otherwise called	Action Research	Pure Research	Survey	Pilot study	Pure Research
15	Motivation Research is a type of …… research	Quantitative	Qualitative	Pure	applied	Qualitative
16	Research related to abstract ideas or concepts is	Empirical research	Conceptual Research	Qualitative research	Quantitative research	Conceptual Research
17	A research which follows case study method is called	Clinical or diagnostic	Causal	Qualitative	Analytical	Clinical or diagnostic
18	Research conducted in class room atmosphere is called	Field study	Survey	Laboratory Research	Empirical Research	Laboratory Research
19	Research through experiment and observation is called	Experimental Research	Clinical Research	Laboratory Research	Empirical Research	Empirical Research
20	Population Census is an example of …….. Research	Survey	Empirical	Clinical	Diagnostic	Survey
21	…….. is a way to systematically solve the research problem	Research methodology	Research Process	Operations	Technique	Research methodology
22	Good Research is always ……	Fast	Systematic	Slow	Narrow	Systematic
23	Good research is ……	Logical	Non logical	Narrow	Systematic	logic
24	Research method is a part of ……..	Problem	Research methodology	Experiment	Research Techniques	Research methodology
25	Identifying causes of a problem and possible solution to a problem is	diagnosis tic study	Field Study	Action study	Pilot study	diagnosis tic study

26	"Doubt is often better than ……."	Belief	Value	Confidence	Overconfidence	Overconfidence
27	Research help in explaining the …… with which something operates.	Velocity	momentum	frequency	gravity	Frequency
28	…… is a motivation for research in students	Research degree	research academy	Research Labs Research Problems		Research degree
29	Which of the following is an example of primary data?	Book b) Journal c) News Paper d) Census Report	journal	newspaper	census report	News paper
30	Major drawback to researchers in India is …….	Lack of sufficient number of Universities	Lack of sufficient research guides	Lack of sufficient Fund	Lack of scientific training in research	Lack of scientific training in research
31	UGC Stands for	University Grants Commission	Union Government commission	University Governance Council	Union government Council	University Grants Commission
32	JRF is for	Junior Research Functions	Junior Research Fellowship	Junior Fellowship	None of the above	Junior Research Fellowship
33	A question which requires a solution is …….	Observation	Problem	Data	Experiment	Problem
34	Converting a question into a Researchable problem is called ……	Solution	Examination	Problem formulation	problem solving	Problem formulation
35	While Selecting a problem, problem which is …….. is no taken	Very Common	Overdone	Easy one	rare	Overdone
36	The first step in formulating a problem is	Statement of the problem	Gathering of Data	Measurement	Survey	Statement of the problem

37	…….. will help in finding out a problem for research	Professor	Tutor	HOD	Guide	Guide
38	Second step in problem formulation is	Statement of the problem	Understanding the nature of the problem	Survey	Discussions	Understanding the nature of the problem
39	Third step in problem formulation is	Statement of the problem	Understanding the nature of the problem	Survey the available literature	Discussion	Survey the available literature
40	Last step in problem formulation is	Survey	discussion	literature survey	Re phrasing the research problem	Re phrasing the research problem
41	In the formulation of the problem we need to give a …….	Title	Index	Bibliography	Concepts	Title
42	Objectives in problem formulation means	Questions to be answered	methods	Techniques	d)methodology	Questions to be answered
43	The problem selected must have	Speed	Facts	Values	Novelty	Novelty
44	The formulated problem should have	Originality	Values	Coherence	Facts	Originality
45	The purpose of Social Science Research is	Academic and Non academic	Cultivation	Academic	Utilitarian	Cultivation
46	The Academic purpose is to have …….	Information	firsthand knowledge	Knowledge and information	models	Knowledge and information
47	Social Science Research creates Social ……	Alienation	Cohesion	mobility	Integration	Cohesion
48	……. is a quality of Good Researcher	Scientific temper	Age	Money	time	Scientific temper

49	Social Science Research in India aims at a ……. State	Secular	Totalitarian	democratic	welfare	welfare
50	A …… is an abstraction formed by generalization from particulars	Hypothesis	Variable	Concept	facts	Concept
51	Concept is of two types	Abstract and Coherent	Concrete and Coherent	Abstract and concrete	None of the above	Abstract and concrete
52	Concepts are of ……types	4	6	10	2	2
53	There is a concept by ……	Observation	formulation	Theory	Postulation	postulation
54	Concepts are …….	Metaphor	Simile	Symbols	Models	Symbols
55	Concepts represent various degree of ……..	Formulation	Calculation	Abstraction	Specification	Abstraction
56	Concepts which cannot be given operational definitions are …… concepts	Verbal	Oral	Hypothetical	Operational	Hypothetical
57	Concept is in reality a definition in short hand or a class or group of facts" –defined by	Kerlinger	P.V. Young	Aurthur	Kaplan	P.V. Young
58	Different people hold …….. of the same thing	Same and different	Same	different	None of the above	different
59	Many concepts find their origin from	Greek	English	Latin	Many languages	Many languages
60	A tentative proposition subject to test is	Variable	Hypothesis	Data	Concept	Hypothesis

Unit IV – Chemical Safety and Ethical Handling of Chemicals

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Environmental Health and Safety Management System

INTRODUCTION

Many people are interested in an organization's approach to laboratory environmental health and safety (EHS) management including laboratory personnel; customers, clients, and students (if applicable); suppliers; the community; shareholders; contractors; insurers; and regulatory agencies. More and more organizations attach the same importance to high standards in EHS management as they do to other key aspects of their activities. High standards demand a structured approach to the identification of hazards and the evaluation and control of work-related risks.

A comprehensive legal framework already exists for laboratory EHS management. This framework requires organizations to manage their activities in order to anticipate and prevent circumstances that might result in occupational injury, ill health, or adverse environmental impact. This chapter seeks to improve the EHS performance of organizations by providing guidance on EHS to integrate EHS management with other aspects of the organization.

Many features of effective EHS management are identical to management practices advocated by proponents of quality assurance and business excellence. The guidelines presented here are based on general principles of good management and are designed to integrate EHS management within an overall management system.[1] By establishing an EHS management system, EHS risks are controlled in a systematic proactive manner.

Within many organizations, some elements of EHS management are already in place, such as policy and risk assessment records, but other aspects need to be developed. It is important that all the elements described here are incorporated into the EHS management system. The manner and extent to which

individual elements are applied, however, depend on factors such as the size of the organization, the nature of its activities, the hazards, and the conditions in which it operates. An initial status review should be carried out in all organizations that do not have an established EHS management system. This initial status review will provide information on the scope, adequacy, and implementation of the current management system. Where no formal management system exists, or if the organization is newly established, the initial status review should indicate where the organization stands with respect to managing risks.

Figure 2.1 illustrates the major elements of an EHS management system.

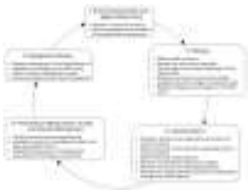


FIGURE 2.1

Overview of environmental health and safety management system.

2.A.1. Environmental Health and Safety Policy

Top management should set in place procedures to define, document, and endorse a formal EHS policy for an organization. The policy should clearly outline the roles and expectations for the organization, faculty, EHS personnel, and individual employees or students. It should be developed in communication with laboratory personnel to ensure that all major concerns are adequately addressed.

The EHS policy should state intent to

- prevent or mitigate both human and economic losses arising from accidents, adverse occupational exposures, and environmental events;
- build EHS considerations into all phases of the operations, including laboratory discovery and development environments;
- achieve and maintain compliance with laws and regulations; and
- continually improve EHS performance.

The EHS policy and policy statement should be reviewed, revalidated, and where necessary, revised by top management as often as necessary. It should be communicated and made readily accessible to all employees and made available to relevant interested parties, as appropriate.

2.A.2. Management Commitment

Management commitment to EHS performance is widely recognized as one of the elements most critical to EHS program success and to the development of a strong culture of safety within an organization. Therefore, the management system document establishes management commitment with a formal statement of intent, which defines examples of how performance goals are supported. Examples of how this commitment is supported include the following:

- Establish methods to use energy more efficiently, reduce waste, and prevent accidents.
- Comply with laws, regulations, and organizational requirements applicable to their operations.
- Improve EHS performance continually.
- Conduct periodic assessments to verify and validate EHS performance.

2.A.3. Planning

Planning is an integral part of all elements of the management system and to be effective involves the design and development of suitable processes and organizational structure to manage EHS aspects and their associated risk control systems proportionately to the needs, hazards, and risks of the organization. Planning is equally important to deal with health risks that might only become apparent after a long latency period. It also establishes objectives that define the criteria for judging success or failure of the management system. Objectives are identified on the basis of either the results of the initial status review, subsequent periodic reviews, or other available data.

Various sources of information are used to identify applicable EHS aspects and to assess the risk associated with each. Examples include, but are not limited to, information obtained from the following:

- hazard/exposure assessment,
- risk assessment,
- inspections,

- permits,
- event investigations (injury and illness investigations, environmental incident investigations, root-cause analysis, trend analysis),
- internal audits and/or external agency audits,
- fire and building codes,
- employee feedback concerning unsafe work conditions or situations,
- emerging issues,
- corporate/institution goals, and
- emergency management.

Once applicable EHS aspects are identified, a risk-based evaluation is performed to determine the potential impact and adequacy of existing control measures. If additional controls or corrective actions are needed to reduce risks to acceptable levels, they are integrated into business planning. Categorizing each item in this manner allows gaps that are identified to be prioritized and incorporated, based on level of importance and available resources.

Care should be taken when developing and disseminating new controls and corrective actions. If requirements are perceived by laboratory personnel as unnecessarily onerous, there is potential for lower compliance within the organization and a loss of credibility on the part of EHS personnel. While understanding that some individuals will never be convinced of the need for new controls, it is important to provide clear, supported justifications for changes to existing protocols to encourage adoption of the new policies and procedures.

2.A.4. Implementation

The design of management arrangements should reflect the organization's business needs and the nature of their risks. However, there should be appropriate activity across all elements of the model (policy; planning; implementation; performance measurement, audits, and change management; and management review).

Specifically the organization should make arrangements to cover the following key areas:

- overall plans and objectives, including employees and resources, for the organization to implement its policy;
- operational plans to implement arrangements to control the risks identified;
- contingency plans for foreseeable emergencies and to mitigate their effects (e.g., prevention, preparedness, and response procedures);
- plans covering the management of change of either a permanent or a temporary nature (e.g., associated with new processes or plant working procedures, production fluctuations, legal requirements, and organizational and staffing changes);
- plans covering interactions with other interested parties (e.g., control, selection, and management of contractors; liaison with emergency services; visitor control);
- performance measures, audits, and status reviews;
- corrective action implementation;
- plans for assisting recovery and return to work of any staff member who is injured or becomes ill through work activities;
- communication networks to management, employees, and the public;
- clear performance and measurement criteria defining what is to be done, who is responsible, when it is to be done, and the desired outcome;
- education and training requirements associated with EHS;
- document control system; and
- contractors should have written safety plans and qualified staff whose qualifications are thoroughly reviewed before a contract is awarded. All contractor personnel should be required to comply with the sponsoring organization's safety policies and plans.

Though it is the responsibility of each individual researcher to ensure that work is performed in a prudent and safe manner, achieving a safe laboratory environment is a cooperative endeavor between management, EHS personnel, and laboratory personnel. Regulations, policies, and plans will never cover

every contingency, and it is important for these different groups to communicate with each other to ensure that new situations can be handled appropriately. One way to ensure that the needs of all groups are being met is by creating safety committees consisting of representatives from each part of an organization. In this forum, safety concerns can be raised, information can be distributed to affected parties, and a rough sense of the efficacy of policies and programs can be gained.

2.A.5. Performance Measurement and Change Management

The primary purpose of measuring EHS performance is to judge the implementation and effectiveness of the processes established for controlling risk. Performance measurement provides information on the progress and current status of the arrangements (strategies, processes, and activities) used by an organization to control risks to EHS. Measurement information includes data to judge the management system by

- gathering information on how the system operates in practice,
- identifying areas where corrective action is necessary, and
- providing a basis for continual improvement.

All of the components of the EHS management system should be adequately inspected, evaluated, maintained, and monitored to ensure continued effective operation. Risk assessment and risk control should be reviewed in the light of modifications or technological developments. Results of evaluation activities are used as part of the planning process and management review, to improve performance and correct deficiencies over time.

Periodic audits that enable a deeper and more critical appraisal of all of the elements of the EHS management system (see Figure 2.1) should be scheduled and should reflect the nature of the organization's hazards and risks. To maximize benefits, competent persons independent of the area or activity should conduct the audits. The use of external, impartial auditors should be considered to assist in evaluation of the EHS management system. When performing these reviews, it is important that the organization have a plan for following up on the results of the audit to ensure that problems are addressed and that recognition is given where it is deserved.

The concept of change management in the laboratory environment varies markedly from methods typically prescribed, for example, in manufacturing operations. By its very nature, the business of

conducting experiments is constantly changing. Therefore, it is a part of everyday activities to evaluate modifications and/or technological developments in experimental and scale-up processes. As such, a number of standard practices are used to identify appropriate handling practices, containment methods, and required procedures for conducting laboratory work in a safe manner. Several examples of these practices include

- identification of molecules as particularly hazardous substances (PHSs),[2] which specifies certain handling and containment requirements and the use of personal protective equipment (PPE);
- approval and training for new radioisotope users;
- completion of biosafety risk assessments for the use of infectious agents; and
- Material Safety Data Sheet (MSDS) review of chemicals being used.

2.A.6. Management Review of EHS Management System

Top management should review the organization's EHS management system at regular intervals to ensure its continuing suitability, adequacy, and effectiveness. This review includes assessing opportunities for improvement and the need for changes in the management system, including the EHS policy and objectives. The results of the management review should be documented.

Among other information, a management review should include the following:

- results of EHS management system audits,
- results from any external audits,
- communications from interested parties,
- extent to which objectives have been met,
- status of corrective and preventive actions,
- follow-up actions from previous management reviews, and
- recommendations for improvement based on changing circumstances.

The outputs from management review should include any decisions and actions related to possible change to EHS policy, objectives, and other elements of the management system, consistent with the commitment to continual improvement.

The management system review ensures a regular process that evaluates the EHS management system in order to identify deficiencies and modify them. Systemic gaps, evidence that targets are not being met, or compliance issues that are discovered during compliance or risk assessments indicate a possible need for revision to the management system or its implementation.

2.A.7. Example Management System: Department of Energy Integrated Safety Management System

One example of a common EHS management system is that used by the Department of Energy (DOE). The agency's Integrated Safety Management (ISM) system, adopted in 1996, is used at all DOE facilities, and has been used as a model for other agencies and institutions. The system consists of six guiding principles and five core management safety functions. The principles and functions in DOE Policy DOE P 450.4 (DOE, 1994), outlined below, require planning, identification of hazards and controls before work begins, and for work to be performed within these defined and planned methods.

Principles:

- **Line management responsibility for safety.** Line management is directly responsible for the protection of the public, the workers, and the environment. As a complement to line management, the Department's Office of Environment, Safety, and Health provides safety policy, enforcement, and independent oversight functions.
- **Clear roles and responsibilities.** Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the Department and its contractors.
- **Competence commensurate with responsibilities.** Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.
- **Balanced priorities.** Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.

- **Identification of safety standards and requirements.** Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.
- **Hazard controls tailored to work being performed.** Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.
- **Operations authorization.** The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

Functions:

- **Define the scope of work.** Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- **Analyze the hazards.** Hazards associated with the work are identified, analyzed, and categorized.
- **Develop and implement hazard controls.** Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.
- **Perform work within controls.** Readiness is confirmed and work is performed safely.
- **Provide feedback and continuous improvement.** Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

In addition, in 2006, and in recognition of a gap within the management system, DOE identified four supplemental safety culture elements. These, as described in DOE Manual DOE M 450.4-1 (DOE, 2006), are as follows:

- **Individual attitude and responsibility for safety.** Every individual accepts responsibility for safe mission performance. Individuals demonstrate a questioning attitude by challenging

assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. All employees are mindful of work conditions that may impact safety, and assist each other in preventing unsafe acts or behaviors.

- **Operational excellence.** Organizations achieve sustained, high levels of operational performance, encompassing all DOE and contractor activities to meet mission, safety, productivity, quality, environmental, and other objectives. High reliability is achieved through a focus on operations, conservative decision making, open communications, deference to expertise, and systematic approaches to eliminate or mitigate error-likely situations.

- **Oversight for performance assurance.** Competent, robust, periodic, and independent oversight is an essential source of feedback that verifies expectations are being met and identifies opportunities for improvement. Performance assurance activities verify whether standards and requirements are being met. Performance assurance through conscious, directed, independent previews at all levels brings fresh insights and observations to be considered for safety and performance improvement.

- **Organizational learning for performance improvement.** The organization demonstrates excellence in performance monitoring, problem analysis, solution planning, and solution implementation. The organization encourages openness and trust, and cultivates a continuous learning environment.

More information about the DOE ISM system can be found at www.directives.doe.gov.

The DOE ISM system is only one example of an EHS management system, and many others exist. It is important that each organization develop a management system to meet the needs of the organization. Small organizations or those that do not handle particularly hazardous materials should not be tempted to “over-engineer” the system. If the burden of organizational oversight and management of the ESH program is not appropriately tied to the organizational risk, then the safety program may lose credibility in the eyes of the people it supports.

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2.B. CHEMICAL HYGIENE PLAN

The foundation of all management system approaches is the identification of EHS concerns, which if not adequately controlled, can result in employee injury or illness, adverse effects on the environment, and regulatory action. One of the most critical EHS aspects for laboratories is the requirement for chemical safety, which in the United States is specifically regulated by OSHA Laboratory Standard, 29 CFR § 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories.* This standard was created to minimize employee exposure to hazardous chemicals in the laboratory and sets forth guidelines for employers and trained laboratory personnel engaged in the use of hazardous chemicals.[3]

The OSHA Laboratory Standard defines a Chemical Hygiene Plan (CHP) as "a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace." "Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan." The CHP is the foundation of the laboratory safety program and should be reviewed and updated, as needed, on an annual basis to reflect changes in policies and personnel. A CHP that is facility specific can assist in promoting a culture of safety to protect employees from exposure to hazardous materials.

Topics included in a CHP are

1. individual responsibilities for chemical hygiene within the organization (see Boxes 2.1, 2.2, and 2.3),
2. emergency preparedness and facility security issues,
3. personal apparel and PPE,
4. chemical management,
5. laboratory housekeeping,
6. standard operating procedures,
7. emergency action plan (EAP) for accidents and spills,
8. safety equipment,

9. chemical waste policies,
10. required training,
11. safety rules and regulations,
12. facility design and laboratory ventilation,
13. medical and environmental monitoring,
14. compressed gas safety,
15. laboratory equipment,
16. biological safety, and
17. radiation safety.

BOX 2.1

Chemical Hygiene Responsibilities in a Typical Academic Institution. The duties of the CHO vary widely from one institution to another but may include the following: Establish, maintain, and revise the Chemical Hygiene Plan (CHP).

BOX 2.2

Chemical Hygiene Responsibilities in a Typical Industry Research Facility. Qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Laboratory Standard. Oversees implementation and (more...)

BOX 2.3

Chemical Hygiene Responsibilities in a Typical Governmental Laboratory. Is given authority by the Director of Safety Services Division to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan (CHP). (more...)

Determining what belongs in the CHP for a given laboratory should be the result of conversations between the Chemical Hygiene Officer (CHO), the director of the laboratory, and laboratory personnel. The laboratory director and the individuals performing the research are responsible for following safe practices, and they are the people most familiar with the work being performed. However, they are less likely to be familiar with all relevant regulations, standards, and codes than the CHO, and they may benefit from assistance in identification and assessment of hazards within the laboratory. Thus there must be communication across the groups to ensure that the CHP is complete and that it contains no irrelevant information (e.g., information on biological safety in a laboratory that only works with inorganic materials).

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2.C. SAFETY RULES AND POLICIES

Safety rules and regulations are created to protect laboratory personnel from unsafe work practices and exposure to hazardous materials. Consistently following and enforcing the safety rules in order to create a safe and healthful laboratory environment in which to work will help encourage a culture of safety within the workplace. What follows is a description of laboratory safety rules, but these will not cover every contingency. Part of the culture of safety is communication and discussion about safety hazards within the laboratory, so that new concerns can be addressed as quickly as possible.

2.C.1. General Safety Rules

Below are some basic guidelines for maintaining a safe laboratory environment.

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1. To ensure that help is available if needed, do not work alone if using hazardous materials or performing hazardous procedures.
2. To ensure that help is available in case of emergencies, laboratory personnel should not deviate from the assigned work schedule without prior authorization from the laboratory supervisor.
3. Do not perform unauthorized experiments.
4. Plan appropriate protective procedures and the positioning of all equipment before beginning any operation. Follow the appropriate standard operating procedures at all times in the laboratory.
5. Always read the MSDS and the label before using a chemical in the laboratory.
6. Wear appropriate PPE, including a laboratory apron or coat, at all times in the laboratory. Everyone, including visitors, must wear appropriate eye protection in areas where laboratory chemicals are used or stored.
7. Wear appropriate gloves when handling hazardous materials. Inspect all gloves for holes and defects before using.
8. Use appropriate ventilation such as laboratory chemical hoods when working with hazardous chemicals.
9. Contact the CHO or the EHS office if you have questions about the adequacy of the safety equipment available or chemical handling procedures.
10. Know the location and proper use of the safety equipment (i.e., eyewash unit, safety shower, fire extinguisher, first-aid kit, fire blanket, emergency telephone, and fire alarm pulls).
11. Maintain situational awareness. Be aware of the hazards posed by the work of others in the laboratory and any additional hazards that may result from contact between materials and chemicals from different work areas.
12. Make others in the laboratory aware of any special hazards associated with your work.
13. Notify supervisors of any chemical sensitivities or allergies.

14. Report all injuries, accidents, incidents, and near misses as directed by the organization's policy.
15. For liability, safety, and security reasons, do not allow unauthorized persons in the laboratory.
16. Report any unsafe conditions to the laboratory supervisor or CHO.
17. Properly dispose of all chemical wastes. Follow organizational policies for drain and trash disposal of chemicals.

Visitors, including children, are permitted in laboratories where hazardous substances are stored or are in use or hazardous activities are in progress as long as they are properly protected. If minors are expected in a laboratory (e.g., as part of an educational or classroom activity), ensure that they are under the direct supervision of qualified adults at all times. The institution should have a review process regarding minors in the laboratory, and prior to their arrival, scheduled activities should be approved. Other laboratory personnel in the area should be made aware that minors will be present.

No pets are permitted in laboratories. Note that service animals are not pets. They are highly trained and may be present in a laboratory. However, a clean, safe area should be provided where the animal can wait.

To prevent some common laboratory accidents:

1. Always protect hands with appropriate gloves when cutting glass tubing. To avoid breakage, do not attempt to dry glassware by inserting a glass rod wrapped with paper towels. Always lubricate glassware with soap or glycerin before inserting rods, tubing, or thermometers into stoppers.
2. To reduce the chances of injuries from projectiles, when heating a test tube or other apparatus, never point the apparatus toward yourself or others.
3. Be sure that glassware has cooled before touching it. Hot glass looks just like cold glass.
4. Dilute concentrated acids and bases by slowly pouring the acid or base into the water while stirring.

2.C.2. Working Alone in the Laboratory

It is not prudent to work alone in a laboratory. The American Chemical Society states that one should, "[n]ever work alone in the laboratory" (ACS, 2003). In Alaimo (2001) it states that "[w]ork should be absolutely forbidden unless there are at least two people present". The OSHA Laboratory Standard states "Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous." Accidents are unexpected by definition, and if a person is working alone when one occurs, his or her ability to respond appropriately could be severely impaired, which could result in personal injury or death and catastrophic facility damage. Thus it is imperative that, whenever working in the laboratory, others are actively aware of your activities. If faced with a situation where you feel it is necessary to work alone in a laboratory:

1. Reconsider the need. Are the increased risks to your health and safety really outweighed by the return?
2. Reconsider the timing and setup of the work. Is there any way to accomplish the required tasks during a time when others will be present?
3. If the timing of the task cannot be changed and you still feel it must be accomplished during a period when the laboratory is empty is there any other person trained in laboratory procedures who can accompany you while you work?
4. If not, is there anyone else within the building who could act as a "buddy" to check on you periodically during the time that you feel you must work alone?
5. If no one can accompany you and you cannot find a "buddy," **do not proceed with the work.** The situation is unsafe. Speak to your supervisor or the organizational safety office to make arrangements to complete the work in a safe manner.

2.C.3. How to Avoid Routine Exposure to Hazardous Chemicals

Many chemicals and solutions routinely used in laboratories present a significant health risk when handled improperly. The Swiss physician and alchemist Theophrastus Phillippus Aureolus Bombastus von Hohenheim (1493-1541), who took the name Paracelsus later in life in homage to Celsus, a Roman physician, is known as "the father of toxicology." Paracelsus is famous for his quote, "What is it that is not poison? All things are poison and nothing is without poison. It is the dose alone that makes a thing not a poison" (Dillon, 1994). Today, in that same spirit, trained laboratory personnel are encouraged to

reduce personal risk by minimizing exposure to hazardous chemicals and by eliminating unsafe work practices in the laboratory.

The OSHA Laboratory Standard defines a hazardous chemical as one "for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed persons." Note that this definition is not limited to toxic chemicals and includes corrosives, explosives, and other hazard classes. Routes of exposure to hazardous materials include contact with skin and eyes, inhalation, ingestion, and injection. Acute exposure is defined as short durations of exposure to high concentrations of hazardous materials in the workplace. Chronic exposure is defined as continual exposure over a long period of time to low concentrations of hazardous materials in the workplace. Overexposure to chemicals, whether a result of a single episode or long-term exposure, can result in adverse health effects. These effects are categorized as acute or chronic. Acute health effects appear rapidly after only one exposure and symptoms include rashes, dizziness, coughing, and burns. Chronic health effects may take months or years before they are diagnosed. Symptoms of chronic health effects include joint paint, neurological disorders, and tumors. (For more information on toxicity of laboratory chemicals, see Chapter 4, section 4.C.)

In addition to the hazards associated with the chemicals themselves, flammable, reactive, explosive, and physical hazards may be present in the laboratory. Reactive hazards include pyrophorics and incompatible chemicals; explosive hazards include peroxide formers and powders; and physical hazards include cryogenic liquids, electrical equipment, lasers, compressed gas cylinders and reactions that involve high pressure or vacuum lines. (For more information about these hazards within a laboratory, see Chapter 4, sections 4.D and 4.E.)

An array of controls exists to protect laboratory personnel from the hazards listed above. Engineering controls (e.g., laboratory chemical hoods and gloveboxes), administrative controls (e.g., safety rules, CHPs, and standard operating procedures), and PPE (e.g., gloves, laboratory coats, and chemical splash goggles) are all designed to minimize the risks posed by these hazards.

Work practices to minimize exposure to hazardous chemicals can be found in Chapter 6.

2.C.4. General Housekeeping Practices in the Laboratory

Good housekeeping practices in the laboratory has a number of benefits. For example, in terms of safety, it can reduce the number of chemical hazards (health, physical, reactive, etc.) in the laboratory

and help control the risks from hazards that cannot be eliminated. Practices that encourage the appropriate labeling and storage of chemicals can reduce the risks of mixing of incompatible chemicals and assist with regulatory compliance. From a security standpoint, order in the laboratory makes it easier to identify items out of place or missing. And finally, good housekeeping can help reduce scientific error by, for example, reducing the chances of samples becoming confused or contaminated and keeping equipment clean and in good working order. More information about housekeeping practices can be found in Chapter 6, section 6.C.3

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2.D. CHEMICAL MANAGEMENT PROGRAM

One of the most important components of a laboratory safety program is chemical management. Prudent chemical management includes the following processes.

2.D.1. Chemical Procurement

According to the nonmandatory OSHA Laboratory Standard (Appendix A, section D.2(a), *Chemical Procurement, Distribution, and Storage*), "Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved." The standard further states that "No container should be accepted without an adequate identifying label. Preferably, all substances should be received in a central location." These procedures are strongly recommended. Personnel should be trained to identify signs of breakage (e.g., rattling) and leakage (e.g., wet spot or stain) on shipments and such shipments should be refused or opened in a hood by laboratory staff.

Some organizations have specific purchasing policies to prohibit unauthorized purchases of chemicals and other hazardous materials. The purchaser must assume responsibility for ownership of the chemical. Because of the possibility of a chemical leak or release and subsequent exposure, chemical shipments should only be received by trained personnel in a laboratory or central receiving area with proper ventilation. Neither administrative offices nor the mail room is appropriate for receipt or opening of chemical shipments.

When preparing to order a chemical for an experiment, several questions should be asked:

- What is the minimum amount of this chemical that is needed to perform the experiment? Is it available elsewhere in the facility? Remember, when ordering chemicals, less is always best.

Prudent purchasing methods will save storage space, money, and disposal costs. Larger containers require more storage space and will incur additional disposal costs if the chemical is not used.

- Has the purchase been reviewed by the CHO to ensure that any special requirements can be met?
- Is the proper PPE available in the laboratory to handle this chemical?
- What are the special handling precautions?
- Where will the chemical be stored in the laboratory?
- Does the laboratory chemical hood provide proper ventilation?
- Are there special containment considerations in the event of a spill, fire, or flood?
- Will there be additional costs or considerations related to the disposal of this chemical?

2.D.2. Chemical Storage

To lessen risk of exposure to hazardous chemicals, trained laboratory personnel should separate and store all chemicals according to hazard category and compatibility. In the event of an accident involving a broken container or a chemical spill, incompatible chemicals that are stored in close proximity can mix to produce fires, hazardous fumes, and explosions. Laboratory personnel should read the MSDS and heed the precautions regarding the storage requirements of the chemicals in the laboratory. A detailed chemical compatibility table is included in Chapter 5, section 5.E.2, Table 5.1

To avoid accidents, all chemical containers must be properly labeled with the full chemical name, not abbreviations, and using a permanent marker. All transfer vessels should have the following label information:

- chemical name,
- hazard warnings,
- name of manufacturer,

- name of researcher in charge, and
- date of transfer to the vessel.

Incoming chemical shipments should be dated promptly upon receipt, and chemical stock should be rotated to ensure use of older chemicals. It is good practice to date peroxide formers upon receipt and date again when the container is opened so that the user can dispose of the material according to the recommendations on the MSDS. Peroxide formers should be stored away from heat and light in sealed airtight containers with tight-fitting, nonmetal lids. Test regularly for peroxides and discard the material prior to the expiration date. (For more information about storage and handling of peroxides, see Chapter 4, section 4.D.3.2, and Chapter 6, section 6.G.3.)

When storing chemicals on open shelves, always use sturdy shelves that are secured to the wall and contain ¾-in. lips. Do not store liquid chemicals higher than 5 ft on open shelves. Do not store chemicals within 18 in. of sprinkler heads in the laboratory. Use secondary containment devices (i.e., chemical-resistant trays) where appropriate. Do not store chemicals in the laboratory chemical hood, on the floor, in the aisles, in hallways, in areas of egress, or on the benchtop. Chemicals should be stored away from heat and direct sunlight.

Only laboratory-grade explosion-proof refrigerators and freezers should be used to store properly sealed and labeled chemicals that require cool storage in the laboratory. Periodically clean and defrost the refrigerator and freezer to ensure maximum efficiency. Domestic refrigerators and freezers should not be used to store chemicals; they possess ignition sources and can cause dangerous and costly laboratory fires and explosions. Do not store food or beverages in the laboratory refrigerator. (For more information, see Chapter 7, section 7.C.3.)

Highly hazardous chemicals must be stored in a well-ventilated secure area that is designated for this purpose. Cyanides must be stored in a tightly closed container that is securely locked in a cool dry cabinet to which access is restricted. Protect cyanide containers against physical damage and separate them from incompatibles. When handling cyanides, follow good hygiene practices and regularly inspect your PPE. Use proper disposal techniques.

Flammable liquids should be stored in approved flammable-liquid containers and storage cabinets. Observe National Fire Protection Association, International Building Code, International Fire Code, and other local code requirements that limit the quantity of flammables per cabinet, laboratory space, and

building. Consult the local fire marshal for assistance, if needed. Store odiferous materials in ventilated cabinets. Chemical storage cabinets may be used for long-term storage of limited amounts of chemicals.

Rooms that are used specifically for chemical storage and handling (i.e., preparation rooms, storerooms, waste collection rooms, and laboratories) should be controlled-access areas that are identified with appropriate signage. Chemical storage rooms should be designed to provide proper ventilation, two means of access/egress, vents and intakes at both ceiling and floor levels, a diked floor, and a fire suppression system. If flammable chemicals are stored in the room, the chemical storage area must be a spark-free environment and only spark-free tools should be used within the room. Special grounding and bonding must be installed to prevent static charge while dispensing solvents.

2.D.3. Chemical Handling

Important information about handling chemicals can be found in the MSDS. A comprehensive file of MSDSs must be kept in the laboratory or be readily accessible online to all employees during all work shifts. Trained laboratory personnel should always *read* and *heed* the label and the MSDS before using a chemical for the first time. Laboratory personnel should be familiar with the types of PPE that must be worn when handling the chemical. Ensure that the ventilation will be adequate to handle the chemicals in the laboratory. One should be familiar with the institutional CHP and EAP so that appropriate actions are taken in the event of a chemical spill, fire, or explosion.

2.D.4. Chemical Inventory

The OSHA Laboratory Standard, Appendix A, section D.2(b) (Chemical Procurement, Distribution, and Storage), states, “Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity.” Section D.2(d) states, “Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom.” Though Appendix A is not mandatory, compliance with the standard is an element of good laboratory management. On a basic level, you cannot safely manage something if you do not know that you have it on-site. Thus, a system for maintaining an accurate inventory of the laboratory chemicals on campus or within an organization is essential for compliance with local and state regulations and any building codes that apply.

There are many benefits of performing annual physical chemical inventory updates:

- ensures that chemicals are stored according to compatibility tables,

- eliminates unneeded or outdated chemicals,
- increases ability to locate and share chemicals in emergency situations,
- updates the hazard warning signage on the laboratory door,
- promotes more efficient use of laboratory space,
- checks expiration dates of peroxide formers,
- ensures integrity of shelving and storage cabinets,
- encourages laboratory supervisors to make "executive decisions" about discarding dusty bottles of chemicals,
- repairs/replaces torn or missing labels and broken caps on bottles,
- ensures compliance with all federal, state, and local record-keeping regulations,
- promotes good relations and a sense of trust with the community and the emergency responders,
- reduces the risk of exposure to hazardous materials and ensures a clean and healthful laboratory environment, and
- may reduce costs by making staff aware of chemicals available within the organization.

Every laboratory should maintain an up-to-date chemical inventory. A physical chemical inventory should be performed at least annually, or as requested by the CHO. Although the software that is used to maintain the inventory and the method of performing the chemical inventory will vary from one institution to another, ultimately, the chemical inventory should include the following information:

- chemical name,
- Chemical Abstract Service number,
- manufacturer,
- owner,

- room number, and
- location of chemical within the room.

Note that the chemical name should be listed with its synonyms. This will allow for cross-indexing for tracking of chemicals and help reduce unnecessary inventory.

Important safety issues to consider when performing a chemical inventory are:

- Wear appropriate PPE and have extra gloves available.
- Use a chemical cart with side rails and secondary containment.
- Use a laboratory step stool to reach chemicals on high shelves.
- Read the EAP and be familiar with the institution's safety equipment.
- If necessary cease all other work in the laboratory while performing the inventory.

Once the inventory is complete, use suitable security precautions regarding the accessibility of the information in the chemical inventory. For example, precautions should be taken when the database shows the location of Department of Homeland Security (DHS) Chemicals of Interest in excess of DHS threshold quantities. (For more information about laboratory security, see Chapter 10)

2.D.5. Transporting, Transferring, and Shipping Chemicals

It is prudent practice to use a secondary containment device (i.e., rubber pail) when transporting chemicals from the storeroom to the laboratory or even short distances within the laboratory. When transporting several containers, use carts with attached side rails and trays of single piece construction at least 2 in. deep to contain a spill that may occur. Bottles of liquids should be separated to avoid breakage and spills. Avoid high-traffic areas when moving chemicals within the building. When possible, use freight elevators when transporting chemicals and do not allow other passengers. If you must use a general traffic elevator, ask other passengers to wait until you have delivered the chemicals.

Always ground and bond the drum and receiving vessel when transferring flammable liquids from a drum to prevent static charge buildup. Use a properly operating chemical fume hood, local exhaust, or adequate ventilation, as verified by monitoring, when transferring PHSs.

All outgoing domestic and international chemical shipments must be authorized and handled by the institutional shipper. The shipper must be trained in U.S. Department of Transportation (DOT) regulations for ground shipments and must receive mandatory International Air Transport Association training for air shipments. DOT oversees the shipment of hazardous materials and has the authority to impose citations and fines in the event of noncompliance. (For more detailed information on the shipment of chemicals, see Chapter 5, section 5.F.)

2.D.6. Chemical Waste

All chemical waste must be stored and disposed of in compliance with applicable federal, state, local, and institutional regulatory requirements. Waste containers should be properly labeled and should be the minimum size that is required. There should be at least 2 in. of headspace in the liquid waste container to avoid a buildup of gas that could cause an explosion or a container rupture. (For more information about handling of hazardous waste, see Chapter 8.)

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2.E. LABORATORY INSPECTION PROGRAM

A program of periodic laboratory inspections helps keep laboratory facilities and equipment in a safe operating condition. Inspections safeguard the quality of the institution's laboratory safety program. A variety of inspection protocols may be used, and the organization's management should select and participate in the design of the inspection program appropriate for that institution's unique needs. The program should embrace the following goals:

- Maintain laboratory facilities and equipment in a safe, code-compliant operating condition.
- Provide a comfortable and safe working environment for all personnel and the public.
- Ensure that all laboratory activities are conducted in a manner to avoid employee exposure to hazardous chemicals.
- Ensure that trained laboratory personnel follow institutional CHPs.

Approach these goals with a degree of flexibility. Consider the different types of inspection, the frequency with which they are conducted, and who conducts them. A discussion of items to inspect and several possible inspection protocols follows, but is not all-inclusive.

Laboratory inspections are performed by EHS staff, the CHO, the safety director, laboratory staff, a safety committee, or an outside entity with the requisite qualifications and experience. The inspection checklist can include sections on chemical storage, chemical waste, housekeeping, PPE, laboratory chemical hoods, gas cylinder storage, emergency safety equipment, signs and labels, and facility issues.

Following each inspection, a detailed report is sent to the laboratory supervisor and appropriate administration. Photographs taken during the inspection process can emphasize the critical nature of a violation. Consider giving special recognition to laboratories demonstrating good laboratory practice and those that have demonstrated significant improvements in safety.

2.E.1. Types of Inspection Programs: Who Conducts Them and What They Offer

There are several types of inspection programs, each providing a different perspective and function. A comprehensive laboratory inspection program includes a combination of some or all of these programs.

2.E.1.1. Routine Inspections

Trained laboratory personnel and supervisors should complete general equipment and facility inspections on a regular basis. For certain types of equipment in constant use, such as gas chromatographs, daily inspections may be appropriate. Other types of equipment may need only weekly or monthly inspection or inspection prior to use if operated infrequently. Keep a record of inspection attached to the equipment or in a visible area. The challenge for any inspection program is to keep laboratory personnel continuously vigilant. They need positive encouragement to develop the habit of inspection and to adopt the philosophy that good housekeeping and maintenance for their workspace protect them and may help them produce better research results.

2.E.1.2. Self-Audits

To supplement an inspection program, some institutions promote self-inspections within the laboratories. Laboratory personnel may conduct their own inspections for their own benefit or management may ask them to self-audit and report their findings, using the routine inspections as a check on the self-inspections. This approach can be mutually beneficial, raising awareness, promoting the institutional safety culture, and easing the burden on management.

2.E.1.3. Program Audits

A program audit includes both a physical inspection and a review of the operations and the facilities. This type of audit is generally conducted by a team, which includes the laboratory supervisor, senior management, and laboratory safety representatives, and presents an excellent opportunity to promote a culture of safety and prudence within an organization. The supervisor and senior management have the opportunity to take a close look at the facilities and operations. They can discuss with individual workers issues of interest or concern that may fall outside the scope of the actual inspection. A constructive and positive approach to observed problems and issues fosters an attitude of cooperation and leadership with regard to safety and helps build and reinforce a culture of teamwork and cooperation that has benefits far beyond protecting personnel and the physical facilities.

The audit begins with a discussion of the safety program and culture, and a review of operations, written programs, training records, and pertinent policies and procedures and how they are implemented in the laboratory. A laboratory inspection that includes interviews with laboratory personnel follows to determine the level of safety awareness. An open discussion with key personnel can ascertain how personnel, supervisors, managers, and safety officers can better support each other.

This type of audit provides a much more comprehensive view of the laboratory than a routine inspection.

2.E.1.4. Peer Inspections

One of the most effective safety tools a facility can use is periodic peer-level inspections. Usually, the people who fulfill this role work in the organization they serve, but not in the area being surveyed. Personnel may participate on an ad hoc basis, or the institution may select specific individuals to be part of a more formal, ongoing inspection team. A peer inspection program has the intrinsic advantage of being perceived as less threatening than other forms of surveys or audits.

Peer inspections depend heavily on the knowledge and commitment of the people who conduct them. Individuals who volunteer or are selected to perform inspections for only a brief time may not learn enough about an operation or procedure to observe and comment constructively. People who receive involuntary appointments or who serve too long may not maintain the desired level of diligence.

A high-quality peer-level inspection program reduces the need for frequent inspections by supervisory personnel. However, peer inspections should not replace other inspections completely. Walk-throughs by the organization's leadership demonstrate commitment to the safety programs, which is key to their continuing success.

2.E.1.5. Environmental Health and Safety Inspections

The organization's EHS staff, the safety committee, or an equivalent group may also conduct laboratory inspections on a routine basis. These inspections may be comprehensive, targeted to certain operations or experiments, focused on a particular type of inspection such as safety equipment and systems, or audits to check the work of other inspectors.

Safety staff are not the only nonlaboratory personnel who may conduct safety inspections. Facility engineers or maintenance personnel may add considerable value to safety inspection programs. They are also given the opportunity to gain a better perspective on laboratory work. It is advisable to have a representative from facilities engineering present during inspections so physical deficiencies can be appropriately and clearly noted and understood and priorities set for correction.

2.E.1.6. Inspections by External Entities

Many types of elective inspections or audits are conducted by outside experts, regulatory agencies, emergency responders, or other organizations. They may inspect a particular facility, equipment, or procedure either during the preexperiment design phase or during operations. As a matter of safety and security, if someone requests entry to a laboratory for the purpose of an audit without a recognized escort, ask to see his or her credentials and contact the EHS office or other appropriate parties.

Tours, walk-throughs, and inspections by regulatory or municipal organizations offer the opportunity to build relationships with governmental agencies and the public. For example, an annual visit by the fire department serving a particular facility will acquaint personnel with the operations and the location of particular hazards. If these individuals are ever called into the facility to handle an emergency, their familiarity with it will make them more effective. During their walk-through, they may offer comments and suggestions for improvements. A relationship built over time helps make this input positive and constructive.

If a pending operation or facility change may raise public attention and concern, an invitation targeted to specific people or groups may prevent problems. Holding public open houses from time to time helps build a spirit of support and trust. Many opportunities exist to apply this type of open approach to dealing with the public. An organization only needs to consider when to use it and what potential benefits may accrue.

Inspections and audits by outside consultants or peer institutions are especially helpful to identify both best practices and vulnerabilities. Many times, the inspectors bring with them experiences and examples from other laboratories that prove useful. When choosing a consultant, best practice is to find one with experience conducting similar audits of peer institutions. More and more often, health and safety experts, facilities staff, and laboratory personnel from peer institutions form inspection teams that conduct inspections of each other's laboratories. Such an arrangement can be beneficial and economical.

Many regulatory agencies promote institutions conducting self-audits, by either consultants or peer auditors, and reporting the findings to the agency. As an incentive, any violations noted in the self-audit may result in reduced or waived fines and fewer visits from the agency inspectors. It is important to fully understand the regulatory agency's self-reporting policy before implementing this option. In some cases, the institution must commit to remediating identified deficiencies within a specific time period.

Finally, regulatory agencies may conduct announced or unannounced inspections on a routine or sporadic basis. Laboratories and institutions should keep their programs and records up-to-date at all times to be prepared for such inspections. Any significant incident or accident within a facility may trigger one or more inspections or investigations by outside agencies. Evidence that the underlying safety programs are sound may help limit negative findings and potential penalties.

2.E.2. Elements of an Inspection

2.E.2.1. Preparing for an Inspection

Whether an inspection is announced or unannounced depends on the objective. There are many advantages to announcing an inspection ahead of time. By announcing and scheduling inspections, the inspectors are more likely to interact with the laboratory personnel and the supervisors. The inspection can be a good learning experience for all and will feel less like a safety-police action and more like a value-added service, with the right attitude and approach. However, if the objective is to observe real-time conditions in preparation for a regulatory inspection, an unannounced targeted inspection might be appropriate.

Before the inspection, have a checklist of inspection items, along with the criteria and the basis for each issue. The criteria may be based on regulations, institutional policies, or recommended practices. Sharing the checklist with laboratory personnel prior to the inspection helps them perform their own inspections before and periodically after the inspection.

Bring a camera. A photograph is much more effective than a long explanation in convincing a manager that something needs attention.

2.E.2.2. Inspection Checklists

Inspection checklists take a variety of formats and vary in length depending on the type and focus of the inspection. Although most inspection forms are paper, some are computer based. Make each inspection item a YES or NO question. Pose the issue so that a positive outcome is a YES, making it easy to spot problems. Always leave room for comments.

There are a number of commercial products on the market offering Web-based applications that work on a laptop or notebook computer. Checklist programs are available for handheld digital devices. Some may download into spreadsheets or word-processing programs. Others automatically create reports that can be e-mailed to recipients. All are intended to streamline the record-keeping and reporting process.

2.E.2.3. Conducting the Inspection

When conducting an inspection, interacting with the individuals in the laboratory is important. Even if inspectors are mainly looking at equipment and conditions, laboratory personnel can provide a great deal of information and the conversation itself may foster positive relationships between laboratory personnel and the group conducting the inspection. Speaking with laboratory personnel also helps gauge how well training programs are working and provides feedback for possible improvements to the laboratory safety program.

Take notes and make comments on the inspection form to be able to recall the details and describe any problems in the report. Where possible, take photographs of issues that need particular attention.

Point out problems as they are found and show laboratory personnel how to fix them. If the problem is corrected during the inspection, make a note that it was resolved.

2.E.2.4. Inspection Report

As soon as possible after an inspection, prepare a report for the laboratory supervisor and others, as appropriate. This may include the CHO, the chair or manager of the department, line supervisors, and directors. Depending on the type and focus of the inspection, it may be helpful to hold a meeting with the key individuals to review the findings.

The report should include all problems noted during the inspection, along with the criteria for correcting them. If photographs were taken, include them in the report. The report should also note any best practices and any improvements since the last inspection.

Include a reasonable time line for corrective actions. Be sure to follow up with the laboratory to ensure that recommended corrections are made.

2.E.2.5. Corrective Actions

In most cases, laboratory personnel will take the appropriate corrective actions once they have been made aware of an issue. If the laboratory supervisor is not supportive and the necessary changes are not made, the inspectors and EHS and other appropriate individuals in the organization will have to decide whether the infractions are serious enough to put either the health or safety of laboratory personnel at risk or the institution at risk for violation of a regulation or code.

The organization must decide what steps to take for those individuals or laboratory groups that are using unsafe work practices or are not in compliance with institutional policies or external regulations.

2.E.3. Items to Include in an Inspection Program

The following list is representative, not exhaustive:

- Required PPE is available and used consistently and correctly (e.g., laboratory coat, gloves, safety glasses, chemical splash goggles, face shield).
- Compressed gas cylinders are secured correctly, cylinders are capped if not connected for use, and proper regulators are used.
- Limitations on where food and drink storage and eating and drinking are allowed are observed.
- Electrical cords are off surfaces where spills of flammable materials are likely, and cords are in good condition, not displaying signs of excessive wear (fraying, cords are not pinched). Equipment not meeting National Electrical Safety Code Division 1, Group C and D explosion-resistance specifications are electrically inspected prior to use in the laboratory. (See Chapter 7, section 7.C.)

- Laboratory chemical hoods have been tested and are operated with inspection information visible, hoods are used properly, work is conducted inside 6 in. from hood face, airflow is not significantly impeded by large pieces of equipment.
- Vacuum glassware is inspected and maintained in good condition, pressure reaction vessels with pressure relief and temperature/pressure measuring capability are used for high-pressure reactions.
- Health classification of materials is conducted (particularly for unknown compounds), and associated work practices and containment based on hazard/risk classification of the material are followed (e.g., low hazard, hazardous, particularly hazardous materials and associated requirements for use of ventilated enclosures, disposal of waste, labeling of areas where work with high-hazard materials is conducted, decontamination of work surfaces).
- Access to emergency equipment is unobstructed (e.g., safety showers, eyewash units, fire extinguishers), and equipment is maintained in good working order. Aisles are unobstructed and minimum egress is maintained. Minimum clearance to sprinkler heads, as required by local building and fire codes, is maintained.
- Chemicals are properly stored and segregated (e.g., flammables, strong acids, strong bases, peroxides).
- Personnel demonstrate ability to access MSDSs or other chemical safety references and knowledge of handling requirements for various classifications of materials.
- Rotating machinery and high-temperature devices have appropriate guards. Safety switches and emergency stops are working.
- Associated egress corridors are unobstructed and minimum egress as required by building and fire codes is maintained. Combustible and surplus materials and equipment are removed from exit passageways.

Depending on the laboratory and the type of work conducted in it, other items may also be targeted for inspection (Box 2.4).

BOX 2.4

Excerpt from an Inspection Checklist. Department/Group/Laboratory: Inspector:

Go to:

2.F. EMERGENCY PROCEDURES

2.F.1. Fire Alarm Policy

When a fire alarm sounds in the facility, evacuate the laboratory immediately via the nearest exit. Extinguish all Bunsen burner and equipment flames. If the fire originates in your laboratory, follow all institutional policies regarding firefighting and suppression. Check restrooms and other areas with possible limited audio or visual notification of an alarm before exiting the facility. Where necessary, provide assistance to persons with disabilities to ensure they are able to exit the facility.

2.F.2. Emergency Safety Equipment

The following is a guide to safety equipment found in a laboratory.

1. A written EAP has been developed and communicated to all personnel in the unit. The plan includes procedures for evacuation, ventilation failure, first aid, and incident reporting.
2. Fire extinguishers are available in the laboratory and tested on a regular basis. If a fire extinguisher is activated for any reason, make an immediate report of the activity to the CHO, fire marshal, or appropriate individual responsible for fire safety equipment so that the fire extinguisher is replaced in a timely manner.
3. Eyewash units are available, inspected, and tested on a regular basis.
4. Safety showers are available and tested routinely.

5. Fire blankets are available in the laboratory, as required. Fire blankets can be used to wrap a burn victim to douse flames as well as to cover a shock victim and to provide a privacy shield when treating a victim under a safety shower in the event of a chemical spill.

NOTE: Laboratory personnel should be taught that fire blankets can be dangerous if used incorrectly. Wrapping a fire blanket around a person on fire can result in a chimney-like effect that intensifies, rather than extinguishes, the fire. Fire blankets should never be used on a person when they are standing. (See Chapter 7, section 7.F.2.3 for more information on responding to fires.)

6. First-aid equipment is accessible, whether through a kit available in the laboratory or by request through the organization.

7. Fire alarms and telephones are available and accessible for emergency use.

8. Pathways to fire extinguishers, eyewash units, fire blankets, first-aid kits, and safety showers are clear.

2.F.3. Chemical Spill Policy

Laboratory personnel should be familiar with the chemical, physical, and toxicological properties of each hazardous substance in the laboratory. Consult the label and the MSDS prior to the initial use of each hazardous substance. Always use the minimal amount of the chemical and use caution when transporting the chemical. In the event of an accidental chemical release or spill, personnel should refer to the following general guidelines.

Most laboratory workers should be able to clean up incidental spills of the materials they use. Large spills, for example, 4 L or more, may require materials, protective equipment, and special handling that make it unsafe for cleanup by laboratory workers themselves. Lab workers should be instructed to contact EHS personnel to evaluate how to proceed with spill cleanup.

In the event that the spill material has been released to the environment, notify EHS personnel immediately. A release to the environment includes spills directly into a drain or waterway or onto land, such as grass or dirt.

Low-flammability and low-toxicity materials that are not volatile (e.g., inorganic acids and caustic bases)

1. Decontaminate any victim at the nearest safety shower or eyewash unit. Take other appropriate action as described in the MSDS.
2. Notify appropriate personnel immediately.[4]
3. Limit or restrict access to the area as necessary.
4. Wear PPE that is appropriate to the degree of hazard of the spilled substance.
5. Use chemical spill kits that contain an inert absorbent to clean up the affected area if this action can be accomplished without risk of additional injury or contamination to personnel. If the spill is located on the laboratory floor, be aware that some absorbents can create a slipping hazard.
6. Dispose of contaminated materials according to institutional policy.
7. Complete an incident report and submit it to the appropriate office or individual.
8. Label all phones with emergency phone numbers.

Flammable solvents of low toxicity (e.g., diethyl ether and tetrahydrofuran)

1. Decontaminate any victims at the nearest safety shower or eyewash unit. Take other appropriate action as described in the MSDS.
2. Alert all other personnel in the laboratory and the general vicinity of the spill.
3. Extinguish all flames and turn off any spark-producing equipment. If necessary, turn off power to the laboratory at the circuit breaker. The ventilation system must remain operational.
4. Immediately notify appropriate personnel.[4]
5. Limit or restrict access to the area as necessary.
6. Wear PPE that is appropriate to the degree of hazard of the spilled substance.
7. Use spill pillows or spill absorbent and nonsparking tools to soak up the solvent as quickly as possible. Be sure to soak up chemicals that have seeped under equipment and other objects in the laboratory. If the spill is located on the laboratory floor, be aware that some absorbents can create a slipping hazard.

8. Dispose of contaminated materials according to institutional policy.
9. Complete an incident report and submit it to the appropriate office or individual.

Highly toxic materials (e.g., dimethylmercury)

1. Alert all trained laboratory personnel in the laboratory and the general vicinity of the spill and immediately evacuate the area.
2. Decontaminate any victims at a safety shower or eyewash unit in a safe location. Take other appropriate decontamination action as described in the MSDS.
3. Immediately notify appropriate personnel.[4]
4. Limit or restrict access to the area as necessary.
5. Do not attempt to clean up the spill. EHS personnel will evaluate the hazards that are involved with the spill and will take the appropriate actions.
6. Only EHS personnel and appropriate outside industrial hygienists are authorized to decontaminate the area and dispose of the contaminated waste.
7. Complete an incident report and submit it to the appropriate office or individual.

2.F.4. Accident Procedures

In the event of an accident, follow all institutional policies for emergency response and notify the internal point of contact for laboratory safety and local emergency responders. All accidents involving personal injury, however slight, must be immediately reported according to your institution's procedure. Provide a copy of the appropriate MSDS to the attending physician, as needed. Complete an accident report (Figure 2.2) and submit it to the appropriate office or individual within 24 hours of the incident.

FIGURE 2.2

Accident report form.

Go to:

2.G. EMPLOYEE SAFETY TRAINING PROGRAM

Newly hired employees or students working in a laboratory should be required to attend basic safety training prior to their first day. Additional training should be provided to laboratory personnel as they advance in their laboratory duties or when they are required to handle a chemical or use equipment for the first time.

Safety training should be viewed as a vital component of the laboratory safety program within the organization. The organization should provide ongoing safety activities that serve to promote a culture of safety in the workplace that will begin when the person begins work and will continue for the length of their tenure. Personnel should be encouraged to suggest or request training if they feel it would be beneficial. The training should be recorded and related documents maintained in accordance with organizational requirements.

Training sessions may be provided in-house by professional trainers or may be provided via online training courses. Hands-on, scenario-based training should be incorporated whenever possible. Safety training topics that may prove to be helpful to laboratory personnel include

- use of CHPs and MSDSs,
- chemical segregation,
- PPE,

- safety showers and eyewash units,
- first aid and cardiopulmonary resuscitation,
- chemical management,
- gas cylinder use,
- fire extinguisher training,
- laser safety, and
- emergency procedures.

o make sure the hazardous chemicals at your workplace are handled and stored correctly, it is essential to have a Chemical Management Procedure (CMP). Your CMP will include a full risk assessment of each substance as well as the development of suitable hazard control measures — like introducing a consistent chemical handling and storage procedure. This blog outlines the four steps involved in creating such a procedure.

1. Identify all the hazardous substances that are onsite

You cannot create a chemical handling and storage procedure until you know what substances are being used onsite, how they are being used, and where they are located. You first task is to identify every chemical at your workplace.

The best way to do this is carrying out a full site inspection, walking around and physically identifying each substance. It's a good idea to carry a sitemap or floor plan, marking the location of each chemical storage area.

An important part of the identification process is to obtain the Safety Data Sheet (SDS) from the manufacturer or supplier of each hazardous chemical. The SDS will specify the chemical hazards as well as handling, storage and emergency information.

2. Assess the risk associated with each chemical storage area

Once you have a list of the chemicals along with where they are located onsite, you can begin your risk assessment. You'll want to look at the health hazards of each chemical(irritant, carcinogenic, poisonous) as well as the physiochemical hazards (explosive, flammable, corrosive).

Some questions you might ask during your risk assessment:

- Can untrained and unauthorised personnel access chemical stores?
- Are there hazardous chemicals which are incompatible with other substances and need to be stored separately?
- Are the flammable chemicals stored far enough away from ignitions sources?
- Are corrosives stored in a metal-free safety cabinet?
- Are chemical storage areas well ventilated?

TIP: to learn more about chemical hazards and how to control them read our blog Chemical Hazards in the Workplace.

3. Implement hazard control measures

Now it's time to implement control measures to ideally eliminate or (at the very least) minimise each of risks associated with the chemical hazards. To comply with Australian WHS legislation you should use the *Hierarchy of Control* to do this.

To understand how the *Hierarchy of Control* works let's imagine you use a hazardous chemical which is corrosive to metal, toxic and flammable. According to the *Hierarchy of Contro*l you should (in this order) try:

- **Elimination**. Could you stop using the corrosive substance completely?
- **Substitution**. Could you use a different chemical that is less harmful?

- **Engineering**. Could you store the corrosive substance in a safety cabinet in a NO SMOKING area away from ignition sources?
- **Administration**. Could you create safe handling and storage procedures?
- **PPE**. Could you have employees wear protective clothing and install safety showers and eye wash stations?

Your control measures might be a combination of items 3-5: storing the chemical into a corrosive cabinet, implementing a NO SMOKING policy at the workplace, and having employees wear chemical resistant gloves and eye guards.

Your chemical handling and storage policy will really be a documented summary of each of the control measures you introduce. And don't forget that a major part of risk control istraining your staff.

TIP: to learn more about controlling chemical hazards why not download our free eBook How to manage the risk of Hazardous Chemicals in the workplace.

4. Review your chemical handling and storage procedures

Once you've implemented all your control measures and trained all your staff, it's important to sustain chemical safety at the workplace. You should have a system in place to ensure risk assessments are completed periodically — like when new chemicals are introduced to the workplace or the changes are made to job design.

Compliance with WHS laws is not something you can do once and then forget. Legislation changes, workplaces expand, chemical brands substituted, different work methods introduced, new staff hired.

Please Make sure your chemical handling and storage procedure is updated regularly and always addresses the hazardous chemicals currently in use at the worksite.

KARPAGAM ACADEMY OF HIGHER EDUCATION

CLASS: IM.Sc CHEMISTRY COURSE NAME:RESEARCH METHODOLOGY FOR CHEMISTRY

COURSE CODE: 19CHP 205A UNIT: IV(Chemical Safety and Ethical Handling of Chemicals) BATCH-2019-2021

S.NO	Questions	Opt-1	Opt-2	Opt-3	Opt-4	Answers
1	1-Probability of the event that might occur X Severity of the event if it occurs =	Accident	Hazard	Risk	chemical	Risk
2	Energy recovery is typically via production of ____	Steam	Light	Heat	Gas	Steam
3	3-The following is indirect cost of accident	Money paid for treatment of worker	Compensation paid to worker	Cost of lost time of injured worker	insurance	Cost of lost time of injured worker
4	Check list for Job Safety Analysis (JSA) consists of	Work area, material, machine, tools	Men, machine, material, tools	Men, machine, work area, tools	Men, work are Material, tools	Work area, material, machine, tools
5	6-A safety programme consists of	Three E's	Four E's	Five E's	Six E's	Four E's
6	7-For household wiring and small units, the following should be used for safety measure	MCB	ACB	OCB	MCCB	MCB
7	Which of the following colour is used for radiation hazard?	Red	Orange	Green	Purple	Purple
8	9-Decibel (db) is a unit used to measure	Light	Sound	Frequency	waves	Sound
9	12-Class-A fire consists of fire due to	Wood	Oil	Transformer	Chemical	Wood

10	The following extinguisher is suitable for cotton or other textile fire	Water	Soda acid	Foam	Dry chemicals	Dry chemicals
11	_____ is best suited to extinguishing oil or flammable liquid fire.	Soda acid	Vaporizing liquid	Foam	Dry chemical	Foam
12	The term “Teratogenic Effect” with reference to exposure to theHazardous Chemical, means, -	Effect on Genes	Effect on the unborn child	Effect on rate of Cell mutation in the body	Effect of development of the Children	Effect on the unborn child
13	The term “Mutagenic Effect” with reference to exposure to theHazardous Chemical, means, -	Effect on Genes	Effect on the unborn child	Effect on rate of Cell mutation in the body	Effect of development of the Children	Effect on Genes
14	While examining a consignment of hazardous chemical at Port, if yourcolleagues Custom Officer has been exposed to a chemical and has become unconscious, which one of the following action you should immediately take?	Immediately take him to the hospital	Immediately activate an emergency response system	Get hold of the MSDS sheet of the Chemical and look for the instruction in the section dealing with First Aid Measures and follow the instruction contained therein.	To call for ambulance	Get hold of the MSDS sheet of the Chemical and look for the instruction in the section dealing with First Aid Measures and follow the instruction contained therein.
15	As a Customs officer, which section of the MSDS sheet will you refer to find out the information about health hazards of the Chemicals before inspecting or examining the consignment?	Hazards Identification	Composition and information on ingredient	First Aid Measures	Accidental Release Measures	Hazards Identification

16	As a Customs Officer, which section of the MSDS sheet will you refer to find out the information about Physical hazards of the Chemicals before inspecting or examining the consignment?	Hazards Identification	Stability and reactivity	First Aid Measures	Accidental Release Measures	Stability and reactivity
17	As a Custom Officer, which section of the MSDS sheet you will refer to find out the information about Personal Protective Equipment (PPE) to be used while dealing with the chemicals in question?	First Aid Measures	Accidental Release Measures	Handling and Storage	Exposure Controls/Personal Protection	Exposure Controls/Personal Protection
18	As a Customs officer, before taking sample from any imported hazardous chemical consignment, what document he must first refer to?	Bill of Entry.	Bill of Lading.	MSDS	Invoice	MSDS
19	Which of the following heading of the section of the MSDS contained information about Physical and Chemical Characteristics of Chemical like odour, appearance, etc?	Hazard Identification	Composition and Information on ingredients	Accidental Release Measures	Physical and Chemical Property	Physical and Chemical Property
20	Which of the following information is not provided in the section of MSDS dealing with Accidental Release Measures?	Precaution to be taken to avoid spillage or leakage	Measure to be adopted to deal with leakage	Measure to be adopted to deal with large spill	Measure to be adopted to deal with small spill	Precaution to be taken to avoid spillage or leakage
21	Workplace health and safety legislation imposes a duty of care on;	the employer	the employee	all participants in the workplace	visitors to the workplace	all participants in the workplace

22	Hazardous substances are:	all participants in the workplace	only those that cause chronic health effects	only those that have set exposure standards	only those that are on the NOHSC list of designated hazardous substances, or that meet the NOHSC approved criteria for classifying hazardous substances	only those that are on the NOHSC list of designated hazardous substances, or that meet the NOHSC approved criteria for classifying hazardous substances
23	An MSDS may not contain information about:	what the hazardous substance should be used for	first aid instructions	the health effects of the hazardous substance	the requirement for health surveillance	the requirement for health surveillance
24	The national exposure standard for glutaraldehyde is:	0.04 ppm	1 ppm	0.2 ppm	0.05 ppm	1 ppm
25	The protective clothing routinely required to be used when reprocessing flexible endoscopes does not include:	half face respirator	gloves	fluid resistant aprons or gowns	specifically designed fluid repellent masks / eye protection / face shields	half face respirator
26	After how many years/period MSDS sheets are normally required to be updated?	Every year	Every 3 years	Every 5 years	No periodicity prescribe	Every 3 years
27	Which of the following information can not be found in MSDS?	First Aid Measures	Accidental Release measures	Medicine to be taken by the effected person if exposed to the Chemical	Composition /information on ingredients	Medicine to be taken by the effected person if exposed to the Chemical

28	Which of the following information is not provided in the Section of an MSDS dealing with Chemical Identification?	Name of the Chemical	Name of the manufacturer and it's address	Toxicity of the Ingredients of the Chemical	Emergency contact number	Toxicity of the Ingredients of the Chemical
29	The term "CHEMTREC" stands for	Chemical Transportation Emergency Centre	Chemical Training Centre	Chemical Treatment Centre	Chemical Toxicity Recovery Centre	Chemical Transportation Emergency Centre
30	What is the main purpose of hazard identification?	To minimise the effect of a consequence	For better risk management	To characterize adverse effect of toxins	To reduce probability of occurrence	To characterize adverse effect of toxins
31	The _____ process determines whether exposure to a chemical can increase the incidence of adverse health effect.	Hazard identification	Exposure assessment	Toxicity assessment	Risk characterization	Hazard identification
32	Which of the following data is not required for hazard identification?	Land use	Contaminant levels	Affected population	Estimation of risk	Estimation of risk
33	Why does site history have to be considered for hazard identification?	To estimate the risk	To calculate carcinogenic exposure	To know the probable source and causes of contamination on site	For determination of remedial actions	To know the probable source and causes of contamination on site
34	What is the main objective of risk assessment?	To evaluate hazard and minimize the risks	Remediation of contaminated sites	Hazard management	To know source of pollutants	To evaluate hazard and minimize the risks
35	What is the first stage of risk assessment?	Exposure assessment	Hazard identification	Toxicity study	Risk characterisation	Hazard identification

36	An incident can be called hazardous only when	Stressor has the potential to cause harm to humans and ecological systems	Poses threat to surrounding	Monitoring is failed	Outburst of chemicals	Stressor has the potential to cause harm to humans and ecological systems
37	Hazard identification mainly focus on	Chemical source and concentration	Chemical exposure	Chemical analysis	Chemical pathway	Chemical source and concentration
38	Proper handling and storage of flammable liquids is important to eliminate dangers and prevent _____.	Safety	Fires	Smoking	Flashpoint	Fires
39	Flammable liquids are divided into _____ categories.	Six	Four	Two	Five	Four
40	It is important that _____ involved in handling flammable liquids understand correct handling and storage requirements.	Supervisors	Short service employees	Managers	All workers	All workers
41	Only store flammable liquids in _____ glass, plastic, or metal containers and portable tanks that have vapor tight, self-closing covers.	Unapproved	Open	Permanent	Approved	Approved
42	It is very important not to store or use flammable liquids around a(n) _____.	Fire extinguisher	Storage cabinet	Ignition source	Safety can	Ignition source
43	Keep flammable liquid containers _____ when not in use.	Closed	Open	Near ignition sources	Empty	Closed

44	Only store _____ materials in the same room with flammable liquids.	Incompatible	Heat-producing	Compatible	Explosive	Compatible
45	Only attempt to put out a fire if you are _____ and can do it safely.	Injured	Alone	Unprepared	Trained	Trained
46	The waste plastics are converted into liquid fuel by the …….process.	Pyrolysis	Cracking	Hydrolysis	Incineration	Pyrolysis
47	Who is responsible for safe disposal of the generated hazardous waste?	Generator	Receiver	Waste facility	TSDF	Generator
48	Why is manifest system necessary?	To monitor journey of waste	To track waste	To analyse chemicals	To export	To monitor journey of waste
49	Which form of shipment is common for transport of hazardous waste?	Rail	Road	Air	Inland water	Road
50	A prohibited waste should not be disposed on _____ according to LDR.	Land	Air	Water	Facility	Land
51	Tracking system can be improved by modifying _____ system.	Analyzing	Chemical component	Waste minimization	DOT	Waste minimization
52	Tracking system has to be done to prevent ____	Illegal waste dumping	Waste minimisation	Waste generation	Waste analysis	Illegal waste dumping

53	Characteristic of an hazardous waste that causes fire is ____	Corrosivity	Reactivity	Toxicity	Ignitibility	Ignitibility
54	Character exhibited by waste oils is ____	Ignitibility	Corrosivity	Reactivity	Toxicity	Ignitibility
55	For a waste to be considered ignitable the alcohol content should be less than _____ percent.	21	24	22	23	24
56	For a waste to be considered ignitable the flash point should be less than _____ Celsius.	50	60	70	80	60
57	Flash point of an ignitable waste is determined by ____ tester.	Pensky-Martens	Donald	Harry-styles	Max-light	Pensky-Martens
58	What is the parameter responsible for ignitibility in non-liquid waste?	Volume	Temperature	Area	Storage	Temperature
59	A _____ exhibits ignitable character.	Metal	Heavy metal	Oxidizer	Pollutant	Oxidizer
60	Hazardous waste number of material that is not considered ignitable is ____	D002	D003	D001	D005	D001

Unit V- Data Analysis and Electronics

Data Analysis: The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

Electronics: Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Basic Components Used in Electronics & Electrical

- ELECTRONICS
  2 COMMENTS

In any electronic circuit, we come across two types of electronic component:

One which responds to the flow of electrical energy and either store or dissipate energy. These are the Passive Components. They can be linear components with a linear response to the electrical energy or non linear components with a non linear response to the electrical energy.

One which supplies energy or controls the flow of energy. These are the Active components. They require an external power source to be triggered and are generally used to amplify electrical signal.

Let us see each and every component in details.

3 Passive Linear Components:

Resistor: A resistor is an electronic component which is used to resist the flow of current and cause a reduction in potential. It consists of a low conductive component joined by conducting wires at both its ends. When current flows through the resistor, the electrical energy is absorbed by the resistor and dissipated in form of heat. The resistor thus offers a resistance or opposition to the flow of current. The resistance is given as **R = V/I,** where V is the voltage drop across the resistance and I is the current flowing through the resistor. The power dissipated is given by:

P = VI.

Laws of Resistance:

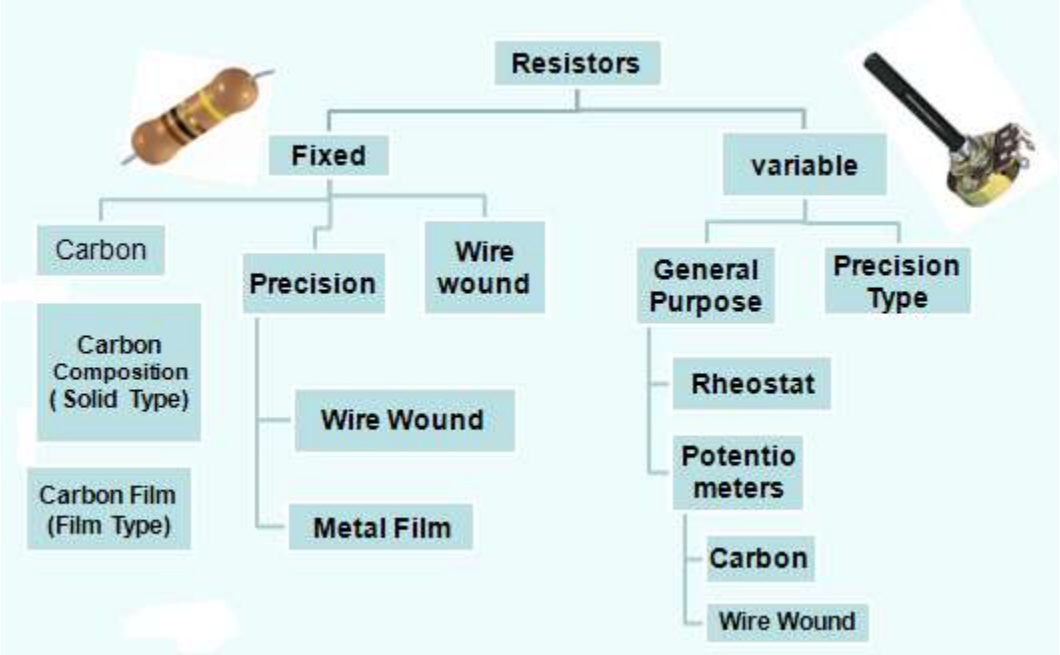
The Resistance 'R' offered by a material depends on various factors

1. Varies directly on its length, l
2. Varies inversely on its cross section area, A
3. Depends on the nature of the material specified by its Resistivity or Specific Resistance, ρ
4. Also depends on the temperature
5. Assuming that the temperature is constant, the Resistance (R) can be expressed as $R = \rho l / A$, Where R is resistance in ohms (Ω), l is length in meters, A is area in square meters and ρ is Specific Resistance in Ω-mts

A resistor's value is calculated in terms of its resistance. Resistance is the opposition to the flow of current.

Two methods to measure resistance values:

- Using color code: Each resistor consists of a 4 or 5 color band on its surface. The first three (two) colors represents the resistor value, whereas the 4th (third) color represents the multiplier value and the last one represents the tolerance.
- Using Multimeter: A simple way to measure resistance is by using a Multimeter to measure the resistance value in ohms.



2 Types of Resistors:

- **Fixed Resistors**: Resistors whose resistance value is fixed and are used to provide a opposition to the flow of current.
  - They can be carbon composition resistors which are made up of mixture of carbon and ceramic.
  - They can be carbon film resistors which consists of carbon film deposited on an insulated substrate.

A Carbon Resistor

- They can be metal film resistor which consists of small ceramic rod coated with metal or metal oxide, with the resistance value being controlled by the

thickness of the coating.

Metal Resistors

- They can be wire wound resistor which consists of an alloy wrapped around a ceramic rod and insulated.
- They can be surface mount resistor which consists of resistive material like tin oxide deposited on a ceramic chip.

- **Variable Resistors**: They provide a variation in their resistance value. They are generally used in voltage division. They can be potentiometers or presets. The resistance can be varied by controlling the wiper movement. The variable resistor or variable resistance, which is consist three connections. Generally used as an adjustable voltage divider. It is a resistor with a movable element positioned by a manual knob or lever. The movable element is also called as wiper; it creates a contact with a resistive strip at any point which is selected by the manual control.

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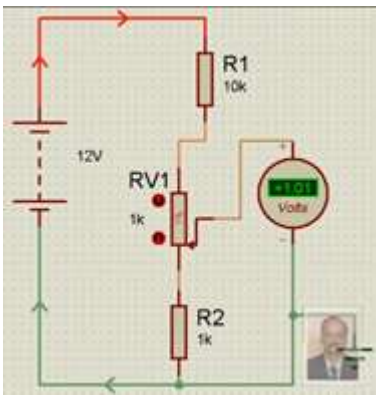
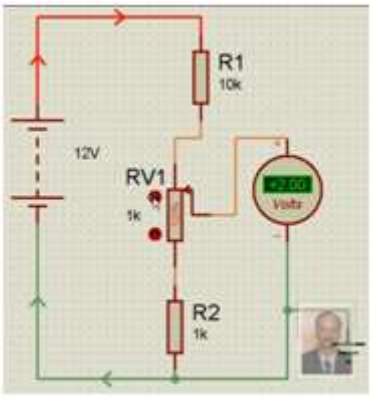
Potentiometer

The potentiometer divides the voltage in to different proportions depending on its movable positions. It is used in different circuits where we require less voltage than the source voltage.

Practical Application of Variable Resistors:

Sometimes it is necessary to design a variable dc bias circuit that should be able to very precisely get some specific voltage say 1.5 volts. Thus a potential divider with a variable resistor is so chosen that one can vary the voltage from 1 volt to 2 volt from a 12 volt DC battery. Not from 0 to 2 volt but 1 to 2 volt for specific reason One can use a 10k pot across a 12 volt dc and can get that voltage but it becomes very difficult to adjust the pot as the full arc angle of about 300 degrees. But if one follows a circuit below he can get easily that voltage because entire 300 degree is available for just 1volt to 2 volt to be adjusted. Shown in the circuit below 1.52 volts. This how we get a better resolution. These onetime set variable resistors are called preset.





- **Capacitors**: A capacitor is a linear passive component which is used to store electrical charge. A capacitor generally provides reactance to the flow of current. Basically a capacitor consists of a pair of electrodes between which there is an insulated dielectric material.

The stored charge is given by

Q = CV where C is the capacitive reactance and V is the applied voltage. Since current is rate of flow of charge. Therefore, the current through a capacitor is:

I = C dV/dt.

When a capacitor is connected in a DC circuit, or when a constant current flows through it, which is constant with time (zero frequency), the capacitor simply stores the whole charge and opposes the flow of current. Thus a capacitor blocks DC.

When a capacitor is connected in an AC circuit, or a time varying signal flows through it (with non zero frequency), the capacitor initially stores the charge and later offers a resistance to the flow of charge. It can thus be used as a voltage limiter in AC circuit. The resistance offered is proportional to the frequency of the signal.

2 Types of Capacitors

- **Fixed Capacitors**: They offer a fixed reactance to the flow of current. They can be Mica capacitor which consists of mica as the insulating material. They can be non polarized ceramic capacitors which consist of ceramic plates coated with silver. They can be electrolyte capacitors which are polarized and used where high value of capacitance is required.

A Ceramic Capacitor

An Electrolyte Capacitor

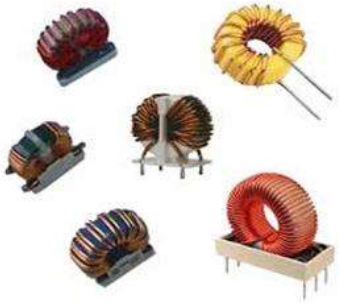
Fixed Capacitors

- **Variable Capacitors**: They offer capacitance which can be varied by varying the distance between the plates. They can be air gap capacitors or vacuum capacitors.

Capacitance value can be either read directly on the capacitor or can be decoded using the given code. For ceramic capacitors, the 1st two letters denote the capacitance value. The third letter denotes the number of zeros and the unit is in Pico Farad and the letter denotes the tolerance value.

- **Inductors**: An inductor is a passive electronic component which stores energy in form of a magnetic field. It generally consists of a conductor coil, which offers a resistance to the applied voltage. It works on the basic principle of Faraday's law of inductance, according to which a magnetic field is created when current flows through the wire and the electromotive force developed opposes the applied voltage. The stored energy is given by:

E = LI^2. Where L is the inductance measured in Henries and I is the current flowing through it.



Inductor Coils

It can be used as a choke to offer resistance to the applied voltage and store the energy or used in combination with a capacitor to form a tuned circuit, used for oscillations. In AC circuits, the voltage leads the

current as imposed voltage takes some time to build up the current in the coil due to opposition.

2 Passive Non Linear Components:

Diodes: A diode is a device which restricts current flow in only one direction. A diode is generally a combination of two differently doped regions forming a junction at the intersection such that the junction controls the flow of charge through the device.

6 Types of Diodes:

- **PN Junction Diode**: A simple PN junction diode consists of a p-type semiconductor mounted on an n-type semiconductor such that a junction is formed between the p and n types. It can be used a rectifier which allows current flowing in one direction through proper connection.

A PN Junction Diode

- **Zener Diode**: It is a diode made up of heavily doped p region compared to the n-region, such that it not only allows current flow in one direction, but also allows current flow in the opposite direction, on application of sufficient voltage. It is generally used as voltage regulator.

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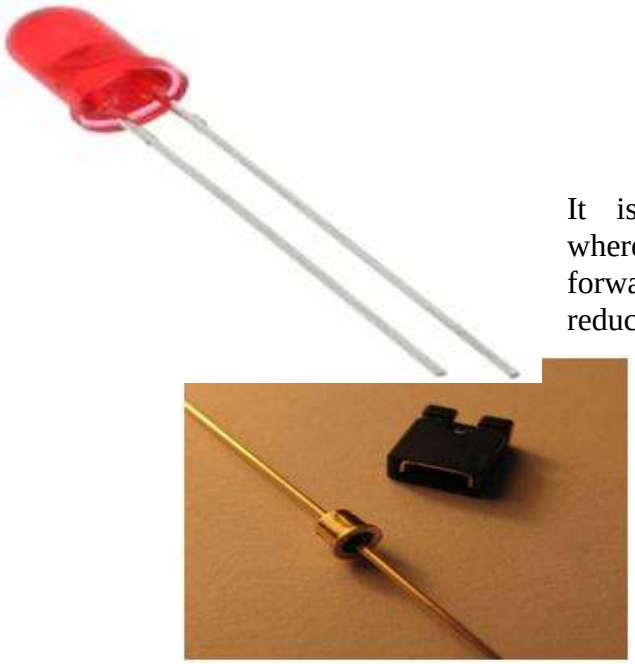


A Zener diode

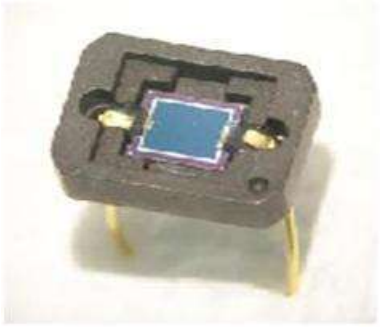
- **Tunnel Diode**: It is a heavily doped pn junction diode where the current decreases with increasing forward voltage. The junction width is reduced with increasing impurity concentration. It is made from germanium or Gallium Arsenide.

A Tunnel Diode

- **Light Emitting Diode**: It is a special type of PN junction diode made from semiconductors like Gallium Arsenide, which emits light when a suitable voltage is applied. The light emitted by the LED is monochromatic, i.e. of single color, corresponding to a particular frequency in the visible band of the electromagnetic spectrum.

A LED

- **Photo Diode**: It is a special type of PN junction diode whose resistance decreases when light falls on it. It consists of a pn junction diode placed inside a plastic.



A Photodiode

- **Switches**: Switches are devices which allow the flow of current to the active devices. They are binary devices, which when completely on, allows flow of current and when completely off, block the flow of current. It can be a simple toggle switch which can be a 2-contact or a 3 contact switch or a push button switch.
-

2 Active Electronic Components:

Transistors: Transistors are devices which generally transform resistance from one part of the circuit to another. They can be voltage controlled or current controlled. A transistor can work as an amplifier or as a switch.

2 Types of Transistor:

- **BJT or Bipolar Junction Transistor**: A BJT is a current controlled device which consists of a layer of n-type semiconductor material sandwiched between two layers of p type semiconductor material. It consists of three terminals – The emitter, base and collector. The collector base junction is less doped compared to the emitter base junction. The emitter base junction is forward biased whereas the collector base junction is reverse biased in normal transistor operation.

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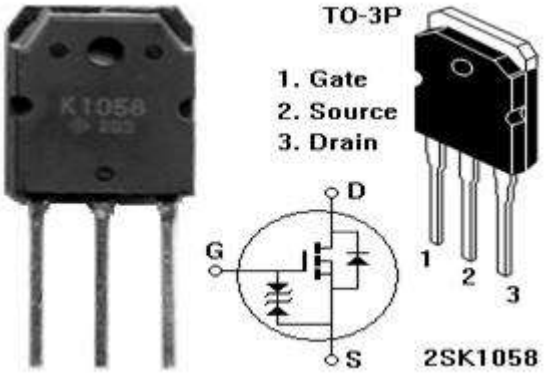
A Bipolar Junction Transistor

- **FET or Field Effect Transistor**: A FET is a voltage controlled device. The ohmic contacts are taken from the two sides of the n type bar. It consists of three terminals – Gate, Drain and Source. The voltage applied across the Gate-Source and the Drain-Source terminal controls the flow of current through the device. It is generally a high resistance device. It can be JFET (junction Field effect transistor) which consists of an n type substrate, on the side of which a bar of the opposite type is deposited or a MOSFET (Metal Oxide Semiconductor FET) which consists of an insulated layer of silicon oxide between the metallic Gate contact and the substrate.



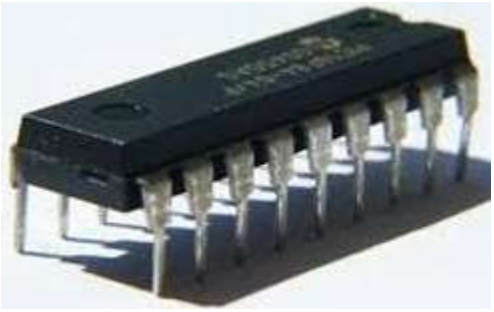
MOSFET

- **TRIACS or SCR**: An SCR or Silicon Controlled Rectifier is a three terminal device which is generally used as a switch in power electronics. It is a combination of two back to back diodes having 3 junctions. The current through the SCR flows because of the voltage applied across anode and cathode and is controlled by the voltage applied across the Gate terminal. It is also used as a rectifier in AC circuits.

An SCR

So these are some of the important components in any electronic circuit. Apart from these active and passive components, there is one more component, which is of vital use in the circuit. That is the Integrated Circuit.

What is an Integrated Circuit?



A DIP IC

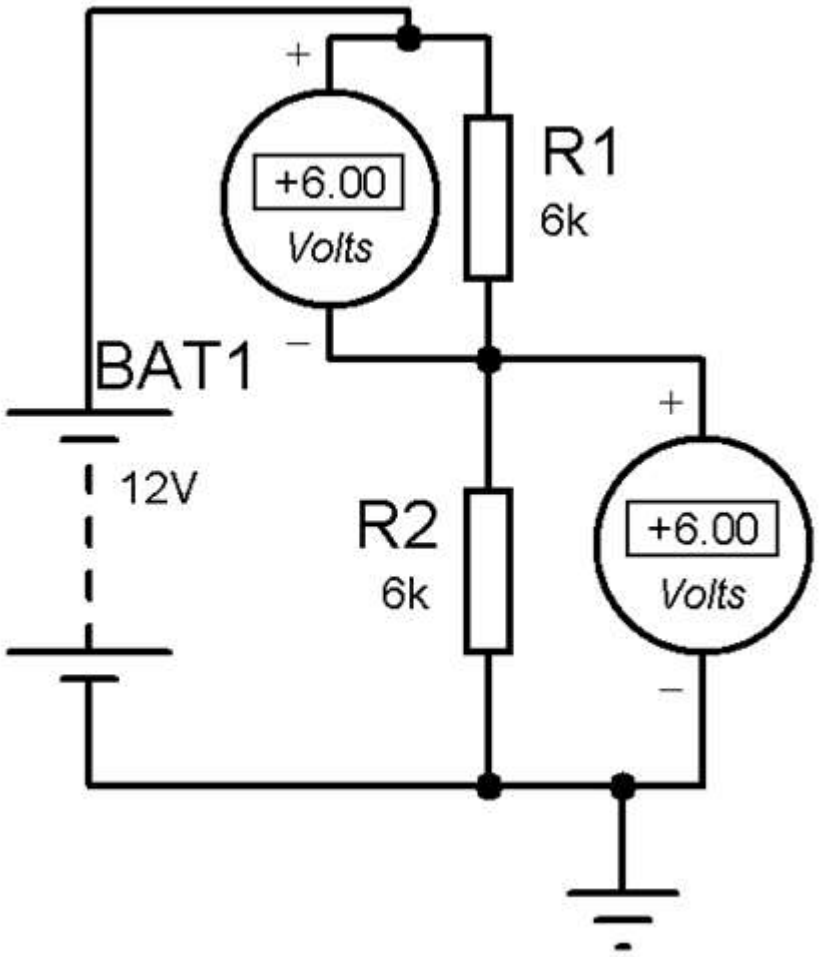
An Integrated Circuit is a chip or a microchip on which thousands of transistors, capacitors, resistors are fabricated. It can be an Amplifier IC, a timer IC, a waveform generator IC, a memory IC or a Microcontroller IC. It can be an analog IC with a continuous variable output or a Digital IC operating at a few defined layers. The fundamental building blocks of Digital ICs are the logic gates.

It can be available in different packages like Dual in Line Package(DIP) or Small Outline Package(SOP) etc.

A Practical application of resistors – Potential Dividers

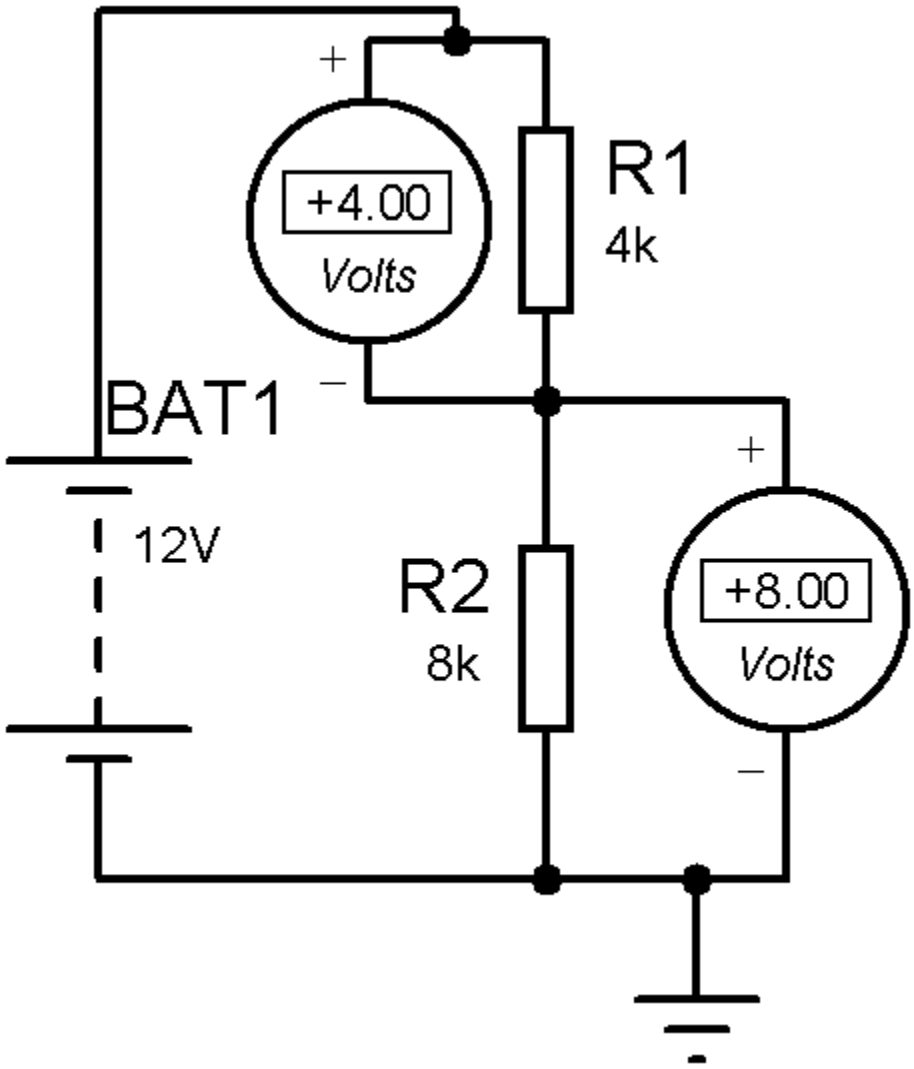
Potential dividers are frequently used in electronic circuits. Therefore it is desired that a thorough understanding of the same would greatly help in designing electronic circuits. Instead of deriving the voltages mathematically by applying Ohm's law, the following example by assessing in ratio way, one would be able to quickly get the approximate voltage while attending to R&D nature of work.

When two resistors of equal value (e.g. 6K both for R1 & R2) are connected across a supply, same current will flow through them. If a meter is placed across the supply shown in the diagram it will register 12v with respect to ground. If the meter is then placed between the ground (0v) and the middle of the two resistors it will read 6v. The battery voltage is then divided in half. Thus voltage across R2 with respect to ground =6v

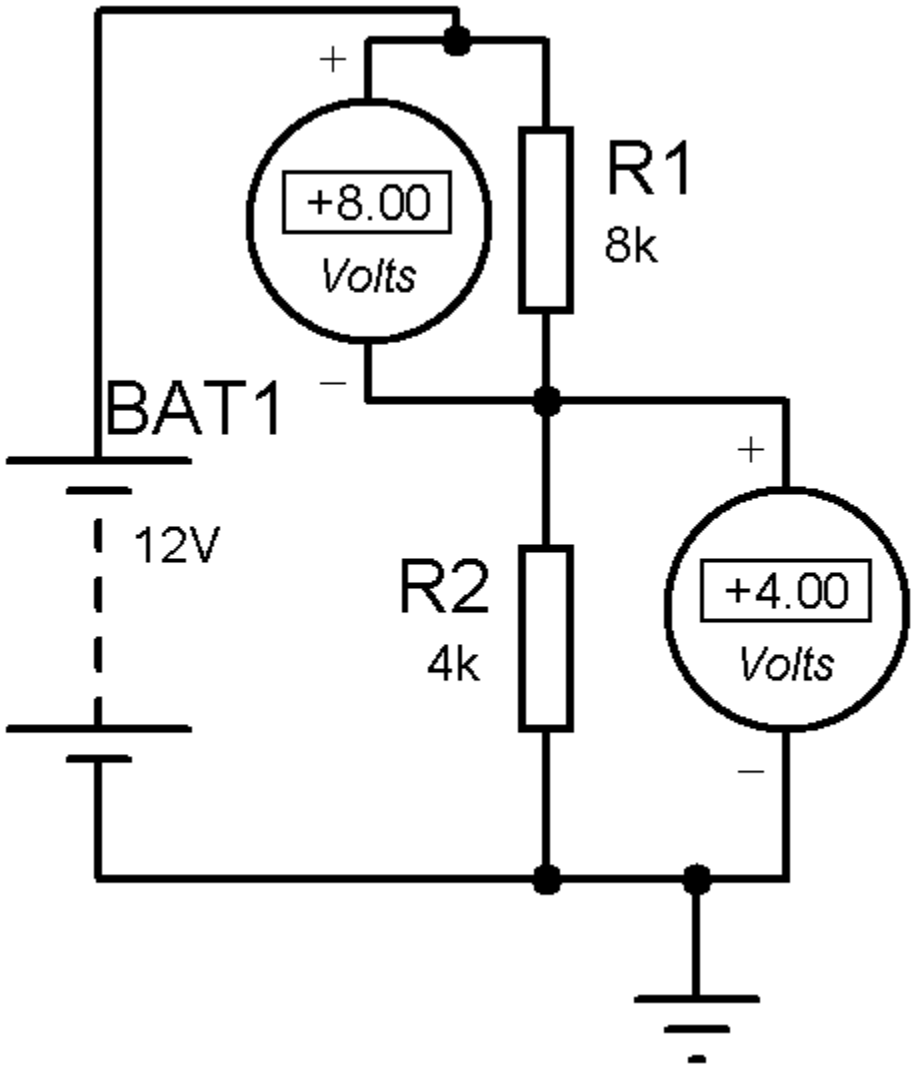


Similarly

2. If the resistor values are changed to 4K(R1) and 8K (R2)the voltage at center will be 8v with respect to ground.



3. If the resistor values are changed to 8K(R1) and 4K (R2) the voltage at the center will be 4v with respect to ground.



The voltage at the center is better determined by the ratio of the two resistor values , though one can go by Ohms law to calculate to arrive at the same value. Case-1 the ratio was 6K:6K = 1:1=6v:6v , Case-2 ratio 4k:8k= 1:2 =4v:8v and Case-3 ratio 8k:4k= 2:1=8v:4v

Conclusion:-In a potential divider, if the upper resistor value is lowered then the voltage at the center goes up (with respect to ground). If the lower resistor value is lowered then the voltage at the center falls.

Mathematically but the voltage at the center can always be determined by the ratio of the two resistor values which is time consuming and is given by the famous Ohms law formula V=IR

Let us see the example-2

V = { supply voltage /(R_1+R_2)} X R2

V= {12v /(4K+8K)}R2

=(12/12000) x 8000

V = 8v

Making and recording measurements

The term data (singular = datum, or data value or variate) refers to measurements of a particular characteristic, or variable, classified as:

- *Quantitative:* where the individual values are described on a numerical scale which may be either
    i. continuous, taking any value on the measurement scale, or
    ii. discontinuous (or discrete),

where only integer values are possible. Many of the variables measured in chemistry are continuous and quantitative, e.g. weight, temperature, time, amount of product formed in an enzyme reaction.

- *Ranked:* where the data values can be listed in order of magnitude. Where such data are given numbered ranks, they are sometimes called 'semi-quantitative data'. Note that such ranks cannot be treated as 'real' numbers and they should not be added, averaged, etc.
- *Qualitative:* where individual values are assigned to a descriptive category, e.g. the detection of the presence or absence of a chemical by a colour test or precipitate.

Variables may be independent or dependent. Usually, the variable under the control of the experimenter (e.g. time, reagent concentration, pH, etc.) is the independent variable, while the variable being measured is the dependent variable. Sometimes, it is inappropriate to describe variables in this way, and they are often referred to as interdependent. Another group of values, often termed derived (or computed) data, are calculated from two or more individual measurements, and these include ratios, percentages and rates.

SI units and their use

When describing a measurement, you normally state both a number and a unit (e.g. 'the length is 1.85 metres'). The number expresses the ratio of the measured quantity to a fixed standard, while the unit identifies that standard measure or dimension. Clearly, a single unified system of units is essential for efficient communication of such data within the scientific community. The Systeme International d'Unites (SI) is the internationally ratified form of the metre-kilogram-second system of measurement and represents the

accepted scientific convention for measurements of physical quantities.

Another important reason for adopting consistent units is to simplify complex calculations where you may be dealing with several measured quantities. Although the rules of the SI are complex and the scale of the base units is sometimes inconvenient, to gain the full benefits of the system you should observe its conventions strictly. The description of measurements in SI involves:

- seven base units and two supplementary units, each having a specified abbreviation or symbol (Table 9.1);
- derived units, obtained from combinations of base and supplementary units, which may also be given special symbols (Table 9.2);
- a set of prefixes to denote multiplication factors of 103, used for convenience to express multiples or fractions of units (Table 9.3).

Measured quantity	Name of SI unit	Symbol
Base units		
Length	metre	m
Mass	kilogram	kg
Amount of substance	mole	mol
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Luminous intensity	candela	cd
Supplementary units		
Plane angle	radian	rad
Solid angle	steradian	sr

Table 9. 1 The base and supplementary SI units

Multiple	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	μ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Table 9.3 Prefixes used in the SI

Measured quantity	Name of unit	Symbol	Definition in base units	Alternative in derived units
Energy	joule	J	$m^2\,kg\,s^{-2}$	N m
Force	newton	N	$m\,kg\,s^{-2}$	$J\,m^{-1}$
Pressure	pascal	Pa	$kg\,m^{-1}\,s^{-2}$	$N\,m^{-2}$
Power	watt	W	$m^2\,kg\,s^{-3}$	$J\,s^{-1}$
Electric charge	coulomb	C	A s	$J\,V^{-1}$
Electric potential difference	volt	V	$m^2\,kg\,A^{-1}\,s^{-3}$	$J\,C^{-1}$
Electric resistance	ohm	Ω	$m^2\,kg\,A^{-2}\,s^{-3}$	$V\,A^{-1}$
Electric conductance	siemens	S	$s^3\,A^2\,kg^{-1}\,m^{-2}$	$A\,V^{-1}$ or Ω^{-1}
Electric capacitance	farad	F	$s^4\,A^2\,kg^{-1}\,m^{-2}$	$C\,V^{-1}$
Luminous flux	lumen	lm	cd sr	
Illumination	lux	lx	$cd\,sr\,m^{-2}$	$lm\,m^{-2}$
Frequency	hertz	Hz	s^{-1}	
Radioactivity	becquerel	Bq	s^{-1}	
Enzyme activity	katal	kat	mol substrate s^{-1}	

Table 9.2 Some important derived SI units

DESIGNING EXPERIMENTS USING THE SCIENTIFIC METHOD

How do the scientists know what they know? When it comes to gathering information, scientists usually rely on the scientific method.

The *scientific method* is a plan that is followed in performing a scientific experiment and writing up the results. It is not a set of instructions for just one experiment, nor was it designed by just one person. The scientific method has evolved over time after many scientists performed experiments and wanted to communicate their results to other scientists. The scientific method allows experiments to be duplicated and results to be communicated uniformly.

As you're about to see, the format of the scientific method is very logical. Really, many people solve problems and answer questions every day in the same way that experiments are designed.

HYPOTHETICALLY SPEAKING

When preparing to do research, a scientist must form a *hypothesis,* which is an educated guess about a particular problem or idea, and then work to *support* it and prove that it is correct, or *refute* it and prove that it is wrong.

THE VALUE OF VARIABLES

Experiments must have the ability to be duplicated because the "answers" the scientist comes up with (whether it supports or refutes the original hypothesis) cannot become part of the knowledge base unless other scientists can perform the exact same experiment(s) and achieve the same result; otherwise, the experiment is useless.

"Why is it useless," you ask? Well, there are things called *variables.* Variables vary: They change, they differ, and they are not the same. A well-designed experiment needs to have an *independent variable* and a *dependent variable*. The independent variable is what the scientist manipulates in the experiment. The dependent variable changes based on how the independent variable is manipulated. Therefore, the dependent variable provides the data for the experiment.

1. A scientist must keep track of the information by recording the data.

The data should be presented visually, if possible, such as through a graph or table.

2. A control must be used.

That way, results can be compared to something.

3. Conclusions must be drawn from the results.

4. Errors must be reported.

Suppose that you wonder whether you can run a marathon faster when you eat pasta the night before or when you drink coffee the morning of the race. Your hunch is that loading up on pasta will give you the energy to run faster the next day. A proper hypothesis would be something like, “The time it takes to run a marathon is improved by consuming large quantities of carbohydrates pre-race.” The independent variable is the consumption of pasta, and the dependent variable is how fast you run the race.

Think of it this way: How fast you run depends on the pasta, so how fast you run is the dependent variable. Now, if you eat several plates of spaghetti the night before you race, but then get up the next morning and drink two cups of coffee before you head to the start line, your experiment is useless.

Why is it useless? By drinking the coffee, you introduce a second independent variable, so you will not know whether the faster race time is due to the pasta or the coffee. Experiments can have only one independent variable. If you want to know the effect of caffeine (or extra sleep or improved training) on your race time, you would have to design a second (or third or fourth) experiment.

CHECKING YOUR STATS

Of course these experiments would have to be performed many times by many different runners to demonstrate any valid statistical significance. *Statistical significance* is a mathematical measure of the validity of an experiment. If an experiment is performed repeatedly and the results are within a narrow margin, the results are said to be significant when measured using the branch of mathematics called statistics. If results

are all over the board, they are not that significant because one definite conclusion cannot be drawn from the data.

TRACKING THE INFORMATION

Once an experiment is designed properly, you can begin keeping track of the information you gather through the experiment. In an experiment testing whether eating pasta the night before a marathon improves the running time, suppose that you eat a plate of noodles the night before and then drink only water the morning of the race. You could record your times at each mile along the 26-mile route to keep track of information. Then, for the next marathon you run (boy, you must be in great shape), you eat only meat the night before the race, and you down three espressos on race morning. Again, you would record your times at each mile along the route.

What do you do with the information you gather during experiments? Well, you can graph it for a visual comparison of results from two or more experiments. The independent variable from each experiment is plotted on the *x*-axis (the one that runs horizontally), and the dependent variable is plotted on the *y*-axis (the one that runs vertically). In experiments comparing the time it took to run a marathon after eating pasta the night before, getting extra sleep, drinking coffee, or whatever other independent variable you may want to try, miles 1 to 26 would be labeled up the *y*-axis. The factor that does not change in all the experiments is that a marathon is 26 miles long. The time it took to reach each mile would be plotted along the *x*-axis. This data might vary based on what the runner changed before the race, such as diet, sleep, or training. You can plot several independent variables on the same graph by using different colors or different styles of lines. Your graph might look something like the one in Figure 1.

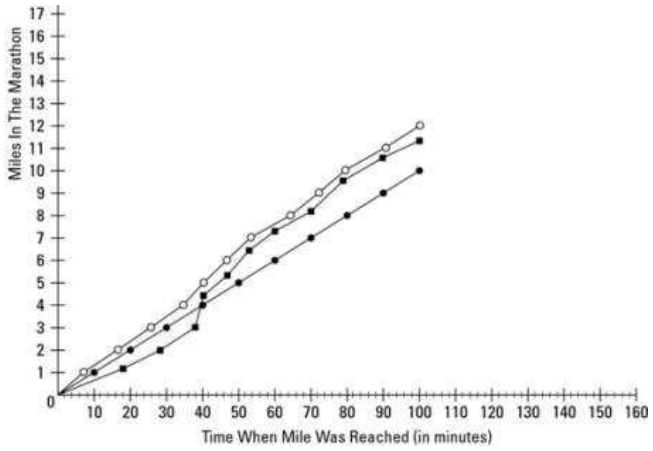


Figure 1: Graph showing the time each mile of a marathon was reached for a runner who consumed pasta (white dotted line), a runner who consumed coffee (squared line), and a runner who slept four extra hours prior to the race (black dotted line).

TAKING CONTROL OF YOUR EXPERIMENT

How would you know if your race times were improved either by eating pasta or drinking coffee? You would have to run a marathon without eating pasta the night before or drinking coffee the morning of the race. (Exhausted yet?) This marathon would be your *control*. A control is a set of base values against which you compare the data from your experiments. Otherwise, you would have no idea if your results were better, worse, or the same.

DRAWING CONCLUSIONS

So, maybe it took you less time to reach each mile along the marathon route after the night of pasta eating, but your race times after drinking the coffee matched those of the control. That would support your initial hypothesis, but it would refute your second

hypothesis. There's nothing wrong with being wrong, as long as the information is useful. Knowing what doesn't work is just as important as knowing what does.

Your *conclusion* to these two experiments would be something like: "Consuming pasta the night before a 26-mile marathon improves race time, but consuming caffeine has no effect."

However, in scientific experiments you have to confess your mistakes. This confession lets other scientists know what could be affecting your results. Then, if they choose to repeat the experiment, they can correct for those mistakes and provide additional beneficial information to the knowledge base. In the pasta-caffeine-race experiment, if you had consumed the pasta the night before and then the caffeine the morning of the race, your major *error* would be that of including more than one independent variable.

Another error would be having too small of a sample. A more accurate determination could be made by recording the race times at each mile for many runners under the same conditions (i.e., having them eat the same amount of pasta the night before a race or consuming the same amount of caffeine the morning of a race). Of course, their individual control times without those variables would have to be taken into account. Science. It's all in the details.

Comparing location (e.g, means)

If you can assume that your data are normally distributed, the main test for comparing two means from independent samples is Student's t-test (see Boxes 41.1 and 41.2, and Table 41.2). This assumes that the variances of the data sets are homogeneous. Tests

based on the t-distribution are also available for comparing paired data or for comparing a sample mean with a chosen value.

When comparing means of two or more samples, analysis of variance (ANOVA) is a very useful technique. This method also assumes data are normally distributed and that the variances of the samples are homogeneous. The samples must also be independent (e.g. not sub-samples). The nested types of ANOVA are useful for letting you know the relative importance of different sources of variability in your data. Two-way and multi-way ANOVAs are useful for studying interactions between treatments.

Suggested transformations altering different types offrequency

Table 41. 1 Suggested transformations alteri ng different types of frequency distribution to the normal type.

For data satisfying the ANOVA requirements, the least significant difference (LSD) is useful for making planned comparisons among several means. Any two means that differ by more than the LSD will be significantly different. The LSD is useful for showing on graphs.

The chief non-parametric tests for comparing locations are the Mann- Whitney U-test and the Kolmogorov-Smirnov test. The former assumes that the frequency distributions of the data sets are similar, whereas the latter makes no such assumption. In the Kolmogorov-Smirnov test, significant differences found with the test may be due to differences in location or shape of the distribution, or both.

Suitable non-parametric comparisons of location for paired quantitative data (sample size ≥ 6) include Wilcoxon's signed rank test, which assumes that the distributions have similar shape.

Non-parametric comparisons of location for three or more samples include the Kruskal-Wallis H-test. Here, the two data sets can be unequal in size, but again the underlying distributions are assumed to be similar.

Critical values of Student's t statistic (for two-tailed tests). Reject the null hypothesis at probability P if your calculated t value exceeds the value shown forthe appropriate degrees of freedom = (n1 − 1) + (n2 − 1)

Table 41.2 Critical values of Student's t statistic (for two-tailed tests). Reject the null hypothesis at probability P if your calculated t value exceeds the value shown forthe appropriate degrees of freedom = (n1 − 1) + (n2 − 1)

Comparing dispersions (e.g, variances)

If you wish to compare the variances of two sets of data that are normally distributed, use the F-test. For comparing more than two samples, it may be sufficient to use the Fmax-test, on the highest and lowest variances. The Scheffe-Box (log-ANOVA) test is recommended for testing the significance of differences between several variances. Non-parametric tests exist but are not widely available: you may need to transform the data and use a test based on the normal distribution.

Determining whether frequency observations fit theoretical expectation

The χ2-test is useful for tests of 'goodness of fit', e.g. comparing expected and observed progeny frequencies in genetical experiments or comparing observed frequency distributions with some theoretical function. One limitation is that simple formulae for calculating χ2 assume that no expected number is less than five. The G-test (2I test) is used in similar circumstances.

Comparing proportion data When comparing proportions between two small groups (e.g. whether 3/10 is significantly different from 5/10), you can use probability tables

such as those of Finney et al. (1963) or calculate probabilities from formulae; however, this can be tedious for large sample sizes. Certain proportions can be transformed so that their distribution becomes normal.

Placing confidence limits on an estimate of a population parameter

On many occasions, sample statistics are used to provide an estimate of the population parameters. It is extremely useful to indicate the reliability of such estimates. This can be done by putting a confidence limit on the sample statistic. The most common application is to place confidence limits on the mean of a sample from a normally distributed population. This is done by working out the limits as Ÿ (Y bar) − (tP[n − 1] × SE) and Ÿ (Y bar) + (tP[n − 1] × SE) where tP[n − 1] is the tabulated critical value of Student's t statistic for a two-tailed test with n − 1 degrees of freedom and SE is the standard error of the mean. A 95% confidence limit (i.e. P = 0.05) tells you that on average, 95 times out of 100, this limit will contain the population mean.

Regression and correlation

These methods are used when testing relationships between samples of two variables. If one variable is assumed to be dependent on the other then regression techniques are used to find the line of best fit for your data. This does not tell you how well the data fit the line: for this, a correlation coefficient must be calculated. If there is no a priori reason to assume dependency between variables, correlation methods alone are appropriate.

If graphs or theory indicate a linear relationship between a dependent and an independent variable, linear regression can be used to estimate the equation that links them. If the relationship is not linear, a transformation may give a linear relationship. For example, this is sometimes used in analysis of chemical kinetics. However, 'linearizations' can lead to errors when carrying out regression analysis: take care to ensure (i) that the data are evenly distributed throughout the range of the independent

variable and (ii) that the variances of the dependent variable are homogeneous. If these criteria cannot be met, weighting methods may reduce errors. In this situation, it may be better to use non-linear regression using a suitable computer program.

Model I linear regression is suitable for experiments where a dependent variable Y varies with an error-free independent variable X and the mean (expected) value of Y is given by a + bX. This might occur where you have carefully controlled the independent variable and it can therefore be assumed to have zero error (e.g. a calibration curve). Errors can be calculated for estimates of a and b and predicted values of Y. The Y values should be normally distributed and the variance of Y constant at all values of X.

Model II linear regression is suitable for experiments where a dependent variable Y varies with an independent variable X which has an error associated with it and the mean (expected) value of Y is given by a + bX. This might occur where the experimenter is measuring two variables and believes there to be a causal relationship between them; both variables will be subject to errors in this case. The exact method to use depends on whether your aim is to estimate the functional relationship or to estimate one variable from the other.

A correlation coefficient measures the strength of relationships but does not describe the relationship. These coefficients are expressed as a number between −1 and 1. A positive coefficient indicates a positive relationship while a negative coefficient indicates a negative relationship (Fig. 41.6). The nearer the coefficient is to −1 or 1, the stronger the relationship between the variables, i.e. the less scatter there would be about a line of best fit (note that this does not imply that one variable is dependent on the other!). A coefficient of 0 implies that there is no relationship between the variables. The importance of graphing data is shown by the case illustrated in Fig.4l.6d.

Pearson's product-moment correlation coefficient (r) is the most commonly used correlation coefficient. If both variables are normally distributed, then r can be used in statistical tests to test whether the degree of correlation is significant. If one or both variables are not normally distributed you can use Kendall's coefficient of rank correlation (τ) or Spearman's coefficient of rank correlation (rs). They require that data are ranked separately and calculation can be complex if there are tied ranks. Spearman's coefficient is said to be better if there is uncertainty about the reliability of closely ranked data values.

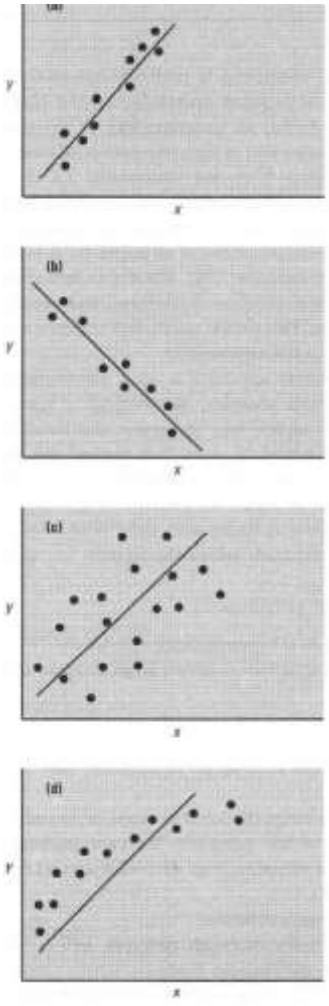


Fig.41.6 Examples of correlation. The linear regression line is shown. In (a) and (b), the correlation between x and y is good: for (a) there is a positive correlation and the correlation coefficient would be close to 1; for (b) there is a negative correlation and the correlation coefficient would be close to −1. In (c) there is a weak positive correlation and r would be close to 0. In (d) the correlation coefficient may be quite large, but the choice of linear regression is clearly inappropriate.

Analysis of variance (**ANOVA**) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among group means in a sample. ANOVA was developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether the population means of several groups are equal, and therefore generalizes the *t*-test to more than two groups. ANOVA is useful for comparing (testing) three or more group means for statistical significance. It is conceptually similar to multiple two-sample t-tests, but is more conservative, resulting in fewer type I errors, and is therefore suited to a wide range of practical problems.

Basic Electronic Components Used in Circuits

In this article, I will give you a simple overview, with an explanation of the basic electronic components – **what they are** and **what they do**.

The Most Common Basic Electronic Components

These are the most common components:

- Resistors

- Capacitors
- LEDs
- Transistors
- Inductors
- Integrated Circuits

Resistor

Find the resistor symbol in the schematic symbols overview.

I  didn't understand the resistor in the beginning.

It didn't seem to do anything! It was just there, consuming power. But with time, I learned that the resistor is actually extremely useful.

You'll see resistors everywhere. And as the name suggests, they *resist* the current.

But you are probably wondering: What do I use it for?

You use the resistor to control the voltages and the currents in your circuit.

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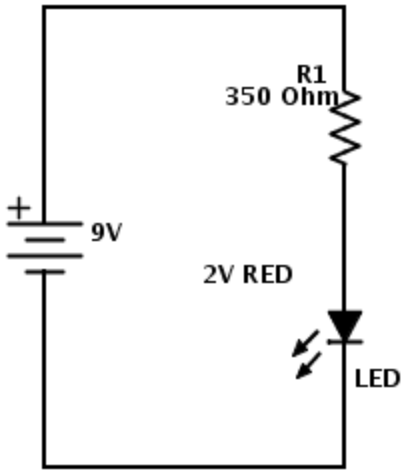


By using Ohm's law.

Let's say you have a 9V battery and you want to turn on a Light-Emitting Diode (LED).

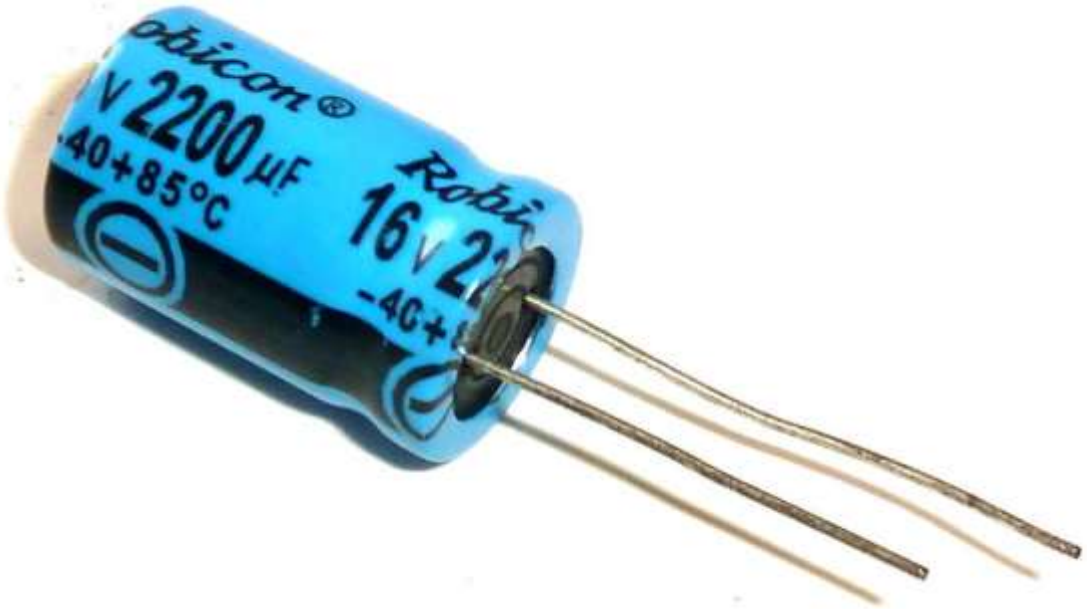
If you connect the battery directly to the LED, LOTS of current will flow through the LED!

Much more that the LED can handle. So the LED will become very hot and burn out after a short amount of time.

But – if you put a resistor in series with the LED, you can control how much current is going through the LED.

In this case we call it a current limiting resistor.

Capacitor



Find the capacitor symbol in the schematic symbols overview.

You can think of a capacitor as a battery with very low capacity.

You can charge and discharge it just like a battery.

The capacitor is often used to introduce a time-delay in a circuit.

For example to blink a light.

It’s commonly used for removing noise, or making the supply voltage of a circuit more stable.

Read more about the capacitor in this article: How Does A Capacitor Work?

There are many capacitor types. Most commonly, we divide them into polarized and non-polarized capacitors.

Light Emitting Diode (LED)

Find the LED symbol in the schematic symbols overview.

A Light Emitting Diode – or LED for short – is a component that can give light.

We use LEDs to give a visual feedback from our circuit.

For example to show that the circuit has power. But, you can also used them to make cool light-show circuits.

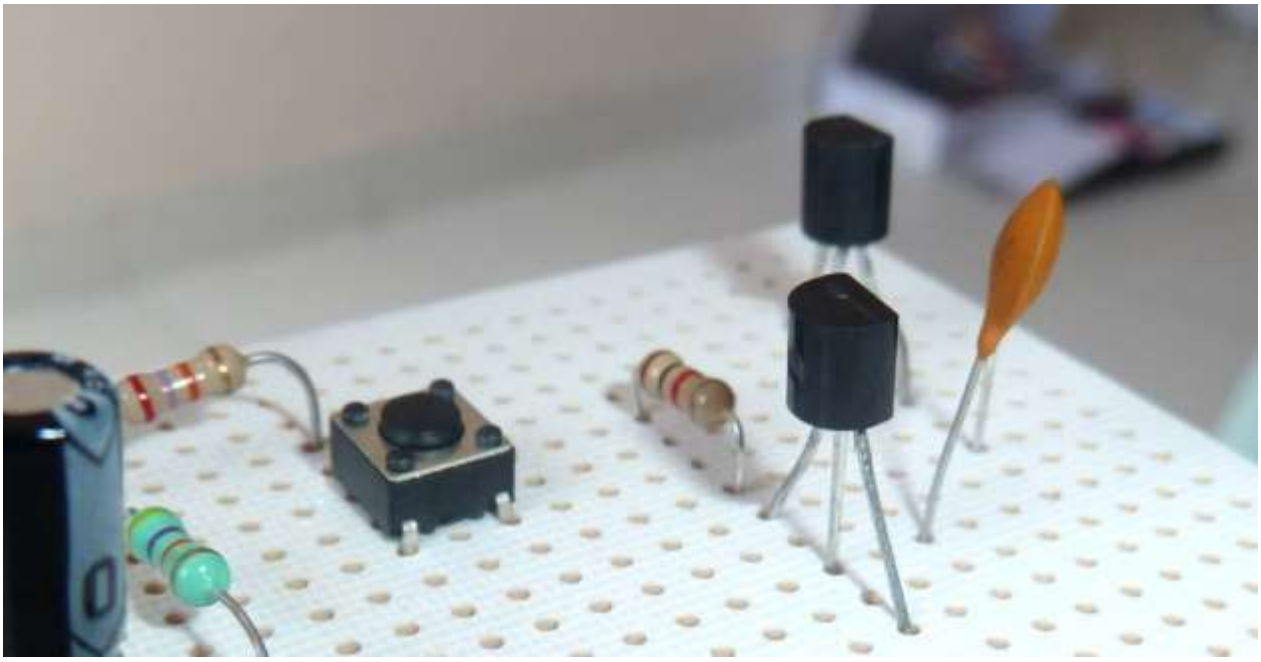
You see these components everywhere:

In your laptop, on your mobile phone, on your camera, in your car +++

And you can find many different types of LEDs.

A very common circuit to build as a beginner is the blinking light circuit.

Transistor



Find the transistor symbol in the schematic symbols overview.

This is probably the hardest of the basic electronic components to understand.

But don't worry, it's not that hard.

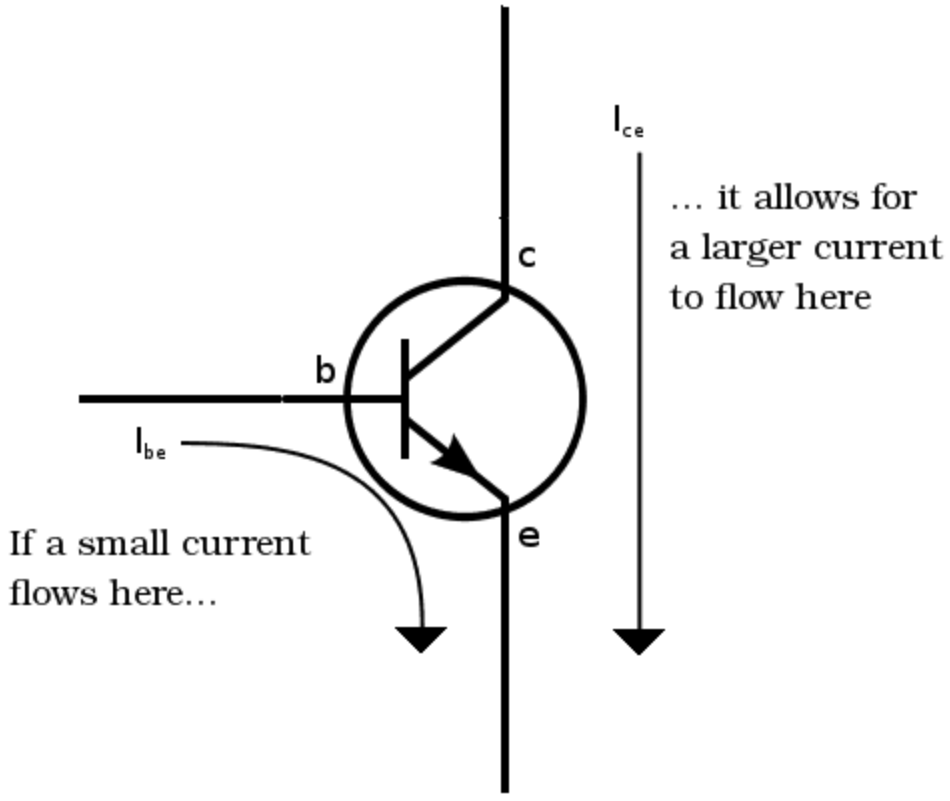
A simple way is to look at the transistor as a switch controlled by an electrical signal.

If you put about 0.7 volts between the base and the emitter, you turn it on.

Note that this is true for NPN transistors. There are also other types, but worry about these later.

But, instead of having just two states (ON or OFF), it can also be “a bit on” by controlling the current that goes through its base.

A bit of current on the base produces a current of maybe 100 times more (depending on the transistor) through the Collector and Emitter. We can use this effect to build amplifiers.



I’ve previously made a video on how transistors work.

Inductor

Find the inductor symbol in the schematic symbols overview.

Inductors are a bit weird.

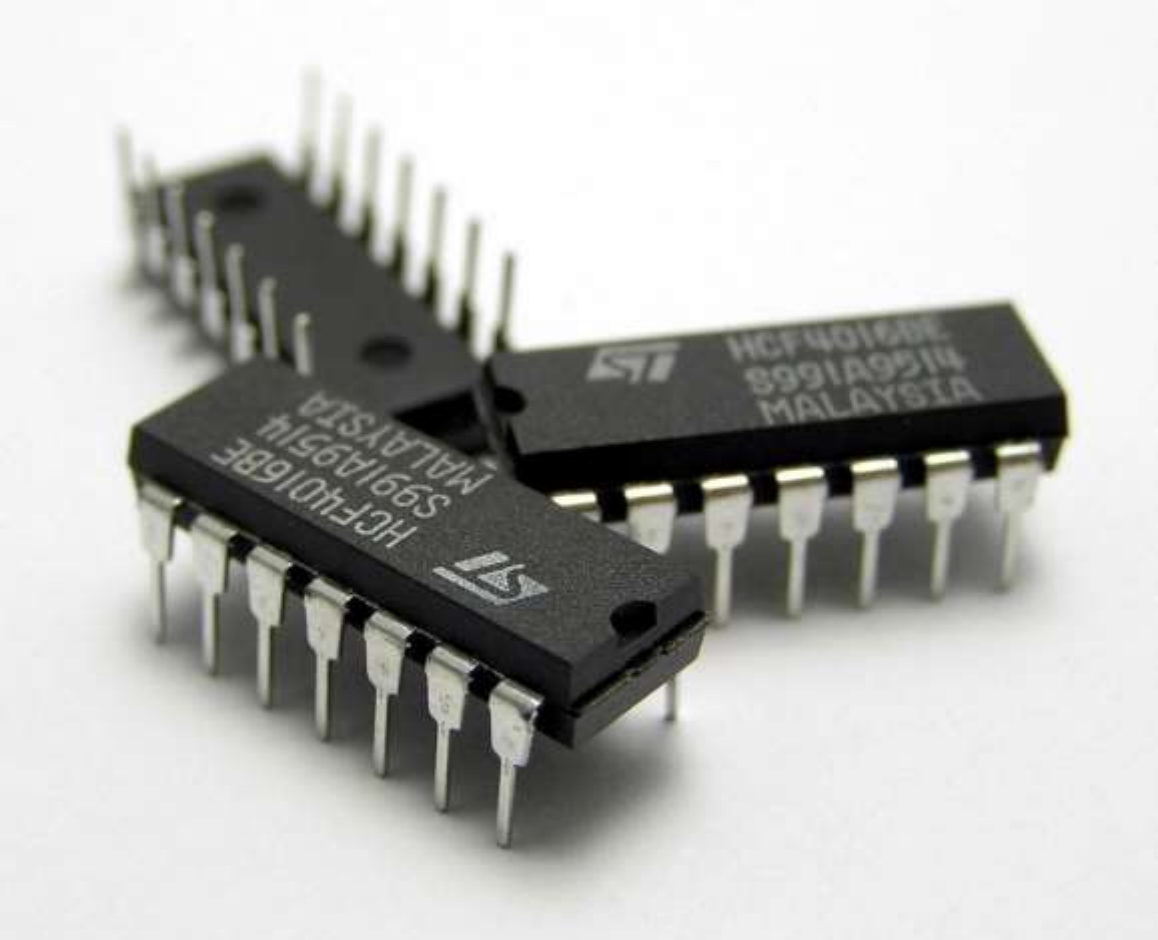
It's just a coil of wire – and you can make one yourself by making some loops out of a wire.

Sometimes they're wound around a metal core of some sort.

They are often used in filters.

I rarely use one actually, but when I wrote that in my article "What is an inductor?" a friend of mine reacted. See his response at the end of that article.

Integrated Circuit



Find the integrated circuit symbol in the schematic symbols overview.

An Integrated Circuit (IC) consists of many basic electronic components.

It’s nothing mysterious or magical.

It's just an electronic circuit that has been shrunk to fit inside a chip.

It could be an amplifier, it could be a microprocessor, it could be a USB to serial converter… It could be anything!

To figure out what a specific IC does, you can read its datasheet.

Spectrophotometer Instrumentation : Principle and Applications

July 29, 2016 by Biochemistry Den

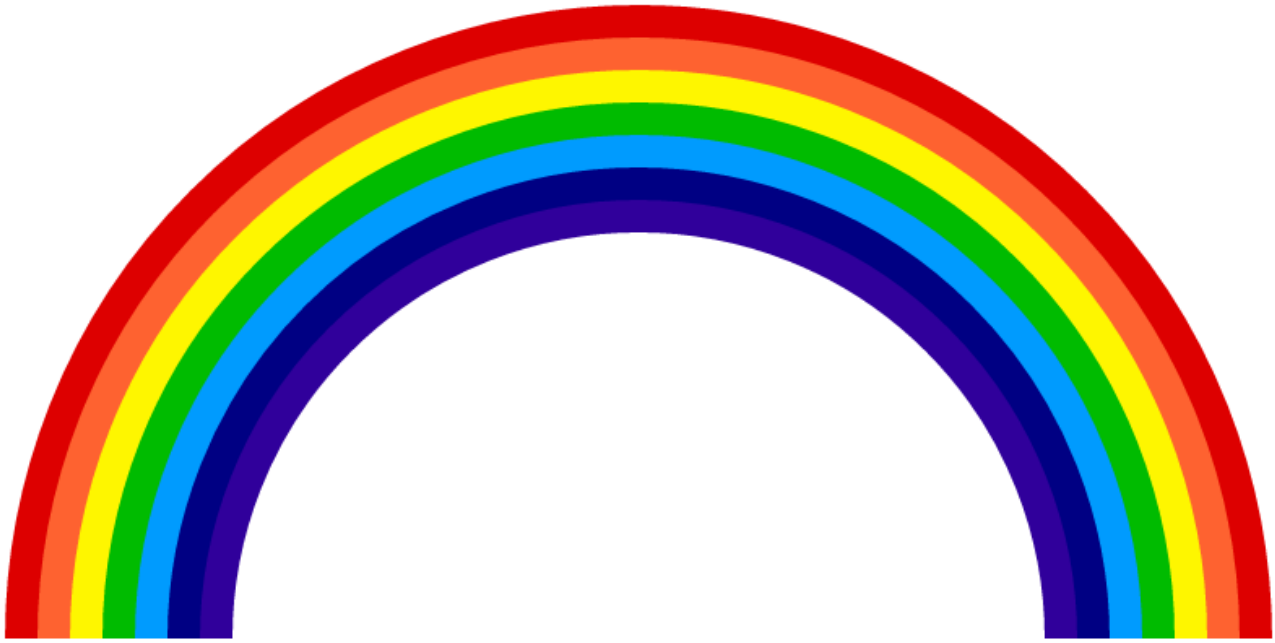
Contents [show]

What are the basic components of Spectrophotometer instrumentation? What is Electromagnetic radiation? Electromagnetic radiation has been put to many uses in our daily routine. The radio and television broadcasting, medical x-ray etc are some common examples. The use of **electromagnetic radiation in analytical chemistry** gained much importance during the last 50 years for characterization of materials. Electromagnetic radiation in the region of 200 to 700nm is generally termed as light. the eye can perceive radiation between 340 to 650 nm and can distinguish it as various (VIBGYOR).

What is VIBGYOR (or) ROYGBIV

ROYGBIV or **Roy G. Biv** is an acronym for the sequence of hues commonly described as making up a rainbow: Red, Orange, Yellow, Green, Blue, Indigo, and Violet.

A rainbow spans a continuous spectrum of colors; the distinct bands are an artifact of human color vision. In *ROYGBIV*, the colors are arranged in the order of decreasing wavelengths, with red being 650 nm and violet being about 400 nm.



A Spectrophotometer has all the basic components of a photoelectric colorimeter with more sophistication.

The instruments that are used to study the absorption (or) emission of electromagnetic radiation as a function of wavelength are called "SPECTROMETERS" or "SPECTROPHOTOMETERS".

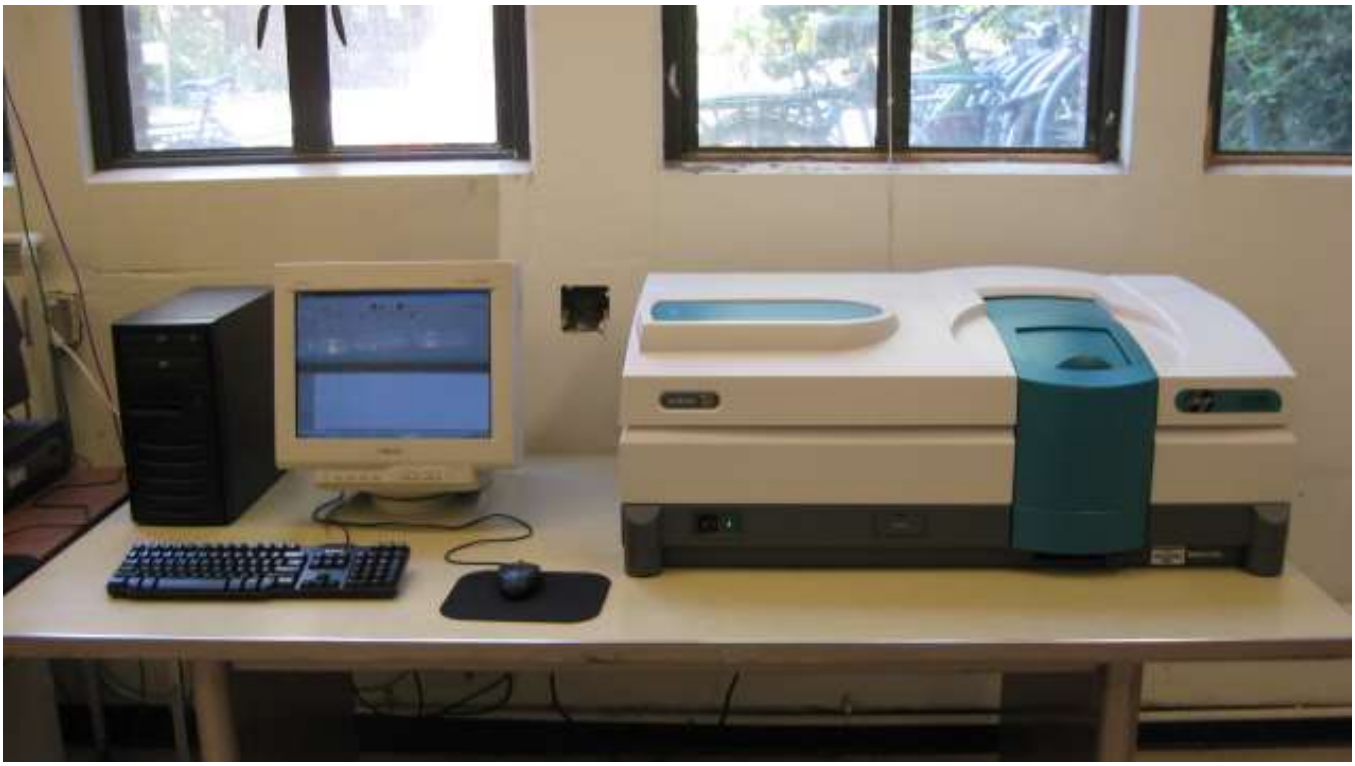
History:

For millions of years, light has defined the life of *Homo sapiens*. Through photosynthesis, light has given us food, energy, and atmosphere. And using light we

communicate information, see the big objects far from us through the telescope and small objects through the microscope.

From where does light get this transcending power?

It took nearly a millennium until **James Clark Maxwell** in 1864 told the world that light is made of waves of disturbances of electric and magnetic fields.



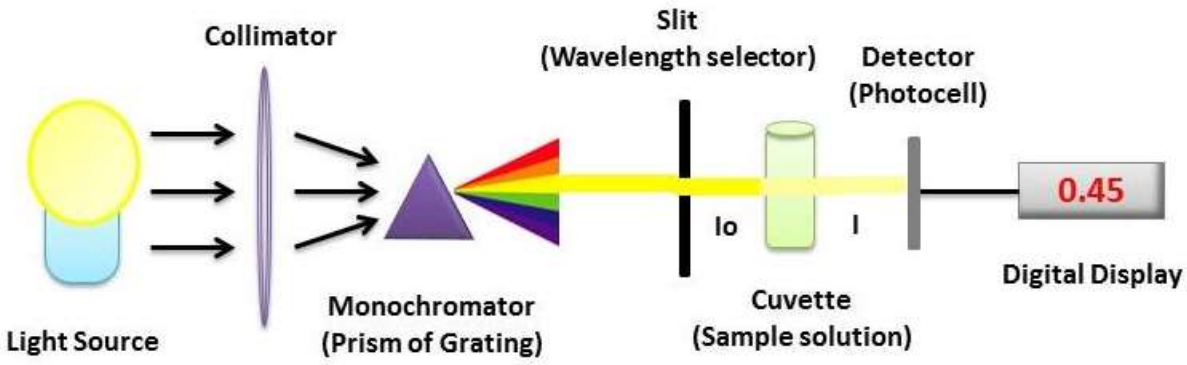
Principle:

What is the Principle of spectrophotometer? The Spectrophotometer is a much more refined version of a colorimeter. In a colorimeter, filters are used which allow a broad range of wavelengths to pass through, whereas in the spectrophotometer a prism (or) grating is used to split the incident beam into different wavelengths. By suitable

mechanisms, waves of specific wavelengths can be manipulated to fall on the test solution. The range of the wavelengths of the incident light can be as low as 1 to 2nm. The spectrophotometer is useful for measuring the absorption spectrum of a compound, that is, the absorption of light by a solution at each wavelength. This is the basic Principle of spectrophotometry in biochemistry.

Spectrophotometer Instrumentation:

The essential components of a spectrophotometer instrumentation include:



Basic Instrumentation of a Spectrophotometer

1. A Stable and cheap radiant energy source
2. A monochromator, to break the polychromatic radiation into component wavelength (or) bands of wavelengths.
3. Transport vessels (cuvettes), to hold the sample
4. A Photosensitive detector and an associated readout system

1. Radiant Energy Sources:

Materials which can be excited to high energy states by a high voltage electric discharge (or) by electrical heating serve as excellent radiant energy sources.

1. **Sources of Ultraviolet radiation:** Most commonly used sources of UV radiation are the hydrogen lamp and the deuterium lamp. Xenon lamp may also be used for UV radiation, but the radiation produced is not as stable as the hydrogen lamp.

2. **Sources of Visible radiation:** "Tungsten filament" lamp is the most commonly used source for visible radiation. It is inexpensive and emails continuous radiation in the range between 350 and 2500nm. "Carbon arc" which provides more intense visible radiation is used in a small number of commercially available instruments.

3. **Sources of IR radiation:** "Nernst Glower" and "Global" are the most satisfactory sources of IR radiation. Global is more stable than the nearest flower.

2. Wavelength selectors:

Wavelength sectors

Wavelength selectors are of two types.

- Filters
- Monochromators

1. **Filters:** "Gelatin" filters are made of a layer of gelatin, colored with organic dyes and sealed between glass plates.

2. **Monochromators:** A monochromator resolves polychromatic radiation into its individual wavelengths and isolates these wavelengths into very narrow bands. The essential components of a monochromator are.

    - Entrance slip-admits polychromatic light from the source
    - Collimating device – Collimates the polychromatic light onto the dispersion device.
    - Wavelength resolving device like a PRISM (or) a GRATING
    - A focusing lens (or) a mirror
    - An exit slip – allows the monochromatic beam to escape.

The kinds of the resolving element are of primary importance

- PRISMS
- GRATINGS

PRISMS:

A prism disperses polychromatic light from the source into its constituent wavelengths by virtue of its ability to reflect different wavelengths to a different extent;

The degree of dispersion by the prism depends on upon

- The optical angle of the Prism (usually 60^0)
- The material of which it is made

Two types of Prisms are usually employed in commercial instruments. Namely, 60^0 cornu quartz prism and 30^0 Littrow Prism.

GRATINGS:

Gratings are often used in the monochromators of spectrophotometers operating ultraviolet, visible and infrared regions.

3. Sample Containers:

Sample containers are also one of the parts of Spectrophotometer instrumentation. Samples to be studied in the ultraviolet (or) visible region are usually glasses (or) solutions and are put in cells known as “CUVETTES”. Cuvettes meant for the visible region are made up of either ordinary glass (or) sometimes Quartz. Most of the spectrophotometric studies are made in solutions, the solvents assume prime importance.

The most important factor in choosing the solvent is that the solvent should not absorb (optically transparent) in the same region as the solute.

4. Detection Devices:

Most detectors depend on the photoelectric effect. The current is then proportional to the light intensity and therefore a measure of it. Important requirements for a detector include

- High sensitivity to allow the detection of low levels of radiant energy
- Short response time
- Long term stability
- An electric signal which easily amplified for typical readout apparatus.

5. Amplification and Readout:

Radiation detectors generate electronic signals which are proportional to the transmitter light. These signals need to be translated into a form that is easy to interpret. This is accomplished by using amplifiers, Ammeters, Potentiometers and Potentiometric recorders.

The above 5 major parts are the major part of Spectrophotometer instrumentation. Now let us see the Applications of Spectrophotometer.

Spectrophotometer applications

How to use the spectrophotometer? There are some uses of spectrophotometry in biochemistry which are listed below:

1. **Qualitative Analysis:**

Absorption Range (nm)	**Structure (or) Type of compounds**
220 to 280nm	Aliphatic (or) alicyclic hydrocarbons (or) their derivatives
220 to 250 nm	The compounds contain two unsaturated linkages in conjugation. Also, be due to “Benzene derivatives”
250 to 330 nm	Presence of more than two conjugated double bonds usually gives rise to absorption.

450 to 500nm	Beta-carotene, a precursor of Vitamin A has eleven double bonds in a conjugated system and appears yellow.
250 to 330 nm (249nm; 260nm and 325nm)	Vitamin K1 (Due to the presence of “NAPTHAQUINONE”)

The visible and UV spectrophotometer may be used to identify classes of compounds in both the pure state and in biological preparations. This is done by plotting absorption spectrum curves. Absorption by a compound in different regions gives some hints to its structure.

2. Quantitative Analysis:

Spectrophotometer uses in the Quantitative analysis of Biochemistry practicals. Quantitative analysis method developing for determining an unknown concentration of a given species by absorption spectrometry. Most of the organic compounds of biological interest absorb in the UV-visible range of the spectrum. Thus, a number of important classes of biological compounds may be measured semi-quantitatively using the UV-visible spectrophotometer. Nucleic acids at 254nm protein at 280nm provide good examples of such use. The absorbance at 280nm by proteins depends on their “Tyrosine” and “Tryptophan” content.

- Estimation of Proteins by Lowry method
- Estimation of Tyrosine by Folin-Ciocalteau Method
- Estimation of Blood Glucose level by Folin-Wu method

3. Enzyme **Assay:**

This is the basic application of spectrophotometry. This assay is carried out most quickly and conveniently when the substrate (or) the product is color (or) absorbs light in the UV range.

Eg 1: Lactate Dehydrogenase (LDH)

Lactate + NAD $^+$ ↔ Pyruvate + NADH + H^+

- The LDH is engaged in the transfer of electrons from lactate to NAD^+.
- The products of the reaction are pyruvate, NAD, and a proton
- One of the products, NADH, **absorbs radiation in the UV range at 340 nm** while its oxidized counterpart, NAD^+ does not.
- The reaction in the forward direction can be followed by measuring the increment in the light absorption of the system at 540nm in a spectrophotometer.

Eg 2: Pyruvate Kinase

Phosphoenolpyruvate + ADP ↔ Pyruvate + ATP

Pyruvate + NADH + H^+ ↔ Lactate + NAD $^+$

We have added a large excess of NADH to the system, the system now absorbs at 340nm. According to the above-given reactions, each molecule of Pyruvate formed in the reaction, **a molecule of NADH is oxidized to NAD+** in the second reaction when the system converts pyruvate to locate.

Since NAD+ does not absorb at 340nm the absorbance goes on decreasing with increased pyruvate generation. Such measurements are known as “Coupled assays”.

Sample enzymatic assays:

- Assay of Urease Enzyme Activity
- Assay of Salivary Amylase enzyme activity
- Effect of Temperature on Amylase activity

4. Molecular Weight determination:

Molecular weights of amine picrates, sugars and many aldehyde and ketone compounds have been determined by this method. Molecular weights of only small molecules may be determined by this method.

1. **Study of Cis-Trans Isomerism:** Geometrical isomers differ in the spatial arrangement of groups about a plane, the absorption spectra of the isomers also differs. The trans-isomer is usually more elongated than its cis counterpart. Absorption spectrometry can be utilized to study Cis-Trans isomerism.
2. **Control of Purification:** Impurities in a compound can be detected very easily by spectrophotometric studies. “Carbon disulfide” impurity in carbon tetrachloride can be detected easily by measuring absorbance at 318nm where carbon sulfide absorbs. A lot many commercial solutions are routinely tested for purity spectroscopically.

5. Other Physiochemical Studies:

Spectrophotometry (UV-VIS) has been used to study the following physiochemical phenomena:

- Heats of formation of molecular addition compound and complexes in solution

- Determination of empirical formulae
- Formation constants of complexes in solution
- Hydration equilibrium of carbonyl compounds
- Association constants of weak acids and bases in organic solvents
- Protein-dye interactions
- Chlorophyll-Protein complexes.
- Vitamin-A aldehyde – Protein complex
- Determination of reaction rates
- Dissociation constants of acids and bases
- Association of cyanine dyes

Digital electronics or **digital (electronic) circuits** are electronics that operate on digital signals. In contrast, analog circuits manipulate analog signals whose performance is more subject to manufacturing tolerance, signal attenuation and noise. Digital techniques are helpful because it is a lot easier to get an electronic device to switch into one of a number of known states than to accurately reproduce a continuous range of values.

Digital electronic circuits are usually made from large assemblies of logic gates (often printed on integrated circuits), simple electronic representations of Boolean logic functions.[1]

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History[edit]

The binary number system was refined by Gottfried Wilhelm Leibniz (published in 1705) and he also established that by using the binary system, the principles of arithmetic and logic could be joined. Digital logic as we know it was the brain-child of George Boole in the mid 19th century. In an 1886 letter, Charles Sanders Peirce described how logical operations could be carried out by electrical switching circuits.[2] Eventually, vacuum tubes replaced relays for logic operations. Lee De Forest's modification, in 1907, of the Fleming valve can be used as an AND gate. Ludwig Wittgenstein introduced a version of the 16-row truth table as proposition 5.101 of *Tractatus Logico-Philosophicus* (1921). Walther Bothe, inventor of the coincidence circuit, shared the 1954 Nobel Prize in physics, for the first modern electronic AND gate in 1924.

Mechanical analog computers started appearing in the first century and were later used in the medieval era for astronomical calculations. In World War II, mechanical analog computers were used for specialized military applications such as calculating torpedo aiming. During this time the first electronic digital computers were developed. Originally they were the size of a large room, consuming as much power as several hundred modern personal computers (PCs).[3]

The Z3 was an electromechanical computer designed by Konrad Zuse. Finished in 1941, it was the world's first working programmable, fully automatic digital computer.[4] Its operation was facilitated by the invention of the vacuum tube in 1904 by John Ambrose Fleming.

At the same time that digital calculation replaced analog, purely electronic circuit elements soon replaced their mechanical and electromechanical equivalents. The bipolar junction transistor was invented in 1947. From 1955 onwards, transistors replaced vacuum tubes in computer designs, giving rise to the "second generation" of computers. Compared to vacuum tubes, transistors have many advantages: they are smaller, and require less power than vacuum tubes, so give off less heat. Silicon junction transistors were much more reliable than vacuum tubes and had longer, indefinite, service life. Transistorized computers could contain tens of thousands of binary logic circuits in a relatively compact space.

At the University of Manchester, a team under the leadership of Tom Kilburn designed and built a machine using the newly developed transistors instead of vacuum tubes.[5] Their first transistorised computer and the first in the world, was operational by 1953, and a second version was completed there in April 1955.

While working at Texas Instruments in July 1958, Jack Kilby recorded his initial ideas concerning the integrated circuit then successfully demonstrated the first working integrated on 12 September 1958.[6] This new technique allowed for quick, low-cost fabrication of complex circuits by having a set of electronic circuits on one small plate ("chip") of semiconductor material, normally silicon.

In the early days of integrated circuits, each chip was limited to only a few transistors, and the low degree of integration meant the design process was relatively simple. Manufacturing yields were also quite low by today's standards. As the technology progressed, millions, then billions[7] of transistors could be placed on one chip, and good designs required thorough planning, giving rise to new design methods.

Properties[edit]

An advantage of digital circuits when compared to analog circuits is that signals represented digitally can be transmitted without degradation caused by noise.[8] For example, a continuous audio signal transmitted as a sequence of 1s and 0s, can be reconstructed without error, provided the noise picked up in transmission is not enough to prevent identification of the 1s and 0s.

In a digital system, a more precise representation of a signal can be obtained by using more binary digits to represent it. While this requires more digital circuits to process the signals, each digit is handled by the same kind of hardware, resulting in an easily scalable system. In an analog system, additional resolution requires fundamental improvements in the linearity and noise characteristics of each step of the signal chain.

With computer-controlled digital systems, new functions to be added through software revision and no hardware changes. Often this can be done outside of the factory by

updating the product's software. So, the product's design errors can be corrected after the product is in a customer's hands.

Information storage can be easier in digital systems than in analog ones. The noise immunity of digital systems permits data to be stored and retrieved without degradation. In an analog system, noise from aging and wear degrade the information stored. In a digital system, as long as the total noise is below a certain level, the information can be recovered perfectly. Even when more significant noise is present, the use of redundancy permits the recovery of the original data provided too many errors do not occur.

In some cases, digital circuits use more energy than analog circuits to accomplish the same tasks, thus producing more heat which increases the complexity of the circuits such as the inclusion of heat sinks. In portable or battery-powered systems this can limit use of digital systems. For example, battery-powered cellular telephones often use a low-power analog front-end to amplify and tune in the radio signals from the base station. However, a base station has grid power and can use power-hungry, but very flexible software radios. Such base stations can be easily reprogrammed to process the signals used in new cellular standards.

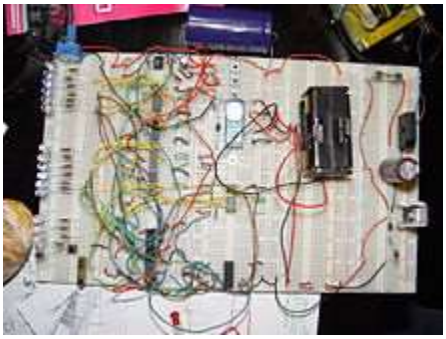
Many useful digital systems must translate from continuous analog signals to discrete digital signals. This causes quantization errors. Quantization error can be reduced if the system stores enough digital data to represent the signal to the desired degree of fidelity. The Nyquist-Shannon sampling theorem provides an important guideline as to how much digital data is needed to accurately portray a given analog signal.

In some systems, if a single piece of digital data is lost or misinterpreted, the meaning of large blocks of related data can completely change. For example, a single-bit error in

audio data stored directly as linear pulse code modulation causes, at worst, a single click. Instead, many people use audio compression to save storage space and download time, even though a single bit error may cause a larger disruption.

Because of the cliff effect, it can be difficult for users to tell if a particular system is right on the edge of failure, or if it can tolerate much more noise before failing. Digital fragility can be reduced by designing a digital system for robustness. For example, a parity bit or other error management method can be inserted into the signal path. These schemes help the system detect errors, and then either correct the errors, or request retransmission of the data.

Construction[edit]



A binary clock, hand-wired on breadboards

A digital circuit is typically constructed from small electronic circuits called logic gates that can be used to create combinational logic. Each logic gate is designed to perform a function of boolean logic when acting on logic signals. A logic gate is generally created from one or more electrically controlled switches, usually transistors but thermionic valves have seen historic use. The output of a logic gate can, in turn, control or feed into more logic gates.

Integrated circuits consist of multiple transistors on one silicon chip, and are the least expensive way to make large number of interconnected logic gates. Integrated circuits are usually designed by engineers using electronic design automation software (see below for more information) to perform some type of function.

Integrated circuits are usually interconnected on a printed circuit board which is a board which holds electrical components, and connects them together with copper traces.

Design[edit]

Each logic symbol is represented by a different shape. The actual set of shapes was introduced in 1984 under IEEE/ANSI standard 91-1984. "The logic symbol given under this standard are being increasingly used now and have even started appearing in the literature published by manufacturers of digital integrated circuits."[9]

Another form of digital circuit is constructed from lookup tables, (many sold as "programmable logic devices", though other kinds of PLDs exist). Lookup tables can perform the same functions as machines based on logic gates, but can be easily reprogrammed without changing the wiring. This means that a designer can often repair design errors without changing the arrangement of wires. Therefore, in small volume products, programmable logic devices are often the preferred solution. They are usually designed by engineers using electronic design automation software.

When the volumes are medium to large, and the logic can be slow, or involves complex algorithms or sequences, often a small microcontroller is programmed to make an embedded system. These are usually programmed by software engineers.

When only one digital circuit is needed, and its design is totally customized, as for a factory production line controller, the conventional solution is a programmable logic controller, or PLC. These are usually programmed by electricians, using ladder logic.

Structure of digital systems[edit]

Engineers use many methods to minimize logic functions, in order to reduce the circuit's complexity. When the complexity is less, the circuit also has fewer errors and less electronics, and is therefore less expensive.

The most widely used simplification is a minimization algorithm like the Espresso heuristic logic minimizer[*needs update*] within a CAD system, although historically, binary decision diagrams, an automated Quine–McCluskey algorithm, truth tables, Karnaugh maps, and Boolean algebra have been used.

Representation

Representations are crucial to an engineer's design of digital circuits. Some analysis methods only work with particular representations.

The classical way to represent a digital circuit is with an equivalent set of logic gates. Another way, often with the least electronics, is to construct an equivalent system of electronic switches (usually transistors). One of the easiest ways is to simply have a memory containing a truth table. The inputs are fed into the address of the memory, and the data outputs of the memory become the outputs.

For automated analysis, these representations have digital file formats that can be processed by computer programs. Most digital engineers are very careful to select computer programs ("tools") with compatible file formats.

Combinational vs. Sequential

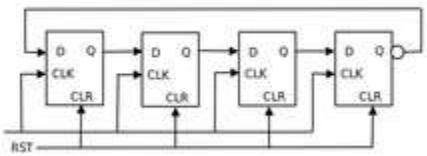
To choose representations, engineers consider types of digital systems. Most digital systems divide into "combinational systems" and "sequential systems." A combinational system always presents the same output when given the same inputs. It is basically a representation of a set of logic functions, as already discussed.

A sequential system is a combinational system with some of the outputs fed back as inputs. This makes the digital machine perform a "sequence" of operations. The simplest sequential system is probably a flip flop, a mechanism that represents a binary digit or "bit".

Sequential systems are often designed as state machines. In this way, engineers can design a system's gross behavior, and even test it in a simulation, without considering all the details of the logic functions.

Sequential systems divide into two further subcategories. "Synchronous" sequential systems change state all at once, when a "clock" signal changes state. "Asynchronous" sequential systems propagate changes whenever inputs change. Synchronous sequential systems are made of well-characterized asynchronous circuits such as flip-flops, that change only when the clock changes, and which have carefully designed timing margins.

Synchronous systems



A 4-bit ring counter using D-type flip flops is an example of synchronous logic. Each device is connected to the clock signal, and update together.

Main article: synchronous logic

The usual way to implement a synchronous sequential state machine is to divide it into a piece of combinational logic and a set of flip flops called a "state register." Each time a clock signal ticks, the state register captures the feedback generated from the previous state of the combinational logic, and feeds it back as an unchanging input to the combinational part of the state machine. The fastest rate of the clock is set by the most time-consuming logic calculation in the combinational logic.

The state register is just a representation of a binary number. If the states in the state machine are numbered (easy to arrange), the logic function is some combinational logic that produces the number of the next state.

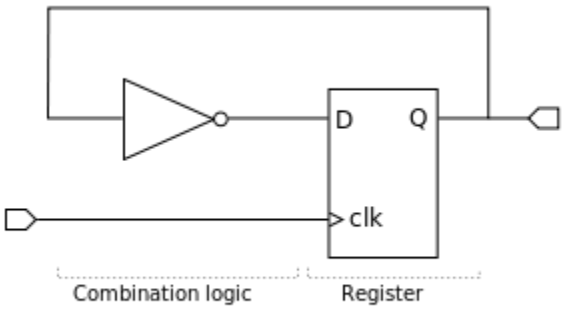
Asynchronous systems

As of 2014, most digital logic is synchronous because it is easier to create and verify a synchronous design. However, asynchronous logic is thought can be superior because its speed is not constrained by an arbitrary clock; instead, it runs at the maximum speed of its logic gates. Building an asynchronous system using faster parts makes the circuit faster.

Nevertheless, most systems need circuits that allow external unsynchronized signals to enter synchronous logic circuits. These are inherently asynchronous in their design and must be analyzed as such. Examples of widely used asynchronous circuits include synchronizer flip-flops, switch debouncers and arbiters.

Asynchronous logic components can be hard to design because all possible states, in all possible timings must be considered. The usual method is to construct a table of the minimum and maximum time that each such state can exist, and then adjust the circuit to minimize the number of such states. Then the designer must force the circuit to periodically wait for all of its parts to enter a compatible state (this is called "self-resynchronization"). Without such careful design, it is easy to accidentally produce asynchronous logic that is "unstable," that is, real electronics will have unpredictable results because of the cumulative delays caused by small variations in the values of the electronic components.

Register transfer systems



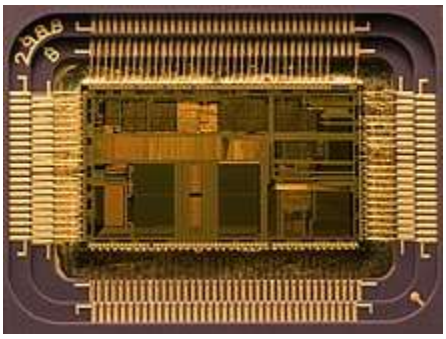
Example of a simple circuit with a toggling output. The inverter forms the combinational logic in this circuit, and the register holds the state.

Many digital systems are data flow machines. These are usually designed using synchronous register transfer logic, using hardware description languages such as VHDL or Verilog.

In register transfer logic, binary numbers are stored in groups of flip flops called registers. The outputs of each register are a bundle of wires called a "bus" that carries that number to other calculations. A calculation is simply a piece of combinational logic. Each calculation also has an output bus, and these may be connected to the inputs of several registers. Sometimes a register will have a multiplexer on its input, so that it can store a number from any one of several buses. Alternatively, the outputs of several items may be connected to a bus through buffers that can turn off the output of all of the devices except one. A sequential state machine controls when each register accepts new data from its input.

Asynchronous register-transfer systems (such as computers) have a general solution. In the 1980s, some researchers discovered that almost all synchronous register-transfer machines could be converted to asynchronous designs by using first-in-first-out synchronization logic. In this scheme, the digital machine is characterized as a set of data flows. In each step of the flow, an asynchronous "synchronization circuit" determines when the outputs of that step are valid, and presents a signal that says, "grab the data" to the stages that use that stage's inputs. It turns out that just a few relatively simple synchronization circuits are needed.

Computer design[edit]



Intel 80486DX2 microprocessor

The most general-purpose register-transfer logic machine is a computer. This is basically an automatic binary abacus. The control unit of a computer is usually designed as a microprogram run by a microsequencer. A microprogram is much like a player-piano roll. Each table entry or "word" of the microprogram commands the state of every bit that controls the computer. The sequencer then counts, and the count addresses the memory or combinational logic machine that contains the microprogram. The bits from the microprogram control the arithmetic logic unit, memory and other parts of the computer, including the microsequencer itself. A "specialized computer" is usually a conventional computer with special-purpose control logic or microprogram.

In this way, the complex task of designing the controls of a computer is reduced to a simpler task of programming a collection of much simpler logic machines.

Almost all computers are synchronous. However, true asynchronous computers have also been designed. One example is the Aspida DLXcore.[10] Another was offered by ARM Holdings. Speed advantages have not materialized, because modern computer designs already run at the speed of their slowest component, usually memory. These do use somewhat less power because a clock distribution network is not needed. An unexpected advantage is that asynchronous computers do not produce spectrally-pure radio noise, so they are used in some mobile-phone base-station controllers. They may be more secure in cryptographic applications because their electrical and radio emissions can be more difficult to decode.[11]

Computer architecture

Computer architecture is a specialized engineering activity that tries to arrange the registers, calculation logic, buses and other parts of the computer in the best way for

some purpose. Computer architects have applied large amounts of ingenuity to computer design to reduce the cost and increase the speed and immunity to programming errors of computers. An increasingly common goal is to reduce the power used in a battery-powered computer system, such as a cell-phone. Many computer architects serve an extended apprenticeship as microprogrammers.

Design issues in digital circuits

Digital circuits are made from analog components. The design must assure that the analog nature of the components doesn't dominate the desired digital behavior. Digital systems must manage noise and timing margins, parasitic inductances and capacitances, and filter power connections.

Bad designs have intermittent problems such as "glitches", vanishingly fast pulses that may trigger some logic but not others, "runt pulses" that do not reach valid "threshold" voltages, or unexpected ("undecoded") combinations of logic states.

Additionally, where clocked digital systems interface to analog systems or systems that are driven from a different clock, the digital system can be subject to metastability where a change to the input violates the set-up time for a digital input latch. This situation will self-resolve, but will take a random time, and while it persists can result in invalid signals being propagated within the digital system for a short time.

Since digital circuits are made from analog components, digital circuits calculate more slowly than low-precision analog circuits that use a similar amount of space and power. However, the digital circuit will calculate more repeatably, because of its high noise immunity. On the other hand, in the high-precision domain (for example, where 14 or more bits of precision are needed), analog circuits require much more power and area than digital equivalents.

S.NO	Questions	Opt-1	Opt-2	Opt-3	Opt-4	Answers
1	According to SI units, mass of a substance is measured in	moles	kilograms	meters	candelas	kilograms
2	Derived units of physical quantities given by SI are	five	seven	eight	nine	five
3	"Candela", according to system international is a	base unit	derived unit	supplementary unit	international unit	base unit
4	Mercury thermometer is used to measure exact	time	length	temperature	pressure	temperature
5	The voltage out of an ideal voltage source is	Zero	Constant	Load resistance dependent	Internal resistance dependent	Constant
6	The current out of an ideal current source is	Zero	Constant	Load resistance dependent	Internal resistance dependent	Constant
7	The path between two points along which an electrical current can be carried is called	network	relay	circuit	loop	circuit
8	The formula for current as per Ohm's Law is	Voltage / Resistance	Resistance * Voltage	Voltage + Resistance	Resistance / Voltage	Voltage / Resistance
9	The unit of electrical resistance is	Volt	Amp	Ohm	Coulomb	Ohm
10	In a constant voltage DC circuit, when the resistance increases, the current will	Decrease	Stop	Increase	Remains constant	Decrease

11	Number of valence electrons in a silicon atom are	1	4	8	16	4
12	The most commonly used semiconductor element is	Silicon	Germanium	Gallium	Carbon	Silicon
13	Copper is a	Insulator	Conductor	Semiconductor	Super Conductor	Conductor
14	The valence electron of a conductor are also called as	Bound electron	Free electron	Nucleus	Proton	Free electron
15	An intrinsic semiconductor at room temperature has	A few free electrons and holes	Many holes	Many free electrons	No holes	A few free electrons and holes
16	At room temperature, an intrinsic semiconductor has some holes in it due to	Doping	Free electrons	Thermal energy	Valence electrons	Thermal energy
17	The number of holes in an intrinsic semiconductor is	Equal to number of free electrons	Greater than number of free electrons	Less than number of free electrons	less or equal number of electrons	Equal to number of free electrons
18	Holes act as	Atoms	Crystals	Negative charges	Positive charges	Positive charges
19	Pick the odd one in the group	Conductor	Semiconductor	Four valence electrons	Crystal structure	Conductor
20	To produce P-type semiconductors, you need to add	Trivalent impurity	Carbon	Pentavalent impurity	Silicon	Trivalent impurity
21	Electrons are the minority carriers in	Extrinsic Semiconductors	p-type Semiconductors	Intrinsic Semiconductors	n-type Semiconductors	n-type Semiconductors
22	A p-type semiconductor contains	Holes and Negative ions	Holes and Positive ions	Holes and Pentavalent atoms	Holes and Donor atoms	Holes and Negative ions
23	How many electrons does pentavalent atoms have?	1	3	4	5	5

24	Negative ions are	Atoms that obtained a proton	Atoms that lost a proton	Atoms that obtained an electron	Atoms that lost an electron	Atoms that obtained an electron
25	Which one of the statement is true regarding residuals in regression analysis?	Mean of residuals is always zero	Mean of residuals is always less than zero	Mean of residuals is always greater than zero	There is no such rule for residuals.	Mean of residuals is always zero
26	To test linear relationship of y(dependent) and x(independent) continuous variables, which of the following plot best suited?	Scatter plot	Barchart	Histograms	degree of freedom	Scatter plot
27	In regression analysis, if observed cost value is 50 and predicted cost value is 7, then disturbance term will be	57	43	67	47	43
28	Number of observations in regression analysis is considered as	degree of possibility	degree of average	degree of variance	degree of freedom	degree of freedom
29	All conditions or assumptions of regression analysis in simple regression can give	dependent estimation	independent estimation	reliable estimates	unreliable estimates	reliable estimates
30	Standard error of regression analysis is known as	average of coefficient	variance of residual	mean of residual	average of residual	variance of residual
31	In Regression Analysis, testing of assumptions if these are true or not is classified as	weighted analysis	average analysis	significance analysis	specification analysis	specification analysis
32	Depletion layer is caused by	Doping	Recombination	Barrier potential	Ions	Recombination
33	The reverse current in a diode is usually	Very small	Very large	Zero	In the breakdown region	Very small

34	Avalanche in Diode occurs at	Barrier potential	Depletion layer	Knee voltage	Breakdown voltage	Breakdown voltage
35	The potential barrier of a silicon diode is	0.3 V	0.7 V	1 V	5V	0.7 V
36	The reverse saturation current in a Silicon Diode is _____ than that of Germanium Diode	Equal	Higher	Lower	Depends on temperature	Lower
37	A Diode is a	Bilateral Device	Nonlinear Device	Linear Device	Unipolar Device	Linear Device
38	The diode current is large for which condition	Forward Bias	Inverse Bias	Poor Bias	Reverse Bias	Forward Bias
39	The output voltage signal of a bridge rectifier is	Half-wave	Full-wave	Bridge-rectified signal	Sine wave	Full-wave
40	If the maximum DC current rating of diodes in Bridge Rectifier is 1A, what is the maximum DC load current?	1A	2A	4A	8A	2A
41	Voltage multipliers produce	Low voltage and low current	Low voltage and high current	High voltage and low current	High voltage and high current	High voltage and low current
42	Zener diode can be described as	A rectifier diode.	A device with constant – voltage.	A device with constant – current.	A device that works in the forward region.	A device with constant – voltage.
43	If the Zener Diode is connected in wrong polarity, the voltage across the load is	0.7 V	10 V	14 V	18 V	0.7 V
44	Number of PN Junctions in a Transistor	One	Two	Three	Four	Two

45	The doping concentration of Base in NPN Transistor is	Lightly Doped	Moderately Doped	Heavily Doped	Not Doped	Lightly Doped
46	The Base – Emitter Diode (Base – Emitter Junction) in an NPN Transistor is	Doesn't conduct	Forward Biased	Reverse Biased	Operates in breakdown region	Forward Biased
47	The size comparison between Base, Emitter and Collector is	Base > Collector > Emitter	Emitter > Collector > Base	Collector > Emitter > Base	All are equal	Collector > Emitter > Base
48	The Base – Collector Diode (Base Collector Junction) is usually	Reverse Biased	Forward Biased	Breakdown Region	No Conduction	Reverse Biased
49	The DC Current Gain of a Transistor is	Ratio of Emitter Current to Collector Current	Ratio of Base Current to Emitter Current	Ratio of Collector Current to Base Current	Ratio of Base Current to Collector Current	Ratio of Collector Current to Base Current
50	If base current is 100μA and current gain is 100, then collector current is	1A	10A	1mA	10mA	10mA
	The majority carriers in NPN and PNP Transistors are	Holes and Electrons	Electrons and Holes	Acceptor Ions and Donor Ions	Elcetrons	Electrons and Holes
51	A Transistor acts as a	Voltage Source and a Current Source	Current Source and a Resistor	Diode and Current Source	Diode and Power Supply	Diode and Current Source
52	The relation between Base Current IB, Emitter Current IE and Collector Current IC is	IE = IB + IC	IB = IC + IE	IE = IB – IC	IC = IB + IE	IE = IB + IC

53	The total power dissipated by a transistor is a product of collector current and	Supply Voltage	0.7V	Collector – Emitter Voltage	Base – Emitter Voltage	Collector – Emitter Voltage
54	The input impedance of Common Emitter Configuration is	Low	High	Zero	Very High	Low
55	The output impedance of Common Emitter Configuration is	Low	Very Low	High	Zero	High
56	The current gain in Common Base configuration (α) is	Ratio of Base Current to Emitter Current (IB/IE)	Ratio of Collector Current to Emitter Current (IC/IE)	Ratio of Collector Current to Base Current (IC/IB)	Ratio of collector current	Ratio of Collector Current to Emitter Current (IC/IE)
57	A covariate is a _____independent variable used in _____.	metric; ANOVA	categorical; ANCOVA	metric; ANCOVA	categorical; ANOVA	metric; ANCOVA
58	How consumers' intentions to buy the brand varies with different price levels is best analyzed via _____.	t tests	one-way ANOVA	ANCOVA	regression	one-way ANOVA
59	Analysis of covariance includes at least one _____ independent variable and at least one _____ independent variable.	categorical; interval	ordinal; categorical	metric; interval	parametric; interval	categorical; interval
60	_____ is an ANOVA technique using two or more metric dependent variables.	Nonmetric ANOVA	Contrasts	Repeated measures ANOVA	Multivariate analysis of variance (MANOVA)	Multivariate analysis of variance (MANOVA)

61	Which of the following evaluation metrics can not be applied in case of logistic regression output to compare with target?	AUC-ROC	Accuracy	Logloss	Mean-Squared-Error	Mean-Squared-Error