NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

COURSE CODE: EHS 301

COURSE TITLE: INTRODUCTION TO BASIC INSTRUMENTATION AND USE

NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCES

COURSE CODE: EHS 301

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COURSE GUIDE

EHS 301: INTRODUCTION TO BASIC INSTRUMENTATION AND USE

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COURSE GUIDE

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Introduction

Environmental health is the branch of public health concerned with all aspects of the natural and built environment affecting human health. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection. Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human Environmental health has been defined in a 1999 document by the World Health Organization (WHO) as:

Those aspects of the human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health.

Environmental health as used by the WHO, includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well being of the broad physical, psychological, social and cultural environment, which includes housing, urban development, land use and transport.

What you will learn in this course

In this course, you have the course units and a course guide. The course guide will tell you what the course is all about. It is general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked Assignment which will form part of your overall assessment at the end of the course. Also, there will be regular tutorial classes that are related to this course, where you can interact with your facilitator and other students. Please, I encourage you to attend these tutorial classes.

Course Aims

The course aims to give you an understanding on instrumentation and its use.

Course Objective

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will guide you on what to concentrate / focus on while studying the unit. Please read the objective before studying the unit and during your study to check your progress.

The Comprehensive Objectives of the Course are given below. By the end of the course/after going through this course, you should be able to:

- Define disciplines in environmental health
- basic principles of laboratory safety
- basic principles of laboratory safety
- basic principles of laboratory safety
- Validation of analytical methods and Precautions

Working through this course

To successfully complete this course, you are required to read each study unit, read the textbooks materials provided by the National Open University.

Reading the referenced materials can also be of great assistance.

Each unit has self-assessment exercises which you are advised to do and at certain periods during the course you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about 17 weeks to complete.

This course guide will provide you with all the components of the course how to go about studying and hour you should allocate your time to each unit so as to finish on time and successfully.

The Course Materials

The main components of the course are:

- The Study Guide
- Study Units
- Reference / Further Readings
- Assignments
- Presentation Schedule

Study Unit

The study units in this course are given below:

MAIN COURSE

CONTENTS

MODULE 4 Basic principles of laboratory safety

Unit 1: Barometer

Unit 2: Weather Balloon

MODULE 5 Validation of analytical methods and Precautions

Unit 1: Precautions in using laboratory equipment

Unit 2: Introduction to the use of the laboratory.

There are activities related to the lecture in each unit which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the TMAs will enable you to achieve the objectives of each unit.

Presentation Schedule

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

Assessment

There are three aspects to the assessment of this course.

The first one is the self-assessment exercises. The second is the tutor marked assignments and the third is the written examination or the examination to be taken at the end of the course.

Do the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.

The work submitted to your tutor for assessment will count for 30% of your total course work.

At the end of this course, you have to sit for a final or end of course examination of about a three hour duration which will count for 70% of your total course mark.

Tutor-Marked Assignment

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given four (4) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of course examination.

These answered assignments are to be returned to your facilitator.

You're expected to complete the assignments by using the information and material in your readings references and study units.

Reading and researching into you references will give you a wider via point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting or the examination. The self-assessment activities and TMAs will be useful for this purposes and if you have any comment please do before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assignment	Marks
Assignments 1 – 4	Four assignments, best three marks of the four count at 10% each–30% of course marks.
End of course examination	70% of overall course marks
Total	100% of course materials.

Facilitators/Tutors and Tutorials

Sixteen (16) hours are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes.

As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignment. He will monitor your progress and provide any necessary assistance you need. He or she will mark your TMAs and return to you as soon as possible.

(You are expected to mail your tutored assignment to your facilitator at least two days before the schedule date).

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if You do not understand any part of the study in the course material. You have difficulty with the self assessment activities. You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you acted the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions which will be answered instantly. It is also period where you can say any problem encountered in the course of your study.

Summary

Environmental health is the branch of public health concerned with all aspects of the natural and built environment affecting human health. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection. Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human Environmental health has been defined in a 1999 document by the World Health Organization (WHO) as: Those aspects of the human health and disease that are determined by factors in the environment.

- Define the term Disciplines in Environmental health
- Validation of analytical methods and Precautions
- Introduction to the use of the laboratory.
- Basic principles of laboratory safety

The list of questions expected to be answer is not limited to the above list. Finally, you are expected to apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course.

Course Code: EHS 301

Course Title: Basic Instrumentation and Use

Course Developer/Writer: **Dr. A. S. Dan-Kishiya**
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University of Abuja

MAIN COURSE

CONTENTS

MODULE 5 Validation of analytical methods and Precautions

Unit 1: Precautions in using laboratory equipments

Unit 2: Introduction to the use of the laboratory.

Module 1 critically examines the environmental health in its entirety. It looks at aspects of toxicology, exposure, epidemiology, environmental engineering and environmental law in the unit one while disciplines under the subject environmental health was also highlighted in unit two

Module 2 takes a look at the basic principle of laboratory safety. It looks at basic use of a collection of laboratory equipment, design, mode of operation, types and safety in their use. It critically examines: spectrophotometer, pH meter, hot air oven and the microscope

Module 3 puts more emphasis on the use of laboratory equipment and devices and covers the use of centrifuge, optical air sensors, incubators and B2 technology. In the various units

Module 4 further examines the use of laboratory equipment. Unit one highlights the use of barometer and the different type of barometer for specific purposes while unit 2 discusses the weather balloon and sundry issues associated with its use.

Module 5 elucidates on the precautions in the use of laboratory and equipment and safety in unit one while unit two talks about safe use of the general laboratory.

Module 1 Introduction To Environmental Health

UNIT 1 General Overview

CONTENTS

1.0 INTRODUCTION

Environmental health is the branch of public health concerned with all aspects of the natural and built environment affecting human health. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection. Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human Environmental health has been defined in a 1999 document by the World Health Organization (WHO) as:

Those aspects of the human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health.

Environmental health as used by the WHO, includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well being of the broad physical, psychological, social and cultural environment, which includes housing, urban development, land use and transport.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Explain the concept of Environmental health
- List various disciplines in Environmental health
- Explain the importance of environmental health
- Main content

3.0 MAIN CONTENT

3.1 Disciplines in Environmental health

Five basic disciplines generally contribute to the field of environmental health: environmental epidemiology, toxicology, exposure science, environmental engineering, and environmental law. Each of these disciplines contributes different information to describe problems and solutions in environmental health, but there is some overlap among them.

Environmental epidemiology studies the relationship between environmental exposures (including exposure to chemicals, radiation, microbiological agents, etc.) and human health. Observational studies, which simply observe exposures that people have already experienced, are common in environmental epidemiology because humans cannot ethically be exposed to agents that are known or suspected to cause disease. While the inability to use experimental study designs is a limitation of environmental epidemiology, this discipline directly observes effects on human health rather than estimating effects from animal studies.

- Toxicology studies how environmental exposures lead to specific health outcomes, generally in animals, as a means to understand possible health outcomes in humans. Toxicology has the advantage of being able to conduct randomized controlled trials and other experimental studies because they can use animal subjects. However there are many differences in animal and human biology, and there can be a lot of uncertainty when interpreting the results of animal studies for their implications for human health.
- Exposure science studies human exposure to environmental contaminants by both identifying and quantifying exposures. Exposure science can be used to support environmental epidemiology by better describing environmental exposures that may lead to a particular health outcome, identify common exposures whose health outcomes may be better understood through a toxicology study, or can be used in a risk assessment to determine whether current levels of exposure might exceed recommended levels. Exposure science has the advantage of being able to very accurately quantify exposures to specific chemicals, but it does not generate any information about health outcomes like environmental epidemiology or toxicology.
- Environmental engineering applies scientific and engineering principles for protection of human populations from the effects of adverse environmental factors; protection of environments from potentially deleterious effects of natural and human activities; and general improvement of environmental quality.

4.0 CONCLUSION

In this unit, you learnt about the general idea of environmental health. Also, you were introduced to various disciplines under environmental health and safety.

5.0 SUMMARY

You have been introduced into the field of environmental health including the fundamental reason for this study. You were also introduced to the disciplines in this field.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the term Environmental health
2. List any five disciplines in environmental health

Solution

Environmental health is the branch of public health concerned with all aspects of the natural and built environment affecting human health. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection. Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human Environmental health has been defined in a 1999 document by the World Health Organization (WHO) as: Those aspects of the human health and disease that are determined by factors in the environment.

- **List any five disciplines in environmental health**

Five basic disciplines generally contribute to the field of environmental health: environmental epidemiology, toxicology, exposure science, environmental engineering, and environmental law. Each of these disciplines contributes different information to describe problems and solutions in environmental health, but there is some overlap among them.

7.0 REFERENCE/FURTHER READING

Mitchell, F.L. (1976) Simplified instrumentation for the clinical laboratory. Bulletin of Pan American Health Organisation, 10, 212.

World Health Organization: Environment and Health The European Charter and Commentary, *WHO Regional Publications European Series No. 35*, 1999 Copenhagen World Health Organization Regional Office for Europe

Valent F, LittleD, Bertollini R, et al. Burden of disease attributable to selected environmental factors and injury among children and adolescents in Europe, *Lancet* , 2004, vol. 363 (pg. 2032-9)

Unit 3: Sources of Environmental health

CONTENTS

1.0 introduction

The word 'health' brings many things to mind. Maintaining good health involves eating right, exercising, vaccinations against diseases, and visiting your doctor regularly. Your health describes how well your body is functioning and your quality of life.

We can also appreciate health in a broader sense. Environmental health involves understanding the impacts of environmental and human-made hazards and protecting human health and ecological systems against these hazards. This includes studying the impacts of human-made chemicals on wildlife or human health, as well as how the environment influences the spread of diseases.

2.0 Objectives

You will know the meaning of the term environmental health at the end of this unit

3.0 Main content

3.1 Types of environmental health

We face countless environmental hazards every day. To better understand them, we can think of them as falling into four categories: physical, chemical, biological, and cultural.

Physical hazards are physical processes that occur naturally in the environment. These include natural disaster events such as earthquakes, tornadoes, volcanoes, blizzards, landslides, and droughts. Not all physical hazards are discrete events - some are ongoing, like ultraviolet radiation. UV radiation is considered a hazard because it damages DNA and can cause human health issues like skin cancer and cataracts.

Chemical hazards can be both natural and human-made chemicals in the environment. Human-made chemical hazards include many of the synthetic chemicals we produce, like disinfectants, pesticides and plastics. Some chemical hazards occur naturally in the environment, like the heavy metals lead and mercury. Some organisms even produce natural chemicals that are an environmental hazard, such as the compounds in peanuts and dairy that cause allergic reactions in humans.

Biological hazards come from ecological interactions between organisms. Viruses, bacterial infections, malaria, and tuberculosis are all examples of biological hazards. When these pathogens and diseases are transferred between organisms, it's called an infectious disease. We suffer from these diseases and pathogens because we're being parasitized by another organism, which, while hazardous, is also a natural process.

Cultural hazards, also known as social hazards, result from your location, socioeconomic status, occupation, and behavioral choices. For example, smoking cigarettes is hazardous to your health, and this is a behavioral choice. If you live in a neighborhood with lots of crime, this is a hazard based on your location. Similarly, your diet, exercise habits, and primary mode of transportation all influence your health and the health of the environment around you.

4.0 Conclusion

As you can see, environmental hazards can come from a variety of sources. While many hazards come from outdoor sources, indoor sources are especially important to understand because we spend so much of our time inside. Your home, office, and car are all part of your environment, and can all be sources of environmental hazards.

5.0Summary

Environmental health involves understanding the impacts of environmental and human-made hazards and protecting human health and ecological systems against these hazards. This includes studying the impacts of human-made chemicals on wildlife or human health, as well as how the environment influences the spread of diseases.

6.0 Tutor-marked assignment

-Define the term environmental health?

Solution

Environmental health involves understanding the impacts of environmental and human-made hazards and protecting human health and ecological systems against these hazards. This includes studying the impacts of human-made chemicals on wildlife or human health, as well as how the environment influences the spread of diseases.

7.0 References

Adamowicz W, Dupont D, Krupnick A, Zhang J. Resources for the Future Discussion Paper 07–39.Washington, DC: 2007. Valuation of Cancer and Microbial Disease Risk Reductions in Municipal Drinking Water: An Analysis of Risk Context Using Multiple Valuation Methods.

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Biswas A. Water Management and Environmental Challenge. New Delhi: Oxford University Press; 2006.

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Unit 4: Environmental Hazards

CONTENTS

1.0 Introduction

An environmental hazard is a substance, a state or an event which has the potential to threaten the surrounding natural environment / or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes.Any single or combination of toxic chemical, biological, or physical agents in the environment, resulting from human activities or natural processes, that may impact the health of exposed subjects, including pollutants such as heavy metals, pesticides, biological contaminants, toxic waste, industrial and home chemicals.

Human-made hazards while not immediately health-threatening may turn out detrimental to man's well-being eventually, because deterioration in the environment can produce secondary, unwanted negative effects on the human ecosphere. The effects of water pollution may not be immediately visible because of a sewage system that helps drain off toxic substances. If those substances turn out to be persistent (e.g. persistent organic pollutant), however, they will literally be fed back to their producers via the food chain: plankton -> edible fish -> humans. In that respect, a considerable number of environmental hazards listed below are man-made (anthropogenic) hazards.

Hazards can be categorized in four types:

1. Chemical
2. Physical (mechanical, etc.)
3. Biological
4. Psychosocial.

Chemical

Chemical hazards are defined in the Globally Harmonized System and in the European Union chemical regulations. They are caused by chemical substances causing significant damage to the environment. The label is particularly applicable towards substances with aquatic toxicity. An example is zinc oxide, a common paint pigment, which is extremely toxic to aquatic life.

Toxicity or other hazards do not imply an environmental hazard, because elimination by sunlight (photolysis), water (hydrolysis) or organisms (biological elimination) neutralizes many reactive or poisonous substances. Persistence towards these elimination mechanisms combined with toxicity gives the substance the ability to do damage in the long term. Also, the lack of immediate human toxicity does not mean the substance is environmentally nonhazardous. For example, tanker truck-sized spills of substances such as milk can cause a lot of damage in the local aquatic ecosystems: the added biological oxygen demand causes rapid eutrophication, leading to anoxic conditions in the water body.

All hazards in this category are mainly anthropogenic although there exist a number of natural carcinogens and chemical elements like radon and lead may turn up in health-critical concentrations in the natural environment:

- Anthrax
- Antibiotic agents in animals destined for human consumption
- Arsenic - a contaminant of fresh water sources (water wells)
- Asbestos - carcinogenic
- DDT
- Carcinogens
- dioxins
- Endocrine disruptors
- Explosive material

Physical

A physical hazard is a type of occupational hazard that involves environmental hazards that can cause harm with or without contact.

- Cosmic rays
- Drought
- Earthquake
- Electromagnetic fields
- E-waste
- Floods

Biological

Biological hazards, also known as biohazards, refer to biological substances that pose a threat to the health of living organisms, primarily that of humans. This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can affect human health.

- Allergies
- Arbovirus
- Avian influenza
- Bovine spongiform encephalopathy (BSE)
- Cholera

Psychosocial

Psychosocial hazards include but aren't limited to stress, violence and other workplace stressors. Work is generally beneficial to mental health and personal wellbeing. It provides people with structure and purpose and a sense of identity.

4.0 Conclusion

Human-made hazards while not immediately health-threatening may turn out detrimental to man's well-being eventually, because deterioration in the environment can produce secondary, unwanted negative effects on the human ecosphere. The effects of water pollution may not be immediately visible because of a sewage system that helps drain off toxic substances. If those substances turn out to be persistent (e.g. persistent organic pollutant), however, they will literally be fed back to their producers via the food chain: plankton ->edible fish -> humans. In that respect, a considerable number of environmental hazards listed below are man-made (anthropogenic) hazards.

5.0 Summary

An environmental hazard is a substance, a state or an event which has the potential to threaten the surrounding natural environment / or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes. Any single or combination of toxic chemical, biological, or physical agents in the environment, resulting from human activities or natural processes, that may impact the health of exposed subjects, including pollutants such as heavy metals, pesticides, biological contaminants, toxic waste, industrial and home chemicals.

6.0 Tutor-Marked Assignment

- What do you understand by the term Environmental hazards

7.0 References

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MODULE 2 Basic principles of laboratory safety

UNIT 1 SPECTROPHOTOMETER

CONTENTS

1.0 INTRODUCTION

Laboratory safety is a concern to scientific personnel conducting research or safety testing, laboratory directors responsible for institutional liability for employees, and to individuals working or residing near the laboratory. A strategy for safe laboratory operations requires an understanding of industrial hygiene, engineering, and the regulations associated with the use of hazardous chemicals. This review describes many of the basic principles involved in laboratory safety. It provides general information on the use of personal protective equipment, selection of laboratory safety equipment, laboratory design, disposal of hazardous waste, and the regulations and guidelines affecting laboratory operations

2.0 OBJECTIVE

At the end of this unit you should be able to :

- Describe the design of a photospectrometer
- List the application of a photospectrometer

3.0 MAIN CONTENT

Spectrophotometry is a tool that hinges on the quantitative analysis of molecules depending on how much light is absorbed by colored compounds. Spectrophotometry uses photometers, known as spectrophotometers, that can measure a light beam's intensity as a function of its color (wavelength). Important features of spectrophotometers are spectral bandwidth (the range of colors it can transmit through the test sample), the percentage of sample-transmission, the logarithmic range of sample-absorption, and sometimes a percentage of reflectance measurement.

A spectrophotometer is commonly used for the measurement of transmittance or reflectance of solutions, transparent or opaque solids, such as polished glass, or gases. Although many biochemicals are colored, as in, they absorb visible light and therefore can be measured by colorimetric procedures, even colorless biochemicals can often be converted to colored compounds suitable for chromogenic color-forming reactions to yield compounds suitable for colorimetric analysis. However, they can also be designed to measure the diffusivity on any of the listed light ranges that usually cover around 200 nm - 2500 nm using different controls and calibrations. Within these ranges of light, calibrations are needed on the machine using standards that vary in type depending on the wavelength of the *photometric determination*

The spectrophotometer is an optical instrument for measuring the intensity of light relative to wavelength. Electromagnetic energy, collected from the sample, enters the device through the aperture (yellow line) and is separated into its component wavelengths by the holographic grating. Simply put, the grating acts to separate each color from the white light. The separated light is then focused onto a CCD array detector where the intensity of each wavelength (or each color if in the visible region) is then measured by a pixel of the array. The CCD is then read-off to a computer and the result is a spectrum which displays the intensity of each wavelength of light. The spectrophotometer allows the scientist or engineer to acquire spectra of by shining white light on a sample and measuring the light that is returned from the sample. With this non-destructive technique, measurements can be made with light transmitted through the sample, reflected from it or even when the sample is made to emit light by processes such as photoluminescence.

Spectrophotometers are employed in many different fields and are found in both scientific laboratories and production facilities. In the production environment, for example, they are used for quality control of everything from clothing to the emission of light when producing LEDs. Spectrophotometers are used by analytical laboratories to identify and quantify microscopic samples ranging from the kinetics, matching colors, the qualification of gems and minerals, the determination of the color of ink or paint by a process chemist. As such, the spectrometer is a highly flexible instrument with many different applications

In astronomy, the term spectrophotometry refers to the measurement of the spectrum of a celestial object in which the flux scale of the spectrum is calibrated as a function of wavelength, usually by comparison with an observation of a spectrophotometric standard star, and corrected for the absorption of light by the Earth's atmosphere

Design

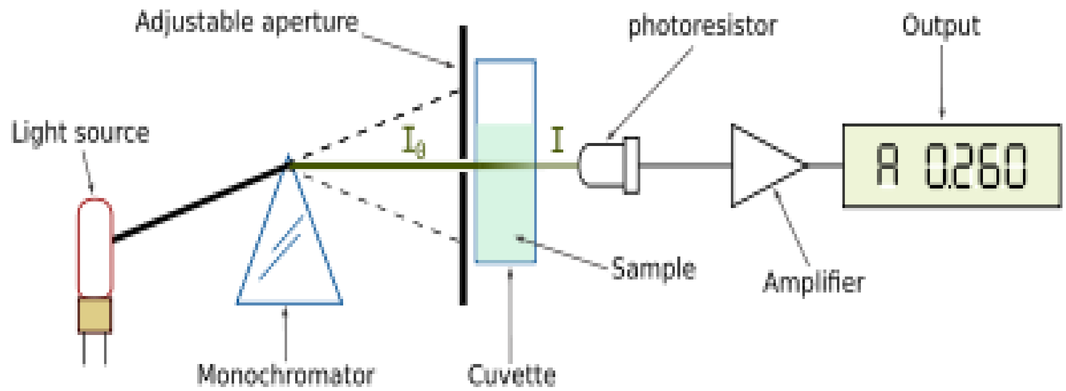

Fig 1

www.google.com

Single beam scanning spectrophotometer

Types of Spectrophotometer

Single Beam And Double Beam.

A double beam spectrophotometer compares the light intensity between two light paths, one path containing a reference sample and the other the test sample. A single-beam spectrophotometer measures the relative light intensity of the beam before and after a test sample is inserted. Although comparison measurements from double-beam instruments are easier and more stable, single-beam instruments can have a larger dynamic range and are optically simpler and more compact. Additionally, some specialized instruments, such as spectrophotometers built onto microscopes or telescopes, are single-beam instruments due to practicality. In short, the sequence of events in a scanning spectrophotometer is as follows:

1. The light source is shone into a monochromator, diffracted into a rainbow, and split into two beams. It is then scanned through the sample and the reference solutions.

2. Fractions of the incident wavelengths are transmitted through, or reflected from, the sample and the reference.
3. The resultant light strikes the photodetector device, which compares the relative intensity of the two beams.
4. Electronic circuits convert the relative currents into linear transmission percentages and/or absorbance/concentration values.

In an array spectrophotometer, the sequence is as follows:

1. The light source is shone into the sample and focused into a slit
2. The transmitted light is refracted into a rainbow with the reflection grating
3. The resulting light strikes the photo-detector device which compares the intensity of the beam
4. Electronic circuits convert the relative currents into linear transmission percentages and/or absorbance/concentration values

Applications in Biochemistry

Spectrophotometry is an important technique used in many biochemical experiments that involve DNA, RNA, and protein isolation, enzyme kinetics and biochemical analyses. Since samples in these applications are not readily available in large quantities, they are especially suited to being analyzed in this non-destructive technique. In addition, precious sample can be saved by utilizing a micro-volume platform where as little as 1uL of sample is required for complete analyses. A brief explanation of the procedure of spectrophotometry includes comparing the absorbency of a blank sample that does not contain a colored compound to a sample that contains a colored compound. This coloring can be accomplished by either a dye such as Coomasie Brilliant Blue G-250 dye measured at 595 nm or by an enzymatic reaction as seen between β-galactosidase and ONPG (turns sample yellow) measured at 420 nm. The spectrophotometer is used to measure colored compounds in the visible region of light (between

350 nm and 800 nm), thus it can be used to find more information about the substance being studied. In biochemical experiments, a chemical and/or physical property is chosen and the procedure that is used is specific to that property in order to derive more information about the sample, such as the quantity, purity, enzyme activity, etc. Spectrophotometry can be used for a number of techniques such as determining optimal wavelength absorbance of samples, determining optimal pH for absorbance of samples, determining concentrations of unknown samples, and determining the pKa of various samples. Spectrophotometry is also a helpful process for protein purification and can also be used as a method to create optical assays of a compound.

4.0 CONCLUSION

In this unit, you have learnt about the spectrophotometer as an important device in laboratory practice and its range of application in other fields

5.0 SUMMARY

A spectrophotometer finds a very important usage in the measurement of transmittance or reflectance of solutions, transparent or opaque solids, such as polished glass, or gases.

6.0 TUTOR-MARKED ASSIGNMENT

- Describe mode of application of a spectrometer
- List and explain areas of application of a spectrometer

7.0REFERENCE/FURTHER READING

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UNIT 2 pH Meter

CONTENTS

1.0 INTRODUCTION

The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution. The pH meter is used in many applications ranging from laboratory experimentation to quality control.

2.0 OBJECTIVE

At the end of this unit you should be able to:

- Describe the operation of a pH meter
- List the application of a pH meter

3.0 MAIN CONTENT

The rate and outcome of chemical reactions taking place in water often depends on the acidity of the water, and it is therefore useful to know the acidity of the water, typically measured by means of a pH meter. Knowledge of pH is useful or critical in many situations, including chemical laboratory analyses. pH meters are used for soil measurements in agriculture, water quality for municipal water supplies, swimming pools, environmental remediation; brewing of wine or beer; manufacturing, healthcare and clinical applications such as blood chemistry; and many other applications.

Advances in the instrumentation and in detection have expanded the number of applications in which pH measurements can be conducted. The devices have been miniaturized, enabling direct measurement of pH inside of living cells. In addition to measuring the pH of liquids, specially designed electrodes are available to measure the pH of semi-solid substances, such as foods. These have tips suitable for piercing semi-solids, have electrode materials compatible with ingredients in food, and are resistant to clogging.

Principle of operation

Potentiometric pH meters measure the voltage between two electrodes and display the result converted into the corresponding pH value. They comprise a simple electronic amplifier and a pair of electrodes, or alternatively a combination electrode, and some form of display calibrated in pH units. It usually has a glass electrode and a reference electrode, or a combination electrode. The electrodes, or probes, are inserted into the solution to be tested.

The design of the electrodes is the key part: These are rod-like structures usually made of glass, with a bulb containing the sensor at the bottom. The glass electrode for measuring the pH has a glass bulb specifically designed to be selective to hydrogen-ion concentration. On immersion in the solution to be tested, hydrogen ions in the test solution exchange for other positively charged ions on the glass bulb, creating an electrochemical potential across the bulb. The electronic amplifier detects the difference in electrical potential between the two electrodes generated in the measurement and converts the potential difference to pH units.

The reference electrode is insensitive to the pH of the solution, being composed of a metallic conductor, which connects to the display. This conductor is immersed in an electrolyte solution, typically potassium chloride, which comes into contact with the test solution through a porous ceramic membrane. The display consists of a voltmeter, which displays voltage in units of pH.

On immersion of the glass electrode and the reference electrode in the test solution, an electrical circuit is completed, in which there is a potential difference created and detected by the voltmeter. The circuit can be thought of as going from the conductive element of the reference electrode to the surrounding potassium-chloride solution, through the ceramic membrane to the test solution, the hydrogen-ion-selective glass of the glass electrode, to the solution inside the glass electrode, to the silver of the glass electrode, and finally the voltmeter of the display device. The voltage varies from test solution to test solution depending on the potential difference created by the difference in hydrogen-ion concentrations on each side of the glass membrane between the test solution and the solution inside the glass electrode. All other potential differences in the circuit do not vary with pH and are corrected for by means of the calibration.

For simplicity, many pH meters use a combination probe, constructed with the glass electrode and the reference electrode contained within a single probe. A detailed description of combination electrodes is given in the article on glass electrodes.

Types of pH meters

pH meters range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer interfaces and several inputs for indicator and temperature measurements to be entered to adjust for the variation in pH caused by temperature. The output can be digital or analog, and the devices can be battery-powered or rely on line power. Some versions use telemetry to connect the electrodes to the voltmeter display device.

Specialty meters and probes are available for use in special applications, such as harsh environments and biological microenvironments. There are also holographic pH sensors, which allow pH measurement colorimetrically, making use of the variety of pH indicators that are available. Additionally, there are commercially available pH meters based on solid state electrodes, rather than conventional glass electrodes.

4.0 CONCLUSION

In this unit, you learnt about the ph meter its mode of operation as well as the different types and uses of ph meter.

5.0 SUMMARY

A pH meter is a scientific instrument that measures the hydrogen-ionactivity in water-based solutions, indicating its acidity or alkalinity expressed as pH.

6.0 TUTOR-MARKED ASSIGNMENT

- Define a p^H meter
- List and explain the types of p^H meter

Solution

A p^H meter is a scientific instrument that measures the hydrogen-ionactivity in water-based solutions, indicating its acidity or alkalinity expressed as pH.

- **List and explain the types of pH meter** pH meters range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer interfaces and several inputs for indicator and temperature measurements to be entered to adjust for the variation in pH caused by temperature. The output can be digital or analog, and the devices can be battery-powered or rely on line power. Some versions use telemetry to connect the electrodes to the voltmeter display device. Specialty meters and probes are available for use in special applications, such as harsh environments and biological microenvironments. There are also holographic pH sensors, which allow pH measurement colorimetrically, making use of the variety of pH indicators that are available. Additionally, there are commercially available pH meters based on solid state electrodes, rather than conventional glass electrodes.

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UNIT 3 MICROSCOPE

CONTENTS

1.0 INTRODUCTION

A microscope is a scientificinstrument. It makes small objects look larger. This lets people see the small things. People who use microscopes commonly in their jobs include doctors and scientists. Students in science classes such as biology or chemistry also use microscopes to study small things.

The earliest microscopes had only one lens and are called *simple microscopes*. *Compound microscopes* have at least two lenses. In a compound microscope, the lens closer to the eye is called the *eyepiece*. The lens at the other end is called the *objective*. The lenses multiply up, so a 10x eyepiece and a 40x objective together give 400x magnification.

Microscopes make things seem larger than they are, to about 1000 times larger. This is much stronger than a magnifying glass which works as a simple microscope.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Discuss the essence of a microscope
- List various types of microscope
- List parts and function of the microscope

3.0 MAIN CONTENT

Microscope

Types of microscopes

The most common kind of microscope is the compound light microscope. In a compound light microscope, the object is illuminated: light is thrown on it. The user looks at the image formed by the object. Light passes through two lenses and makes the image bigger.

The second most common kind are a few kinds of electron microscopes. Transmission electron microscopes (TEMs) fire cathode rays into the object being looked at. This carries information about how the object looks into a magnetic "lens". The image is then magnified onto a television screen. Scanning electron microscopes also fire electrons at the object, but in a single beam. These lose their power when they strike the object, and the loss of power results in something else being generated—usually an X-ray. This is sensed and magnified onto a screen.

Microscope Parts and Specifications

Historians credit the invention of the compound microscope to the Dutch spectacle maker, Zacharias Janssen, around the year 1590. The compound microscope uses lenses and light to enlarge the image and is also called an optical or light microscope (versus an electron microscope). The simplest optical microscope is the magnifying glass and is good to about ten times (10x) magnification. The compound microscope has two systems of lenses for greater magnification, 1) the ocular, or eyepiece lens that one looks into and 2) the objective lens, or the lens closest to the object. Before purchasing or using a microscope, it is important to know the functions of each part.

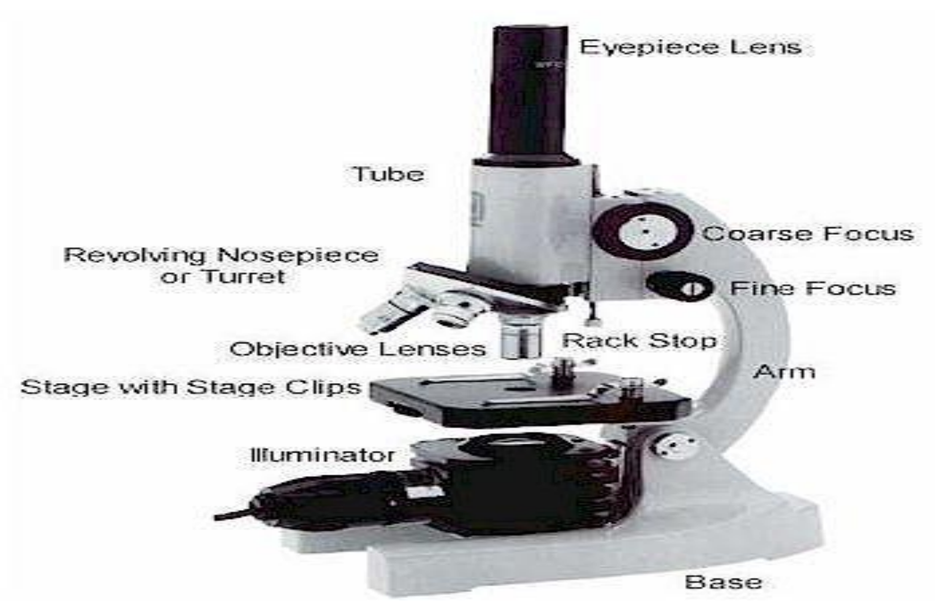

Fig 2

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Microscope parts

Eyepiece Lens: the lens at the top of the microscope that you look through. They eyepiece is usually 10x or 15x power.

Tube: Connects the eyepiece to the objective lenses.

Arm: Supports the tube and connects it to the base of the microscope.

Base: The bottom of the microscope, used for support.

Illuminator: A steady light source (110v) used in place of a mirror. If your microscope has a mirror, it is used to reflect light from an external light source up through the bottom of the stage.

Stage: The flat platform where you place your slides. Stage clips hold the slides in place. If your microscope has a mechanical stage, you will be able to move the slide around by turning two knobs. One moves it left and right, the other moves it forward and back.

Removing Nosepiece or Turret: This is the part of the microscope that holds two or more objective lenses and can be rotated to easily change power (magnification).

Objective Lenses: Usually you will find 3 or 4 objective lenses on a microscope. They almost always consist of 4x, 10x, 40x and 100x powers. When coupled with a 10x (most common) eyepiece lens, we get total magnification of 40x (4x times 10x), 100x, 400x, and 1000x. To have good resolution at 1000x, you will need a relatively sophisticated microscope with an Abbe condenser. The shortest lens is the lowest power, the longest one is the lens with the greatest power. Lenses are color coded and if built to DIN standards are interchangeable between microscopes. The high power objective lenses are retractable (ie 40xr). This means that if they hit a slide, the end of the lens will push in (spring loaded) thereby protecting the lens and the slide. All quality microscopes have achromatic, parcentered, parfocal lenses.

Rack Stop: This is an adjustment that determines how close the objective lens can get to the slide. It is set at the factory and keeps students from cranking the high power objective lens down into the slide and breaking things. You would only need to adjust this if you were using very thin slides and you weren't able to focus on the specimen at high power. (Tip: If you are using thin slides and can't focus, rather than adjust the rack stop, place a clear glass slide under the original slide to raise it a bit higher).

Condenser Lens: The purpose of the condenser lens is to focus the light onto the specimen. Condenser lenses are most useful at the highest powers (400x and above). Microscopes with a stage condenser lens render a sharper image than those with no lens (at 400x). If your microscope has a maximum power of 400x, you will get the maximum benefit by using a condenser lenses rated at 0.65 NA or greater. 0.65 NA condenser lenses may be mounted in the stage and work quite well. A big advantage to a stage mounted lens is that there is one less focusing item to deal with. If you go to 1000x then you should have a focusable condenser lens with an N.A. of 1.25 or greater. Most 1000x microscopes use 1.25 Abbe condenser lens systems. The Abbe condenser lens can be moved up and down. It is set very close to the slide at 1000x and moved further away at the lower powers.

Diaphragm or Iris: Many microscopes have a rotating disk under the stage. This diaphragm has different sized holes and is used to vary the intensity and size of the cone of light that is projected upward into the slide. There is no set rule regarding which setting to use for a particular power. Rather, the setting is a function of the transparency of the specimen, the degree of contrast you desire and the particular objective lens in use.

How to Focus Your Microscope: The proper way to focus a microscope is to start with the lowest power objective lens first and while looking from the side, crank the lens down as close to the specimen as possible without touching it. Now, look through the eyepiece lens and *focus upward only* until the image is sharp. If you can't get it in focus, repeat the process again. Once the image is sharp with the low power lens, you should be able to simply click in the next power lens and do minor adjustments with the focus knob. If your microscope has a fine focus adjustment, turning it a bit should be all that is necessary. Continue with subsequent objective lenses and fine focus each time.

4.0 CONCLUSION

In this unit, you learnt about the microscope. Various types of microscopes were also listed with their ranges of resolution. Parts and functions of microspores were also elucidated upon.

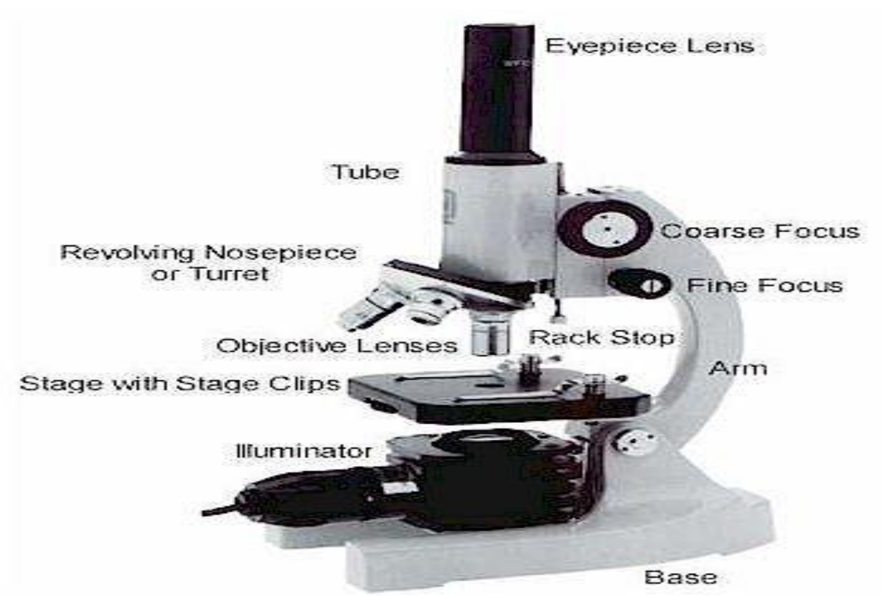
6.0 SUMMARY

The microscope was a game changer in various fields of biological sciences. It enables organisms and molecules to be studied in better and finer details giving broader insight into scientific research.

7.0 TUTOR-MARKED ASSIGNMENT

- Draw and label the microscope
- list the parts of the microscopes and their function

Solution



- list the parts of the microscopes and their function

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UNIT 4 Hot Air Oven

CONTENTS

1.0 INTRODUCTION

Hot air ovens are electrical devices which use dry heat to sterilize. They were originally developed by Pasteur. Generally, they can be operated from 50 to 300 °C, using a thermostat to control the temperature.

2.0 OBJECTIVE

At the end of this unit, you should be able to:

- Describe the hot air oven
- List various uses of the hot air oven

3.0 MAIN CONTENT

Hot air oven

Their double walled insulation keeps the heat in and conserves energy, the inner layer being a poor conductor and outer layer being metallic. There is also an air filled space in between to aid insulation. An air circulating fan helps in uniform distribution of the heat. These are fitted with the adjustable wire mesh plated trays or aluminum trays and may have an on/off rocker switch, as well as indicators and controls for temperature and holding time. The capacities of these ovens vary. Power supply needs vary from country to country, depending on the voltage and frequency (hertz) used. Temperature sensitive tapes or biological indicators using bacterial spores can be used as controls, to test for the efficacy of the device during use.

Advantages and Disadvantages

They do not require water and there is not much pressure build up within the oven, unlike an autoclave, making them safer to work with. This also makes them more suitable to be used in a laboratory environment. They are much smaller than autoclaves but can still be as effective. They can be more rapid than an autoclave and higher temperatures can be reached compared to other means. As they use dry heat instead of moist heat, some organisms like prions, may not be killed by them every time, based on the principle of thermal inactivation by oxidation.

Usage

A complete cycle involves heating the oven to the required temperature, maintaining that temperature for the proper time interval for that temperature, turning the machine off and cooling the articles in the closed oven till they reach room temperature. The standard settings for a hot air oven are:

- 1.5 to 2 hours at 160 °C (320 °F)
- 6 to 12 minutes at 190 °C (374 °F) plus the time required to preheat the chamber before beginning the sterilization cycle. If the door is opened before time, heat escapes and the process becomes incomplete. Thus the cycle must be properly repeated all over.

These are widely used to sterilize articles that can withstand high temperatures and not get burnt, like glassware and powders. Linen gets burnt and surgical sharps lose their sharpness.

4.0 CONCLUSION

In this unit, you learnt about the hot air oven as an integral laboratory device. The hot air oven uses electrical energy to generate thermal energy that can used for sterilization and sundry other purposes.

5.0 SUMMARY

The hot air oven unlike the autoclave is very much safe to work with as it does not build up pressure and does not require water to operate

6.0 TUTOR-MARKED ASSIGNMENT

- Describe the operation of the hot air oven
- What are the uses of the hot air oven?

Solution

Their double walled insulation keeps the heat in and conserves energy, the inner layer being a poor conductor and outer layer being metallic. There is also an air filled space in between to aid insulation. An air circulating fan helps in uniform distribution of the heat. These are fitted with the adjustable wire mesh plated trays or aluminum trays and may have an on/off rocker switch, as well as indicators and controls for temperature and holding time. The capacities of these ovens vary. Power supply needs vary from country to country, depending on the voltage and frequency (hertz) used. Temperature sensitive tapes or biological indicators using bacterial spores can be used as controls, to test for the efficacy of the device during use.

- What are the uses of the hot air oven?

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Module 3 BASIC PRINCIPLES OF LABORATORY SAFETY

Unit 1: Incubators

Unit 2: Centrifuge

Unit 3: Portable optical air sensor

Unit 4: B2 Technology and Application

UNIT 1 INCUBATORS

CONTENTS

1.0 INTRODUCTION

In microbiological cultures or cell cultures. The incubator maintains optimal temperature, humidity and other conditions such as the CO (CO_2) and oxygen content of the atmosphere inside. Incubators are essential for a lot of experimental work in cell biology, microbiology and molecular biology and are used to culture both bacterial as well as eukaryotic cells.

Louis Pasteur used the small opening underneath his staircase as an incubator. Incubators are also used in the poultry industry to act as a substitute for hens. This often results in higher hatch rates due to the ability to control both temperature and humidity. Various brands of incubators are commercially available to breeders.

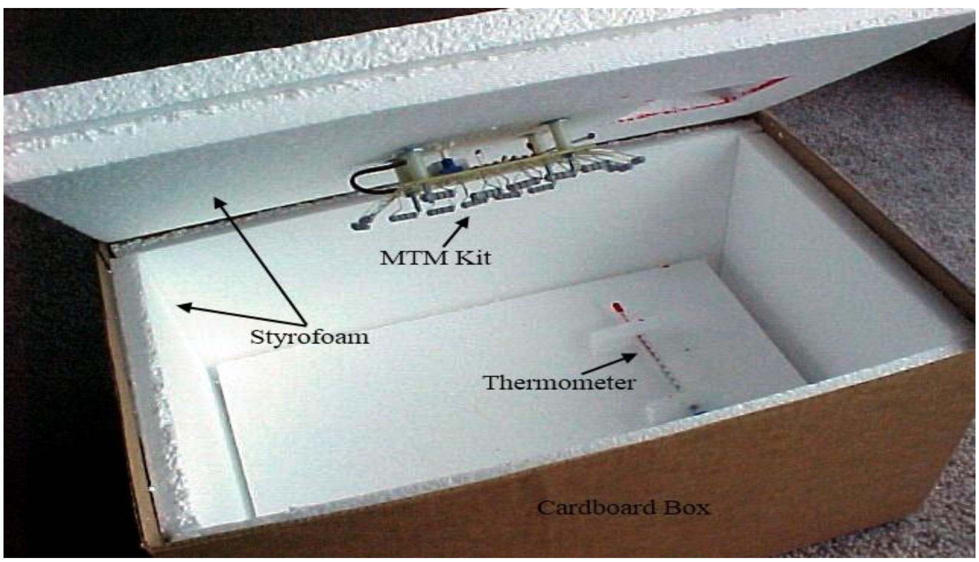
2.0 OBJECTIVE

At the end of this unit, you should be able to:

- Describe the incubator
- Describe the use of the incubators

3.0 MAIN CONTENT

Incubators



Typical incubator built using cardboard box, insulated with Styrofoam.

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The simplest incubators are insulated boxes with an adjustable heater, typically going up to 60 to 65 °C (140 to 150 °F), though some can go slightly higher (generally to no more than 100 °C). The most commonly used temperature both for bacteria such as the frequently used E. coli as well as for mammalian cells is approximately 37 °C (99 °F), as these organisms grow well under such conditions. For other organisms used in biological experiments, such as the budding yeast Saccharomyces cerevisiae, a growth temperature of 30 °C (86 °F) is optimal.

More elaborate incubators can also include the ability to lower the temperature (via refrigeration), or the ability to control humidity or CO_2 levels. This is important in the cultivation of mammalian cells, where the relative humidity is typically >80% to prevent evaporation and a slightly acidic pH is achieved by maintaining a CO_2level of 5%.

Perhaps one of the most important pieces of equipment in the laboratory, the incubator has provided a foundation for countless medical advances and experimental work in cellular and molecular biology. From aiding in hatching chicken eggs to enabling scientists to understand and develop vaccines for deadly viruses, the laboratory incubator has seen numerous applications over the thousands of years it has been in use.

An incubator is made up of a chamber with a regulated temperature. Some incubators also regulate humidity, gas composition, or ventilation within that chamber. While many technological advances have occurred since the primitive incubators used in ancient Egypt and China, the main purpose of the incubator has remained unchanged: to create a stable, controlled environment conducive to research, study, and cultivation.

Incubators serve a variety of functions in a scientific lab. Incubators generally maintain a constant temperature, however additional features are often built in. Many incubators also control humidity. Shaking incubators incorporate movement to mix cultures. Gas incubators regulate the internal gas composition. Some incubators have a means of circulating the air inside of them to ensure even distribution of temperatures. Many incubators built for laboratory use have a redundant power source, to ensure that power outages do not disrupt experiments. Incubators are made in a variety of sizes, from tabletop models, to warm rooms, which serve as incubators for large numbers of samples.

4.0 CONCLUSION

In this unit, you have learnt about the incubator as device responsible for temperature regulation. You also learnt some incubator also maintain air flow as well as relative humidity.

5.0 SUMMARY

Incubators make a very important device for maintaining optimum physical parameters for various biological studies

6.0 TUTOR-MARKED ASSIGNMENT

- Describe the operation of an incubator

Solution

- **Describe the operation of an incubator**

The simplest incubators are insulated boxes with an adjustable heater, typically going up to 60 to 65 °C (140 to 150 °F), though some can go slightly higher (generally to no more than 100 °C). The most commonly used temperature both for bacteria such as the frequently used E. coli as well as for mammalian cells is approximately 37 °C (99 °F), as these organisms grow well under such conditions. For other organisms used in biological experiments, such as the budding yeast Saccharomyces cerevisiae, a growth temperature of 30 °C (86 °F) is optimal.

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UNIT 2 CENTRIFUGE

CONTENTS

1.0 INTRODUCTION

A centrifuge is a laboratory device that is used for the separation of fluids, gas or liquid, based on density. Separation is achieved by spinning a vessel containing material at high speed; the centrifugal force pushes heavier materials to the outside of the vessel. This apparatus is found in most laboratories from academic to clinical to research and used to purify cells, subcellular organelles, viruses, proteins, and nucleic acids. There are multiple types of centrifuge, which can be classified by intended use or by rotor design. From the large floor variety to the micro-centrifuge, there are many varieties available for the researcher.

2.0 OBJECTIVE

At the end of this unit, you should be able to:

- Describe the centrifuge
- List various types of centrifuge
- List the uses of the centrifuge

3.0MAIN CONTENT

3.1 CENTRIFUGE

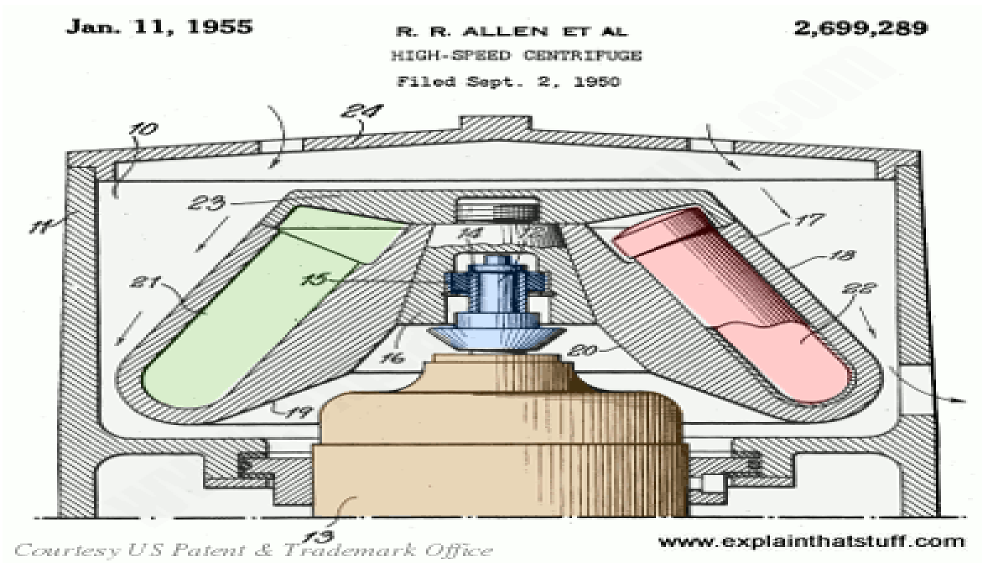

Diagram of centrifuge

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A centrifuge is a piece of equipment that puts an object in rotation around a fixed axis (spins it in a circle), applying a force perpendicular to the axis of spin (outward) that can be very strong. The centrifuge works using the sedimentation principle, where the centrifugal acceleration causes denser substances and particles to move outward in the radial direction. At the same time, objects that are less dense are displaced and move to the center. In a laboratory centrifuge that uses sample tubes, the radial acceleration causes denser particles to settle to the bottom of the tube, while low-density substances rise to the top.

TYPES

There are three types of centrifuge designed for different applications. Industrial scale centrifuges are commonly used in manufacturing and waste processing to sediment suspended solids, or to separate immiscible liquids. An example is the cream separator found in dairies. Very high speed centrifuges and ultracentrifuges able to provide very high accelerations can separate fine particles down to the nano-scale, and molecules of different masses.

Large centrifuges are used to simulate high gravity or acceleration environments (for example, high-G training for test pilots). Medium-sized centrifuges are used in washing machines and at some swimming pools to wring water out of fabrics.

Gas centrifuges are used for isotope separation, such as to enrich nuclear fuel for fissile isotopes.

Bench top Centrifuges are a broad class of centrifuges characterized by their small bench space footprint. Depending on the research need, a variety of different aspects can be considered. Maximum speed in RCFs can range from as low as a few hundred to to over 50,000 x g. Tube volumes can range from under 1 mL (such as with PCR tubes) to a few liters. Different types of rotors such as fixed angle, swinging bucket, and continuous flow are also typically interchangeable. Check out our diverse listings of bench top centrifuges. Refrigerated Bench top Centrifuges are compact instruments ideal for centrifugation of samples that may be temperature sensitive, such as live cells, animals or proteins. Many feature interchangeable rotors and adaptors to accommodate a wide range of sample volumes from under 1 mL to a few liters. Speeds can also vary, and some models can reach up to 60,000 x g. Check out the different refrigerated bench top centrifuges currently on the market. Clinical Bench top Centrifuges are compact, low-speed centrifuges ideal for the separation of whole blood components, such as serum, plasma, Buffy coat, red blood cells, as well as other bodily fluids. Their speeds may range between around 200 rpm to 6,000 rpm. Most clinical centrifuges can accommodate common blood draw tubes, but be sure to check with each vendor for specific tube sizes or tube adaptors. Check out a variety of clinical benchotop centrifuges from different manufacturers.

Micro-centrifuges are staple instruments in many research laboratories that generally accommodate small tube volumes such as 2 mL, 1.5 mL, 0.5 mL and PCR tubes. Micro-centrifuges for routine laboratory procedures typically spin at speeds up to 16,000 x g, while more specialized instruments can reach speeds up to 30,000 x g. In addition, manufacturers may also offer interchangeable rotors and tube adaptors. Compare a variety of different ambient temperature micro-centrifuges and refrigerated micro-centrifuges.

Vacuum Centrifuges / Concentrators can use vacuum, centrifugal force, temperature and/or gas to remove liquid solvent for the concentration or desiccation of samples. This instrument is ideal for purification or preparation of samples such as nucleic acids, proteins, peptides, and other compounds for a variety of research applications. For evaporation of solvents, vacuum centrifuges typically utilize built in heating systems. Check out different vacuum centrifuges or concentrators here.

4.0 CONCLUSION

In this unit, you have learnt about the centrifuge as a laboratory device. The centrifuge is used in the laboratory for the separation of suspension.

5.0 SUMMARY

The spinning action of the centrifuge separates materials on the principle of heavier objects or materials falling to the bottom. It finds great use also in different aspects of medical and laboratory research

6.0 TUTOR-MARKED ASSIGNMENT

- List any four types of centrifuge you know
- What are the uses of centrifuge?

Solution

- List any four types of centrifuge you know

Industrial scale centrifuges

Large centrifuges

Gas centrifuges

- **What are the uses of Centrifuge?**

A centrifuge is a piece of equipment that puts an object in rotation around a fixed axis (spins it in a circle), applying a force perpendicular to the axis of spin (outward) that can be very strong. The centrifuge works using the sedimentation principle, where the centrifugal acceleration causes denser substances and particles to move outward in the radial direction. At the same time, objects that are less dense are displaced and move to the center. In a laboratory centrifuge that uses sample tubes, the radial acceleration causes denser particles to settle to the bottom of the tube, while low-density substances rise to the top.

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Unit 3: PORTABLE OPTICAL AIR SENSOR

CONTENTS

1.0 INTRODUCTION

Optical air sensors center on detection of some form of light created by a chemical process, in order to identify or measure amounts of individual molecules. Portable sensors are specifically sensors that are easy to transport and use in the field.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe optical air sensor
- List optical air sensing methods

3.0 MAIN CONTENT

3.1 Optical Air Sensor

One of the primary methods of optical air sensing involves taking a sol-gel, which is created by taking a sol, a liquid with stable colloidal particles, and mixing it with a gel, which is a three dimensional continuous network encompassing a liquid. The sol-gel is then exposed to a certain indicator which becomes part of the sol-gel. Typically the production of a sol-gel follows a hydrolysis and then condensation pathway. Hydrolysis involves adding a hydrogen atom onto the gel. Condensation is a method involving bonding two different gel molecules together to create a sol-gel as a whole. This method consists of dissolving some solid into a solvent and then maintaining a basic pH as the mixture is refluxed to condense and produce a gel. One example of the sol-gel method in use today is the sensing of air acidity. The sol-gel is made with an organic dye, (2-[4-(dimethylamino)- phenylazo]benzoic acid). The dye has a pH color range of 6.7-8.7. This means that below a pH of 6.7 you see one color, in this case a red-pink, and at a pH higher than 8.7 you see a different color, in this case yellow, and you see a changing orange in between. The testing procedure is incredibly simple since all you have to do is expose the sol-gel to the air and monitor the color change.

Sol-gels can also be formed into monoliths, or columns, which are larger structures of sol-gel, unlike the typical thin layer. These monoliths are shown to be better for sensing molecules with smaller molar absorptivity, which are molecules that don't absorb into something very well. An example of a molecule that would be measured here is a metal-ligand complex. These monoliths operate in a similar method to the thin layer sol-gels in that they trap some analyte and show a color change.

Florescence

Another example of portable optical air sensors can involve fluorescence. One example of a fluorescence based sensor is an electronic nose, which can measure analytes in vapor or air. It operates so that an analyte is detected by different sensors in different ways to ensure what is being measured can be differentiated. As the vapor flows into the system it is hit with a high intensity light so that different organic dyes located in different small holes, or micropores, emit a certain wavelength and varied intensity of light based on what vapor compound they are in contact with. The light from the different sensors can then be compiled and used to determine what analytes were present. One large application of the fluorescent method is the detection of volatile organic compounds (VOC's). Another type of fluorescent sensor focuses on metal complexes, rather than organic complexes. One example is the use of dirhodium tetracarboxylate structure to detect nitrogen monoxide, a common pollutant. This involves a nitrogen monoxide molecule coming in and bonding to the dirhodium tetracarboxylate to cause a shift in the intensity of the fluorescence of the molecule

Air Sampling Methods

Air sampling methods vary according to the contaminants you are testing for. The most common type of air sampling methods includes the following:
Whole air sampling Solid sorbent sampling (Active) Solid sorbent sampling (Passive) Impinger sampling Filter sampling In this post we will go over each of those air sampling methods in detail so you'll know the correct way to gather a sample depending on what kind of air quality testing you'll be doing.

The 5 Types of Air Sampling Methods

Whole Air Sampling -This is the most simple of all air sampling methods. It involves collecting a whole air sample in a sample bag or can. This method is perfectly acceptable for sampling permanent gases, such as oxygen.

The difficulty with this sampling method is that the holding time for bag samples is only around 1 to 3 days. That means a sample would need to be rushed to the laboratory immediately upon collecting the sample to ensure best results.

Solid Sorbent Sampling (Active) . This method of air sampling involves drawing air through a tube filled with solid sorbent material. Any contaminants that may be in the air are chemically absorbed within the material inside the tube. It’s important to note that this is not a catch-all solution. There is no sorbent material designed to capture all types of air contaminants at once. However, there are numerous types of sorbent materials available for capturing the particular chemical or class of chemicals you’re testing for.

Solid Sorbent Sampling (Passive). Select sorbent material can be used in passive mode. The difference between active and passive is that passive mode means the contaminants are absorbed into the sorbent material via diffusion. Active mode means having to actively pull the air through the sorbent material with a pump.

Passive sorbent sampling has a few advantages over active sampling. It is discreet, the sampling material is easy to work with, and it’s a method that can be used for long-term sampling. Investigating odors and ambient air perimeter (“fence line”) monitoring can be accomplished especially well with passive solid sorbent sampling.

Impinger Sampling - Liquid impingers can be used to sample certain contaminants in the air. This method is very similar to active solid sorbent sampling in the sense that it works by having contaminants chemically react with a solution as a sample of air is bubbled through the liquid.

This method of air sampling is not as commonly used as it once was, there are now many alternative methods which use treated sorbent tubes instead of impingers.

Filter Sampling - This method of air sampling is designed for collecting contaminants in the form of vapors. Collecting contaminants in the vapor phase involves using chemically treated filter material designed to cause a reaction when the contaminant you're testing for passes through it. This method is also similar to active sorbent sampling, in the sense that filter sampling involves using a sampling pump to pull a known volume of air through a filter cassette.

4.0 CONCLUSION

In this unit, you have learnt the optical air sensor. You also learnt about the different methods or air sampling and comparative study among them

5.0 SUMMARY

There you have it, the five most common types of air sampling methods. If indoor air quality is a concern of yours, know that we offer an air quality testing kit that tests for over 700,000 compounds affecting indoor air quality. To see if the air you're breathing every day contains any toxic organic chemicals, order one of our home air quality testing kits today.

6.0 TUTOR-MARKED ASSIGNMENT

- Briefly explain sol gel as one techniques of air sensing

Solution

One of the primary methods of optical air sensing involves taking a sol-gel, which is created by taking a sol, a liquid with stable colloidal particles, and mixing it with a gel, which is a three dimensional continuous network encompassing a liquid. The sol-gel is then exposed to a certain indicator which becomes part of the sol-gel. Typically the production of a sol-gel follows a hydrolysis and then condensation pathway. Hydrolysis involves adding a hydrogen atom onto the gel. Condensation is a method involving bonding two different gel molecules together to create a sol-gel as a whole. This method consists of dissolving some solid into a solvent and then maintaining a basic pH as the mixture is refluxed to condense and produce a gel. One example of the sol-gel method in use today is the sensing of air acidity. The sol-gel is made with an organic dye, (2-[4-(dimethylamino)- phenylazo]benzoic acid.

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UNIT 4: B2 Technology and Application

CONTENTS

1.0. INTRODUCTION

The B2 technologies are portable devices used for taking measurement of various environmental features including pressure, ozone concentration and nitrous gas to mention but a few.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe the operation of the ozone monitor device
- Describe the workings of nitrous oxide monitor
- Describe the mercury monitor

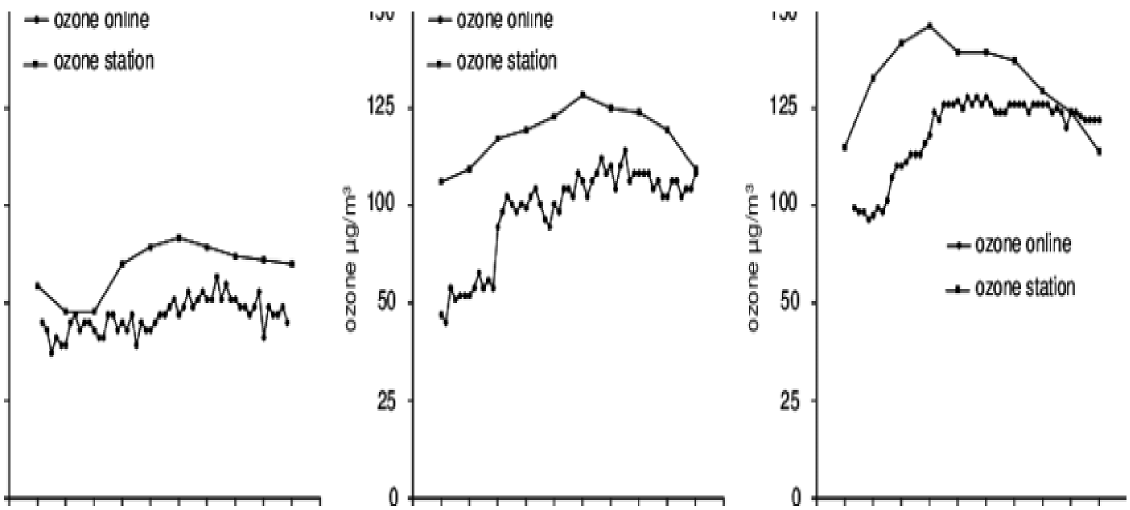
3.0 MAIN CONTENT

3.1Ambient ozone monitor

3.2 NO_2 monitor

3.3 Mercury monitor

3.1 Ambient ozone monitor

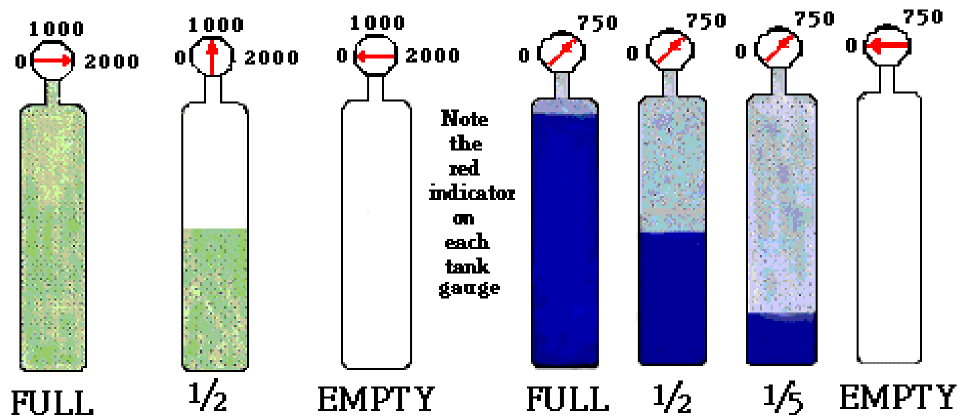


Ambient ozone monitoring

www.google.com

The Ozone Monitor is designed to enable accurate and precise (±1.5 ppb) measurements of ozone ranging from a few ppb to 250,000 ppb (0-250 ppm) based on the well-established technique of UV absorbance at 254 nm. The Model is lightweight (5.5 lb, 2.5 kg) and has a power consumption of only ~7 watts. It can be used in almost any application where much larger ozone monitors have been used in the past and in many environments where measurements using traditional ozone monitors are impossible. Flash card memory and a quiet, long-life internal air pump are now standard on the Model 202. The Model 202 has been used for the past decade in ozone monitoring networks of the U.S. National Park Service and National Forest Service. It also is widely used by NOAA, EPA, Environment Canada and the British Antarctic Survey for studies of ground-level ozone

3.2 Nitrous oxide Monitor

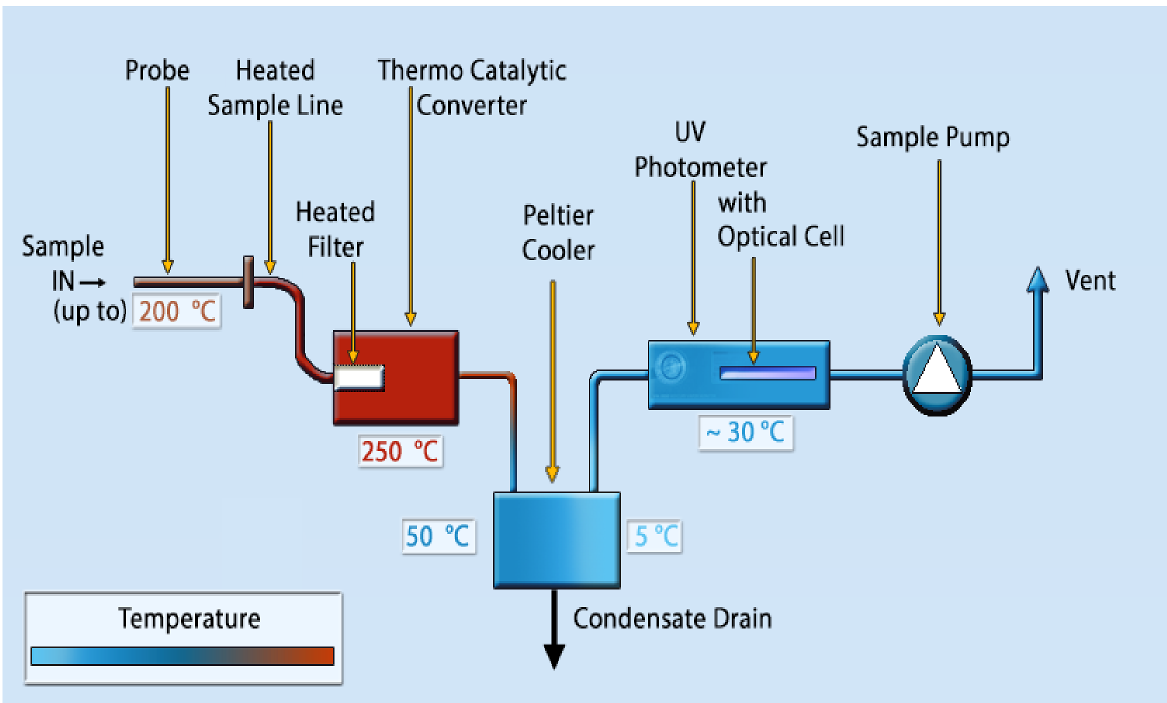


Nitrous oxide monitor

www.google.com

The Model 405 nm $NO_2/NO/NO_3$ Monitor™ measures nitrogen dioxide (NO_2) directly by absorbance at 405 nm using a folded cell with corner mirrors to achieve a ~2-meter path length. Nitric oxide (NO) is measured by modulating the addition of ozone to quantitatively convert NO to NO_2. This new instrumental approach has the advantages over chemiluminescence of being an absolute method and of requiring much less power, enabling portable measurements of NO_2, NO and NOx

3.3 Mercury Monitor



Mercury monitor

www.researchgate.com

The HERMES Personal Mercury Monitor™ is the next step in miniaturization of UV-based mercury monitors. A folded optical path enables the HERMES to deliver extremely sensitive measurements of mercury in the atmosphere (~2 g/m3 detection limit for Hg and a linear dynamic range of 0-2000 g/m3 Hg with 0.1 g/m3 Hg resolution). The compact, lightweight design of HERMES makes it well suited to applications such as workplace and industrial monitoring, personal exposure monitoring for studies of health effects of air pollutants, and monitoring at remote locations.

4.0 CONCLUSION

In this unit, you have learnt about the range of B2 technology their mode of operation and their uses in measuring different environmental parameters.

5.0 SUMMARY

Efficient and quick reading of environmental features is the hallmarks of b2 technology. It gives easy and efficient ways of taking measurements both in the laboratory and on the field.

6.0 TUTOR-MARKED ASSIGNMENT

- Write briefly on the operation of the Ambient ozone monitor

Solution

The Ozone Monitor is designed to enable accurate and precise (±1.5 ppb) measurements of ozone ranging from a few ppb to 250,000 ppb (0-250 ppm) based on the well-established technique of UV absorbance at 254 nm. The Model is lightweight (5.5 lb, 2.5 kg) and has a power consumption of only ~7 watts. It can be used in almost any application where much larger ozone monitors have been used in the past and in many environments where measurements using traditional ozone monitors are impossible. Flash card memory and a quiet, long-life internal air pump are now standard on the Model 202. The Model 202 has been used for the past decade in ozone monitoring networks of the U.S. National Park Service and National Forest Service. It also is widely used by NOAA, EPA, Environment Canada and the British Antarctic Survey for studies of ground-level ozone

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Module 4 Basic principles of laboratory safety

Unit 1: Gas plume Imaging

Unit 2: Barometer

Unit 3: Weather Balloons

Unit 1: Gas plume imaging

CONTENTS

1.0 Introduction

Gas Plume Imaging LLC (GPI) is a company providing trace gas monitoring services using networks of revolutionary sensors for Oil & Natural Gas and related industries, serving the upstream as well as the downstream segments.

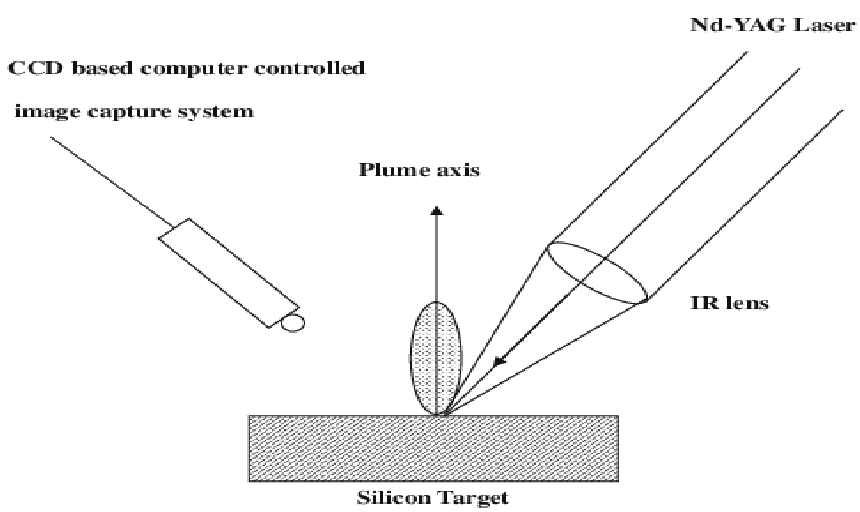
2.0 Objectives

At the end of this unit, you will get to know what is meant by gas pluming imaging.

3.0 Main contents

3.1 Definition of term

GPI was formed to commercialize specific gas detection technologies, based on the intellectual property that GATS has developed and improved over the past 30 years for different space missions. GPI brings major advance in ground-based instrumentation by offering complete monitoring solutions (fixed, ground mobile or airborne for pipeline monitoring) based on sensitive next-generation sensors that deliver superior measurements for real-time identification of leaks as well as analyzing, quantifying, and mapping fugitive emissions (either toxic, combustible or explosive gases), with main focus on greenhouse gases (methane CH_4, carbon dioxide CO_2, nitrous oxide N_2O), as well as other simple molecules (like CO, NH_3, SOx, NOx, etc.).



Plume imaging

www.google.com

Currently there is no efficient and affordable way to monitor gas releases over large areas. GPI's patented PIGC™ technology fills that void with grid deployment of a novel sensor, representing a true paradigm shift in the gas detection market.

4.0 Conclusion

GPI brings major advance in ground-based instrumentation by offering complete monitoring solutions (fixed, ground mobile or airborne for pipeline monitoring) based on sensitive next-generation sensors that deliver superior measurements for real-time identification of leaks as well as analyzing, quantifying, and mapping fugitive emissions (either toxic, combustible or explosive gases).

5.0 Summary

Currently there is no efficient and affordable way to monitor gas releases over large areas. GPI's patented PIGC™ technology fills that void with grid deployment of a novel sensor, representing a true paradigm shift in the gas detection market.

6.0 Tutor marked assignment

-what do you understand by the acronym GPI?

Solution

GPI was formed to commercialize specific gas detection technologies, based on the intellectual property that GATS has developed and improved over the past 30 years for different space missions. GPI brings major advance in ground-based instrumentation by offering complete monitoring solutions (fixed, ground mobile or airborne for pipeline monitoring) based on sensitive next-generation sensors that deliver superior measurements for real-time identification of leaks as well as analyzing, quantifying, and mapping fugitive emissions (either toxic, combustible or explosive gases), with main focus on greenhouse gases (methane CH_4, carbon dioxide CO_2, nitrous oxide N_2O), as well as other simple molecules (like CO, NH_3, SOx, NOx, etc.)

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UNIT 2 Barometers

CONTENTS

1.0 INTRODUCTION

A barometer is a scientific instrument used in meteorology to measure atmospheric pressure. Pressure tendency can forecast short term changes in the weather. Many measurements of air pressure are used within surface weather analysis to help find surface troughs, high pressure systems and frontal boundaries. Barometers and pressure altimeters (the most basic and common type of altimeter) are essentially the same instrument, but used for different purposes. An altimeter is intended to be transported from place to place matching the atmospheric pressure to the corresponding altitude, while a barometer is kept stationary and measures subtle pressure changes caused by weather. The main exception to this is ships at sea, which can use a barometer because their elevation does not change.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe how the barometer works
- Types of barometer
- Functions of a barometer

3.0 MAIN CONTENT

3.1 Barometer

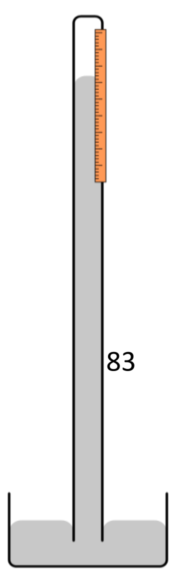
Types

Water-based barometers

The concept that decreasing atmospheric pressure predicts stormy weather, postulated by Lucien Vidi, provides the theoretical basis for a weather prediction device called a "weather glass" or a "Goethe barometer" (named for Johann Wolfgang Von Goethe, the renowned German writer and polymath who developed a simple but effective weather ball barometer using the principles developed by Torricelli).

The weather ball barometer consists of a glass container with a sealed body, half filled with water. A narrow spout connects to the body below the water level and rises above the water level. The narrow spout is open to the atmosphere. When the air pressure is lower than it was at the time the body was sealed, the water level in the spout will rise above the water level in the body; when the air pressure is higher, the water level in the spout will drop below the water level in the body. A variation of this type of barometer can be easily made at home.

Mercury barometers



www.researchgate.com

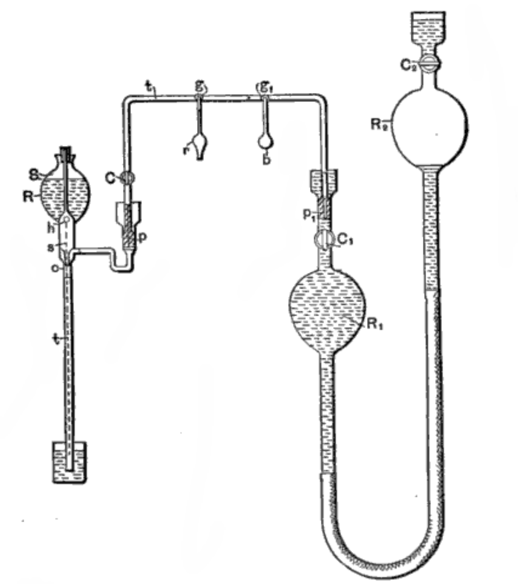
Schematic drawing of a simple mercury barometer with vertical mercury column and reservoir at base

A mercury barometer has a vertical glass tube closed at the top sitting in an open mercury-filled basin at the bottom. The weight of the mercury creates a vacuum in the top of the tube known as Torricellian vacuum. Mercury in the tube adjusts until the weight of the mercury column balances the atmospheric force exerted on the reservoir. High atmospheric pressure places more force on the reservoir, forcing mercury higher in the column. Low pressure allows the mercury to drop to a lower level in the column by lowering the force placed on the reservoir. Since higher temperature levels around the instrument will reduce the density of the mercury, the scale for reading the height of the mercury is adjusted to compensate for this effect. The tube has to be at least as long as the amount dipping in the mercury , head space and the maximum length of the column.

The mercury barometer's design gives rise to the expression of atmospheric pressure in inches or millimeters or feet (torr): the pressure is quoted as the level of the mercury's height in the vertical column. Typically, atmospheric pressure is measured between 26.5 inches (670 mm) and 31.5 inches (800 mm) of Hg. One atmosphere (1 atm) is equivalent to 29.92 inches (760 mm) of mercury.

Design changes to make the instrument more sensitive, simpler to read, and easier to transport resulted in variations such as the basin, siphon, wheel, cistern, Fortin, multiple folded, stereometric, and balance barometers. Fitzroy barometers combine the standard mercury barometer with a thermometer, as well as a guide of how to interpret pressure changes. Fortin barometers use a variable displacement mercury cistern, usually constructed with a thumbscrew pressing on a leather diaphragm bottom. This compensates for displacement of mercury in the column with varying pressure. To use a Fortin barometer, the level of mercury is set to the zero level before the pressure is read on the column. Some models also employ a valve for closing the cistern, enabling the mercury column to be forced to the top of the column for transport.

Vacuum pump oil barometer



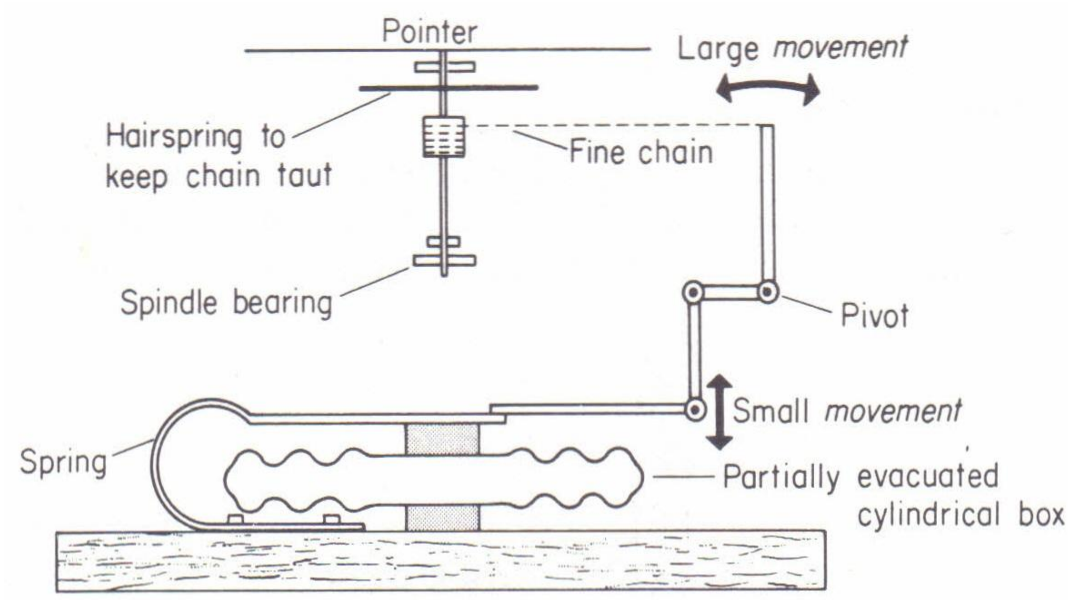
APPARATUS USED FOR OBTAINING HIGH DEGREES OF EXHAUSTION.

Vacuum pump oil barometer

www.google.com

Using vacuum pump oil the working fluid in a barometer has led to the creation of the new "World's Tallest Barometer" in February 2013. The barometer at Portland State University (PSU) uses doubly distilled vacuum pump oil and has a nominal height of about 12.4 m for the oil column height; expected excursions are in the range of ±0.4 m over the course of a year. Vacuum pump oil has very low vapor pressure and it is available in a range of densities; the lowest density vacuum oil was chosen for the PSU barometer to maximize the oil column height.

Aneroid Barometer



***A**neroid barometer*

www.researchgate.com

An aneroid barometer is an instrument used for measuring pressure as a method that does not involve liquid. Invented in 1844 by French scientist Lucien Vidi, the aneroid barometer uses a small, flexible metal box called an aneroid cell (capsule), which is made from an alloy of beryllium and copper. The evacuated capsule (or usually several capsules, stacked to add up their movements) is prevented from collapsing by a strong spring. Small changes in external air pressure cause the cell to expand or contract. This expansion and contraction drives mechanical levers such that the tiny movements of the capsule are amplified and displayed on the face of the aneroid barometer. Many models include a manually set needle which is used to mark the current measurement so a change can be seen. In addition, the mechanism is made deliberately "stiff" so that tapping the barometer reveals whether the pressure is rising or falling as the pointer moves. This type of barometer is common in homes and in recreational boats, as well as small aircraft. It is also used in meteorology, mostly in barographs and as a pressure instrument in radiosondes.

USAGE

Barometric pressure and the pressure tendency (the change of pressure over time) have been used in weather forecasting since the late 19th century. When used in combination with wind observations, reasonably accurate short-term forecasts can be made. Simultaneous barometric readings from across a network of weather stations allow maps of air pressure to be produced, which were the first form of the modern weather map when created in the 19th century. Isobars, lines of equal pressure, when drawn on such a map, give a contour map showing areas of high and low pressure. Localized high atmospheric pressure acts as a barrier to approaching weather systems, diverting their course. Atmospheric lift caused by low-level wind convergence into the surface brings clouds and sometimes precipitation. The larger the change in pressure, especially if more than 3.5 hPa (0.1 inHg), the greater the change in weather that can be expected. If the pressure drop is rapid, a low pressure system is approaching, and there is a greater chance of rain. Rapid pressure rises, such as in the wake of a cold front, are associated with improving weather conditions, such as clearing skies.

With falling air pressure, gases trapped within the coal in deep mines can escape more freely. Thus low pressure increases the risk of firedamp accumulating. Collieries therefore keep track of the pressure. In the case of the Trimdon Grange colliery disaster of 1882 the mines inspector drew attention to the records and in the report stated "the conditions of atmosphere and temperature may be taken to have reached a dangerous point".

Aneroid barometers are used in scuba diving. A submersible pressure gauge is used to keep track of the contents of the diver's air tank. Another gauge is used to measure the hydrostatic pressure, usually expressed as a depth of sea water. Either or both gauges may be replaced with electronic variants or a dive computer.

4.0 CONCLUSION

In this unit, you have learnt extensively about the barometer. Types of barometer was sufficiently explained and the various applications were also shown

5.0 SUMMARY

Barometer of different types and mode of operations are very important device for various studies. Outside the main purpose of pressure reading, barometers are also employed in measuring heights.

6.0 TUTOR-MARKED ASSIGNMENT

- List the types of barometer
- What are the functions of a barometer

Solution

-Water-based barometers, -Mercury barometers, -Vacuum pump oil barometer,

-Aneroid Barometer

- **What are the functions of a barometer**

Barometric pressure and the pressure tendency (the change of pressure over time) have been used in weather forecasting since the late 19th century. When used in combination with wind observations, reasonably accurate short-term forecasts can be made. Simultaneous barometric readings from across a network of weather stations allow maps of air pressure to be produced, which were the first form of the modern weather map when created in the 19th century. Isobars, lines of equal pressure, when drawn on such a map, give a contour map showing areas of high and low pressure. Localized high atmospheric pressure acts as a barrier to approaching weather systems, diverting their course.

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UNIT 3 WEATHER BALLOON

CONTENTS

1.0 INTRODUCTION

A weather or sounding balloon is a balloon (specifically a type of high-altitude balloon) that carries instruments aloft to send back information on atmospheric pressure, temperature, humidity and wind speed by means of a small, expendable measuring device called a radiosonde. To obtain wind data, they can be tracked by radar, radio direction finding, or navigation systems (such as the satellite-based Global Positioning System, GPS). Balloons meant to stay at a constant altitude for long periods of time are known as transosondes. Weather balloons that do not carry an instrument pack are used to determine upper-level winds and the height of cloud layers. For such balloons, a theodolite or total station is used to track the balloon's azimuth and elevation, which are then converted to estimated wind speed and direction and/or cloud height, as applicable.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- State the uses of a weather balloon
- Describe the makeup and operation of a weather balloon

3.0 MAIN CONTENT

3.1 Weather Balloons

The balloon itself produces the lift, and is usually made of a highly flexible latex material, though Chloroprene may also be used. The unit that performs the actual measurements and radio transmissions hangs at the lower end of the string, and is called a radiosonde. Specialized radiosondes are used for measuring particular parameters, such as determining the ozone concentration.

- The balloon is usually filled with hydrogen due to lower cost, though helium can also be used. The ascent rate can be controlled by the amount of gas with which the balloon is filled. Weather balloons may reach altitudes of 40 km (25 miles) or more, limited by diminishing pressures causing the balloon to expand to such a degree (typically by a 100:1 factor) that it disintegrates. In this instance the instrument package is usually lost. Above that altitude sounding rockets are used, and for even higher altitudes satellites are used.

3.2 Launch time, location, and uses

Weather balloons are launched around the world for observations used to diagnose current conditions as well as by human forecasters and computer models for weather forecasting. About 800 locations around the globe do routine releases, twice daily, usually at 0000 UTC and 1200 UTC. Some facilities will also do occasional supplementary "special" releases when meteorologists determine there is a need for additional data between the 12-hour routine launches in which time much can change in the atmosphere. Military and civilian government meteorological agencies such as the National Weather Service in the US typically launch balloons, and by international agreements almost all the data are shared with all nations.

4.0 CONCLUSION.

In this unit, you have learnt about the weather balloon as a meteorological device for observing weather and other purposes.

5.0 SUMMARY

The weather balloon is a very suitable device for taking weather at a very altitude and at a very low cost compared to aircrafts.

6.0 TUTOR-MARKED ASSIGNMENT

- Define weather ballon
- Uses of weather ballon

Solution

A weather or sounding balloon is a balloon (specifically a type of high-altitude balloon) that carries instruments aloft to send back information on atmospheric pressure, temperature, humidity and wind speed by means of a small, expendable measuring device called a radiosonde. To obtain wind data, they can be tracked by radar, radio direction finding, or navigation systems (such as the satellite-based Global Positioning System, GPS). Balloons meant to stay at a constant altitude for long periods of time are known as transosondes. Weather balloons that do not carry an instrument pack are used to determine upper-level winds and the height of cloud layers.

- **Uses of weather ballon**

The weather balloon is a very suitable device for taking weather at a very altitude and at a very low cost compared to aircrafts.

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MODULE 5 Procedure and technique for analytical method

Unit 1. Validation of analytical methods and Precautions

CONTENTS

1.0 INTRODUCTION

Validation of analytical method plays a crucial role before it is put to routine use. It is therefore important that required precautions be taken during the validation process itself as otherwise it is as good as adopting an un-validated method.

The article underlines such parameters and suggests measures that should be taken during the validation process. In other words authentication becomes important at all stages and contributes towards the complete validation process.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- State the essence of validity in scientific research
- State essential precautions in the use of laboratory wares

3.0 MAIN CONTENT

- 3.1Validation of analytical methods and Precautions

Instrument

The instrument on which validation is required needs to be calibrated in advance and its calibration should be valid on the day of its use for the validation purpose. The same applies to other instruments which may be required such as pH meter, UV- visible spectrophotometer, thermometers, etc.

Glassware

All required glassware should be scrupulously clean and dry. Volumetric apparatus like burettes, pipettes, volumetric flasks need to be calibrated and it is equally important to maintain a constant environmental condition in laboratory such as temperature and humidity.

Freedom from contamination

Freedom from contamination is important for any laboratory. Its sources can be other test samples, laboratory environment, sample handling tools, laboratory visitors or from analysts themselves. It becomes all the more necessary to restrict visitor entry and ensure that the chemists wear protective clothing while conducting method validation studies

Standards

Standards used for validation purpose should be procured from reliable sources and accompanied with the certificate of analysis. It is also important that they should bear traceability to standard regulatory bodies

Reagents

The required reagents should be of highest purity grades. Reagent blanks should be free of any analyte of interest. The same holds for acids, water and other solvents used in sample preparation, calibration standards dilutions, digestion media and mobile phase preparations. Laboratory water used for validation activities should meet the purity criteria.

Sample Blanks

Sample blanks should also be carefully selected so that they are free from presence of analyte of interest

Calibration standards

Great care should be exercised in preparing calibration standards as dilution errors at this stage can multiply during subsequent serial dilutions. The spiking range should cover at least 80 – 120 percent of the expected concentration range of the analyte

Weighing

Proper weighing technique and periodic calibration of the weighing balance cannot be underestimated. The method validation exercise would be in vain if errors get introduced due to weighing errors at time of preparation of samples, standards or reagents.

4.0 CONCLUSION.

In the unit and module, you have learnt the essence method validity and essential precautions in maintaining validity of scientific processes.

5.0 SUMMARY

Method validation is a critical operation which requires all the precautions outlined above so that the selected method will meet the desired requirements of the analysis.

6.0 TUTOR-MARKED ASSIGNMENT

- State any two precautions in measuring to ensure validity of results

Solution

Instrument

The instrument on which validation is required needs to be calibrated in advance and its calibration should be valid on the day of its use for the validation purpose. The same applies to other instruments which may be required such as pH meter, UV- visible spectrophotometer, thermometers, etc.

Glassware

All required glassware should be scrupulously clean and dry. Volumetric apparatus like burettes, pipettes, volumetric flasks need to be calibrated and it is equally important to maintain a constant environmental condition in laboratory such as temperature and humidity.

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Unit 2: Precautions in using laboratory equipment

1.0 Introduction

Some of the hazards related with equipment used in research labs include Electrical hazards

- Hot surface which can cause burns and which can be a source of ignition.
- High noise level
- Unguarded rotating parts
- Use of vacuum which can cause implosion.
- Use of high pressure
- Generation of magnetic fields
- Ultra violet and infra red radiation
- Many accidents in research laboratories result from improper use and lack of maintenance of equipment.

2.0 Objectives

At the end of this unit, you will get to know the different laboratory equipment and its various precautionary measures.

3.0 Main content

3.1 precautions in using laboratory equipment

The following precautions must be adopted while working with equipment in the laboratory. Refer the operating manual/user manual of the equipment before starting operation. The manual will contain details of hazards and safety precautions to be taken during installation, operation and maintenance.

- The operating manuals of equipment must be located at an easily accessible location in the laboratory.
- Personnel who are not authorised and trained must not carry out operation of the equipment. New users must carry out the operation under guidance of senior research scholars.
- A schedule for maintenance and inspection of equipment must be prepared as per manufacturer's instruction and must be adhered to.
- Unauthorized maintenance activity must not be done. Service personnel must be contacted where required.
- Switch off and unplug the equipment while making adjustments.
- Switch off the equipment at the end of the operation and when not in use.

Commonly used laboratory equipment and precautions to be taken during usage

Heating Devices

- Ensure that the heating element of the equipment is in good condition. If the elements are exposed, ensure that it is repaired or replaced.
- Variable transformers must be placed outside the fumehood. This helps to prevent spillage of chemicals/water over it and prevent chances of ignition of flammable vapours due to the spark produced by it.
- Electrical connections to the heating device must be fully insulated to prevent electric shock.
- Keep combustible materials away from heating devices.
- Overheating of the heating equipment can lead to fire. Use of temperature sensing devices helps to cutoff power if there is a sudden increase of temperature.

Ovens

- Laboratory ovens must not be used for heating food items, as the air inside would be contaminated.
- Ensure that the materials placed inside for heating are thoroughly washed and doesn't contain traces of chemicals.
- Maintain air space around the oven as recommended by the manufacturer.
- Use protective equipment while handling hot materials.

Hot plates

- Always consider the surface of the hot plate as hot
- Ensure that the electrical cord of the hot plate doesn't come in contact with the heating surface.
- The controls on the hotplate must be properly labelled to easily distinguish between the stirrer and temperature controls.

Oil baths

- Prevent water being spilled into the bath, as this can cause the splatter of the hot material.

- Use of thermal sensing devices helps to turn off the electric power if the oil bath overheats.
- The heated oil must be placed in a secondary container (heat resistant tray) to contain the spill in case of breakage.
- The equipment used must be clamped high enough so that if there is a sudden overheating the heating element on the lab jack can be lowered immediately.

Heat guns

- Never use heat guns near open containers containing flammable liquid or inside the fume hood where flammable vapors could be present.
- The heating element or the switch of the heat gun can become a source of ignition

Microwave Ovens

- Use lab purpose microwave ovens. Do not place any material between the sealing surface and the door on the oven's front face.
- Do not overheat samples.
- The materials used inside the oven must be those specified by the manufacturer.
- Do not use metal containing objects in the microwave, as they can cause arcing.
- Do not heat sealed containers in a microwave oven, as they can explode

4.0 Conclusion

Some of the hazards related with equipment used in research labs include:

- Electrical hazards
- High noise levels
- Unguarded rotating parts
- Use of vacuum which can cause implosion.
- Use of high pressure
- Generation of magnetic fields

- Ultra violet and infra red radiation

5.0 Summary

Many accidents in research laboratories result from improper use and lack of maintenance of equipment.

6.0 Tutor-Marked Assignment

State the precautions to be taken during the usage of Oil baths.

Solution

- Prevent water being spilled into the bath, as this can cause the splatter of the hot material.
- Use of thermal sensing devices helps to turn off the electric power if the oil bath overheats.
- The heated oil must be placed in a secondary container (heat resistant tray) to contain the spill in case of breakage.
- The equipment used must be clamped high enough so that if there is a sudden overheating the heating element on the lab jack can be lowered immediately.

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Unit 3: Introduction to the use of laboratory

1.0 Introduction

Having a strong set of overall laboratory safety rules is essential to avoiding disasters in the lab. *Lab Manager* recently scoured the safety policies of several laboratories to determine some of the most common lab safety rules out there, to help you whether you're developing or updating a set of policies for your own lab. Of course, safety rules are only effective when they are enforced, which is why strong lab management is so important to a safe laboratory as well. Knowing the proper laboratory safety signs and symbols is also important.

2.0 Objectives

At the end of this unit, you will get to know how laboratory is used.

3.0 Main content

3.1 Laboratory safety rules

The following are rules that relate to almost every laboratory and should be included in most safety policies. They cover what you should know in the event of an emergency, proper signage, safety equipment, safely using laboratory equipment, and basic common-sense rules.

1. Be sure to read all fire alarm and safety signs and follow the instructions in the event of an accident or emergency.

2. Ensure you are fully aware of your facility's/building's evacuation procedures.

3. Make sure you know where your lab's safety equipment—including first aid kit(s), fire extinguishers, eye wash stations, and safety showers—is located and how to properly use it.

4. Know emergency phone numbers to use to call for help in case of an emergency.

5. Lab areas containing carcinogens, radioisotopes, biohazards, and lasers should be properly marked with the appropriate warning signs.

6. Open flames should never be used in the laboratory unless you have permission from a qualified supervisor.

7. Make sure you are aware of where your lab's exits and fire alarms are located.

8. An area of 36" diameter must be kept clear at all times around all fire sprinkler heads.

9. If there is a fire drill, be sure to turn off all electrical equipment and close all containers.

10. Always work in properly-ventilated areas.

11. Do not chew gum, drink, or eat while working in the lab.

12. Laboratory glassware should never be utilized as food or beverage containers.

13. Each time you use glassware, be sure to check it for chips and cracks. Notify your lab supervisor of any damaged glassware so it can be properly disposed of.

14. Never use lab equipment that you are not approved or trained by your supervisor to operate.

15. If an instrument or piece of equipment fails during use, or isn't operating properly, report the issue to a technician right away. Never try to repair an equipment problem on your own.

4.0 Conclusion

As you'd expect, laboratory dress codes set a clear policy for the clothing employees should avoid wearing in order to prevent accidents or injuries in the lab. For example skirts and shorts might be nice for enjoying the warm weather outside, but quickly become a liability in the lab where skin can be exposed to heat or dangerous chemicals.

5.0 Summary

Unlike laboratory dress code policies, rules for personal protection cover what employees *should* be wearing in the lab in order to protect themselves from various hazards, as well as basic hygiene rules to follow to avoid any sort of contamination.

6.0 Tutor-Marked Assignment

-List 5 safety rules in the laboratory.

Solution

- If an instrument or piece of equipment fails during use, or isn't operating properly, report the issue to a technician right away. Never try to repair an equipment problem on your own.
- If you are the last person to leave the lab, make sure to lock all the doors and turn off all ignition sources.

- Do not work alone in the lab.
- Never leave an ongoing experiment unattended.
- Never lift any glassware, solutions, or other types of apparatus above eye level.
- Never smell or taste chemicals.

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