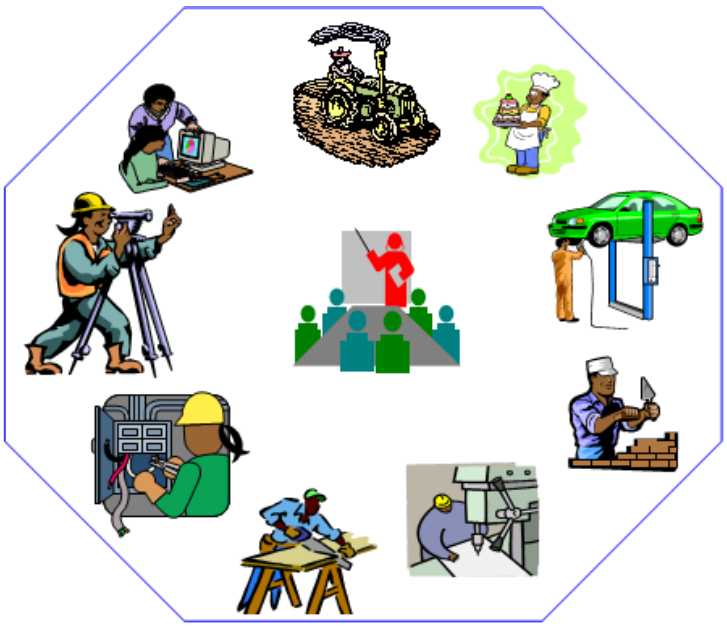
Fruit and Vegtable Processing

Level-III

Based on May 2019, Version 2 OS and March. 2021, V1 Curriculum



Module Title: Performing Basic Product Test

LG Code: IND FVP3 M14 LO (1-5) LG (45-49)

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Table of content

Contents

LG #45	LO #1- Interpret Test Requirements

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Reviewing test request
- Identifying hazards and enterprise controls

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Review test request
- Identify hazards and enterprise controls

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
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Information Sheet 1- Reviewing test request

1.1 Reviewing test request

Testing is an important process, which relies on scientific analysis to identify problems with fruit and vegetable products. It provides analytical data on the quality of a product or production process to support quality control in the HACCP system. Any testing program should be science based and objective driven prior to implementation one should know why testing is being performed, the basic assumptions underlying the test, the relative certainty of detecting an issue, and potential results. This will allow one to identify the type of samples to be collected, the sampling plan to be used, the specific test to be performed , and action to be taken prior to and after the test results are obtained.

One of the most important reasons for analysing /testing of fruit and vegetable products from both the consumers and the manufacturers standpoint is to ensure that they are safe. Fruit and vegetable produce manufacturers need analytical techniques to test / analyze produts materials before, during and after the manufacturing process to ensure that the final product meets the desired standards.

Therefore, fruit and vegetable produce manufacturers must have traceability in their industry to ensure their products are safe, with no contaminants or residues, and to provide accurate nutritional information. General laboratory testing of a manufacturer's product may include the following techniques:

1.1 Analytical chemistry testing

The study of the separation, identification, and quantification of the chemical components of natural and artificial materials such as pH, additives, colors, contaminants, preservatives, minerals and trace elements in fruits and vegetable products.

1.2 Fruit and vegitable product microbiology testing

The study of the microorganisms that inhabit or contaminate fruit and vegitable product to help manufacturers assess the safety of raw materials, components, ingredients and final products, thus guaranteeing the safety of products. Testing for spoilage organisms and pathogens may be used to examine and prevent food poisoning outbreaks caused by fruit and vegitable product products and ingredients. This is important, as the whole supply chain may be contaminated in the process of fruit and vegetable products production.

1.3 Fruit and vegetable product nutrition testing

An analysis of value and the nutritional content in fruit and vegitable product provides information for nutrition labeling on product packaging that manufacturers are required to include to comply with the labeling regulations of destination countries. Therefore, manufacturers and importers/exporters should be fully aware of the applicable laws and regulations of a country before offering their products for distribution.

1.4 Fruit and vegetable product sensory testing

Sensory testing is identification of fruit and vegitable product properties by using the human senses (sight, smell, taste, touch and hearing) for the purposes of evaluating consumer products acceptance. In smell testing, olfactory receptors in the nose identify rancidity in a product. In tasting, the sensory organs on the tongue can identify the intensity of sweetness in fruit and vegitable products.

Self-check 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Which of the following is techniques testing of a manufacturer's product. (1.5pts)

a. Microbiology testing
b. Product testing
c. Sample testing
d. All

2. _____ is identification of fruit and vegitable product properties by using the human senses for the purposes of evaluating consumer products. (1.5pts)
   a. Sensory testing
   b. Nutrient testing
   c. Product performance
   d. Equipment performance

Test II: Write short answer for the following questions

1. List the main reason for product test ?(3pts)
2. List sensory attribute of fruits and vegitable product?(3pts)

Note: Satisfactory rating above-3.5 points Unsatisfactory - below 3.5points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

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Information Sheet 2- Identifying hazards and enterprise controls

2.1 Identifying hazards and enterprise controls in fruits and vegetables sector

Organizations with strong safety cultures also find ways to integrate the process of identifying hazards, evaluating the risks presented by those hazards, and managing the risks of hazards of the experiment to be performed into the experimental design process. Qulity control experiments change frequently and may involve a wide variety of hazards (for example, chemical, physical, biological, radiological, and so forth). Hazard identification, hazard evaluation, and hazard mitigation in laboratory operations are critical skills that must be part of any laboratory worker's education.

2.1.1. Identifying hazards

Recognizing the existence of hazards is central to completing a sufficient analysis. Simply stated, a hazard is a potential for harm. The term is often associated with an agent, condition, or activity (a natural phenomenon, a chemical, a mixture of substances, a process involving substances, a source of energy, or a situation or event) that if left uncontrolled, could result in an injury, illness, loss of property, or damage to the environment. Hazards are an intrinsic property of the agent, condition, or activity. Table 1 provides a short list of hazards often identified for testing activities. It is often easier to identify agents or conditions that present hazards, but it is more difficult to identify the hazards associated with an activity.

Table 1: Hazards commonly identified for testing activities

Hazard Types	Examples
Agent	Corrosive, toxic, explosive, nonionizing radiation, biological hazard / pathogenic, flammable,oxidizing, self-reactive or unstable, potentially explosive, reducing, water reactive, sensitizing, peroxide forming, catalytic

Condition	High pressure, low pressure, electrical, uneven surfaces, pinch points, suspended weight, hot surfaces, extreme cold, steam, noise, clutter, magnetic fields, oxygen-deficient spaces, ultraviolent radiation, or laser light
Activity	Creation of secondary products, lifting, chemical mixing, long-term use of dry boxes, repetitive pipetting, scale up, handling waste, transportation of hazardous materials, handling glassware and other sharp objects, heating chemicals, recrystallizations, extractions, or centrifuging

2.1.2. Hazard evaluation

The product of a hazard evaluation should be the qualitative and sometimes quantitative understanding of a hazard. The results of an assessment or evaluation of the risk of the hazards of a given experiment should guide the selection of risk management techniques and tools elimination or substitution of materials; primary safety devices or engineering controls, such as chemical fume hoods; personal protective equipment (PPE); and specific procedures and processes.

2.1.3. Selection of hazard controls

The purpose of conducting a hazard evaluation is to determine what hazard controls need to be put in place to allow the work to be performed safely. Hazard controls are normally discussed in terms of the “hierarchy of control” elimination, engineering controls, administrative controls, and PPE. They are called the “hierarchy of controls” because they should be considered in this order.

2.1.4. Performing work within controls of hazards

A hazard identification and evaluation process will be ineffective if the results of the hazard analysis are not applied. Once an evaluation is complete and the necessary

hazard controls have been identified, it is imperative that researchers understand the hazard analysis information and that they are committed to following the agreed upon controls.

Self-check 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Which of the following is type of hazard during testing. (1.5pts)
   a. Biological hazard
   b. Physical hazard
   c. Chemical hazard
   d. All
2. _____ is to determine what hazard controls need to be put in place to allow the work to be performed safely. (1.5pts)
   a. Hazard testing
   b. Hazard evaluation
   c. Hazard control
   d. HACCP

Test II: Write short answer for the following question

3. List the types hazard during testing activity ?(3pts)

Note: **Satisfactory rating above-3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Operation Sheet 1– Identification of hazard

Objectives of conducting procedure for hazard identification;

- ✓ To establish, implement & maintain a documented procedure for ongoing identification of the hazards.

List of Materials needed

- Microscope
- Atomic Absorption Spectrophotometer
- Thermometer
- Analytical Balance
- Sample holder
- Others

Procedures to identify hazards

1. Apply safety rules and regulation
2. Identification and list possible hazards
3. Identification adverse conditions hazards
4. Identify past, present and future situations related to hazards
5. Detect possible maintenance hazards
6. Find hazards during material handling
7. Pinpoint hazards on different premises of work area
8. Identify a hazardous area having chemical fire/explosion hazards in working.
9. Determine risks on account of statutory / legal requirement.

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 1: Identify hazards in work area

LG #46	LO #2- Prepare sample

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Recording and comparing sample description with specification ,and recording and reporting discrepancies
- Preparing sample

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Record and compare sample description with specification ,and recording and reporting discrepancies
- Prepare sample

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Information Sheet 1-Recording and comparing sample description with specification, and recording and reporting discrepancies

1.1 Recording and comparing sample description with specification, and recording and reporting discrepancies

The quality of sampling and analytical data is a major determinant of database quality. The term *sampling* is used to describe the activities involved in the selection and collection of items of food defined in terms of number, weight and nature of the material to be analysed. Much of the formal terminology developed for use in sampling was designed for use in the commercial sector for the purposes of surveillance and determination of contamination. Some of these terms have little relevance for nutrient database work and therefore are not discussed further.

Because of the variability and heterogeneity of foods, all sampling is associated with some degree of error when the results are extrapolated back to the composition of the whole population of a food. Sampling can merely provide data that define the probability that the values will apply to any one isolated unit of the food.

The selection of a representative sample and the combined protocols for sampling and analysis must be based on a clear understanding of the nature of the foods and the population of food being studied (i.e. all the individual units of the food).

Standard sampling procedures have been defined for many commodities and these should be followed: International Organization for Standardization (ISO, 2003); Official Methods of the Association of Analytical Communities (AOAC International, 2002, 2003); Codex Alimentarius (FAO, 1994; FAO/WHO, 2003). Care should be taken to ensure that samples are truly representative of the bulk commodity. Random sampling is preferable to the collection of readily accessible units.

Sampling of wholesale foods generally follows the principal approaches used with bulk commodities. Randomization of sampling is essential.

1.1.1 Major sources of variability in nutrient composition

Foods are inherently variable in composition, and the approach to sampling and the design of the sampling and analytical protocols need to take account of this factor.

Geographical samples: In a single country there may be a wide diversity of soil and climatic conditions, resulting in significant variance in food composition. Variations in food marketing and food preparation within different parts of a country or among countries in the case of a multi-country database may also produce notable variance. For these reasons, geographically-specific data may be presented in the database as a supplement to nationwide and/or region wide averages. In other countries, the variations may be of similar magnitude to those due to other causes, in which case the national sample could be weighted according to the proportions of the population living in the regions or the proportions of the total consumption of the foods.

Seasonal samples: Seasonal variations in nutrient composition need to be accommodated in the combined protocols. Plant foods are especially prone to variation, particularly in their water, carbohydrate and vitamin content. Fish also show seasonal variations, especially in fat content, and milk and milk products exhibit variations in vitamin content primarily due to seasonal differences in feeding patterns. The collection of samples needs to be organized, in terms of timing and frequency, to reflect these variations. In some cases, seasonal data need to be given separately in the database. The analytical measurements of the seasonal samples can often be restricted to those nutrients showing variation.

Physiological state and maturity: The states of maturity of plants and animal foods cause variation in composition: in the concentrations of sugars, organic acids and vitamins in many plants, and of fats and some minerals in animal foods. Some of these variations are a consequence of seasonal effects.

Cultivar and breed: These may be a significant source of variation for some nutrients and the combined protocols will need to provide for this variation. It is desirable to document this cultivar or breed variation within the database. Some research organizations sample specifically to capture cultivar and breed differences. The significance of the differences attributable to cultivar or breed can only be ascertained by controlling for other factors that can influence variation, and by sampling and analyzing individually, not in composite, a large number of samples.

1.1.2 Methods of sampling

Random sampling: Random samples are collected in such a way as to ensure that every item in the population of the food being sampled has an equal chance of being collected and incorporated into the sample to be analyzed. This is difficult to achieve in practice because it is difficult to visualize the entire population of, say, all the cabbages in a country let alone ensure that each one has an equal chance of being selected. It is more usual to set up stratification (see below) of the food population.

Stratified sampling: In this method the population of food is classified into strata, taking into account the most important causes of variation.

Stratification by geographical area may be useful even where there are no known significant regional variations (Smits *et al.*, 1998). Stratification according to the distribution of the consuming population, among rural and urban sources, or by type of retail outlet, are other useful examples (Torelm, 1997). The sampling of branded foods can be stratified according to manufacturing plant. Where different brands of the same food are not expected to show significant variation, the sample can be weighted according to market share.

Where this information is not available, extrapolating from similar foods or an intuitive assessment will be required.

Selective sampling: Selective sampling is widely used in experimental studies of plant and animal husbandry and in home economics. The resultant data are valuable guides for the design of sampling protocols but since they are not generally representative of the foods available, they require careful documentation when included in the database.

This method is often legitimately used in the analysis of contamination, where the objective may be to identify maximal exposure to contaminants. The distribution of contaminants in foods is frequently highly skewed. Random sampling will therefore often include samples in which the concentration of the contaminant is below the level of detection. This is the primary reason why data on the levels of contaminants are often held separately from representative nutrient data in the database.

Samples of foods prepared in a laboratory can be regarded as selective samples. Laboratory preparation may be the only practicable way to obtain data on the composition of certain foods and therefore the derived data may be useful in databases. Generally, however, samples collected from cooks working in domestic or industrial kitchens are to be preferred as they can be regarded as more representative of foods generally available for consumption.

Convenience sampling: The collection of samples from conveniently accessible points is a very common, and possibly misleading, practice in compositional studies. This method may be acceptable as a preliminary exercise to obtain estimates of variation in composition, but in general data obtained using this method should be regarded as low quality.

Convenience sampling may be the only option in the case of wild or uncultivated foods; provided the sources of the samples are fully documented the values can be used in a database.

1.1.3 Choice of sampling method

Size and number of samples:

Size: The total amount of food required for the different analyses forms the basis for deciding the size of individual samples. In practice, because foods are heterogeneous, taking small portions at the primary sampling stage can lead to error. For many foods the individual items for collection are readily identifiable; in other cases they will need to be defined. In practice, 100–500 g represents a convenient guide to the size of a primary sample, with preference being given to the upper end of this range. Some food items, for

example certain cuts of meat, are much larger than this and cannot easily be reduced to a smaller but still representative unit; for the purpose of the primary sample these should be used in their entirety.

Number: In order to calculate the number of samples needed, information is first required on the variability of the composition of the food (Proctor and Muellenet, 1998). This also assumes that the concentration of the nutrient is uniformly distributed in the food, which is a reasonable assumption for many nutrients but often not true for trace elements.

In practice, the required information is often incomplete and one has to proceed intuitively. Furthermore, many nutrients, especially vitamins, show greater variability than, say, protein, so the number of samples required formally will be greater.

1.1.4 Preparing the protocols

The protocols are written documents that describe the sampling process: the identity of the food, the size and weight of units to be collected, the stratification to be used and the distribution of sampling sites.

The volume of information recommended in this documentation may seem excessive, but experience suggests that information from different stages is very critical when assessing the quality of sampling and subsequent analyses. Moreover, if the details are not recorded at the appropriate time they cannot be recovered retrospectively.

Identification: sets out the information required. The first section constitutes a label that should be securely and permanently attached to the sample. The laboratory may subsequently add an acquisition number. Most of the information required is self-evident.

Record of collection: sets out the information to be recorded during sample collection. The items recorded correspond to the sampling plan as set out in the combined protocols. This indicates the designed stratification and the method for achieving randomization within the strata. The use of random number tables is one useful approach. The protocol must also specify the procedure to be followed if the defined

sample item is not available for collection. This may be the nomination of a replacement item or the need to choose an alternative sampling point

Description of samples collected

Table 1. Suggested food sample record for food composition studies: record of handling in laboratory

Common name of food	
Sample code number	
Date of receipt in laboratory	
Handling stage	***Examples of record***
Weight and nature of inedible matter	Prior to further preparation (e.g. head and feet of poultry, outer wilted leaves)
Weight and nature of edible matter	Prior to further preparation (e.g. remainder of poultry carcass)
Method of preparation	Preparation of raw sample or cooking method, type, time, temperature and end-point temperature of foodstuff
Weight before cooking	
Ingredients added, if any	
Weight after cooking	
Weight and nature of edible portion of prepared food	
Weight and nature of inedible material	Bone, gristle, etc.
Method of mixing and reduction	Grinding, homogenizing in blender (type of blades)
Details of preparation of composite sample, if applicable	Simple mixing of equal weights or weighting of primary samples from the designated strata
Type of storage	Addition of preservatives, temperature of storage, etc.
Method used to take analytical samples	
Storage of analytical samples or further processing	
Name and signature of person completing record	
Date of record	
Other details	Any details that the collector thinks may be relevant

Record of handling in laboratory:

It provides a record of the early preparation of samples in the laboratory leading up to the preparation of the analytical samples. The laboratory may wish to add its own laboratory acquisition number.

Storage of the analytical samples:

The logistics of sampling preparation usually mean that it is more convenient to store the analytical samples prior to analysis. At least three sample replicates should be stored.

Storage in a frozen state is usually the minimum acceptable with preference given to –40 or even –70 °C, which is current common practice. Storage at –20 or –30 °C is acceptable for fat analyses. The container must be closely sealed with the minimum of headspace. When the samples are taken from storage any sublimed water above the sample must be carefully reincorporated in the mass.

Where freeze-drying is possible, storage of the freeze-dried samples in frozen or chilled conditions is satisfactory. Air-dried samples should be stored in such a way as to prevent uptake of water or contamination with insects or mites.

A sampling plan should be a well-organized document that establishes the required procedures for accomplishing the program's objectives. It should address the issues of who, what, where, why, how. The primary aim of sampling is to obtain a sample, subject to constraints on size that will satisfy the sampling plan specifications. A sampling plan should be selected on the basis of the sampling objective, study population, statistical unit, sample selection criteria and analysis procedures

Factors determine the choices of a sampling plan are enlisted in table. The two primary objectives of sampling are often to estimate the average value of a characteristic and determine if the average value meets the specifications defined in the sampling plan. The presence of a well-designed plan is important provides a consistent model to guide people performing the sampling activity. It serves as a reminder of the important elements in this part of the overall sample analysis program.

Table 2: Factors determine the choice of a sampling plan.

Factors to be considered		**Questions**
Purpose of inspection	A	Is it to accept or reject the lot?
	B	Is it to measure the average quality of the lot?
	C	Is it to determine the variability of the product?
Nature of Product	A	Is it homogeneous or heterogeneous?
	B	What is the unit size?

	C	How consistently have past populations met specifications?
	D	What is the cost of the material being sampled?
Nature of the test method	A	Is the test critical or minor?
	B	Will someone become sick or die if the population fails to pass the test?
	C	Is the test destructive or non-destructive?
	D	How much does the test cost to complete?
Nature of the population being investigated	A	Is the lot large but uniform?
	B	Does the lot consist of smaller, easily identifiable sublots?
	C	What is the distribution of the units within the Population?

1.1.5 Sub sampling for analysis and taking the test portion

If the test portion analyzed does not represent the sample or the lot from which it was taken, in that case, even the best analysis could give misleading information. Distortions introduced at this point will carry through the path of analysis and adversely affect the final results and the conclusions drawn from them. There are generally two choices in analytical sub sampling: Preparation of a composite laboratory sample (if multiple units are submitted for analysis).

Good sampling practices require the following:

a. Inspection of the lot before sampling.
b. Use of suitable sampling devices for the particular commodity and type of sample desired.
c. Use of suitable containers to hold the sample.
d. Maintenance of the integrity of the sample and associated records.
e. Use of adequate precautions in preserving, packing and delivery of the sample to the lab in a timely manner.
f. Provision of appropriate storage conditions for the sample both prior to and following analysis

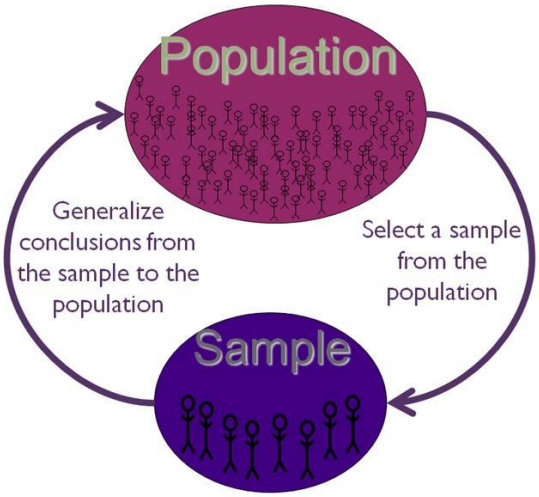

Figure 1: Preliminary considerations in selecting a sample

1.1.6 Sampling Procedures

There are many sampling procedures that have been developed to ensure that a sample adequately represents the target population. A few of the most common are described below.

a. Simple random sampling

In simple random sampling, every individual in the target population has an equal chance of being part of the sample. This requires two steps:

- Obtain a complete list of the population.
- Randomly select individuals from that list for the sample.

Random is a technical term in social science research that means that selection was made without aim, reason, or patterns.

b. Stratified random sampling

In stratified random sampling, the researcher first divides the population into groups based on a relevant characteristic and then selects participants within those groups.

Stratified random sampling requires four steps:

- Determine the strata that the population will be divided into.
- Determine the number of participants necessary for each stratum.
- Split the units of analysis into the respective strata
- Randomly sample participants from within the group

c. Purposive sampling

In purposive sampling, the researcher uses their expert judgment to select samples that are representative of the population.

d. Multi-stage sampling

More frequently, researchers use multi-stage sampling. In multi-stage sampling, the sample is selected in multiple steps, or stages.

The steps in multi-stage sampling are as follows:

- Organize the sampling process into stages where the unit of analysis is systematically grouped.
- Select a sampling technique for each stage.
- Systematically apply the sampling technique to each stage until the unit of analysis has been selected.

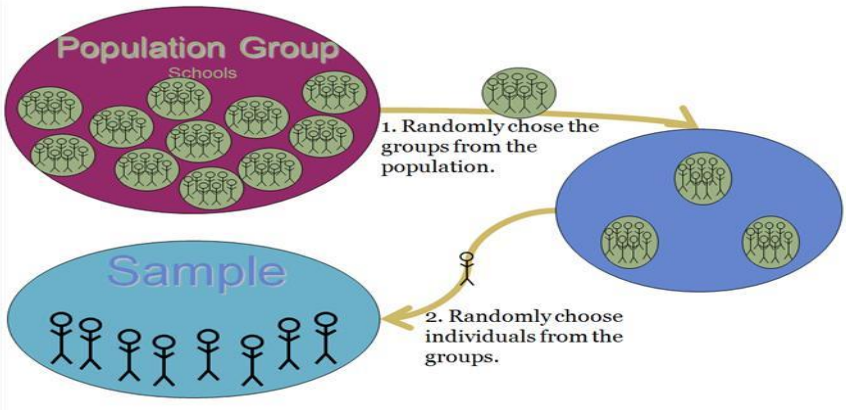

Figure 2: Stages of startfied sampling

1.1.7 Problems in sampling

Sampling bias is due to non-statistically viable convenience, errors by not understanding population distribution and inappropriate sampling plan. Unreliable data also can be obtained non-statistical factors-poor sample storage resulting in sample degradation. Samples should be stored in a container to protect the sample from moisture and other environmental factors (e.g., heat, light, air). To protect moisture loss, stored in an airtight container. Light sensitive samples should be stored in containers made of opaque glass or the container wrapped in aluminum foil. Oxygen sensitive samples should be stored under nitrogen or an inert gas.

Refrigeration or freezing may be necessary to protect chemically unstable samples. However, freezing should be avoided when storing unstable emulsions. Preservatives (e.g., mercuric chloride, potassium dichromate, and chloroform) can be used to stabilize certain food substances during storage.

Mislabeling of samples causes mistaken sample identification. Samples should be clearly identified by markings on the sample container in a manner such that markings will not be removed or damaged during storage and transport. For example, plastic bags that are to be stored in ice water should be marked with water-insoluble ink. If the sample is an official or legal sample the container must be sealed to protect against tampering and the seal mark easily identified. Official samples also must include the date of sampling with the name and signature of the sampling agent.

Self-check 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations / answers.

Test I: Choose the best answer among the given alternative

1. Food products are analyzed for_____. (1.5pts)
   a. To comply with legal and labeling requirements
   b. To assess product quality
   c. To determine nutritive value
   d. All
2. Sampling procedures (as dictated by the plan objectives) (1.5pts)
   a. Sample size
   b. Sample testing
   c. Hazard control
   d. HACCP

Test II: Write short answer for the following question

1. List the sampling report content? (3pts)

Note: **Satisfactory rating above - 3 points** **Unsatisfactory - below 3**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 2-Preparing sample

2.1 Prepare sample

Every type of material that is to be prepared for analysis presents its own practical difficulties. The requirements for suitable sample preparation are dictated by consistency and the chemical characteristics of the analyte and the matrix, the distribution of the analyte in the sample. Even seemingly homogeneous materials such as liquids may be subject to sedimentation or stratification.

Precautions to be followed while preparing a sample for analysis mixing:

- Single phase liquids can generally be mixed, stirred, shaken or blended.
- Dry particulate materials can be reduced in the volume by coning and quartering, by rolling and quartering, or by the use of a splitter.
- A variety of implements and machines are available for sample disintegration, such as mills, grinders and cutters.
- Care in their use is necessary to prevent loss of dust or change in composition through partial separation of components.
- Screening can be used to improve the efficiency of particle size reduction, followed by mixing to attain homogeneity.
- Sampling errors can occur even in well mixed particulate mixtures especially in trace analysis if the particles differ appreciably in size or physical properties.

a. Cleanliness of equipment used in process

Every piece of equipment used in the preparation of a sample must be examined critically to ensure their cleanliness. Grinders were known to segregate materials with in the mix by size as well, with the finer material, collecting beneath the blade e.g., Metal screens can pass fine particles, but retain powder that adheres to the screen materials. Glass containers and laboratory apparatus can adsorb certain materials and may require surface treatment. Plastic containers can retain contaminants, such as animal hairs, while the rest of the sample is transferred with apparent ease. In the other

words, validation of a method of analysis, includes, most certainly validation of the method of sample preparation and storage.

b. Changes in chemical characteristics

When volatile organic constituents are present in any sample, processing may be difficult and needs special care, e.g. maintaining chilled condition to prevent any loss of volatile constituents. Similarly, in case of photo-sensitive chemicals (e.g. natural product pesticides), it is required to process a sample under darkness to prevent degradation on exposure to light.

1.1.8 Sample accountability

Documentation a laboratory sample is generally the starting point for analytical work. The sample may be delivered by mail, courier, flight, or directly by the collector. It may arrive in any of various containers and conditions: frozen, packed in ice, or at room temperature. The package may be sealed or unsealed, and the sample itself may be spoiled or broken. The sample may or may not be accompanied by appropriate documentation to advise the laboratory regarding purpose, test parameters and the conditions of storage, etc. Once a sample is received, all the circumstances and conditions must be documented as they could have bearing upon the quality or the significance of the test results. It is important for appropriate quality analysis that sample arrives in proper condition with meaningful documents. Procedures for these must be established, continually reviewed, and enforced, to avoid any future legal complications, the laboratories are advised to protect statement in the “test report results relate only to the sample that was tested”.

1.1.5 Chain of care form

The first important activity is the documentation to ensure product traceability. The sample should be easily identifiable and placed under seal and packing. Shipping and delivery instructions are followed to effect delivery to the laboratory. The documentation consists of a chain-of-custody that accompanies the sample as it moves through the

laboratory and subsequent administrative handling. This form is usually prepared in multiple copies for distribution to various units in the organization, may be supplemented with affidavits, dealer's statements, bills or other relevant information that concerns the sample, its origin, the transfers from one custodian to the next and the sample's significance or importance. Information such as sample number, product name and identification, reason for collection, description of the sample method of collection, size of the lot from which the sample was taken, codes, shipment information, collection date, name of the collector, means of transportation, whether or not sealed if the sample is sealed, the seal includes the sample number, date the seal was affixed, and the collector's signature. The seal is attached to the package in such a way that it must be broken before the sample can be obtained.

Self-Check – 2	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write short answer for the following question

1. Define chain of custody form during sample preparation? (2pts)
2. Write necessary procedure of sample preparation? (2pts)

Test II: write true if the statement is correct and false if the statement is incorrect

1. The first important activity is the documentation to ensure product traceability. (2pts)
2. Every type of material that is to be prepared for analysis presents its own practical difficulties.(2pts)

Note: **Satisfactory rating above 4 points** **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Operation Sheet 2– Preparing sample for analysis

Objective: To prepare sample for product test according to the sampling plan

List of Materials needed:

- Spatula
- Mortal and pestle
- Miller
- Homogenizer
- Mixer
- Analytical balance
- Packaging material
- Hot air oven

Procedures:

Sampling procedures (as dictated by the plan objectives)

1. Determine sample number
2. Take the sample
3. Prepare bulk samples and reduced the samples size
4. Weigh the sample
5. Package the sample
6. Label the packaged sample with right material
7. Store the sample at the right environmental condition

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 2: Prepare sample

LG #47	LO #3- Setting up test equipment

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Setting up test equipment
- Performing pre-use and safety checks
- Identifying and reporting faulty or unsafe equipment
- Checking calibration status of equipment and reporting any out of calibration items

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Set up test equipment
- Perform pre-use and safety checks
- Identify and reporting faulty or unsafe equipment
- Check calibration status of equipment and report any out of calibration items

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,

9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Setting up test equipment

1.1 Setting up test equipment

Fruit and vegetable laboratories shall be designed to meet the testing requirements. The layout of laboratory shall be arranged in such a way that test procedures can be carried out in sequential manner and risk of contamination can be reduced. The space shall be managed with respect to specialized activities such as separate space for wet analysis and dry analysis. The laboratory layout shall meet the instructions of equipment's and instruments handling.

Special provisions / rooms shall be available for weighing balance, sensitive instruments, radioactive material, media preparation, storage (samples and chemicals) and washing of glassware. Provision of water (potable & distilled), cupboards, sinks, dustbins, reagent shelves, glassware, fumes cupboards and power is necessary. Ventilators and fume cupboard shall be placed carefully such as to maintain the dust free environmental conditions in laboratory and to avoid risk of contamination of test samples/ chemicals. Appropriate system/device shall be used to control environmental contamination. Laboratory shall follow good housekeeping activities such as floor and wall cleaning, washrooms, dustbins, fume hoods, freezers, refrigerators, air conditioners, air filters, flies killer lamp.

List of equipment which can be used in product analysis is as follows:-

- Autoclave
- Centrifuge
- Chromatography assembly/ analyzer
- Colony counter
- Crude fiber assembly
- Deep freezer
- Distillation assembly
- Homogenizer
- Hunter color lab
- Incubator
- Kjeldahl apparatus
- Laboratory hoods
- Laboratory sterilization equipment
- Laminar flow
- Microscope
- Mixer Grinder
- Moisture Analyzer
- Muffle furnace
- Oven

- PH Meter
- Refractometer
- Refrigerator
- Rheometer
- Rotary Evaporator
- Shaking Incubator
- Soxhlet apparatus
- Texture analyzer
- Titration assembly
- UV-Vis Spectrophotometer
- Viscoanalyzer
- Viscometer
- Water activity meter
- Weighing Balance (sensitivity according to the requirements)
- Any other equipment as per requirement

1. Autoclave setting up

General Description: An autoclave is a large pressure cooker. It is a moist sterilization unit. Principle: It operates under the principle of steam under pressure as the sterilizing agent. High pressures enable steam to reach high temperatures, thus increasing its heat content and killing power. Most of the heating power of steam comes from its latent heat of vaporization (the amount of heat required to convert boiling water to steam).

Placing:

1. The sterilizer must be placed on a rigid and leveled surface. The counter top or stand must be able to withstand the load of the device and loaded material.
2. Check and verify that the counter carrying the autoclave is a rigid and leveled surface and can carry a load of 275lbs.
3. The back of the autoclave must be a minimum of 2” from the rear wall. If placed in a cabinet, the rear of the cabinet must be open to allow ventilation. Failure to provide proper space for air circulation will result in failed cycles.
4. Check and verify that the counter dimensions are, at least, 22” x 24”.

Note: Make sure while placing the autoclave, to leave space around the machine for ventilation and to give the technician access to service the machine. It is recommended that a minimum 2” (50mm) space be provided. Insufficient space for ventilation can cause cycles to fail and may result in an increase of the autoclave’s temperature which can damage the unit.

4. Check and verify that the room ventilation is 10 cycles per hour minimum.

5. Check and verify that the ambient temperature range is 41ºF-104ºF (5ºC-40ºC), it is preferable not to exceed 86ºF (30ºC).

6. Check and verify that the ambient relative humidity does not exceed 85%

7. Operate the autoclave only in the manner specified in the manual. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Setup

1. Make sure the counter is level and sturdy.
2. Make sure all the feet are on the autoclave and none of them has been lost.
3. Position the autoclave on the counter.
4. Connect the power cord to the socket on the rear side of the autoclave; then plug it into the supply outlet.
5. Turn on the power switch located on the right side of the unit.
6. Set date and time will appear on the screen. On initial set up it is important to set the date and time see sec. setting the date and time will cause the software to reload.
6. This machine is equipped with an electronic door lock. The door will not open when the power is off or the system is running a cycle or an error message is displayed.
7. When the software has finished loading the door will unlock. To prevent melting of the plastic packing material in the chamber, open the door and immediately use the arrow keys on the Pad to advance to the vacuum test cycle. This will turn off the pre heating mode. Make sure to remove all accessories and plastic material from the chamber.
8. Fill the reservoir with steam distilled water

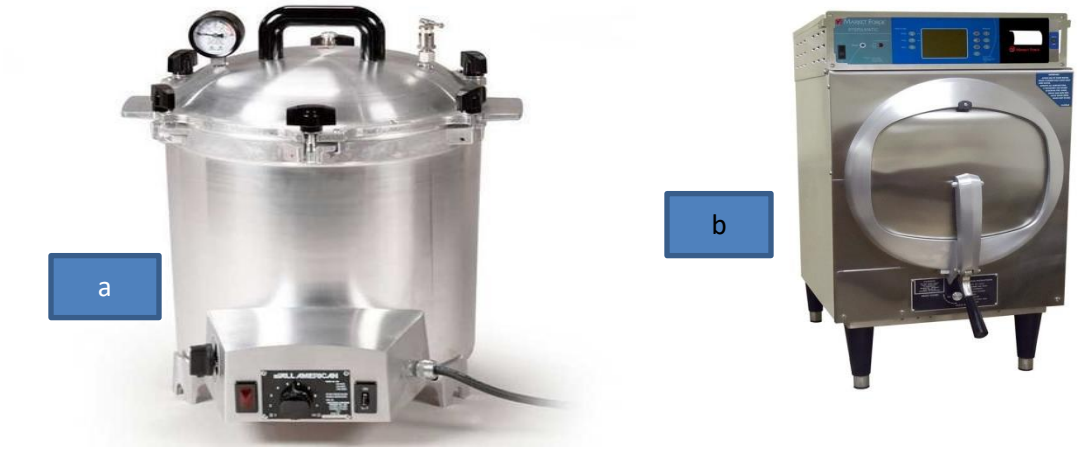

Figure 3: Manual (a) and Digital Autoclave Image (b)

2. Hot Air Oven

General Description: It is a dry heat sterilization unit. A dry heat cabinet is easy to install and has relatively low operating costs; it is nontoxic and does not harm the environment and it is noncorrosive for metal and sharp instruments.

The Hot air oven is mounted on four rubber foots to prevent slipping and this protects the bench surface. The control panel houses a main ON/OFF switch indicator lamp and temperature setting knob. The scale is calibrated in 5°C steps.

Working Principle of Hot Air Oven is the forced circulation of hot air inside the chamber of oven. As it is a universal scientific fact that in any chamber hot air rises above, so by utilizing this principle when the hot air reaches the top of chamber it is circulated back to bottom by a fan installed inside the chamber and hence optimum amount of heat is achieved gradually inside the Hot Air Oven.

Setup

(1) Scope of delivery.

Main body (1set), Operation manual (1EA), Glass fuse (2EA), Shelf(2EA), Shelf guide(4EA)

(2) This unit will work correctly on proper power supply. Please check power supply and ID Plate information are the same. User must use power supply connected earth and power cord must be connected to wall outlet supplying ground point.

(3) Please install the unit in the flat place where prevent vibration and shock.

(4) Please let the unit avoid heat source and direct sun light and let the unit located in ambient temperature range in 5 ^{o}C - 40 ^{o}C relative humidity lower than 80%.

(5) Please do not install the unit where water and organic solvent is easily penetrates in the unit.

They cause short circuit.

(6) Please do not install the unit in dangerous place. (Where there are flammable gas and explosive material)

(7) Please secure enough space for installation because the door of it opened 180¡.

(8) Please secure enough space for installation. The blower is back side of the oven.

(9) Please donot install the unit nearby machines generating strong high frequency noise.

(10) This unit is quite heavy. Please move the unit with proper moving tool or 2 people together.

Figure 5: Natural convection oven

3. pH Meter General

Description: This equipment measures pH of the solutions and the tissue culture media. Appropriate buffers stabilize the pH of the electrode and the machine reads the pH of the solution in complement with the buffer.

Figure 6: pH Meter Image

Setting up

Unpack the instrument and ensure the following items are present:

1. Model 350 pH Meter (350 201)
2. Epoxy bodied combination pH electrode (924 001)
3. PH 4, 7 & 10 buffer sachets
4. 2 x AA alkaline batteries (021 007) (fitted)

4. Texture Analyzer

Major food companies routinely apply texture analysis techniques both in new product development and as part of quality control in finished processed foods. Texture, flavor and appearance are key factors which influence food sampling, buying and repurchase. While flavor and appearance are well established in the sphere of quality control, texture is a relative newcomer in the determination of product acceptability. Orally, visually, manually – texture is assessed in many ways to determine a wide range of properties: hardness, cohesiveness, springiness, adhesiveness, fracturability and chewiness. Major food companies routinely apply texture analysis techniques both in new product development and as part of quality control in finished processed foods.

While subjective testing still plays a role, objective analysis is key to maintaining consistency and textural quality in manufactured foods. Food processors now use a number of instruments to provide quick and repeatable information as a cost-effective

method for determining the effects of raw material quality and ingredient/process variables on end-product acceptability.

As demands on food manufacturers have become more pressing, texture analysis equipment has become more sophisticated. Instruments have developed from single textural parameter testing, such as penetrometers, to multi-functional instruments, including fully computerized systems, which carry out a variety of measurements.

In a simple test, the arm of the texture analyzer, which contains the load cell, moves down to penetrate or compress the product and then returns to its initial position. During testing, data characterizing the product is collected as time, distance and force values, at a rate of up to 500 readings per second. These values are typically plotted on Force/Distance or a Force/Time graph and then analyzed. The test results can be viewed in a spreadsheet, chart or report format. Coefficients of variations (C.V) account for variations between individual samples. Low C.Vs demonstrates reliability and accuracy of results.

Setting Up

The TA1 Texture Analyzer is a heavy item and great care should be taken in choosing the location where it is to be installed. Ensure the bench is capable of remaining firm and stable, withstanding the combined weight of the machine and any accessories supplied. Please see the Specification page at the end of this manual for the weight of the apparatus. The machine must be vertical, otherwise the results may be affected, particularly for very low loads. The TA1 must be positioned such that the front can be easily accessed, and that the emergency stop button is not obstructed in any way. Please ensure utmost care is taken when lifting this instrument, use safe working practices. Lifting equipment should be used as necessary.

The two recommended methods are described below:

1. Lifting with a pallet. A pallet may be fitted under the machine so it may be lifted to the desired position with a forklift or a suitable lifting trolley.

2. Lifting by hand. The machine can be lifted manually, at least 2 people should be employed to do this as the machine weighs more than 50kg (110lb). Do not lift using plastic base cover.

Figure 7: Texture Analyzer image

5. Electronic Weighing Balance

Principle & Working: Electronic weighing balance accurately measures the weight of chemicals. Calibrate the balance by internal calibration. Place the weighing boat and tare the weight. Wait till it becomes zero. Chemical should be weighed slowly according to the need. Wait till the symbol “g” stabilizes next to the weight shown.

Figure 8: Electronic Analytical Balance image

Setup

The balances are designed in a way that reliable weighing results are achieved in common conditions of use. You will work accurately and fast, if you select the right location for your balance.

Therefore, observe the following for the installation site:

• Place the balance on a firm, level surface;

• Avoid extreme heat as well as temperature fluctuation caused by installing next to a radiator or in the direct sunlight;

• Protect the balance against direct draughts due to open windows and doors;

• Avoid jarring during weighing;

• Protect the balance against high humidity, vapours and dust;

• Do not expose the device to extreme dampness for longer periods of time. Non-permitted condensation (condensation of air humidity on the appliance) may occur if a cold appliance is taken to a considerably warmer environment. In this case, acclimatize the disconnected appliance for ca. 2 hours at room temperature.

• Avoid static charge of goods to be weighed or weighing container.

If electro-magnetic fields or static charge occur, or if the power supply is unstable major deviations on the display (incorrect weighing results) are possible. In that case, the location must be changed.

6. Muffle furnace

A muffle furnace is a front-loading box-type oven or kiln for high-temperature applications such as fusing glass, creating enamel coatings, ceramics and soldering and brazing articles. They are used in order to determine what proportion of a sample is noncombustible and non-volatile that is called as ash.

Figure 9: Muffle furnace image

Setup

- Open shipping package to check if all components are good condition
- The furnace must be placed in flat surface to avoid vibration, where must keep from flammable and explosive materials.
- The furnace uses AC single phase 220V / 9.5KW power. Please make sure that power source in your lab is enough to meet this power requirement.
- Use a power plug (not included) at > 100A current rating to connect furnace.

7. UV-Visible Spectrophotometer

General Description: To measure the chemical constituents of the sample and to get spectrometric analysis of the given samples. ation, inactivation and even for industrial incubation procedures.

Figure 10: UV-Visible Spectrophotometer image

Working Principle:

The spectrophotometer consists of five parts:

1) Halogen or deuterium lamps to supply the light;

2) A Monochromator to isolate the wavelength of interest and eliminate the unwanted second order radiation;

3) A sample compartment to accommodate the sample solution;

4) A detector to receive the transmitted light and convert it to an electrical signal; and

5) A digital display to indicate absorbance or transmittance.

The block diagram (Fig 2) below illustrates the relationship between these parts.

Block diagram for the Spectrophotometer.

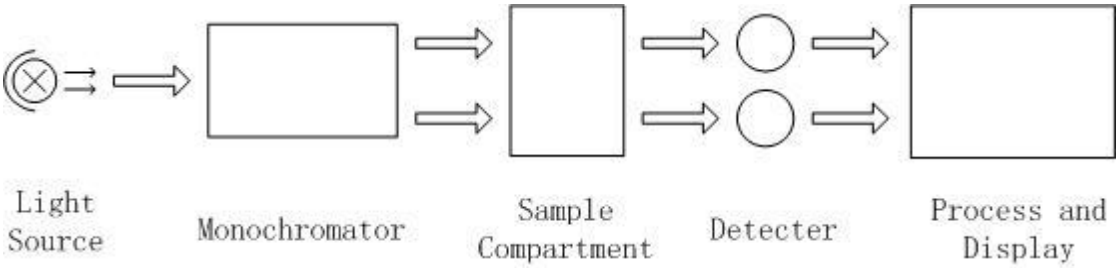

Figure 11: Block diagram for the Spectrophotometer.

Setup

1. After carefully unpacking the contents, check the materials with the packing list (page 4) to ensure that you have received everything in good condition.
2. Place the instrument in a suitable location away from direct sunlight. In order to have the best performance from your instrument, keep it as far as possible from any strong magnetic or electrical fields or any electrical device that may generate high-frequency fields. Set the unit up in an area that is free of dust, corrosive gases and strong vibrations.
3. Remove any obstructions or materials that could hinder the flow of air under and around the instrument.
4. Use the appropriate power cord and plug into a grounded outlet.
5. Turn on your SQ-4802 model spectrophotometer. Allow it to warm up for 15 minutes before taking any readings. We suggest you then do the Calibrate System with the Search 656.1nm to set the wavelength to the deuterium lamp emission line.

8. Dial Viscometer

Viscosity testing is a tool used in the production process of just about every type of food and beverage. The viscosity of a fluid is a measure of its resistance to deformation at a given rate. For liquids, it corresponds to the informal concept of "thickness": for example, syrup has a higher viscosity than water.

Food viscosity is defined as frictional resistance to shear. Food texture is defined as the group of physical properties derived from the structure of the food that can be sensed by touch. Touch usually is performed by elements of the oral and pharyngeal cavities.

a.  b. 

Figure 12: Image of jam sample (a) and viscosity meter (b)

Set-Up

1) Assemble the laboratory stand

2) Mount the Viscometer securely on a Brookfield laboratory stand. On some Viscometers,

it may be necessary to unscrew the nut located at the point where the power cord enters the viscometer. This permits the metal handle to be inserted into the laboratory stand clamp.

Note: The position of the laboratory stand clamp assembly is important. Level the viscometer, referring to the bubble level on the instrument. If the viscometer cannot be leveled, recheck the laboratory stand assembly

3) Verify that the viscometer's power requirements match your power source before connecting it to power.

Self-Check – 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Special provisions / rooms shall be available for_____? (pts)

a. Weighing balance
b. Sensitive instruments
c. Radioactive material
d. All

Test II: Write short and precise answer for the following questions ?

1. Write the setup of autoclave? 2pts
2. Write the setup of analytical balance? 2pts
3.

Note: **Satisfactory rating above– 2.5 points Unsatisfactory - below 2.5**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Operation Sheet 3– Set-up and Pre-use Checks of the Microscope

Objective: To avoid any possible hazard and to ensure safety

List of Materials needed:

Procedures: Perform Set-up and Pre-use Checks of the Microscope

1. Carefully unpack the microscope from its carrying box or remove the dust cover.
2. Place in a suitable position on the bench at the correct working height for the user. Do not place too close to the edge of the bench.
3. Check the power cord is in good order and plug it in if not already plugged into a power socket.
4. Switch on the power at the socket and on the microscope, check the light bulb is operating.
5. Rotate the objective lens turret to place the 4x objective lens in position over the light source.
6. Clean all refracting surfaces to remove dust and grease. See the 'SOP: Care of an Optical Microscope' for more information.

Always fill in the microscope user's book with your name, date, time you used the instrument and note any comments on its performance.

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 3: Perform set-up and pre-use checks of the Microscope

Information Sheet 2- Performing pre-use and safety checks

2.1 Perform pre-use and safety checks

Pre-use inspections are required before use of any equipment or work process that has a potential to result in a severe loss. This inspection must be recorded in a log that is kept on the equipment or near the process and be available for review.

Performing the pre-operational check is important for the safety of the operator and everyone in its working environment. Unfortunately this safety check is often forgotten or ignored. Not every operator is aware about the items that need to be check before he can start his machine and begin to perform his daily tasks.

These inspections are conducted prior to use for the first time that day, the employee using the equipment must check the inspection log and determine if it has been inspected. Many pieces of equipment are used several times a day and they will only require the pre use inspections once on any given day. In cases where equipment is not used daily, a pre use inspection is not necessary until the day it is used. The employee conducting the pre use inspection completes the inspection and then dates and signs the checklist and returns it to the appropriate location.

a. Corrective action

If during the course of the pre use inspection the employee determines that there is a deficiency this must be corrected before use. If it is a minor issue that the employee can correct then the equipment can be used. If the deficiency is of a nature that the employee cannot correct to make the equipment safe to use then the equipment must be taken out of service and the supervisor must be immediately contacted.

Because of the nature of its work a laboratory normally contains many hazards. If these hazards are not properly understood and managed, they have the potential to cause harm to people working in and around the environment.

An optical microscope is a piece of equipment with few inherent safety hazards but safety still needs to be considered prior to using the microscope. Safety hazards include:

- Heavy weight hazard from dropping the heavy microscope onto your foot
- Sharps hazard from broken slides during handling
- Chemical hazard from the stains used on the slides
- Infection hazard from biological samples
- Electrical hazard from frayed or broken wires
- Burns hazard from the light bulb after prolonged use.

2.1.1 Proving safety – pre-start equipment checks

Conducting a pre-start check of equipment is important to ensure equipment is safe to use. The traditional approach to a pre-start equipment check is to provide a worker with a booklet of pre-formatted forms, typically some sort of checklist, which they will go through and tick off each of the relevant items, making a comment where they think it is appropriate. On completion, the worker will sign and date the form. Increasingly, the form is transitioning from paper-based to electronic and workers are completing pre-start inspections on mobile phones or other devices

First, what is the purpose of the pre-start inspection regime? It may be different for different organizations, it is to ensure that the piece of equipment is safe to use. Within that broad statement of purpose, it seems to me there are three key objectives.

First, that the equipment is inspected. Second, that identified faults or hazards are reported and rectified. Third, that unsafe equipment is taken out of service until it is safe to use.

Self-Check – 2	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. _____are required before use of any equipment or work process that has a potential to result in a severe loss? (1.5pts)

a. Control measure
b. Sampling method
c. Control hazard
d. Pre-use inspections

2. _____ is important to ensure equipment is safe to use ? (1.5pts)

a. Conducting a pre-start check of equipment
b. Maintenance of equipment
c. Repairing of equipment
d. Processing equipment

Test II: Write short answer for the following questions

1. List the importance of pre use check of equipment's? (2pts)
2. Write advantage of safety check? (2pts)

Note: **Satisfactory rating above – 3.5 points** **Unsatisfactory - below 3.5**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 3- Identifying and reporting faulty or unsafe equipment

3.1 Identifying and reporting faulty or unsafe equipment

Laboratory equipment maintenance and intermediate performance checks are conducted on a scheduled basis. A schedule, identifying and eliminating potential sources of problems, is established for the servicing of laboratory equipment. Such maintenance and performance checks are recorded to demonstrate that the program is being followed according to schedule. Manufacturer's instructions are used for guidance in performing equipment maintenance. In the absence of manufacturer's instructions, instructions are provided in the equipment operation procedure. The maintenance and performance checks records may be maintained in a logbook, log sheet, or electronically. Preventative maintenance procedures, other than basic cleaning, are developed for each equipment item. General Service equipment is typically maintained only with cleaning and safety checks.

3.1.1 Out of Service Equipment

Equipment that is not in use, and therefore has not been calibrated, verified, or not operating properly must be clearly tagged out of service. Out of service equipment must be calibrated or verified prior to use. Equipment is not returned to service until performance checks and verification have been performed and recorded. An exception may be made if the equipment failure is not directly related to its analytical function, such as a problem with peripheral equipment. For example, if a printer or computer attached to a chromatographic system is out of order, performance checks and verification for the chromatograph may not be needed following repair.

3.1.2 Inspect and tag equipment

The first step towards maintaining an effective preventative maintenance program is to have a running maintenance program and reporting procedures in place. An important part of any running maintenance program is identifying faults and using an appropriate sign system, called tagging, on faulty machines and equipment.

a. Identifying problems

Identifying faulty equipment and machinery is part of both preventative and running maintenance. Problems are considered to be either major or minor. Deciding what kind of problem exists will determine what kind of maintenance needs to be carried out.

Major problems: major problems are all maintenance tasks that need specialist maintenance personnel to fix them. The problem may be a complete breakdown or an occasional malfunction. If you think that a major problem exists there is usually a procedure to follow for reporting the problem.

Minor problems: minor problems do not require specialist personnel. Machine operators or other trained staff are usually able to deal with them. A minor problem may be present if: the machine operates but production levels are reduced, or the quality of output is affected. In the resources section you can find examples of some major and minor problems for you to check through.

b. Tagging equipment

When a machine breaks down or is faulty it must be locked out and tagged with a sign that can be easily seen by workers. This sign should be a clear warning to workers that the machine cannot be used until the necessary maintenance has been carried out.

c. Locking out

Locking out of equipment or machinery is the most effective way of preventing accidental operation while maintenance is carried out. Locking out is effective because it uses a "one key per lock" and "one lock per person" system.

If there is only one key per lock, the key has to be with the person carrying out the maintenance. Where more than one person is working on equipment or machinery a multi-lock system should be used. Each person must attach a 'personal' lock to the equipment or machine's multi-lock switch.

d. Tagging

There are two types of signs or tags used to warn workers that machines cannot be used: Danger tags and Out Of Service or Caution tags.

These tags are used to indicate that the situation may constitute a hazard. They must be used in specified ways and whenever a machine or equipment has been identified as faulty or has broken down.

Self-Check – 3	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Equipment that is not in use, and therefore has not been calibrated, verified, or not operating properly must be clearly_____?(1.5pts)
   a. Tagged out of service
   b. Maintaining equipment

c. Operating equipment d. Checking of equipment

2. _____ is part of both preventative and running maintenance? (1.5pts)
   a. Regulating equipment
   b. Identifying faulty equipment and machinery
   c. Controlling equipment
   d. All

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Identifying faulty equipment and machinery is part of both preventative and running maintenance (2pts).
2. Major problems are not all maintenance tasks that need specialist maintenance personnel to fix them (2pts).

Note: **Satisfactory rating above– 4.5 points** **Unsatisfactory - below 4.5**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 4-Checking calibration status of equipment and reporting any out of calibration items

4.1 Checking calibration status of equipment and reporting any out of calibration items

Calibration is the set of operations, under specified conditions, establishing the relationship between values of quantities by a measuring instrument or measuring system, or values represented by a material measure or reference material, and the corresponding values realized by standards.

4.1.1 Equipment Calibration or Verification

A calibration or verification procedure is prepared by the testing laboratory for all critical laboratory equipment where laboratory personnel perform the testing. If the procedure is described in an operator's manual or a test procedure, this can be referenced on a separate procedure. Calibration or verification records are maintained. Minimum calibration or verification schedules according to AOAC International for the most common types of laboratory equipment are important. For analytical equipment not listed, the laboratory must develop a comparable schedule. Generally, laboratory equipment is categorized as follows:

1. General service equipment such as blenders, ovens, hotplates, furnaces, stirrers;
2. Volumetric equipment such as Class A glassware, mechanical and automatic pipettes and burets; Note: A manufacturer's certificate of graduation accuracy for Class A glassware may be accepted. Other volumetric equipment, including mechanical and automatic pipettes and burets, are calibrated by the laboratory's procedure.
3. Measuring instruments such as balances, chromatographs, spectrometers, thermometers; and
4. Physical standards such as reference weights and reference standards.

Data acquired on equipment which fails a parameter are investigated to include items between the failing assessment date and the last successful calibration or verification date. The problems and investigation are conducted according to the laboratory's procedures for managing nonconforming work and corrective actions.

a. Calibration of Digital Refractometer

The Refractometer's zero position must be inspected prior to initial use and periodically A zero point calibration should be performed at least once daily and prior to any measurement where the highest possible accuracy is required, or when moving to a different environment with a different ambient temperature. For the majority of models all you need for calibration/zero point calibration is distilled and deionized water. Ideally, the ambient and calibration liquid temperature should be between 10 °C and 30 °C (50 °F–86 °F) during calibration. Calibration liquid with 60% sugar is required for a variety of models.

You should be aware of the adjustment condition when using a measuring instrument.

1. Inspect the prism to ensure that the surface is clean and dry.
2. Apply a few drops of the calibration liquid onto the prism window.
3. Press the CAL button for five seconds; the measuring instrument begins the zero point calibration process.
4. The measuring instrument is performing the calibration process when 'CAL3', 'CAL2', 'CAL1', 'CAL0' appear in the display.
5. When the calibration process is complete this is shown in the display
6. Calibration liquids vary, depending on the measuring range of the instrument.

b. Calibration of Muffle Furnace

The measurement range from the controller to the thermocouple can exhibit measurement errors. The measurement range consists of the controller inputs, the

measurement wires, sometimes terminals and the thermocouple. If you discover that the temperature value on the controller display no longer agrees with the value of a comparison measurement (calibration), this controller offers the option of an easy matching of the measurement values for each thermocouple.

By entering up to 10 base points (temperatures) with the relevant offsets these temperatures

can be matched very flexibly and precise.

When an offset of a grid point is entered, the actual value of the thermocouple and the entered offset are added.

Example:

- ✓ **Adaptation using a comparative measurement:** The control thermocouple outputs a value of 1000 °C. Calibration measurements near the control thermocouple return a temperature value of 1003 °C. By entering an offset of "+3 °C" at 1000 °C, this temperature is raised by 3 °C and the controller, then also returns a value of 1003 °C.
- ✓ **Adaptation using a transducer:** Instead of the thermocouple, a transducer supplies the measurement range with an actual value of 1000 °C. The display outputs a value of 1003 °C. The deviation is "-3 °C" from the reference value. Hence, the offset that must be entered is "-3 °C".
- ✓ **Adaptation using a calibration certificate:** On the calibration certification (for example for a thermocouple) there is, at 1000 °C, a deviation of "+3 °C" from the reference value. The correction is "-3 °" between the display and the reference value. Hence, the offset that must be entered is "-3 °C".
- ✓ **Adaptation using a TUS measurement:** During a TUS measurement, a deviation of the display from the reference band of "-3 °C" is determined. Here, the offset that must be entered is "-3 °C".

Caution

The thermocouple calibration certificate does not take into account the deviations of the measurement range. Deviations of the measurement range must be determined by a

measurement range calibration. The two values are added together to produce the correction values that need to be entered.

Caution

Please observe the instructions at the end of the section.

The setting function in this instance follows specific rules:

- The values between two support points (temperatures) are linearly interpolated. That means that a straight line is projected between the two values. The values between the supporting points are then on this line.
- The values below the first support point (for example, between 0 and 20 °C) are located on a straight line that is connected (interpolated) with 0 °C.
- Values above the last supporting point (for example >1800 °C) are project further with the final offset (a final offset at 1800 °C of +3 °C is also used at 2200 °C)

Temperature inputs for the support points must be in ascending order. Support points that follow gaps ("0" or a lower temperature for a support point) are ignored.

c. Calibration of viscometer

1) Ensure that the circulating bath used maintains the stated calibration temperature to within ± 0.1°C.

2) The attachment of the cone spindle and sample cup, and the gap setting between the cone and cup must be accomplished by following "Cone/Plate Rheometer Set Up" Procedure.

3) Put the proper amount of viscosity standard fluid into the sample cup.

4) Attach sample cup to viscometer and allow approximately 15 minutes for temperature equilibrium.

5) Measure the fluid's viscosity and record the viscometer readings (both % torque and cP).

6) See "Interpretation of Test Results" shown below for calculation of total calibration tolerance (instrument and fluid).

Notes: 1) The spindle must rotate at least (5) times before a viscosity reading is taken.

2) The use of Brookfield Viscosity Standard fluids in the range of 5 cP to 5000 cP is recommended for cone/plate instruments. Please contact Brookfield Engineering Laboratories or an authorized dealer if your calibration procedure requires more viscous standards.

3) Select a viscosity standard fluid that will give viscosity readings between 10% and 100% of full scale range.

Self-Check –4	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations / answers.

Test I: Choose the best answer among the given alternative

1. _____is the set of operations, under specified conditions, establishing the relationship between values of quantities by a measuring instrument? (1.5pts)
   a. Testing
   b. Calibration
   c. Measurement
   d. Grading
2. _____is prepared by the testing laboratory for all critical laboratory equipment where laboratory personnel perform the testing.(1.5pts)
   a. Calibration or verification procedure
   b. Testing procedure
   c. Experiment
   d. All

Test II: Write short answer for the following questions

1. Write the calibration procedure of refractometer (3pts)
2. Write how to calibrate viscometer?(3pts)

Note: **Satisfactory rating above- 4.5 points Unsatisfactory - below 4.5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Operation Sheet 4– Perform calibration of Refractometer

Objective: To lay down a procedure for calibration Refractometer

List of Materials needed:

- Distilled water
- Refractometer
- Cleaning material

Procedures: Conduct calibration of refractometer.

1. Operate the instrument as mention in the operation procedure
2. The instrument should be checked by determining the refractive index of distill water at 25 ^{O}C.
3. If the refractive index of distilled water at 25 ^{O}C is not between 1.3320-1.3330 and adjust the diving line exactly at the intersection of the cross wire by turning the key clockwise or anticlockwise, remove the key.
4. The instrument shall be further checked by determining the reference index of the reference liquids. (carbon tetrachloride,Toluene, Distilled water) and record

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 4: Perform calibration of Refractometer

LG #48	LO #4- Perform tests on samples

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying, preparing and weighing or measuring sample and standards
- Conducting tests.
- Recording data.
- Performing calculations on data
- Identifying and reporting out of specification result

Shutting down equipment This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify, prepare and weigh or measure sample and standards
- Conduct tests.
- Record data.
- Performing calculations on data
- Identifying and reporting out of specification result

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets

7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Identifying, preparing and weighing or measuring sample and standards

1.1 Identifying, preparing and weighing or measuring sample and standards

Once the reason for carrying out the analysis has been established it is necessary to clearly specify the particular property that is going to be measured, e.g., color, weight, presence of extraneous matter, fat content or microbial count. The properties of product can usually be classified as either attributes or variables. An attribute is something that a product either does or does not have, e.g., it does or does not contain a piece of glass, or it is or is not spoilt. On the other hand, a variable is some property that can be measured on a continuous scale, such as the weight, fat content or moisture content of a material. Variable sampling usually requires fewer samples than attribute sampling. The type of property measured also determines the seriousness of the outcome if the properties of the laboratory sample do not represent those of the population. For example, if the property measured is the presence of a harmful substance (such as bacteria, glass or toxic chemicals), then the seriousness of the outcome if a mistake is made in the sampling is much greater than if the property measured is a quality parameter (such as color or texture). Consequently, the sampling plan has to be much more rigorous for detection of potentially harmful substances than for quantification of quality parameters.

a. Sample identification

Laboratory samples should always be labeled carefully so that if any problem develops its origin can easily be identified. The information used to identify a sample includes: a) Sample description, b) Time sample was taken, c) Location sample was taken from, d) Person who took the sample, and, e) Method used to select the sample. The analyst should always keep a detailed notebook clearly documenting the sample selection and

preparation procedures performed and recording the results of any analytical procedures carried out on each sample. Each sample should be marked with a code on its label that can be correlated to the notebook

b. Sample receipt and handling

A dependable record of sample handling is important so that the sample is accepted by a sample custodian who documents the action by completing a sample accountability record. This document should contain the Sample number, name of the product and date received, Indicate who received it, Describe the method of shipment or delivery, Describe the packages received and their condition, provide space for recording various storage locations before and after analyses. Deliveries of the sample or portions of the sample to the analyst, and its return, will also be recorded on this form. There will be a signed statement concerning the final disposition of the reserve sample. Sample Receipt and Handling A two-part form can be used for this purpose; one copy remains with the sample guardian and the other moves with the sample through the laboratory and is used by a supervisor for sample management purposes. Some laboratories use a sample receiving log book for sample control. The information entered in the log book is essentially the same as that described for the two-part form.

The sample accountability in a laboratory can be monitored by a simple computer program; a unique label should be generated and affixed to the sample container, and all the pertinent sample information should be entered into the computer database. The information entered at log–in becomes part of the data base, which is then built up through the manual or automatic addition of sample handling information and analytical data. Worksheet pages or reports can be calculated and printed, and the data base itself latter queried and manipulated for various information and reporting purposes.

Regardless of the recording system used, the analytical information generally reported includes a Description of the sample, sub sampling procedure sample preparation

methods used, deviations from methods, validation and recovery experiments (if performed), standards used, source of reference materials, raw data, calculations and description of the reserve sample and how it was prepared for storage after the completion of the analysis. If the reserve sample is sealed, the information placed on the seal is shown in the report. The sample is then returned to the sample custodian to be stored for whatever future action may be necessary, or until the sample is destroyed.

Self-Check – 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among given alternative

1. The information used to identify a sample includes ____?(1.5pts)
   - **a.** Sample description,
   - **b.** Time sample was taken,
   - **c.** Location sample was taken from,
   - **d.** All
2. The analytical information generally reported includes ____? (1.5pts)
   - **a.** Description of the sample,
   - **b.** Sub sampling procedure
   - **c.** Sample preparation methods used,
   - **d.** All

Test II: Write true if the statement is correct and false if the statement is incorrect

1. An attribute is something that a product either does or does not have, e.g., it does or does not contain a piece of glass, or it is or is not spoilt. (2pts)

2. A variable is some property that can be measured on a continuous scale, such as the weight, fat content or moisture content of a material. (2pts)

Note: **Satisfactory rating above -3.5 points Unsatisfactory - below 3.5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 2- Conducting tests

2.1 Conducting tests

Determination of total soluble solids or sugar (tss) by refractometer

This document describes an objective test to determine the total content of soluble solids (TSS) or sugar in a product by means of the refractometer.

A refractometer measures TSS as °Brix in 0.1% graduations. There are hand-held refractometers as well as digital battery/mains-operated models available. All models apply similar principles. However, the manufacturers' instructions must always be followed.

Some refractometers automatically compensate for changes in temperature, whereas others may be calibrated to read accurately at a fixed temperature (usually 20°C). To obtain accurate readings at temperatures other than 20°C it is necessary to refer to the International Temperature Correction Table (1974) which is usually supplied with the instrument or ISO standard 2173 - (edition 2003).

Refractometers should not normally require re-calibration, however, the following calibration instructions may prove useful.2 If there is any doubt as to the accuracy of any reading it is important to consult the manufacturer's instructions.

a. Use of the refractometer

Depending on the purpose of the analysis, several drops of distilled water, sucrose solution or juice are placed on the prism surface. The liquid on the prism plate should be free from bubbles or floating particles of pulp or other matter.

Hand-held model: The prism lid is closed. To get proper readings, the instrument is turned towards the light. If necessary the eye piece is focused until a clear image appears. The position at which the demarcation line between the light and dark regions crosses the vertical scale gives the percentage soluble solids reading.

LCD Digital model: Push the button to get the soluble solids reading in percent.

Checking and re-calibration to zero Requirements:

- A bottle of distilled water.
- A small bottle of 6 % sucrose solution.

The solution should be stored in a bottle, kept away from daylight and used within 48 hrs of preparation.

Several drops of distilled water are placed on the prism surface.

Distilled water should give a reading of zero. If not and where possible, the refractometer must be adjusted to read zero.

The prism plate is wiped dry with a soft tissue free from fluffs. Several drops of 6% sucrose solution are placed onto the clean and dry prism plate. The refractometer should give a reading of 6%. If the reading is not accurate:

a) A new fresh solution of accurate 6% sucrose may be required.

b) The refractometer may need to be repaired or replaced.

b. Taking care of the refractometer

Optical glass is relatively soft and damage can easily occur to prism surfaces. Care should be taken not to scratch the prism and therefore metal and glass objects should be kept away from the prism surface.

Samples should be washed off the instrument as soon as possible with distilled water. A prism is susceptible to alkalis and acids if left in contact for any length of time. They should be washed clean with a suitable solvent before being rinsed with distilled water and dried off with a soft tissue.

Periodically it is an advantage to wipe the prism plate with alcohol to remove any oils which may adhere. Alcohol must not be used on battery/mains operated models. It is always advisable to keep any liquids confined to the prism end of the refractometer.

c. Sample preparation

(a) Clear liquid products: Thoroughly mix the sample and use it directly for determination.

(b) Semi thick products (purees etc.): Thoroughly mix the sample. Press a part of the sample through a gauge/muslin cloth folded in four, rejecting the first drops of the liquid and reserving the remainder of the liquid for the determination.

(c) Thick products (jams, Jellies etc): Weigh into the tared beaker to the nearest 0.01 gm, a suitable quantity (upto 40 gm) of the sample and add 100 – 150 mL of distilled water. Heat the contents of the beaker to boiling and allow to boil gently for 2-3 minutes, stirring with a glass rod. Cool the contents and mix thoroughly. After 20 minutes weigh to the nearest 0.01gm, then filter through a fluted filter paper or a Buchner funnel into a dry vessel. Reserve the filtrate for determination.

d. Measurement

An equal number of drops from the prepared sample are placed onto the refractometer prism plate. The reading on the prism scale is noted to one decimal place. After each test the prism plate must be cleaned with (distilled) water and wiped dry with a soft tissue.

Put a small quantity of the test solution (2- 3 drops are sufficient) on the fixed prism of the refractometer and immediately adjust the movable prism. Suitably illuminate the field of view. Bring the line dividing the light and dark parts of the surface in the field of view to the crossing of the threads and read the value of refractive index. Determine percent sugar from the table.

If the determination has been carried out at a temperature other than 20°C ± 0.50C the following corrections are required.

(a) For the scale indicating refractive index apply the formula

$n^{20}D = n^{t}D + 0.00045\ (t - 20)$

Where,

$n^{20}D$ is the refractive index at 20°C;

$n^{t}D$ is the refractive index at the temperature of measurement;

t D is the temperature of measurement, in degrees Celsius.

(b) For the scale indicating percentage by mass or sucrose correct the result according to the standard Table.

Self-Check – 2	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write short answer questions for the following questions

1. What is the device name which measures total soluble solid or sugar in a product?(2pts)
2. What is the percentage of total soluble solid in distilled water? (2pts)
3. Write the jam and jelly sample preparation way for total soluble solid? (2pts)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Optical glass is relatively soft and damage can easily occur to prism surfaces. (2pts)

2. A prism is susceptible to alkalis and acids if left in contact for any length of time. (2pts)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Operation Sheet 5– Determination of total soluble solids

Objective: To determine the total soluble solids in fresh and processed fruit and vegetable products.

List of Materials needed:

- Hand Refractometer
- Abbe-Refractometer

Procedure for estimation of total solubule solid

1. Calibrate the refractometer with a drop of distilled water; adjust the scale to 0 %
2. Wipe the prism with a cotton swab.
3. i) Cut a piece of fruit and squeeze a drop of juice on the prism of the refractometer.

ii) Place a drop of juice/squash/syrup on the prism.

iii) Place small quantity of jam/jelly in muslin cloth and squeeze and place on the prism.

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 5: Determination of Total Soluble Solids

Information Sheet 3- Recording data

3.1 Recording data

The skill of recording data involves the documenting of data and observations in a variety of forms in order to preserve it for later use.

The general purpose of data recording is to set in writing and assure the preservation of the data collected in the course of field or laboratory studies. The experimental design of each study determines the types of data to be collected in terms of the objectives and resources available for the study.

The sum total of all readings are averaged (rounded to one decimal place) to give a mean figure.
In a second step the sum total of these readings should be averaged (round to one decimal place) to give a mean figure.

Self-Check – 3	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write short answer for the following questions

1. List the importance of recording data?(3pts)
2. Write the skill of data recording? (3pts)

Note: **Satisfactory rating above – 3.5 points** **Unsatisfactory - below 3.5**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 4- Performing calculations on data

4.1 Performing calculations on data

(a) Refractometer with refractive index scale

The percentage mass of sucrose corresponding to the value of refractive index corrected for temperature if necessary. In the case of liquid or semi thick products the soluble solid content is equal to the number found. If the determination has been carried out on a diluted sample the soluble solid content is equal to

$$P \times m1/m0$$

Where,

P is the percentage by mass of soluble solids in the diluted solution m0 is the mass, in gm of the sample before dilution m1 is the mass in gm of the sample after dilution.

Take the result as the arithmetic mean of two determinations. Express the result to one decimal place.

(b) Refractometer with sugar scale:

In the case of liquid or semi thick products the soluble solid content, as a percentage by mass of the sucrose is equal to the value read, corrected for temperature if necessary. If the determination has been made on a diluted solution calculate the soluble solids as shown above.

Take the result as the arithmetic mean of two determinations.

(Ref: - IS 13815: 1993 / ISO 2173: 1978 Fruit and Vegetable Products Determination of Soluble solid Content - Refractometer method)

Self-Check – 4	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Calculate the refractive index of fruit samples? (5pts)

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 5- Identifying and reporting out of specification result

4.1 Identifying and reporting out of specification result

Out-of-Specification (OOS) means that the test results for your sample do not meet the accepted established criteria. These criteria may be set by either an official compendia, by your organization, or by the testing laboratory.

In the case that your sample is considered an OOS, an investigation must be conducted. Unfortunately, the final report will be delayed and there may be a chance that the batch you were waiting to release will need to be rejected. However, you would much rather ensure the problem is identified, resolved, and learned from, rather than having it reoccur and cause greater consequences in future.

a. The investigation

Now that your sample has been labeled as OOS, an investigation is initiated to attempt to determine the cause. Every testing facility has its own system of handling OOS results.

Essentially, the investigation is structured into two parts: Phase I and Phase II, the purpose being to determine if the OOS result is due to a laboratory error or to a compounding or production error.

Phase I – Laboratory Investigation: In the first phase of the OOS investigation the laboratory will assess the initial data and determine if it was accurate. Did the analyst who tested the sample make any errors in the testing process? Were there any malfunctions with the testing instruments? Basically, this part of the investigation serves

to eliminate laboratory, equipment, and analyst error from the list of potential root causes of the OOS result.

1. If the laboratory determines that a laboratory error may have occurred, your sample may be re-tested.
    - If your sample is re-tested, a different analyst will perform the new test in order to rule out analyst error
    - If the laboratory investigation identifies a source of laboratory error in the initial test, the initial test results are invalidated, and the retest results are reported
2. If no clear laboratory error is identified, re-testing will not be performed.
3. If no testing error is found from the lab, and test results appear to be accurate, we move on to the second phase of the investigation.

Phase II – Full-Scale Investigation at Compounding Facility: The goal of Phase II of an OOS investigation is to identify the root cause of the OOS results so that proper corrective and preventive action can be taken. Within this phase, a review of the production may occur. Was there an inadequate amount of raw material used? Was there some sort of variation during the manufacturing process? Was the product formulation lacking robustness?

As mentioned before, every testing facility will have its own system for handling an OOS result. You will hear different variations of “Phase I and Phase II.” In the FDA guidance, Phase I is the laboratory investigation, and Phase II is the full-scale investigation at the compounding facility. Phase I involves reviewing the test results and data to identify any laboratory errors. If there are none, we can presume the results are valid and the client has the option to investigate on their site.

If laboratory errors are found, initiates a Phase II investigation, which also typically involves re-testing of the sample.

Self-Check – 5	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write short answer questions for the following questions

1. What is Out-of-Specification (OOS) result? (3pnts)
2. Write the phase I and phase II investigation way of Out-of-Specification (OOS) result? (3pnts)

Note: **Satisfactory rating above – 3.5 points** **Unsatisfactory - below 3.5**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 6-Shutting down equipment

6.1 Shutting down equipment

An equipment item is normally shut down manually when it is no longer required for duty or during inspection or maintenance. A shutdown can also occur in an emergency when:

- An emergency shutdown button is pressed
- A trip is activated by an automatic shutdown system.

When an item of equipment is to be manually shut down, the type of shutdown must be selected which will cause:

- Minimum disruption to test
- Minimum risk of damage to equipment.

The type of shutdown selected could be:

- Item shutdown
- Maintenance shutdown
- Unit shutdown
- Operations or total shutdown
- Emergency shutdown.

Item shutdown: An item shutdown will shut down only the equipment item, without shutting down the entire process or plant.

In some cases, two equipment items are connected in parallel to prevent the need for a process shutdown:

- If one of the equipment items is on duty while the other is on standby, one of the equipment items can be isolated and shut down without effecting production
- If both equipment items are on duty, isolating and shutting down one equipment item will reduce but not stop production.

Maintenance shutdown: A maintenance shutdown will consist of shutting down, then fully isolating, draining and purging an equipment item to make it safe for maintenance work.

Unit shut down: A unit shutdown will shut down only the process unit in a plant, but will not shutdown the entire plant. Many units will feed to storage tanks so that downstream processes can take their feed from the storage and continue to operate when another unit is offline.

Total shutdown: A total shutdown will shut down an entire plant.

Emergency shutdown: An emergency shutdown due to fire, major spills or gas release, will shut down an equipment item as quickly as possible, then depressurize and drain equipment and lines to leave them in the safest possible condition. Emergency shutdowns can create extra wear and tear on machinery, as the shutdown time is shorter than for a normal shutdown.

Self-Check – 6	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write short answer for the following question

1. Define the following shut down types ?(8pts)
    a. Item shutdown
    b. Maintenance shutdown
    c. Emergency shutdown
    d. Operation shutdown

Note: **Satisfactory rating above– 4 points Unsatisfactory - below 4points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

LG #49	LO #5-Maintain a safe work environment

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Establishing safe work practices and using personal protective equipment
- Minimizing the generation of wastes and environmental impacts.
- Ensuring safe disposal of laboratory and hazardous wastes.
- Cleaning, caring and storing of equipment and reagents as required

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Establish safe work practices and using personal protective equipment
- Minimize the generation of wastes and environmental impacts.
- Ensure safe disposal of laboratory and hazardous wastes.
- Clean, care and store of equipment and reagents as required

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,

9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Establishing safe work practices and using personal protective equipment

5.1 Establishing safe work practices and using personal protective equipment

Safe work practices are generally written methods outlining how to perform a task with minimum risk to people, equipment, materials, environment, and processes.

Safe work practices should be developed as a result of completing a job safety analysis (JSA) or a hazard risk assessment (HRA) and should closely reflect the activities most common in the company's type.

All safe work practices should be kept in a location central to the work being performed and readily available to the workforce. Some safe work practices will require specific job procedures, which clearly set out in a chronological order each step in a process.

5.1.1 Safe work procedures

A safe work procedure (SWP) is an integral part of the risk management process as it outlines the hazards, risks and associated controls measures to be applied to ensure the task/activity is conducted in a way to reduce the risk of injury. Safe work procedures are a series of specific steps that guide a worker through a task from start to finish in a chronological order. Safe job procedures are designed to reduce the risk by minimizing potential exposure.

A safe work procedure (SWP), which may also be referred to as a job safety analysis (JSA), job hazard analysis (JHA) or safe work method statement (SWMS), is a procedure which describes how work is to be carried out in a safe and standardized

process. SWPs outlines the hazards, risks and associated controls measures to be applied to ensure the task/activity is conducted in a way to reduce the risk of injury.

Development: Safe job procedures are usually developed by management and workers as a result of a JSA/HRA, accident or incident investigation, and/or as a supplement to a safe work practice.

Safe work procedures should be included in the company's "Worker Orientation" program. All workers should be aware of the fact that safe job procedures have been established, are in effect, are written down, and must be followed.

Delivery: Safe work procedures should be included in the company's "Worker Orientation" program. All workers should be aware of the fact that safe job procedures have been established, are in effect, are written down, and must be followed.

Formatting SWPs

There is no single required format for SWPs. However, SWPs should include the following information:

1. Name or description of the work task
2. Management approval
3. Date of creation
4. Date of review or revision
5. Any hazards that may cause harm to a worker
6. Equipment / devices, personal protective equipment (PPE), or other considerations necessary to perform the task safely
7. Required training and / or relevant documentation needed to perform the task
8. Common signs and symptoms of a musculoskeletal injury (MSI), if MSI risk is present

   Note: Injuries affecting the muscles, ligaments, and joints (MSI) account for a large percentage of workplace injuries
9. A statement indicating that workers must be trained on the SWPs, and employers must ensure that workers follow the procedures

10.Steps to perform the task safely

SWPs provide information to assist workers to perform tasks safely. They include:

- Describing how the work is carried out
- Identifying the work activities assessed as having safety or environmental risks
- Stating what the safety and environmental risks are
- Describing the control measures that will be applied to the work activities
- Describing how measures will be implemented to undertake the work in a safe and
- Environmentally sound manner
- Outlines the legislation, standards and codes to be complied with and
- Describing the equipment used in the work, the qualifications of the personnel undertaking the work and the training required to undertake the work in a safe manner.

5.1.2 Using personal protective equipment

Personal protective equipment (PPE) is protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.

All personal protective equipment should be safely designed and constructed, and should be maintained in a clean and reliable fashion. It should fit comfortably, encouraging worker use. If the personal protective equipment does not fit properly, it

can make the difference between being safely covered or dangerously exposed. When engineering, work practice, and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use. Employers are also required to train each worker required to use personal protective equipment to know:

- When it is necessary
- What kind is necessary
- How to properly put it on, adjust, wear and take it off
- The limitations of the equipment
- Proper care, maintenance, useful life, and disposal of the equipment

If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance, and use of PPE; the training of employees; and monitoring of the program to ensure its ongoing effectiveness.

Self-Check – 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Safe work practices are generally written methods outlining how to perform a task with minimum risk to ____?(1.5pts)
    a. People
    b. Equipment and materials,
    c. Environment and processes.
    d. All

2. _____are a series of specific steps that guide a worker through a task from start to finish in a chronological order. (2 pnts)
    a. Job hazard analysis
    b. Experimental procedure
    c. Safe work procedures
    d. All

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Safe job procedures are usually developed by management and workers (2pts)
2. There is uniform single required format for safety work procedure? (2pts)

Note: **Satisfactory rating above - 4 points** **Unsatisfactory - below 4**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 2- Minimizing the generation of wastes and environmental impacts

2.1 Minimizing the generation of wastes and environmental impacts.

Waste minimization is a set of processes and practices intended to reduce the amount of waste produced. By reducing or eliminating the generation of harmful and persistent wastes, waste minimization supports efforts to promote a more sustainable society.

Until recently, it might not have paid much attention to the waste your organization produces. Many organizations are content simply to establish a system for removing trash. Increasingly, greater attention is being paid to waste management, and pro-active organizations are seeing the benefits of establishing a waste reduction program.

- *Save Money* - increasing recycling can cut your disposal costs and improve your bottom line.
- Knowledge is power - By understanding the amount and types of wastes your organization produces, you're better positioned to find ways to reduce hauling costs and negotiate for waste and recycling services that actually fit your needs.
- Streamline reporting and information sharing - Tracking your waste management activities in one platform and using a standard set of metrics, makes it easier to share and report information with stakeholders.
- Enhance sustainability - Managing waste, water, and energy more efficiently are core components of sustainability. Improving your organization's sustainability can boost your corporate image, attract quality tenants to your properties and positively engage employees.
- Reduce greenhouse gas emissions - Waste prevention and recycling offer significant potential for reducing greenhouse gas emissions.

- Conserve resources - Reuse and recycling conserves natural resources including trees, metals and water.

1. Track waste

Materials and wastes offer an often overlooked opportunity to improve an organization's sustainability, prevent greenhouse gas emissions and reduce costs. The first step is tracking the amount of wastes your organization generates, for as the old adage goes, "you can't manage what you don't measure." Tracking your waste and recycling provides the key foundation for a successful waste reduction program.

2. Team Up and aim high

Getting others involved and following an action plan helps ensure the success of your waste reduction program.

Team Up

- Leverage an existing team. Consider adding a focus on waste reduction to your organization's existing green team. This may mean bringing in additional team members with a focus on waste and recycling.
- Create a new team. If your organization doesn't have a green team, consider creating a group responsible for planning, designing and implementing waste reduction activities.

Set Goals

Having clear measurable goals gives teams a shared understanding of what they're working to accomplish and how they're progressing. Look at your tracking data to establish a benchmark and inform your goal setting. Look at your tracking data to establish a benchmark and inform your goal setting. Setting goals helps you prioritize

activities for preventing waste and expanding recycling programs. Then track progress towards the goals using your benchmark.

To identify specific activities that may most effectively lead you to reaching your goals, conduct a waste assessment. The information collected will help you pinpoint the waste reduction areas on which to focus.

3. Assess the program

Tracking the amount of recyclables and wastes hauled from your building gives you an understanding of how your waste management program is performing – data on the amount of waste produced and recycling rate. However, to gain insights on how to improve, a waste assessment is critical. A waste assessment will provide you with important data to discover opportunities for waste reduction.

A waste assessment or audit is a systematic review of your building and its operations to identify the quantity and composition of materials in your waste stream. Knowing what's in waste enables you to effectively tailor your waste reduction program.

4. Using the waste assessment results

a) Focus first on waste prevention, which will help eliminate waste at the source, saving natural resources and energy and cutting costs.
b) Evaluate recycling and composting options to manage waste that cannot be prevented.
c) Implement waste reduction activities best suited for your organization. You may want to start off with one or two clear activities to get others engaged. Then roll out other initiatives as some of the early waste prevention and recycling behaviors become a habit.

5. Improve your practices

Waste prevention and recycling programs can be significantly improved by actively engaging and educating employees and identifying markets for your recovered materials.

Waste Prevention: The most effective way to reduce your organization's waste is to generate less in the first place. Waste prevention offers the greatest environmental benefits and cost savings.

- **Reduce:** Organizations can modify their current practices to reduce the amounts of waste generated by changing the design, manufacture, purchase, or use of materials or products. For example, your organization could encourage employees to only print what they need and ensure that printer settings are defaulted to print double sided to save paper.
- **Reuse:** Reuse of products and packaging prolongs the useful life of these materials, thus delaying final disposal or recycling. Reuse is the repair, refurbishing, washing, or just simple recovery of worn or used products, appliances, furniture and building materials. For example, by encouraging occupants to use reusable coffee mugs rather than single-use, disposable cups, you don't have to manage the disposal of a bunch of coffee cups.
- **Donate:** Organizations can donate products or materials to others who need and can use the items. For example, restaurants, hotels and cafeterias promptly distribute perishable and prepared foods to hungry people in their communities. Many local food banks will pick up food donations free of charge, saving you storage and disposal costs.

Recycling: Recycling saves energy, helps keep materials out of landfills and incinerators, and provides raw materials for the production of new products. When waste cannot be prevented, recycling is the next best option. Recycling is more than extending the life of landfills. It is about making the best use of the resources we have

available and conserving those resources for future generations. It is about conserving water, energy, land and raw materials.

Composting is recycling for organics. It converts organic materials, like food waste and yard trimmings, into a valuable soil amendment that contributes to soil health and keeps organic wastes out of landfills.

Self-Check – 2	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. _____is a set of processes and practices intended to reduce the amount of waste produced. (2 pts)
    a. Loss minimization
    b. Waste minimization
    c. Risk minimization
    d. All
2. What are the advantage of waste minimization? (2pts)
    a. Save money
    b. Reduces greenhouse gas emissions
    c. Conserve resources'
    d. All

Test II: Write short answer for the following questions

1. What is track wasting? (3pts)
2. What is waste assessment or adult? (3pts)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 3- Ensuring safe disposal of laboratory and hazardous wastes

3.1 Ensuring safe disposal of laboratory and hazardous wastes

Hazardous waste is waste that is dangerous or potentially harmful to our health or the environment. Waste can still be characteristically hazardous if it exhibits any one of the following characteristics:

- Ignitability
- Corrosivity
- Reactivity; or
- Toxicity.

Ignitability:

- Flammable Liquids – Flashpoint <140ºF (e.g., alcohols, acetone, ethyl acetate, mineral spirits, gasoline)
- Oxidizers (e.g., nitrates, perchlorates, bromates, permanganates, peroxides, iodates)
- Organic Peroxides (e.g., benzoyl peroxide, cumene hydroperoxide, methyl ethyl ketone peroxide)

Corrosivity:

Aqueous liquids with a pH < 2 or > 12.5 or other liquids capable of corroding steel at a rate of > 6.35 mm (0.250 inches) per year at a test temperature of 55ºF.

- Inorganic Acids (e.g., hydrochloric acid, sulfuric acid, nitric acid, perchloric acid, phosphoric acid)
- Organic Acids – (e.g., formic acid, lactic acid)
- Bases – (e.g., hydroxide solutions, amines)

Reactivity:

Materials which can react violently or create toxic fumes:

- Sulfides and cyanides
- Peroxide formers (e.g., ethers, potassium amide, sodium amide, vinyl acetate, tetrahydrofuran)

- Water Reactive Materials (e.g., sodium, potassium, lithium, calcium carbide)
- Multi-nitrated Compounds (e.g., picric acid, nitrosoguanidine, trinitroaniline)
- Perchlorate crystal formers (e.g., perchloric acids)
- Compounds that may undergo vigorous polymerization (e.g., acrylic acid, vinyl acetate, methyl acrylate)

Toxicity:

A waste which, when using the toxicity characteristic leaching procedure (TCLP), leaches any number of metallic, organic, or pesticide constituents in concentrations greater than specified in the regulation. Examples for these constituents include arsenic, barium, cadmium, chloroform, chromium, m-cresol, mercury, selenium, and silver.

Disposal of hazardous materials into sinks, drains, commodes, or other sewage disposal channels is strictly prohibited.

Storage:

All chemical wastes shall be stored using proper chemical segregation practices to avoid intermixing of incompatible materials.

Labeling:

All hazardous waste containers shall be properly labeled with the words "Hazardous Waste", a description of the waste contained in the container, the hazards associated with the waste, and the location where the material was generated. If bottles are reused, remove the old chemical name and hazards completely and indicate the type of chemical waste on the container without abbreviations. Hazardous waste containers not labeled in accordance with this policy shall not be removed from the area until such label is affixed to the container .

Empty Chemical Containers:

Chemical containers that have been emptied of their contents by normal methods are not regulated as hazardous waste. The container shall be triple rinsed with water or other suitable solvent and air-dried to ensure that it is free of liquid or other visible chemical residue before disposal.

Glass Containers:

Empty, intact, unbroken glass chemical containers that meet the above requirements for empty containers may be disposed of as regular laboratory waste in the general waste stream.

Metal Containers:

Metal containers must be triple-rinsed with water or other suitable solvent and air-dried. If the container is free of hazardous chemical residues, remove or deface any hazard markings or labels, it may then be placed in the regular laboratory trash or recycling receptacles.

Secondary Containers:

Containers that were used as over pack for the primary chemical container may be placed in regular trash or recyclable trash. Any packing materials, such as vermiculite, perlite, clay, Styrofoam, etc., may be placed in the regular trash unless it was contaminated with the chemical as a result of container breakage or leak. Packing materials contaminated with hazardous materials shall be disposed of as hazardous waste.

Hazardous Waste Minimization:

It is the responsibility of all employees to reduce the amount of chemicals requiring disposal. The following guidelines shall be followed:

Supported by Principal Investigators, Lab Personnel, Laboratory Safety Specialists, and the Office of Research Safety:

- Only purchase what is needed for a three to six month period;
- If practical, use non-hazardous materials;
- Segregate non-hazardous waste materials from hazardous wastes;
- Use sound chemical hygiene practices to avoid spills while handling chemicals and keep all containers closed when not actively adding/removing chemicals;
- If the chemical is still useful, recycle the waste instead of disposing of it by finding an associate that could use the remainder of the chemical;
- If the material can be safely neutralized at the point of use, then do so; and
- Properly label waste to communicate hazards, which helps the disposal vendor more accurately define/manage waste streams.

Process level impacts:

Supported by Environmental and Health and Safety and the hazardous waste disposal vendor:

- Stress the importance of properly labeling laboratory waste at the point of generation; and
- The contractor providing disposal services shall segregate chemical waste from non-hazardous waste.

Laboratory waste disposal procedure summary

Make sure the materials placed in the municipal waste are suitable for this type of disposal, especially:

- Do not place any liquids in the municipal waste.
- Do not dispose of chemical waste, including stock containers with unused product, in the municipal waste.

- Empty or rinsed containers must be free of any hazardous residue and be marked "empty."
- All sharps must be in an appropriate, puncture-resistant container to prevent injuries.
- If a material can be mistaken as a hazardous, radioactive, or biological waste, but is not, it must be identified as non-hazardous.

Self-Check – 3	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Write Short answer for the following questions

1. What are the characteristics of hazardous waste exhibits? (2pts)
2. What are the possible waste hazards in work environment? (3pts)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Hazardous waste minimization is the responsibility of all employees (2pts)

Note: **Satisfactory rating -3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 4- Cleaning, caring and storing of equipment and reagents as required

4.1 Cleaning, caring and storing of equipment and reagents as required

The care and maintenance of laboratory equipment is an integral part of quality assurance in the lab. Well-maintained lab equipment ensures that data is consistent and reliable, which in turn impacts the productivity and integrity of the work produced. Furthermore, since laboratory equipment generally takes up a big cut of the budget, good maintenance contributes to cost-cutting measures, by lowering the chances of premature repurchases and replacement. In addition, routine maintenance ensures that lab equipment is safe for use through highlighting and repair of faulty equipment and equipment parts.

Various procedures and routines will ensure that your laboratory equipment is well-maintained and cared for, this includes;

- Developing standard operating procedures for all lab equipment.
- Preparing documentation on each specific equipment, outlining the repairs and maintenance undertaken.
- Outlining a preventive maintenance program for each equipment.
- Training both technical and managerial staff on proper use and care of lab equipment.

Standard operating procedures (SOPs) are a must for all complex lab equipment. This ensures that the correct use and maintenance of the equipment is integrated within routine work. Detailed instructions of equipment use should be sourced from the manufacturer's operator manual. The SOP can be written by the lab manager, an equipment officer, or staff that frequently works with the specific equipment. The SOP should also be easily accessible at the workbench.

A proper SOP should contain the following;

- The title and description of the content/scope of the SOP.
- Definitions of all abbreviations used.
- An outline of the personnel responsible for the equipment or involved in its use, including their qualifications and training requirements.
- Detailed instructions for the use of equipment, containing the do's and don'ts of operating them.
- A description of quality control and maintenance.
- Instructions on waste management, where applicable.
- Reference documents, such as manuals used to prepare SOP and manufacturer's websites, should be outlined for use when further information is required.

General care tips for lab equipment

1. Cleaning

Regular cleaning of lab equipment ensures that it is ready for use when needed, that stubborn stains/substances do not get a firm hold, and that experiments are not contaminated by impurities carried over from previous experiments.

Make certain that;

- The equipment is always cleaned before and after each use.
- Cleaning reagents and cleaning aids used are specific for laboratory equipment care.
- In addition to cleaning lab equipment before and after each use, a schedule is required for more in-depth cleaning. This might involve dissembling certain machines to clean hard-to-reach parts.
- Always follow instructions from the manufacturer on cleaning policy. Certain parts of the equipment might require very specific solvents, cleaning materials, or drying procedure.

2. Calibration

Calibration involves comparing the measurements of an equipment against the standard unit of measure, for the purpose of verifying its accuracy and making necessary adjustments. Regular calibration of laboratory equipment should be done because over time, biases develop in relation to the standard unit of measure. This guards against invalid data and ensures safety during experimentation. An independent specialist, that can provide calibration certificates where necessary, should be engaged in the process.
Calibration should be done when;

- The recommended time by the manufacturer elapses.
- The equipment is hit by a force, dropped on the ground, or involved in any accident or an event of safety concern.
- There are unusual patterns or sounds while the equipment is in use.
- Measurements obtained are questionable.
- Highly critical measurements, where data accuracy is of utmost importance, are to be carried out.

Repairs and Refurbishments

Lab equipment is generally costly and repairs and refurbishment prolong the lifespan of equipment, saving the lab the expense of new purchases.
The following are points to consider;

- Repair and/or refurbish faulty or worn out lab equipment without any delay. Faulty machines may stop working suddenly in the middle of an experiment leading to loses and they can also be a source of safety concerns.
- Minor repairs can be done by a dedicated staff, while major repairs should be directed to specialist with knowledge on the specific machine or equipment.
- Refurbish old equipment to give them a new lease of life by cleaning thoroughly, polishing where necessary, lubricating movable parts, and replacing small worn out bits.

Quality Replacement

Equipment that cannot be repaired or refurbished should be replaced. It is advisable to buy equipment from well-known sources that can guarantee quality and offer technical support. High-quality lab equipment is easier to maintain and its durability translates to reduced costs in the long term. Non-faulty equipment that is too old should also be replaced, while some wear and tear might not be noticeable during its operation, outdated machines are not reliable and technical support in terms of servicing and acquisition of spare parts may be limited.

The care and maintenance of laboratory equipment should be a routine and embedded within the standard operating procedure of the lab. This will ensure that the life span of the equipment is prolonged and data collected within the laboratory is reliable.

Storing Reagents

A reagent in chemical science is a “substance or compound that is added to a system in order to bring a chemical reaction or is added to check whether a reaction is occurred or not.” Such a reaction is used to confirm the detection of the presence of another substance. Chemical reagents are classified according to their hazardous nature, such as being flammable, harmful, toxic, irritant, corrosive, and hazardous when decomposed during storage or dangerous for the environment. Many reagents consist of a combination of such hazards

Most chemical agents have some toxicity and risk. To chemical agents to strengthen management, to ensure not only the quality of analysis needs, but also to ensure that people's lives and property safety.

Chemicals management should be based on different characteristics of toxic agents, flammable, corrosive and deliquescent, etc., in different ways properly managed. In many ways reagents is not store and handle their reagents properly. This can lead to reagents that do not work as expected, and this can have a huge impact on your experimental results.

Always check the data sheet, follow the manufacturer's storage recommendations and use some common-sense. Also check how much reagent is left in the bottle before you start out on your mammoth experiment. You don't want to run out!!

Remember that although using the dregs of your reagents may save some money, if it means not getting optimal results, repeating the whole experiment will end up costing you so much more.

Storage of reagents and supplies is a very important part of inventory control. Good practices to keep in mind are: Keep the storeroom clean, organized and locked to protect the inventory. Make sure storage areas are well ventilated and protected from direct sunlight

Chemicals must be stored at an appropriate temperature and humidity level. Chemicals should never be stored in direct sunlight.

Reagents should not be stored in moist or damp areas and should be kept dry and moisture free at all times. Powders, crystals and acids are very stable and have an excellent shelf life if kept dry and aren't exposed to sunlight.

Chemicals should be stored no higher than eye level and never on the top shelf of a storage unit. Do not overcrowd shelves. Each shelf should have an anti-roll lip. Avoid storing chemicals on the floor (even temporarily) or extending into traffic aisles.

Store Reagents

- **With a parafilmed cap:**
  - ✓ Reagents that might suffer negative effects from the laboratory atmosphere.
- **Covered with aluminum foil:**
  - ✓ Reagents that are light-sensitive.
- **In a plastic bag:**
  - ✓ Reagents that smells awful. You might even want to double-bag.

- **On the shelf:** Reagents that are
  - ✓ thermally stable
  - ✓ not volatile
  - ✓ have low or no moisture or oxygen sensitivity
- **In the desiccator:** Reagents that are
  - ✓ thermally stable
  - ✓ not volatile.
  - ✓ have some moisture or oxygen sensitivity that could lead to decomposition
- **In the glove box:** Reagents that are
  - ✓ Thermally stable
  - ✓ Not volatile.
  - ✓ Degrade extensively when exposed to the laboratory atmosphere for an extended period of time.
- **In the refrigerator:** Reagents that
  - ✓ are heat-sensitive
  - ✓ decompose over days or weeks at room temperature
  - ✓ have a label that says "Refrigerate!" or "Store at > +4 ° C"
  - ✓ are volatile
  - ✓ are highly reactive
- **In the freezer:** Reagents that
  - ✓ have a label that says "Freeze"
  - ✓ are very volatile and stay liquid in the freezer

Very few reagents really need to be in the freezer. If you really want to put a reagent at low temperature, always consider whether the contents of your bottle might freeze and break the bottle.

Storage of laboratory chemicals/reagents

- Store the chemical/reagents as per the manufacturer instruction on the container considering safety precautions.

- If the manufacturer does not mention any recommended condition, store the chemicals/reagents in a designated reagent/ chemical storage room controlled at 25 ^{o}c ± 2 ^{o}c
- In the case of general reagent, where specific storage condition is not required, shall be stored at ambient temperature
- If the recommended storage condition of any laboratory reagent is below 15 ^{o}c , it shall be stored in the refrigerator.
- If the case where recommended storage condition of any laboratory reagent is below 0 ^{o}c , store in deep freezer.
- Handle chemical / reagents with proper precautions as per its safety data sheet.
- Acid corrosive chemicals bottles/ containers shall be opened after wearing proper PPE

Self-Check –4	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer among the given alternative

1. Standard operation procedure should contain ____? (2pts)
    a. The title and description of the content/scope of the SOP.
    b. Definitions of all abbreviations used.
    c. Detailed instructions for the use of equipment, containing the do's and don'ts of operating them.
    d. All

Test II: Write short answer for the following questions

1. The care and maintenance of laboratory equipment is an integral part of quality assurance in the lab. (3 pts)
2. Standard operating procedures (SOPs) are a must for all complex lab equipment. (3 pts)

Note: **Satisfactory rating above - 4 points** **Unsatisfactory - below 4**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

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