Fruit and Vegetable Processing -Level-II

Based on May 2019, Version 2 Occupational standards

Module Title: - Performing Juice Extraction Process

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Instruction sheet

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

- Confirming, blending and preparing extraction materials
- Identifying and following workplace documentation
- Making available requiring equipment facilities and personnel
- Carrying out line clearance procedures
- Following procedures to eliminate or control the risk of cross-contamination
- Loading material and adding solvents

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:

- Confirm, blend and prepare extraction materials
- Identify and follow workplace documentation
- Make available requiring equipment facilities
- Carry out line clearance procedures
- Follow procedures to eliminate or control the risk of cross-contamination
- Load material and add solvents

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, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Confirming, blending and preparing extraction materials

1.1. Introduction

Juice extraction the elimination of the juice from fibrous, solid particles—is a basic technological step of fruit juice production. The fruit has to be prepared prior to juice extraction, which is then followed by juice clarification. Subsequently, the finished drink is packed and preserved.

Best Fruits for Juicing Everyone knows that fruit makes great juice. With every bite you can taste the sweet, natural juice that's delicious and loaded with vitamins and minerals. While you can conceivably juice nearly any fruit, there are a few that give you maximum amount of juice and taste great. Juicing also leaves the extra stuff like seeds and skin behind, so you don't have to waste time peeling your fruit before getting the juice. Try these fruits in your juicer:

- Apples
- Oranges
- Papaya
- Pineapples
- Pomegranate
- Grapefruit
- Grapes
- Melon
- Lemons
- Kiwi fruit
- Limes

Best Fruits for Blending Not all fruits are as loaded with juice as apples or oranges, but that doesn't mean that they aren't worth eating. These fruits still have plenty of beneficial vitamins and minerals, not to mention other dietary aspects such as fiber. Your blender will let you drink these fruits as a smoothie along with some extra liquid like water, milk, juice or yogurt. Plus, your blender leaves in the fiber and other nutrients that a juicer leaves out. Here are a few fruits that are better in you blender than the juicer:

- Bananas
- Mango
- Berries
- Avocado
- Peaches.

Best Fruits vegetable for juicing: Just like fruit, you can juice vegetables too. This is the perfect solution for anyone who struggles to get his or her daily dose of vegetables. Simply throw your favorite vegetable in your juicer and drink it down. You can even mix you vegetable juice with other veggies or fruits for a tasty juice cocktail. Try one of these vegetables in your juicer for more vitamins and minerals:

- Beets
- Broccoli
- Carrots
- Cucumber
- Radish
- Leafy greens (kale, chard, spinach)
- Wheat grass
- Celery
- Cabbage
- Tomatoes
- Herbs

Best vegetable for blending: Many of the vegetables you use in your juicer can actually work well in your blender as well. While the juicer gives you a more concentrated dose of vitamins and nutrients, the blender lets you get the fiber or roughage found in veggies which can be important for digestion. Here are a few of the best vegetables to mix in your blender for a smoothie or puree:

- Squash
- Kale
- Spinach
- Herbs.

Self-check #1	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (8 points)

1. List out best fruit for juicing?
2. Writ best fruit and vegetable for blending?

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

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

Information Sheet 2 - Identifying and following workplace documentation

2.1 Introduction

Working in the food industry implies having complete and transparent product documentation from all your suppliers. Generally, this product documentation gathers all documents relative to the delivered goods, from the product to the packaging related information's such as origin certificates or raw material quality declaration**.** All those documents will be necessary for the merchandise traffic and for the downstream documentation of your products. Complete and up-to-date product documentation facilitates an efficient supplier's management and helps in being audit ready at any time. To help you keeping an overview of your product documentation, we have gathered here the five most requested product documents in the food industry.

The Workplace Documents assessment measures skills that individuals use when they read real workplace documents and use that information to make job-related decisions and solve problems. The documents include messages, emails, letters, directions, signs, bulletins, policies, websites, contracts, and regulations.

2.2. Documentation of Food processing:

There are six simple steps to follow that will help you organize your company's documentation processes and thereby better prepare your facility to pass an audit. Each step can be catered according to you company profile, but the basis of this plan works across the industry. Furthermore, the following process has been recognized by The Global Food Safety Initiative (GFSI):Food Safety Systems Manual: The food safety manual is a collection of documents which contains all validated and authorized written policies; procedures; programs; specifications; work instruction; register forms; and other documents that are necessary to consistently achieve the production of safe food.

Policies: A policy is a statement of principles and commitments that establishes the course of actions and acceptable methods. They are in place to guide senior

management decision making to achieve company goals, both in the present and the future. The food safety policy must come from, and be signed, by senior management, who is also responsible for allocating appropriate resources in order to enforce the company's policies.

Specifications: Specifications are an exact statement of the particular characteristics or attributes required to comply with applicable regulations, as well as the customers' needs and the company's performance standards regarding a good; method; material; process; work; or, system. Specifications must be written in a fashion that allows them to be measured and evaluated to determine the degree of compliance by the manufacturer.

Procedure: Usually, this document describes routine activities that require different functions, from the simple to the complex, and possibly involves several participating parties to meet its accomplishment. A procedure consists of a series of steps that must be followed in a regular, definite sequence in order to achieve consistent results every time. The following elements are usually included in written procedures: title of the procedure; objective; scope of work; definitions; references; responsible parties; materials and equipment; activities description; and, register.

Work Instructions or Standard Operating Procedures (SOP): SOP's are fixed, step-by-step actions, with definite start and end points. These instructions must be followed in the same order to perform the specific tasks correctly, thereby assuring consistent results every time.

Product specification:

The product specification includes information about the ingredients/materials and their characteristics contained in the delivered food products. This information are most of the time based on the purchase conditions and includes data such as the product description, origin, sensory properties, materials (including allergens) or certifications.

Forms and Registers: A form is a document designed to collect objective data generated from a process or activity. Once a form has been filled out, it becomes a register. Documents aid in a company's ability to organize itself, it's processes, and to

pass audits. The larger the firm, the greater becomes the need for documenting its systems. Note, there is no time like the present; pressure is on the food industry to develop GSFI approved standards; customers are savvy; and regulatory entities call for formalizing and documenting food safety management.

Standard forms

Ensure details are accurate.

Include relevant details, such as date, time and place of incident.

Fill in all required fields.

Follow the instructions on the form.

Store forms in the appropriate place.

Self-check#2	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (10 points)

1. What is documentation?
2. List out all six documentation steps?
3. Writ documentation standard forms?

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

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

Information Sheet 3 - Making requiring equipment, facilities and personnel

3.1. Extraction Equipment

In order to prepare fruits and vegetable juices at commercial level, several equipment's are needed. Some of the important equipment's required for processing of specific fruit and vegetables are discussed herein.

Kitchen Blenders: or bulk blending or thicker mixtures, a **countertop kitchen blender** will come in handy. While these have more parts to clean, they're also more versatile and have a larger capacity. Most come with variable speeds from chopping action to liquid puree, meaning you can add almost any ingredient and get a smooth blend from it.

Fig3.1 juice blender

Functions to Consider when using juice blender:

Not all blenders are made the same, and you may be wondering which features you need. For starters, if your blender has a metal container, make sure it's stainless steel. Always ensure your blender parts are dishwasher safe to keep them as clean as

possible. Speed control is useful, as well, especially if you need to start with a slow pulse to break up large chunks of ice or fruit. Consider capacity, too. If you want a quick individual serving, a single-serving blender is fine. However, if you prefer to blend in batches, you may need a larger kitchen blender.

Percolator: Percolators emit a robust aroma and a distinct gurgling sound while brewing. It is extremely convenient when making fruit you want to stay piping hot for large gatherings. Primula's percolator is made of durable aluminum and features a matching lid, lipped spout and stay-cool black plastic handle

Fig3.2 Percolator

Fruit Pulpier: Designed for extracting the pulp of most fruits vegetables such as mangoes, guavas, peaches, tomatoes, bananas, carrot, apples etc.

The Pulpier cum finisher is used for extraction of pulp by separating skin and fiber from fruits.

Fig3.3.Fruit juice Pulpier

Pome Fruit and Small Fruit Processing: Generally, most pome fruit (e.g. Apple, Pear, and Quince) and small stone fruit (e.g. Plum, Olive, Peach, Cherry) can be used for juice extraction. No peeling is needed. Small stone fruit such as apricots and plums might have to be destoned (pitted) depending on the grinding extraction equipment selection. Cherries, although containing a pit, may be pressed with the pit intact. Breakage of the pit will release Benz aldehyde, the familiar aroma of maraschino-type cherries.

Filter/ Sieve: Stainless steel big basin 28-40 cm filter water wash fruit vegetable wash basket drain rice Mesh Sifter Colander Strainer Sieve

Fig3.4 filter/ Sieve

Juice collection vessels or tanks tanks to the pump fresh juice can be transported for example to a pasteurizer or buffer tank. The pump is switched on and off automatically by means of a special fluid level sensor, after collecting the right amount of juice in the basin. The pump can also always be started manually by pressing the appropriate button.

Fig3.5 tanks

Fruit DE stoner: The destoning machine separates the stones (pits) from the fruit before processing. The pits are ejected separately from the mash. Our electric

destoning machine simplifies the job everywhere when large amounts of fruit need to be processed – reliably and fast!

Fig3.6 Fruit DE stoner

Hammer mills: these are devices used to crush the whole fruit in preparation for pressing. Hammer mills consist of heavy stainless steel bars spinning from a common axis under high-speed rotation. The fruit is disintegrated until it passes out through a screen of a specific size mounted in the bottom of the mill. With firm fruit, a small screen size should be used, and the mash will be of a finer particle size. Mash from firm fruit will press more easily, and the smaller particle size will allow greater yields.

Grating mills: These mills are used in small juice operations to produce uniformly sized fruit pieces. Fruit is fed to a rotating grating disk with fixed aperture, and the shredded fruit is discharged at the bottom. Fruit must be relatively firm with small seeds or pitted.

Stemmer/crushers: These crushers are used in grape juice processing to remove residual stems, leaves, and petioles from grapes and to perform the initial crush of the fruit. These units are designed around a perforated rotating drum, with holes 2.5 cm in diameter. While traversing the rotating drum, the grapes are caught by the perforated drum and knocked from the stems. Individual grapes are broken open or crushed in the

process and dropped through the drum. Stems, leaves, etc. continue on to the center of the drum and are discharged at the end for waste. Grapes are generally put through the crusher in order to gently express the juice and free up the flesh, yet still not break the seeds. Breakage of the seeds releases increased amounts of phenolics, adding to the astringency of the juice.

Turbo extractors: These are used for extraction of juice and puree from fruits and vegetables. The cold extractor unit has a feeding section with a variable speed screw and a cutting head; a softening section consisting of a stator and rotor (roto-pulse); and an extraction area equipped with a rotor with paddles and a perforated cylindrical screen that continuously turns the product by centrifugal force (Figure 13.1). The extractor can be adjusted by changing the feeding speed, the rotor speed, the gap between the rotor and the screen, and the screen size. The fruit can be protected from oxidation by the injection of nitrogen gas or antioxidant solution to the cutting area through built-in openings

Hot Break Process: in order to maximize juice yield and color-flavor extraction, a hot break process is often used. The most common use is in grape juice processing, but other fruits such as cherries, plums, and berries may also benefit. Increased interest in highly colored juices, rich in phenolic compounds with associated health benefits, is driving the development of better techniques to preserve the functional components while maximizing the extraction. Typically crushed fruit or mash passes through a large bore, tubular heat exchanger where it is heated to 50 to 60^{o}C. This stage, known as the *hot break process,* is designed to extract a large amount of color and assist in maximizing the yield. To the hot fruit, a pectolytic enzyme is added, and in case of red grape juice processing, Kraft (wood pulp) paper is also added prior to pressing to serve as a press aid.

Fruit and vegetable crusher: Suitable for crushing hard seedless fruits & vegetables such as pineapple, apple, tomato, carrots etc. before pulping or juice extraction.

Fig3.7 Fruit and vegetable crusher

Twin pluper Suitable: to deseed or deskin and extract pulp from fruits & vegetables like mango, litchi and tomato. It consists of two stages of pulping. First stage is for deseeding or deskinning. The pulp extracted from first stage goes into the second stage for refining. All contact parts are made of SS with optional covers in MS or SS.

Hammer crusher Suitable to crush seedless fruits & vegetables before pulping or juice extraction. Fitted with swing type hammer which ensures even granulating of crushed material.

Fig3.8 Hammer crusher

Pulveriser For Fresh Paste Extraction Suitable to make paste by pulverizing hard fruit and vegetables like ginger, garlic, onion, carrot, and tomato etc. Whole or cut pieces are fed into the hopper which pulverizes and grind the same at high rotation of the crushing head. Specially designed pulverizing head with removal sieve ensures adaptability to different fruits and vegetables. The pulverizes head is water jacketed and ensure high-end product quality as the pulverizing is kept low.

Helicoidally juice extractor: Suitable for continuous extraction of juices from fruits like pineapple, orange, apple and kiwi etc. Unique spiral design of the machine ensures high yield juice recovery without making it bitter.

Presses are the usual and traditional method of removing juice from fruit and vegetable materials. However, recently diffusion extraction, centrifugation, and specialized ultrafiltration techniques have been explored and have been exploited commercially to a limited extent. Yield efficiency diagrams that relate juice yields to mash feed rates provide a mechanism for comparing presses and other processes such as enzyme treatments or decanter centrifuges for efficiency under a stated set of circumstances. Diffusion extraction is capable of removing 90 to 94% of soluble solids from properly prepared apple slices, but the resulting juice is diluted with extraction water and is high in extracted tannins. Concentration is necessary to obtain juice solids equivalency, and the resulting juice has sour/astringent flavors that must be removed with tannin absorbents to provide acceptable flavor. Currently, decanter centrifuges are used commercially and have provided an alternative to presses under certain circumstances. When naturally colored and flavored (unoxidized) juices are desired, the decanter provides a useful alternative to presses because it is easily inert gas blanketed. Utilization of a metallic ultra-filter as a press has been patented but has not achieved commercial utilization. The technical literature describing the application of these juice extraction juices, primarily to apples, is reviewed extensively.

Storage of Fruits and Vegetables

There are five methods of storing vegetables and fruit: drying, canning, curing and salting, freezing and common storage. Which method is chosen depends upon the type of produce, the quality desired and the facilities available for storage.

Regardless of the method chosen, some general rules should be followed:

- Use only fresh produce.
- Begin the preservation process immediately after harvest.
- Avoid damaged, cut, bruised and pest or disease infested produce.
- Use all preserved produce within one year of storage.

Freezing: A common and very desirable way to preserve certain types of garden produce is through freezing. This method does not improve quality, but is fairly easy to do if one has access to a freezer and takes the time to package properly so that moisture is retained. Like other preservation methods, freezing prevents microorganisms from growing causing spoilage. One large advantage of freezing is that the nutritional quality remains relatively good, plus food can be kept for many months with little change in color. For certain soft produce, the texture may change considerably, though the importance of this is largely depends upon how the food will be subsequently used. Green peppers can be frozen but will become watery when brought back to room temperature. The texture will be very different from fresh produce, but the color will remain good.

Factors to Consider fruit storage time.

A Clean Storage Space: Always keep the storage area clean of debris and discard fruits and vegetables as soon as they begin to show signs of decay. Containers should be removed during the summer, washed and dried in the sun.

Monitor the Temperature: Monitor temperatures to avoid produce being destroyed by any exposure to low or high temperatures, which can happen in extreme cases. Thermometers should be placed inside and outside the storage facility. Stored produce will give off heat during storage making it necessary to regulate temperatures by use of the ventilation windows. If the outside temperature is 25 degrees and the inside is 32 degrees with the ventilation windows closed, the temperature will begin to rise and windows should be opened to lower the temperatures. Close the ventilation windows when outside temperatures are above the desired storage temperatures. Because certain crops are more sensitive to low temperature injury, learn their freezing point. Most fall within a range of 29 to 31 degrees.

Regulate the Humidity: Over time, vegetables and fruit will give up moisture and shrivel. Maintain proper moisture levels during storage by regulating humidity. This can be done by increasing the water in the air through humidifying or by using plastic bags and box liners for storage in individual crops. Humidification is simply taken care of by sprinkling water inside the storage area, but not directly on the produce. For root crops which lose moisture regardless of attempts to humidify with free water, placing them in plastic bags is perhaps the best way to keep them fresh. Plastic liners and bags should be ventilated by creating holes. Produce should never be sealed shut.

Handling Fruit and Vegetables: Handle all produce with care to avoid wounds which become good sites for storage diseases. Pick all produce dry or let dry before storage. Pack produce in plastic or wooden baskets or boxes. Move the produce to the storage area when the field heat has been reduced. Harvesting in the early morning or cooling overnight outdoors will help.

Fruit juice storage

Fruits are perishable commodities and their quality is deteriorated during transportation due to the action of environmental factor (temperature and sunlight) and enzymes. With the application of innovative technologies deterioration can be minimized and juices can be stored for longer period of time. In this research project fresh, properly ripe fruits were selected and their juice was extracted. The extracted filtered juices were pasteurized at 72 o C for 15 minutes following by condensation using evaporation. The product was stored at refrigeration temperature and evaluated for chemical and organoleptic analyses like ascorbic acid, malic acid, tartaric acid, acidity, pH, total soluble solids, reducing and non-reducing sugars at zero to thirty days after every ten days interval. Results showed that the loss of ascorbic acid was minimum in peach which was 11.42 %. The maximum loss of ascorbic acid was recorded in mango which was 16.05 % at the end of storage period of 30 days. In case of malic acid it had been increased slightly. The minimum increase of malic acid was found in AJC (Apple juice concentrate) which is 2.78 % while the maximum increase of malic acid was recorded in PJC (Peach juice concentrate) which is 5 % at the end of storage period. Tartaric acid was detected in least quantity as compared to other organic acids because it was present in trace amounts. The minimum decrease of tartaric acid was in peach juice concentrate which was 0.26% while the maximum decrease of tartaric acid was recorded in mango juice concentrate which was 0.93%. Overall the stability of organic acids was minimum in mango juice concentrates and maximum stability was

Self-check#3	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (8 points)

1. List out all juice extraction equipment's?
2. What is Percolator used?

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

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

Information Sheet 4 - Carrying out line clearance procedures

4.1. Introduction:

Line Clearance: Line clearance is a structured procedure for ensuring that the equipment and work area are free of products, documents and materials from the previous process that are not required for the next scheduled process, and that the equipment is clean and ready for the next scheduled process. This control procedure must be defined in properly authorized packaging instructions. Line clearance is a structured procedure for ensuring that the equipment and work area are free of products, documents and materials from the previous process that are not required for the next scheduled process, and that the equipment is clean and ready for the next scheduled process. An important element in the avoidance of cross-contamination, mix-ups and substitutions during packaging is systematic cleaning of the packaging line. This involves cleaning up remaining bulk product according to the valid cleaning instructions and removal of loose packaging materials belonging to the previous batch. The cleaning process and subsequent line inspection have to ensure that neither bulk product (e.g. loose tablets, capsules or bottles) nor packaging materials (e.g. package leaflets, folding cartons or labels) from the previous packaging process find their way into subsequent packaging processes. The procedure must be clearly defined in an SOP. The SOP must specify when and to what extent the procedure must be carried out. The machine-specific guidelines must be clearly formulated to exclude the possibility of staff interpreting them incorrectly. The machine-specific critical parts can be listed in a check list. Product transfers can only be excluded if this SOP is adhered to in detail. Not only the machine itself, but the surroundings/room where the utensils, remnants and containers are stored, must be assessed in accordance with the SOP. Samples removed during the packaging process must also be systematically removed. The process description must state who is responsible for carrying out and checking the individual steps of the cleaning process. For example, production personnel can be responsible for cleaning and dismantling, persons responsible for the in-process

controls (also frequently referred to as line inspectors) can be responsible for controls and release. The completed check list is enclosed in the batch documentation of the following product as proof of implementation.

Standard Operating Procedure:

Basic Principle of Production should be clearly understood before this activities are done. It covers several aspects of production, ranging from starting materials, equipment, premises, methods, procedure, documents etc. Each of this aspect can be described in more detailed information, as the scope of this principle is quite large. This basic principle can be “translated “into practical aspects by a various standard operating procedures.

Line Opening: A Line Opening is carried out after a Line Clearance has been completed and signed to ensure that all related components, machine settings, BPN, Expiry Date, Date of Manufacture (if required) and information boards are all correct and complete before Production starts.

If a foreign product/material is found during a production run then these MUST be completed:

- Stop the line immediately.
- Record in the Non-Compliance Logbook.
- Report to and give to the area Manager immediately.
- Communicate to the Team.

Line Cleaning: The Line Cleaning form must be signed by an Authorized Person. More than one Team member may clean and clear the line, but it is the responsibility of the Operator trained and assessed in Line Cleaning to ensure that the tasks have been performed and the Line

Basic production principles in line clearance:

Starting materials: should be approved according its specification, identification and approval label should be appeared on each packing .not yet expired or has been retested.

Work area and equipment are clean and free from any starting materials or other materials not required for the current operation.

Any necessary in-process controls and environmental controls should be carried out and recorded.

Means should be instituted of indicating failures of equipment or of services (e.g., water, gas) to equipment.

Defective equipment should be withdrawn from use until the defect has been rectified.

Production equipment should be cleaned according to detailed written procedures and stored only under clean and dry conditions.

Containers for filling should be cleaned before filling. Any significant deviation from the expected yield should be recorded and investigated.

Any deviation results should be recorded and reported to the supervisor(s)

Repair and maintenance operations should not present any hazard to the quality of the products.

Sanitization according to written procedure. Calibration or services of weighing, measuring or control equipment should be done on pre specified interval base.

Record of calibration or services should be kept and maintained.

starting materials should have been tested and passed requirements before these can be delivered to production:

Self-check#4	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (1o points)

1. What is line clearance?
2. Write line clearance benefits?
3. List out basic production principle of line clearance?

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

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

Information Sheet 5- Following procedures to eliminate or control the risk of cross-contamination

5.1. Food Contamination

Cross-contamination is the physical movement or transfer of harmful bacteria from one person, object or place to another. Food becomes contaminated through a variety of mechanisms. Some things that can contribute to foodborne illness are: inadequate hand washing, cross-contamination, storage and cooking temperatures, and contamination of food by animal waste

5.2. BEST PRACTICES FOR FRUIT PROCESSING:

To meet consumer demands for fresh and safe fruits and vegetables, growers and processors must adhere to high safety standards to prevent product contamination and ensure good quality. Foodborne illnesses have also been of particular concern in recent years as outbreaks of *Salmonella, Listeria* and *E. coli* often make the news. Preventing foodborne illnesses from entering the consumer market can protect people's health and even potentially save lives. Product contamination can tarnish brand reputation if recalls are issued, and it can even result in driving a company out of business. Assuring food safety practices during produce processing is essential to providing safe and healthy ready-to-eat fruits and vegetables from companies that consumers trust. Produce processing involves numerous stages from farm to store that differ based on the final product. After produce is harvested, it's transported to processing facilities where it's then further prepared to make it safe for public consumption. Removal of potentially harmful bacteria from the produce is an important part of produce processing. Some of the activities that produce processing can include are:

- Sorting by color or size
- Washing and sanitizing
- Adding preservatives to increase shelf life
- Chopping or mixing
- Cooking or freezing

- Pasteurizing for juices
- Canning and packaging

Each of these common steps in produce processing involves their own best practices for food safety, but food safety must begin at the growing facility or farm. Best practices should be followed from farm to fork to reduce the majority of common food contamination occurrences. Once produce leaves the farm, it's transported to various processing facilities depending on the intended final product. Whether it's chopped, cooked, frozen, cleaned or processed into a new product, there are general food safety guidelines for ready-to-eat foods such as fruit and vegetables that are essential to protect against microbial contamination. These basic food safety procedures can help prevent contaminations due to human mishandling, improper packing processes, and contamination of containers or improper temperature management:

Clean and secure loading docks: Loading docks should be kept clean and free of grass, dirt or outside debris. When not in use, loading docks should be closed and locked to ensure outside pests or traffic cannot enter the processing facility.

Clean and sanitize all surfaces regularly: Any food contact surface should be cleaned and sanitized regularly to prevent cross-contamination or spreading of microbial contamination. This includes counters where food is prepared and tools such as knives and machines used for processing produce. It's essential to first clean, which removes any dirt or debris, then follow with a sanitizing step to kill bacteria present. Materials used in any food processing facility should be easy to clean and sanitize. It's best practice to create a written cleaning and sanitation schedule and ensure it is performed regularly.

Enforce good employee hygiene: Gloves should be worn when handling produce, and employees should practice good personal hygiene. Restrooms and employee break rooms should be in a separate area from anywhere produce is processed.

Test for harmful bacteria regularly: While it's important to visually check the cleanliness of food contact surfaces, harmful bacterial pathogens are microscopic and cannot be seen with the naked eye. That's why regular testing for microbes on food contact surfaces is essential to identify and minimize any areas contamination.

Establish preventative plans and hazard controls: Good Manufacturing Practices (GMP's) and Hazard Analysis and Critical Control Points (HACCP) are essential and effective measures for identifying and controlling risks during produce processing. Creating a written preventative plan is an essential step for food manufacturing safety.

Report hazards immediately: Employees should be trained on the importance of food hygiene so they can recognize potential hazards and report them to management at the earliest possible sign. This allows necessary steps to be taken for minimizing the possibility of contaminated product reaching consumers and potentially causing foodborne illness. Catching a potential hazard or risk early may be the only chance for effective remediation prior to release of the product into commerce.

Blanch produce before freezing: Blanching is the process of quickly and briefly boiling or steaming vegetables or fruit. Blanching is an effective method to inactivate enzymes and damage microbes before freezing which can limit deterioration of the produce.

Freeze produce quickly: After blanching produce, it should be frozen rapidly. Reducing the temperature of the product quickly will prevent it from further cooking and help ensure the continued freshness of the product while also slowing the activity of any microbes that might be present.

Add ascorbic acid or other preservatives: Another effective technique for stopping enzyme activity in frozen produce is by additional of ascorbic acid, commonly known as vitamin C, to prevent any further chemical deterioration.

Self-check#5	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(8 points)

1. Food Contamination?
2. List out best practice for food processing?

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

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

Information Sheet 6- Loading material and adding solvents

6.1.Introduction

Bioactive compounds are extracted from natural sources and they have beneficial effects on human health. Fruits and vegetables are rich in carotenoids, phenolic compounds, Vitamin C, among others. Extraction processes for these compounds depend on several factors such as the technique that is used, the raw material, and the organic solvent. Conventional techniques generally require large amounts of organic solvents, high energy expenditure, and are time consuming, which has generated interest in new technologies that are referred to as clean or green technologies. These can reduce or eliminate the use of toxic solvents, and thus preserve the natural environment and its resources. The aim of this review is to discuss recent techniques used to extract bioactive compounds from natural sources, in order to reduce the economic and ecological impact of these processes.

The efficiency of conventional extraction methods depends on the choice of solvent and the polarity of the compound, since solvents of different polarities are needed for identification and isolation. The polarities of compounds vary and it is difficult to develop a single method for the efficient extraction of all compounds. A good solvent provides low toxicity, a low boiling point, quick mass transfer, preservative action, and the inability to make the complex extract dissociate. The yield and the amount of the extract obtained also depend on several other factors such as the type of extract, the temperature, and the extraction time

6.1.Methods of Extraction

Method of production for all the fruit based vegetable the first stage is the extraction of juice or pulp from the fruit. The following are the key manufacturing stages:

- Selection and preparation of raw material
- Juice extraction
- Filtration (optional)
- Batch preparation
- Pasteurization
- Filling and bottling.

Any fruit can be used to make fruit juice, but the most common ones include pineapple, orange, grapefruit, mango and passion fruit. Some juices, such as guava juice, are not filtered after extraction and are sold as fruit nectars.

Preparation of raw material Select mature, undamaged fruits. Any fruits that are mouldy or under-ripe should be sorted and removed. Wash the fruit in clean water. It may be necessary to chlorinate the water by adding 1 tablespoon of bleach to 5 liters of water. Peel the fruit and remove stones or seeds. If necessary, chop the fruit into pieces that will fit into the liquidizer or pulpier. Remember that at this stage, you are exposing the clean flesh of the fruit to the external environment. Make sure that the utensils are clean. Do not leave the cut surfaces exposed to the air for long periods of time or they may start to turn brown and this will discolor the juice. The fruit pieces can be placed in water that contains lemon juice (250ml lemon juice per liter of water) to stop them browning.

Juice extraction

There are several methods to extract juice depending on the type of fruit you use. For citrus fruits which are naturally juicy, the best option is to use a hand presser (or a revolving citrus 'rose'. Some fruits such as melon and papaya are steamed to release the juice. Apples are pressed and fruits such as mango, guava, sour sop, pineapple, strawberry must be pulped to extract the juice. The fruit pieces are pushed through a perforated metal plate that crushes and turns them into a pulp. Some fruits can be pulped in a liquidizer and then filtered to remove the fruit pieces. There is a range of equipment available that varies in size and in the type of power supply (some are manual while the larger ones require electricity). For the small scale processor, the Moulin Legume or a hand-powered pulpier/sieve which force the fruit pulp down through interchangeable metal strainers At slightly higher production levels, it is necessary to use a power source to achieve a higher throughput of juice. The multi-purpose Kenwood Chef Food mixer is strongly recommended. This has a pulping attachment that is similar to the Moulin Legume and it can also be used for other operations such as liquidizing and mixing.

In recent years there has been considerable interest in using extraction instead of expression for recovering juices from fruits and vegetables. Countercurrent screw extractors, some operated intermittently, have been used to extract juice with water. In some cases this results in higher yields of good quality compared to that obtained by expression**.** Centrifugation may be used for a variety of tasks in fruit juice processing. Self-opening centrifuges are used to remove pulp and control the level of pulp remaining in pineapple and citrus juices. Centrifuged apple juice is cloudy but free from visible pulp particles. Tubular bowl centrifuges were originally used to clarify apple juice but more recently nozzle and self-opening machine are used. The use of hermetically sealed centrifuges prevents excessive aeration of the juice. In the production of oils from citrus fruits centrifugation is applied in two stages. The concentrated emulsion is then separated in a second centrifuge to produce the citrus oil. There are many other applications for centrifugation in food processing, e.g. tubular bowl machines for clarifying cider and sugar syrups , nozzle and self-opening machines for dewatering starches and decanting centrifuges for recovering animal and vegetable protein, separating fat from comminuted meat and separating coffee and tea slurries.

The results revealed that the highest yield extracts were obtained by the diethyl ether and methanol for seeds and peels fruits extracts, respectively. Significant differences were observed among extraction yields obtaining by methanol compared to other solvents in seeds and peels fruits .This difference may be attributable to the higher solubility of extractable bioactive components such as carbohydrates and proteins in methanol than in diethyl ether and acetone. The variation in the yields of extracts could be attributed to the difference in solvent polarities used witch also plays a key role in increasing the solubility of phytochemical compounds. Differences in the structure of phytochemical compounds also determine their solubility in solvents of different polarity

The results presented in this work confirmed that methanol was the best solvent to extract fruit juices and the amount of the solvent used depends on the amount of the fruit for the extraction and the maturity of the fruit.

Self-check_6	Written test

Name…… ID…… Date…….

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

Test I: Choose the best answer (12 point)

1. List out juice extraction methods?
2. What is Juice extraction?
3. Which solvent is used for juice extraction process?

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

Operation Sheet 1- Preparing the extraction equipment and process for operation

Procedure for Preparing the extraction equipment and process for operation

Step 1- wear personal protective equipment

Step 2- prepare best Fruits and vegetable for blending

Step 3- follow Work Instructions or Standard Operating Procedures (SOP)

Step 4- prepare juice blender, Filter/ Sieve, percolator requiring, facilities

Step 5-carry out line clearance process.

Step 6- Load material into percolator

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 **1** hour. The project is expected from each student to do it.

Task- Prepare extraction equipment and process for operation

LG #42	LO #2- Operate and monitor peeling, destoning and crushing process

Instruction sheet

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

- Starting and operating peeling and crushing process
- Performing destoning process
- Performing and crushing process

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:

- Start and operate peeling and crushing process
- Perform destoning process
- Perform crushing process

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, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Starting and operating peeling and crushing process

1.1. PEELING

This operation is performed on a regular basis. It consists of the removal of the skin of the fruit or vegetables. It may be performed by using physical devices like knives or similar instruments, by using heat or chemical methods. Such methods basically aim to bring about the decomposition of the walls of the external cells of the skin, so that the skin is removed as a result of the tissue's loss of integrity.

Peeling is an operation that allows for a better presentation of the product, and at the same time fosters sensory quality, for the material with a firmer and rougher texture is eliminated. Moreover, the skin often presents a color that has been affected by the thermal processes normally used in processing methods.

Peeling facilitates the operation of cutting raw material into pieces or into slices before processing. Peeling is an operation that allows for a better presentation of the product, and at the same time fosters sensory quality, for the material with a firmer and rougher texture is eliminated. Moreover, the skin often presents a color that has been affected by the thermal processes normally used in processing methods.

Peeling facilitates the operation of cutting raw material into pieces or into slices before processing

Trimming and peeling (skin removal): This processing step aims at removing the parts of the fruit which are either not edible or difficult to digest especially the skin.

Up to now the industrial peeling of fruit and vegetables was performed by three procedures: mechanically; by using water steam; chemically; this method consists in treating fruit and vegetables by dipping them in a caustic soda solution at a temperature of 90 to 100° C; the concentration of this solution as well as the dipping or immersion time varying according to each specific case.

1.2. Crushing:

Powered machines that are used to crush pineapples or other hard fruits consist of a rotating screw inside a casing. The casing has a screen in the base. Juice/pulp drains from an outlet in the base of the casing and skin is ejected from the end of the casing down a chute. The casing should be fitted with wing nuts to remove it easily.

Fig1.1.fruit crusher

Crushers should be cleaned after use as follows:

1. Remove the hopper and wash with detergent. Rinse with clean water and allow to dry.
2. Remove the casing and wash as for the hopper
3. Wash the screw and screen thoroughly, using a brush and detergent. Rinse with clean water.
4. Clean the chute and juice/pulp pipe with a water hosepipe and spray gun.
5. Ensure that no particles of fruit remain in the machine after cleaning

Self-check 1	Written test

Name…… ID…… Date…….

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

Test I: Choose the best answer (30 point)

1. What is peeling?
2. Write crushing cleaned after use procedures?
3. Why we use crushing?

Test II: Short Answer Questions

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15points**

Information Sheet 2- Performing destoning process

2.1. destoning

Destoning is the **process** of removing stone or contamination from fruit and vegetable processing of different size and color. It is a Post harvesting process for Value addition of harvested fruit. Be it fruit, Pulses & any cereals, at the time of harvesting Mud & stones come along with harvested fruit. The fruit enters the cylindrical screen through a hopper, transported by a worm screw. A fast rotating rotor with adjustable 3 blades is pressing the fruit flesh through the screen holes. A clean stone is leaving the machine, and the pulp and juice are collected for further processing. According to the desired result, the screens are interchangeable and can easily be exchanged with different sizes of holes for different fruits.

Fig2.1 DE stoning machine

The de-stoning/mashing unit is an easy mechanical machine used for removing the stones/seeds and/or mashing from fruits, such as cherries, plums, peaches, apricots, Williams pear, tomatoes, carnell cherry, apricots, raspberries, strawberries, blackcurrants etc.

DE stoning machine benefits:

To remove stones or seeds from fruits

To break up the mash / flavor

To achieve a homogenous mash/pulp

For distillery, jam and juice production

Self-check#2	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (8 points)

1. What is destoning?
2. Writ the benefits of destoning?

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

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

Information Sheet 3- Performing and crushing process

3.1. Crushing process

There are many fruit-specific ways to extract juice. Some are well-established, large-scale procedures for commercial fruits and will be explained in detailed for those fruits. Operations range from kitchen to industrial scale depending upon volume, end use and raw material. Provides some general guidelines for various fruit types. The goal in juice manufacture is to remove as much of the desirable components from the fruit as possible without also extracting the undesirables. Thorough comminution maximizes the yield, but by so doing extracts substances from everything, i.e. seed, skin, core, etc.

Thus the compromise between juice yield and quality dictates the juicing and subsequent steps. Fruit with unpalatable skin and seeds must be treated more cautiously than one that can be completely pulverized. It is possible to minimize extraction of skin and seed components by a crushing regime that mashes or removes edible flesh, while sparing other portions. However, some fruit must be carefully peeled and deseeded or cored prior to juicing. Hand lab our is the current alternative with many minor fruits, although there is an economic incentive to mechanize if possible.

Contour peelers, such as used with apples can be adapted to a range of fruits that are sufficiently firm and uniform to facilitate the rotary peeling action. Peeling systems that are effective with some vegetables such as lye, abrasion, enzymatic, explosive, are less satisfactory with delicate fruit flesh. Nevertheless, cleverly designed machinery can greatly facilitate these lab our-intensive operations. Under all circumstances, a final human inspection and piece selection/rejection step is mandatory.

Generally a whole fruit is more stable than the juice, unless rapidly preserved after extraction. So fruit should not be committed to juice until the material can rapidly be stabilized or the processes go to completion. Attention to quality at the pre juicing step is extremely critical. Otherwise surface debris and portions of skin or seed can easily ruin the colour or flavor of an entire batch of juice. Of course, in a similar sense,

microbial and chemical contaminants at juicing can and have caused disastrous public health consequences.

Juice extraction equipment ranges from hand operated crushers to tons/hour mechanical extractors (With soft or comminuted fruit a cone screw expresser or paddle pulper fitted with appropriate screens serves to separate the juice from particulate matter. Where skin or seed shattering is a problem, brush paddles can replace metal bars. Two pullers in series with screens of ~1 to 0.2 mm can effectively clean up many juices and often yield a usable thick pulp by-product.

The juice extraction from fruits and vegetables can be done by size reduction methods as crushing, chopping and comminuting. This is usually employed for fruits that are fully ripened and too soft for whole or diced or sliced packs. The following points must be remembered in such situations.

- Crushing of products by chopping them into small pieces (0.025-0.075 inch) prior to heating speeds enzyme activity. Hence it is required to remove the air at the time of crushing and immediately after comminuting.
- Therefore, direct super-heated steam introduction into the chopper or crusher is applied.
- Super-heated steam aids in creating a partial vacuum. So superheated steam preferably under a vacuum will eliminate the air and aid immensely in creating a better consistency in the final product.

In this step fruit juice is pressed from pulped raw material with help of decanters or pressor. Decanter is a horizontal, cylindrical screen lined with press cloth material, with a large inflatable tube in the center that inflates and presses pulp up against the loath-covered wall The whole assemblage is rotated after it is filled and closed and as the tube is bedding inflated. Juice is expressed into a catch trough below and collected from a drain. Pressure on the tube reaches a maximum of 6 atmospheres or approximately 600 kPa. Usually a press aid is needed to keep the pulp from adhering to the press cloth and stopping the free flowing of the juice. Solid waste from juice extraction process

is discharged at the end part of decanter and can be reused for getting some additional juice extraction with help of enzymes.

Juice clarification:

For more fluid juices where cloud or turbidity is not acceptable primary extracted juice must be treated further. A settling step can help, if the juice can be held refrigerated for a few hours. At ambient tropical temperatures holding is not recommended. Rapid methods such as centrifugation and filtration can produce a clear juice. A continuous or a decanting centrifuge with automatic desludging to produce a clear or nearly clear juice is quite effective. (Juices where a cloud is desired generally do not require filtration; centrifugation is adequate.) The stream should be settled or coarse strained prior to centrifugation in order to reduce the sludge load in the feed going to the centrifuge. A fine mesh shaker screen can further remove particulates (Figure 6.13). A centrifuge is a very costly item; however, it greatly simplifies subsequent filtration steps and is an essential component in many juice processing operations (Figure 6.14).

Filtration

To make a clear juice, the extracted juice or pulp is filtered through a muslin cloth or a stainless steel filter. Some of the larger filter presses have a filter included. Although juice is naturally cloudy, some consumers prefer a clear product. It may be necessary to use pectic enzymes to break down the pectin and to help clear the juice. Pectic enzymes may be difficult to find and expensive and therefore should only be used if really necessary and readily available.

Self-Check#3	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(1o points)

1. Write down Crushing?
2. What are the uses of crushing?

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Operation Sheet 1- Operating peeling, destoning and crushing process

Procedure _for peeling, destoning and crushing process

Step 1- wear personal protective equipment

Step 2- prepare best Fruits and vegetable for blending

Step 3- follow Standard Operating Procedures (SOP

Step 4- prepare juice blender, Filter/ Sieve, percolator and water.

Step 5-carry out line clearance process.

Step 6- Load material into percolator and check destoning

Step 7-start peeling process**.**

Step 8- perform Crushing process

Step 9- perform Juice clarification/or filtering.

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 **1** hour. The project is expected from each student to do it.

Task1- starts juice extraction process.

LG #43	LO #3- Operate and monitor the extraction process

Instruction sheet

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

- Monitoring extraction process.
- Identifying and reporting out-of-specification product/process
- Maintaining work area.
- Conducting work
- Maintaining workplace documentation

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:

- Monitoring extraction process.
- Identifying and reporting out-of-specification product/process
- Maintaining work area.
- Conducting work
- Maintaining workplace documentation

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)

Information Sheet 1- Monitoring extraction process

1.1. Quality Control:

The freshness and quality of the expressed fruit juice is central to the quality of the final product. The quality of each day's production should be monitored and controlled to ensure that every bottle of juice has the correct keeping and drinking qualities.

What is a hazard analysis? The hazard analysis is an evaluation of potential microbiological, chemical, and a physical hazard associated with a particular product and process and is used to determine which hazards are reasonably likely to occur and, if they occur, how they can best be controlled. The regulation requires that the hazard analysis be written.

Acceptance of raw material:

The production process of fruit juice and concentrates begins with raw material purchasing. Fruit is verified in terms of quality before unloading. It should look healthy and be ripe.

Fruit pulp preparation and processing:

Raw materials from pre-production warehouse are transferred to the dosing units (known as sorting units). The task of the sorting unit is to dose fruits evenly to the vertical screw feeder (known as elevator). Sorting units have designs individually adjusted to the capacity of elevator and floatable chutes.

Fruit transported by a feeder made of acid proof materials and plastics suitable for use with food are transferred to the inspection belt or roller table Trained employees carry out inspection and reject raw material which does not satisfy the requirements.

Sorted material falls down to the mill. Replaceable or adjustable mill elements, such as: knives, sieves, pressing rollers enable adjusting to the quality of raw material and obtaining optimal pulp parameters.

A cutting line is controlled by the system automated with visualization and operated from a touch panel on the control cabinet.

Juice yielding.

A correctly performed pressing stage guarantees maximum yield of juice from raw material. An extrusion process starts with pre-filling. Pulp is pumped to a closed

cylinder, filling up the pressure chamber space. It is a fully automated process owing to the self-optimizing press control system, which determines the level of product extrusion at each process stage. After completing the press filling-up cycle, pressing takes place. Piston presses the pulp and juice flows out through filtering elements to both juice chambers encased in the resistance board and press-down board. Then, the piston retracts, while the cylinder is rotating, thus, the entire pulp is carefully loosened. This phase is repeated in cycles and each piston feed is a few millimeters longer than the previous one.

Washing equipment and piping in production line

CIP (clean in place) station is used for washing installations, devices and pipelines in the production line in CIP system.

In the production process of juice and concentrates, washing station ensures cleanliness and hygiene in process tanks and storage tanks as well as in pipelines transporting raw material in pipe layers.

Washing products are prepared in the station in the form of working solutions and pumped to the device or installation which is to be cleaned. Then, they circulate in a closed circuit between CIP station and a given device within the time which ensures thorough cleaning at a set temperature. Washing temperature and solution concentration undergoes ongoing verification and automatic adjustment.

A washing procedure consists of the following phases:

- recovery of the products remains from the technological system,
- pre-rinsing of superficial staining,
- washing with the use of cleaning agents (acid washing and alkali washing),
- rinsing with clean water,
- optional disinfection

Closed circuit washing allows for cleaning agent economy and reduction of sewage discharged. Working solutions are prepared in the CIP station in the concentrations

recommended by the manufacturer and in adequate temperatures. Solutions are retained in three tanks insulated with a double coat and fed by a pump as needed.

In particular extraction juice the following points should be observed:

- Only fresh, fully ripe fruit should be used; mouldy or insect damaged fruit should be thrown away. All unwanted parts (dirt, skins, stones etc.) should be removed.
- All equipment, surfaces and floors should be thoroughly cleaned after each day's production.
- Water quality is critical. If in doubt use boiled water or add one tablespoon of bleach to 5 litres of water to sterilize it. If water is cloudy, a water filter should be used.
- Pay particular attention to the quality of re-usable bottles, check for cracks, chips etc. and wash thoroughly before using. Always use new caps or lids.
- The concentration of preservatives should be carefully controlled for correct preservation of squashes and cordials and may be subject to local laws. Check first and use accurate scales to measure the preservative.
- The temperature and time of heating are critical for achieving both the correct shelf life of the drink and retaining a good color and flavor.
- The correct weight should be filled into the bottles each time.

Monitoring by workers: Inspect juice, check for colour and any pieces of fruit on sieve/cloth. Color compared to standard colour chart for the product

Control point: All juice passes through filter cloth. Juice having poor colour or insufficient sweetness either rejected or blended with other juices

Self-Check #1	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(8 points)

1. What is extraction process?
2. What quality control?

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

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

Information Sheet 2- Identifying and reporting out-of-specification product/process

Fruit juice is the unfermented but fermentable liquid obtained from the edible part of sound, appropriately mature, ripe and fresh fruit or of fruit maintained in sound condition by suitable means. Some juices may be processed with pips, seeds and peel, which are not usually incorporated in the juice, but some parts or components of pips, seeds and peel, which cannot be removed by Good Manufacturing Practices (GMP), will be acceptable. The juice is prepared by suitable processes, which maintain the essential physical, chemical, organoleptic and nutritional characteristics of the juices of the fruit from which it is derived. The juice may be cloudy or clear and may have restored aromatic substances and volatile flavor components, all of which shall be obtained by suitable physical means, and all of which shall be recovered from the same kind of fruit. Pulp and cells obtained by suitable physical means from the same kind of fruit may be added.

Quality criteria

1. Shall contain no additives
2. The fruit juices and fruit nectars shall have the characteristic color, aroma and flavor of juice from the same kind of fruit from which it is made.
3. The product shall be free from seeds, bits of seed or bits of peel
4 Shall be free from deterioration or spoilage
5. The product shall be clean and free from foreign matter
6. The fruit juices and fruit nectars shall conform to the requirements in pH value max 4.5

Quality control the freshness and quality of the expressed fruit juice is central to the quality of the final product. As soon as the juice is expressed from the fruit it starts to deteriorate, both as a result of chemical activity (enzyme action) and bacterial spoilage. It is important to move from the juice extraction stage to pasteurization as quickly as possible to minimize any spoilage.

Extracted fruit juice that is left to stand for long periods in the heat will start to ferment and may start to discolor due to enzyme activity. The juice should be stored in a refrigerator (if one is available) or in a cool place and away from the direct sunlight. It should be collected into a clean, sterile container (food grade plastic buckets is the best option) and covered to keep out dirt, dust and insects. For the best quality product, it is essential to work quickly between the extraction of the juice and the bottling stage. The longer the juice is out of the bottles, the more chance there is of contamination.

Self-Check #2	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (8 points)

1. List out quality criteria?
2. How juice extraction out-of-specification?

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

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

Information Sheet 3- Maintaining work area.

3.1. Maintaining work area according to housekeeping standards

Good housekeeping is the foundation of a safe, healthy and pleasant workplace. It is essential that all areas be kept clean, orderly, and with all necessary things in the proper places. Employees should be aware of hazards arising from poor housekeeping. Good housekeeping improves safety, efficiency and quality at the same time.

Work environment. Many production jobs in food manufacturing involve repetitive, physically demanding work. Food manufacturing workers are highly susceptible to repetitive-strain injuries to their hands, wrists, and elbows. This type of injury is especially common in meat- and poultry-processing plants. Production workers often stand for long periods and may be required to lift heavy objects or use cutting, slicing, grinding, and other dangerous tools and machines. To deal with difficult working conditions and comply with safety regulations, companies have initiated ergonomic programs to cut down on work-related accidents and injuries.

There are 11 tips for effective workplace housekeeping

1. **Prevent slips, trips and falls:** Slips, trips and falls were the second leading cause of nonfatal occupational injuries or illnesses
2. **Eliminate fire hazards**: Employees are responsible for keeping unnecessary combustible materials from accumulating in the work area. Combustible waste should be “stored in covered metal receptacles and disposed of daily,” according to OSHA’s Hazardous Materials Standard
3. **Control dust**: Dust accumulation of more than 1/32 of an inch or 0.8 millimeters covering at least 5 percent of a room’s surface poses a significant explosion hazard,
4. **Avoid tracking materials**: Work-area mats – which can be cloth or sticky-topped – should be kept clean and maintained.
5. **Prevent falling objects**: protections such as a toe board, toe rail or net can help prevent objects from falling and hitting workers or equipment.

6. **Clear clutter**: A cluttered workplace can lead to ergonomics issues and possible injuries because workers have less space to move
7. **Store materials properly**: According to OSHA's Materials Handling, Storage, Use and Disposal Standard
8. **Use and inspect personal protective equipment and tools:** Wear basic PPE such as closed-toe shoes and safety glasses while performing housekeeping,
9. **Determine frequency** All workers should participate in housekeeping, especially in terms of keeping their own work areas tidy, reporting safety hazards and cleaning up spills, if possible.:
10. **Create written rules**: Experts agree that housekeeping policies should be put in writing. Written protocols could specify which cleaners, tools and methods should be used.
11. **Think long-term:** Housekeeping should be more than a one-time initiative it should continue through monitoring and auditing. Keep records, maintain a regular walkthrough inspection schedule, report hazards and train employees to help sustain housekeeping. Set goals and expectations, and base auditing on those goals,

Self-Check #3	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(8 points)

1. Write 11 tips Housekeeping?

2. What is Juicing Equipment Sanitization?

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

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

Information Sheet 4- Conducting work

4.1. Environmental Regulations and the Food Industry

Environmental standards are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment. Environmental standards are set by a government and can include prohibition of specific activities, mandating the frequency and methods of monitoring, and requiring permits for the use of resources or food process. Standards differ depending on the type of environmental activity.

4.2. Food control

Food control is the regulation of the food supply industry and enforcement of food laws by national or local authorities. Its purpose is to provide consumer protection and ensure that all foods during production, handling, storage, processing and distribution are safe, wholesome and fit for human consumption. A food control system ensures that foods conform to safety and quality requirements and are honestly and accurately labeled, as required by law. The scope of food control includes:

1. Food safety, which refers to all those hazards that may make food unhealthy for the consumer.
2. Food quality standards, which includes all other attributes that influence a product's value to the consumer, e.g. composition, labeling, etc.

Food control covers all stages of production, processing and distribution of food. It covers controls on food that is produced or imported for consumption within the region and food that is exported outside the country.

The principal objective of the national food control system is the protection of public health by protecting consumers from unsafe, unwholesome, mislabeled or adulterated food. It also contributes to economic development by maintaining consumer confidence and providing sound regulatory controls for domestic and international trade in food.

Components of a food control system

The main components of a national food control system are:

- food law and regulations
- food control management
- inspection services
- laboratory services for food monitoring and epidemiological data
- Information, education, communication and training.

To be effective, food law and regulations should be relevant, enforceable and 'proactive' (that is, have a preventive component) so that they can provide a high level of health protection. They must also include clear definitions to increase consistency and legal security.

There needs to be monitoring of compliance with food laws. Quantitative monitoring includes counting the number of food premises inspected, the number of food samples taken, the number of food complaints dealt with and the number of food poisoning cases dealt with.

Government regulators are responsible for auditing the performance of the food system through monitoring, surveillance and enforcing legal and regulatory requirements. The more economic and effective strategy is to entrust food producers and operators with primary responsibility for food safety and quality. An important aspect of education is to promote voluntary compliance with food regulations. Voluntary compliance means that food producers and providers adhere to the food laws voluntarily, because they understand the benefits of good practice, rather than be prosecuted or penalized for breaching the regulations.

Responsibility for food control

In Ethiopia, national food control is shared between different agencies and ministries including the Ministry of Health, Ministry of Agriculture, and the Quality and Standards Authority. Their roles and responsibilities are quite different and there may possibly be duplication of regulatory activity, fragmented surveillance and lack of coordination.

There is also considerable variation in expertise and resource between the different agencies, and a conflict between the need to protect public health and obligations to facilitate trade or develop an industry or business sector. You need to be aware of these potential difficulties with the food control system.

Self-Check #4	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (12points)

1. What is Food control?
2. Write Components of a food control system

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

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

Information Sheet 5- Maintaining workplace documentation

5.1. Workplace documentation

Maintaining a system of organized, accurate and consistent documentation in the workplace is both necessary and beneficial. Making documentation a priority, especially when it comes to the company's HR department, can help mitigate disputes, offer resources when they are needed and answer important questions about the company. In this article, we will discuss why documentation is important and ways you might consider improving your documentation process.

What is a Material Safety Data Sheet (MSDS)?

A material safety data sheet is a technical document which provides detailed and comprehensive information on a controlled product related to:

- health effects of exposure to the product
- hazard evaluation related to the product's handling, storage or use
- measure to protect workers at risk of exposure
- Emergency procedures.

The Purpose of the Data Sheet

The data sheet is the second element of the WHMIS information delivery system and is intended to supplement the alert information provided on labels. The third element of the system is the education of employees in hazard information on controlled products, including instruction in the content and significance of information on the MSDS.

Specifications: Food quality specifications are guidelines that are used to help develop food and drink products. Written by manufacturers and retailers from the industry, these cover product colour, flavor, and texture, as well as tolerances for specific defects.

Manufacturing formulae: A formula is how a professional specialty food manufacturer will document your information and is based on pounds, kilograms, grams and other

weight measurements. These weights are then converted to percentages so any amount or batch size can be made on those confirmed percentages.

Standard Operating Procedures (SOPs: A standard operating procedure is a set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations. SOPs aim to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

Batch production records: A batch manufacturing record is a document designed to provide a complete record of the manufacturing history of a batch of product. The terminology is widely applied within the Pharmaceutical & Chemical industries and is referenced in many of the pharmaceutical and food regulatory agency requirements.

Self-Check #5	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions (12 points)

3. What is Workplace documentation
4. Write the Purpose of the material Data Sheet?
5. What are batch production records?

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

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

LG #44	LO #4- Perform pre-heating

Instruction sheet

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

- Operating pre-heater
- Adjusting equipment and temperature

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:

- Operate pre-heater
- Adjust equipment and temperature

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

Information Sheet 1- Operating pre-heater

1.1. THERMAL TREATMENT

The optimal thermal treatment for processing the product is described below. In this example, we use the HRS MI and MR series heat exchangers which are suitable for this application. Where applicable and required, a temperature sensor and a visual thermometer is fitted to control the process at various stages.

1. **pre-heater:** The product is preheated in the MR type corrugated multi tube heat exchangers. This is a direct recovery of energy using the product itself to provide the heat needed for the preheating phase. After preheating, the product passes through the DE aerator.
2. **Preheating 2:** After DE aeration, the product is subjected to a second regenerative heat treatment similar to the first. By using MR type corrugated multi tube heat exchangers, we can achieve recuperation values between 70 and 80% heat recovery from the product.

The primary pasteurization is done as soon as possible after juice extraction, or as a first step in the evaporator. This pasteurization is commonly done at 95–98°C for 10 to 30 seconds. The main objective is to inactivate enzymes from the fruit, but microorganisms also are inactivated during the pasteurization. Inactivation of enzymes generally requires more intensive pasteurization conditions than what is required to destroy microorganisms

The first pasteurization, in order to deactivate enzymes, kills most microorganisms, leaving the juice or concentrate commercially sterile. For NFC juice (Not From Concentrate) there is a risk that microorganisms enter the juice during transport or bulk storage and recontamination the juice. If the juice or nectar is made from concentrate the recontamination may occur during storage and transport of the concentrate or during reconstitution with water. The water used for reconstitution should always be of high quality.

Self-Check #1	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions.(points)

1. Write the uses operating pre heating
2. .what temperature is pre heated?

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

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

Information Sheet 2- Adjusting equipment and temperature.

2.1. Low temperature Pasteurization process

The heating medium is hot water, usually under the boiling temperature. The pasteurizer heat up the raw materials to 68-70℃, keep this temperature for 30min and cool down suddenly to 4-5℃**.** As the death point of most bacteria is 68℃ and under 30 min, so this process can eliminate most bacteria. Then, the sudden temperature drop will cause the bacteria to die.

Pasteurization of juice can be done for temporary preservation (pre-pasteurization) and in this case this operation is carried out with continuous equipment (heat exchangers, etc.); warm juice is stored in drums or large size receptacles (20-30 kg). Pasteurization conditions are at 75°C in continuous stream.

2.2. Fruit juice heating equipment's

Nowadays, large fruit and vegetable juice manufactures usually adopt UHT technology to heat up the liquid to high temperature and keep for very short time. Generally, there are plate pasteurizer, tubular pasteurizer and steam pasteurizer 3 types, and plate pasteurizer is the most prevalent. Plate pasteurizer integrates the function of preheating, sterilization, heat preservation and cooling. It applies to milk, tea drinks, fruit juice and concentrates with without high fiber or high viscosity Current practice is to install clear juice heaters ahead of first effect evaporators to ensure that the juice entering the evaporator is above its boiling temperature, allowing flashing to occur on entry. The alternative, of allowing the juice heating to take place in the evaporator, is sometimes rejected on the basis that heating transfer performance of an evaporator is very poor when operating in the juice heating regime. To allow this alternative to be evaluated on a quantitative basis, available data on the relative heat transfer performance of juice heaters and Kestner evaporators have been collated, providing estimates of the difference in heating surface area required. By combining this information on heating surface area requirement with equipment costs, it is possible to make a rational assessment on whether it is advisable to dispense with clear juice heaters by installing extra heating surface area in the first effect evaporators.

Self-Check #2	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions (8 points)

1. What temperatures are best for pre heating juice?

2. Write the equipment used to heating juice?

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

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

LG #45	LO #5- Shut down the extraction process

Instruction sheet

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

- Shutting down process.
- Identifying and reporting maintenance requirements

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**:

- Shut down process.
- Identify and report maintenance requirement

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).

Information Sheet 1- Shutting down process

1.1 shutting down.

Normal shutdown includes steps to render the systems safe, such as removal of hazardous process materials and inert (asphyxiating) gases. The systems might be cleaned as part of the shutdown; cleaning is often a process unto itself requiring its own set of startup, operation, and shutdown procedures.

Shut down must be conducted using the standard procedures established for the machine or equipment (not emergency procedures or other shortened/simplified method).

Equipment shut down pre conditions:

- A disconnect switch;
- A manually-operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and, in addition, no pole can be operated independently;
- A line valve, bolted blank flange, and bolted slip blinds;
- The machinery/equipment has no potential for stored or residual hazardous energy or re-accumulation of stored energy after shutdown;
- The machinery/equipment has a single energy source which can be readily identified and isolated;
- The isolation and locking out of that energy source will completely deenergize and deactivate the machinery/equipment;
- The machinery/equipment is isolated from the one identified energy source and locked-out during servicing or maintenance;
- The lockout device is under the exclusive control of the “Authorized Employee” performing the service or maintenance;
- The servicing or maintenance does not create hazards for other employees;
- There have been NO accidents involving the unexpected activation or re-energization of the machine or equipment during prior servicing or maintenance.

Fig1.1 juice extractor.

1.2. Juice extractor shut down process.

1. Ensure the Juice Extractor is turned off by pressing the 'On/Off' switch on the control panel to 'Off '. Then switch the appliance off at the power outlet and unplug the cord.

2. Remove the pulp container by tilting the base away from the motor base, and then unlatch it from under the juicer cover and the container support extending from under the motor base.

3. Use the grip handle located on the safety locking arm to lift the locking arm from the juicer cover and lower down out of position.

4. Lift the juicer cover off the Juice Extractor.

5. Step 5 Remove the filter bowl surround with the stainless steel filter basket still in place.

6. To remove the stainless steel filter basket from the fi lter bowl surround, insert fingers under the grooves marked ‘LIFT BASKET’ and lift the fi lter basket up. For easy cleaning, it is recommended to remove the fi lter basket over the sink.

Self-Check#1	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(6 points)

1. Write shut down procedures for juice extractor.
2. Write three shut down pre conditions?

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

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

Information Sheet 2- Identifying and reporting maintenance requirements

1.1. Maintenance

Maintenance is the function whose objective is to ensure the fullest availability of production equipment, utilities and related facilities at optimal cost and under satisfactory conditions of quality, safety and protection of the environment. The purpose of maintenance is to ensure the maximum efficiency and availability of production equipment, utilities and related facilities at optimal cost and under satisfactory conditions of quality, safety and protection for the environment.

2.2. Objectives of maintenance.

The more specific objectives of maintenance management are as follows:

- To optimize the reliability of equipment and infrastructure;
- To ensure that equipment and infrastructure are always in good condition;
- To carry out prompt emergency repair of equipment and infrastructure so as to secure the best possible availability for production;
- To enhance, through modifications, extensions, or new low-cost items, the productivity of existing equipment or production capacity;
- To ensure the operation of equipment for production and for the distribution of energy and fluids;
- To improve operational safety;
- To train personnel in specific maintenance skills;
- To advise on the acquisition, installation and operation of machinery;
- To contribute to finished product quality;
- To ensure environmental protection.

Scheduled maintenance

This includes the repair or replacement of worn components identified from a routine inspection or condition monitoring. These measures are preventative in nature to avoid the failure of components which are necessary to the normal operation of the device. The alternative may be total loss of the asset, or damage and injury to other water users or adverse environmental impact. It may be necessary to carry out minor maintenance

or inspection tasks on a regular basis at the site, with larger operations carried out either at the site or nearby port at longer intervals. The required maintenance and inspection intervals for particular components will depend on the reliability for the given application and this can be determined from component testing programmers in representative conditions (i.e. sea-trials or destructive/nondestructive laboratory tests and the development of reliability prediction tools.. Another factor will be the logistical effort required to complete the task. For example, the inspection of sub-sea mooring components is currently reliant on device position and load monitoring, sonar detection systems or visual inspections from remotely operated vehicles (ROV) and/or dive teams. More detailed inspections require the recovery of components and perhaps complete mooring lines (requiring vessels with lifting or winch equipment) Commercial Off-The-Shelf (COTS) equipment manufacturers can usually recommend (or specify as part of an equipment warranty) the required maintenance intervals and actions required for their equipment.

Preventive maintenance	The principle of preventive maintenance is anticipation. It is put into practice in two forms: systematic (periodic) maintenance and condition-based maintenance.
Corrective maintenance	Also called breakdown maintenance, palliative or curative maintenance. This form of maintenance consists of: - troubleshooting on machines whose poor condition results in stoppage, or in operation under intolerable conditions;
Systematic maintenance	This consists of servicing equipment at regular intervals, either according to a time schedule or on the basis of predetermined units of use (hours of operation or distance travelled). The aim is to detect failure or premature wear and to correct this before a breakdown occurs. The servicing schedule is usually based on manufacturers' forecasts, revised and adjusted according to experience of previous servicing; this information is recorded in the machine file. This type of maintenance is also called periodic maintenance.
Condition-	This type of maintenance, also called predictive or auscultative

based maintenance	maintenance, is a breakdown-prevention technique which requires no dismantling, as it is based on inspection by auscultation of the equipment involved. It requires continuous observation of an item of equipment in order to detect possible faults or to monitor its condition.
Design-out maintenance	This is also known as plant improvement maintenance, and its object is to improve the operation, reliability or capacity of the equipment in place. This sort of work usually involves studies, construction, installation, start-up and tuning.
Preventive maintenance	The principle of preventive maintenance is anticipation. It is put into practice in two forms: systematic (periodic) maintenance and condition-based maintenance.
Corrective maintenance	Also called breakdown maintenance, palliative or curative maintenance. This form of maintenance consists of: - troubleshooting on machines whose poor condition results in stoppage, or in operation under intolerable conditions; - repairs.
Systematic maintenance	This consists of servicing equipment at regular intervals, either according to a time schedule or on the basis of predetermined units of use (hours of operation or distance travelled). The aim is to detect failure or premature wear and to correct this before a breakdown occurs. The servicing schedule is usually based on manufacturers' forecasts, revised and adjusted according to experience of previous servicing; this information is recorded in the machine file. This type of maintenance is also called periodic maintenance.
Condition-based maintenance	This type of maintenance, also called predictive or auscultative maintenance, is a breakdown-prevention technique which requires no dismantling, as it is based on inspection by auscultation of the equipment involved. It requires continuous observation of an item of

	equipment in order to detect possible faults or to monitor its condition.
Planned maintenance	Maintenance which is known to be necessary sufficiently in advance for normal planning and preparation procedures to be followed.
Unplanned maintenance	This is maintenance which is not carried out regularly as the need for it is not predictable; it is sometimes called unscheduled maintenance.

Self-Check #2	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions(6 points)

1. Write maintenance requirements?
2. What are the uses of maintenance?
3. Writ the difference between planned and unplanned maintenance?

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

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

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