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**KNOWLEDGE COMPONENT: FACILITATOR FORMATIVE AND SUMMATIVE ASSESSMENT TOOLS AND MODEL ANSWERS: KNOWLEDGE MODULE 2**

**Occupational Certificate: Sugar Processing Machine Operator**

**KNOWLEDGE COMPONENT: FACILITATOR FORMATIVE AND SUMMATIVE ASSESSMENT TOOLS AND MODEL ANSWERS**

**KNOWLEDGE MODULE 2: SUGAR PROCESSING EQUIPMENT AND TECHNOLOGY**

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**OCCUPATIONAL CERTIFICATE: SUGAR PROCESSING MACHINE OPERATOR**

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1. INTRODUCTION TO THE FACILITATOR ASSESSMENT TOOLKIT OF THE OCCUPATIONAL CERTIFICATE SUGAR PROCESSING MACHINE OPERATOR

Dear Facilitator

This Toolkit has been created to assist you to assess the Formative Learning Activities of learners undertaking the NQF 3 Occupational Certificate: Sugar Processing Machine Operator Qualification.

During the programme, Learners must be directed to their Learning and Activities Guide to complete Learning Activities associated with each module of the Knowledge Component.

The time allocated to the Learning Activities is provided in the Facilitator’s Implementation Guide, this Facilitator Assessment Toolkit and Model Answers and the Learning and Activities Guide.

The marks allocated to each Learning Activity are provided in this Facilitator Assessment Toolkit and Model Answers and the Learning and Activities Guide.

**Instructions to be given to Learners**

* They must work individually to present the results of each Learning Activity in each of the Learning and Activities Guides (Workbooks).
* They must complete all the sections.
* They must use a black pen and ensure that they complete the questions in their own handwriting.
* The time provided to complete each activity is shown.
* The marks they will attain for each learning activity are shown in brackets.
1. KNOWLEDGE MODULE 2: SUGAR PROCESSING EQUIPMENT AND TECHNOLOGY

**NQF LEVEL: 3**

**CREDITS: 24**

**PURPOSE OF THE KNOWLEDGE MODULE: The main focus of the learning in this knowledge module is to build an understanding of the mechanical knowledge of equipment, systems and technology used in a sugar processing plant.**

The learning will enable learners to demonstrate an understanding of:

* KM-02-KT01: Equipment hygiene and cleaning (10%)
* KM-02-KT02: Raw and refined sugar processing equipment and technology (30%)
* KM-02-KT03: Introduction to mechanical systems (25%)
* KM-02-KT04: Introduction to process flow and control (5%)
* KM-02-KT05: Mechanical workshop practices (10%)
* KM-02-KT06: Maintenance (10%)
* KM-02-KT07: Energy, utilities and services (10%)

2.1 Knowledge Topic 1: Equipment hygiene and cleaning (10%)

Topic elements to be covered include:

* KT0101 Cleaning processes (CIP)
* KT0102 Cleaning materials and chemicals
* KT0103 Equipment hygiene and product quality standards
* KT0104 Causes of equipment contamination and general preventative and cleaning practices

Internal Assessment Criteria and Weight

* IAC0101 The importance of equipment hygiene can be explained
* IAC0102 Safe handling of cleaning chemical and empty containers can be explained
* (Weight 10%)

**Learning activity 1.1: Individual Learning activity: 15 minutes (14 marks)**



**Learning Objective:** The importance of equipment hygiene can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. Mention six (6) examples of sugar equipment you know. (6)

|  |
| --- |
| Conveyors, cranes, cutters, slicers, diffusers, mills, sugar centrifuges, boilers, evaporators, vacuum pans, crystallizers, shredders, agitators, mixers, driers, packaging equipment, pipes, valves, pumps, |

1. What are the steps involved in sugar processing.(6)

|  |
| --- |
| * Extraction of juice
 |
| * Clarification
 |
| * Concentration and Crystallization
 |
| * Separation of crystals
 |
| * Refining of sugar
 |
| * Recovery of sugar molasses
 |

1. What does Cleaning in place (CIP) mean? (2)

|  |
| --- |
| Cleaning in place, or CIP, refers to all those mechanical and chemical systems that are necessary to prepare equipment for food processing, either after a processing run that has produced normal fouling or when switching a processing line from one recipe to another. Cleaning in place means that cleaning takes place without dismantling the system. |

**Learning activity 1.2: Individual Learning activity: 1.5 hours (70 marks)**



**Learning Objective:** Safe handling of cleaning chemical and empty containers can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. List ten (10) examples of sugar processing equipment. (10)

|  |
| --- |
| * Laboratory Equipment
 |
| * Centrifugals
 |
| * Clarifiers
 |
| * Dryers and Coolers
 |
| * Evaporators
 |
| * Filter Press
 |
| * Cane Mud Filter
 |
| * Pan Instrumentation
 |
| * Entrainment Arrestor
 |
| * Magma Pumps
 |

1. Mention the two ways of performing CIP. (2)

|  |
| --- |
| Single-use cleaning  |
| Recovery CIP. |

1. Mention and discuss four (4) parameters that are used in cleaning. (8)

|  |
| --- |
| **Mechanical force**: The mechanical force in cleaning in place (CIP) is the shear forces created by the flow. Compare cleaning a car with a nozzle on the water hose or without a nozzle. With a nozzle the area through which the water is passing is restricted which increases the velocity of the water and the water jet gets “harder”. In a plant the flow velocity of the cleaning liquids can be increased by pumping it faster. As a general CIP rule it is said that the flow must be turbulent and that the flow velocity should be at least 1.5 m/s to have an adequate mechanical force. |
| **Chemical force**: This force is used to get soil (dirt of any kind) to leave a surface. To get equipment clean chemicals have to be used in combination with the mechanical force of the flow. Most often alkaline detergents are used first. They dissolve protein, fat and sugars (i.e. mostly organic “soil”). The detergent can be pure sodium hydroxide (NaOH) or it can be a formulated detergent. |
| **Thermal force (heat)**: Molecules move faster at an elevated temperature and therefore the effectiveness of a detergent is increased with increased temperature. As a general rule a plant should be cleaned at the same temperature as it has been processing the food. If a higher cleaning temperature is used, then reactions in the soil layers, such as denaturation and crosslinking may be induced, making the soil harder to remove. |
| **The time**, the forces act: how much time the other three forces are in action. Eventually most surfaces will be clean but it will just take longer if the optimal temperature is not used or the correct concentration of detergent or a non-sufficient flow is used. |

1. Discuss the procedure often followed in cleaning the plant.(12)

|  |
| --- |
| * The plant is first pre-rinsed with water at 40-60°C, to remove sugar and melt any fats. The temperature should not exceed 60°C in order to avoid denaturing any native proteins, which would then become much more difficult to clean.
 |
| * Alkaline detergent is then circulated in the system to remove organic soil such as proteins and fats. Alkali is added to the concentration set-point and the temperature is raised to the temperature set-point. The flow is kept at a level giving satisfactorily flow velocity. The alkali step lasts for a pre-set time period.
 |
| * Water is then used to purge out the alkaline detergent plus the dissolved soil.
 |
| * Acidic detergent is then most commonly circulated through the plant to dissolve mineral deposits and lime scale deposits caused by hard water. The frequency of applying an acidic step depends on whether the surfaces are hot or cold, the type of food and the water quality. During the acid step concentration, flow and temperature are kept at their set-points for the pre-set time.
 |
| * Water is then used to purge the acidic detergent and rinse out dissolved soil. The final water rinse must also ensure that any detergent residues are removed and only water is left in the plant. Now the plant should be visibly clean.
 |
| * Disinfection or sterilization is then applied before production starts, in order to kill microorganisms to a certain level. In addition, the results of the cleaning procedure should be verified.
 |

1. What are the main components of all formulated detergents? (2)

|  |
| --- |
| * Alkali
 |
| * Acid
 |

1. Mention and discuss the additional components included in all formulated detergents.(8)

|  |
| --- |
| * **Surfactants**, or wetting agents, that lower surface tension, enabling them to wet a surface more effectively and make cleaning more efficient.
 |
| * **Sequestering agents** can bind calcium and magnesium ions in order to soften water.
 |
| * **Complex-forming agents** can only bind one metal ion per molecule in contrast to sequestering agents, which can bind to a number of metal ions.
 |
| * **Oxidation Agents** can boost cleaning effects. Examples are sodium hypochlorite and hydrogen peroxide.
 |

1. List all three (3) types of the chemical cleaning agents with their weight percentages.(3)

|  |
| --- |
| * NaOH (sodium hydroxide) = 25 – 46 wt%
 |
| * HNO3 (nitric acid) = 52 – 68 wt %
 |
| * H3PO4 (phosphoric acid) = 75 – 85 wt%
 |

1. Describe how the wash-down should be to prevent contaminating the production area. (4)

|  |
| --- |
| All vehicle and equipment that need to enter production areas will be cleaned using high pressure water or compressed air. Wash down should be located in an area between the driveway and farm roads away from the production area. It should be a sealed (concrete or bitumen) surface with a sump to collect waste water and debris. Make sure mud, soil and plant material are kept away from crops, storage areas and waterways. Inspect the area around the wash down facility regularly for the presence of pests or weeds, treat as required. |
| The wash-down area may be the same as that used for chemical wash-down of vehicles and equipment. If so, all occupational health and safety issues associated with chemical wash-down areas must be taken into account. An on-farm wash down facility can also be used to clean machinery before moving between the Sugar Cane Biosecurity Zones; however the machine will still need an inspector’s approval first. |

1. Discuss seven (7) general safety rules at the sugar mill. (7)

|  |
| --- |
| * Smoking, eating and drinking are allowed in designated areas only, never in production areas.
 |
| * Always maintain good personal hygiene. Wash hands before starting work, and after using the toilet.
 |
| * Never touch unpacked products unless absolutely necessary. If touched, the product must be discarded or reprocessed if possible.
 |
| * Plasters must be blue with a metal strip.
 |
| * Earplugs must, if relevant, be metal detectable.
 |
| * Keep doors and windows closed to prevent insects, birds or vermin from entering.
 |
| * Before commencing repair work, the supervisor in charge should be consulted on how to carry out the work so that no products become contaminated.
 |
| * After repair work, production equipment should be restored and cleaned to avoid product contamination. Please make sure to follow the appropriate cleaning procedures.
 |
| * Packaging materials must be used exclusively for the products for which they are intended.
 |
| * Packaging materials, ingredients, processing aids and other chemicals must be stored to avoid contamination.
 |
| * Materials used in contact with food products or intermediate products must be intended for this purpose.
 |
| * Waste containers must be marked and, where possible, covered.
 |
| * Pets are not allowed anywhere at the factory.
 |
| * Always inform your supervisor if you suffer from vomiting, diarrhea, infected wounds or any serious systemic infection, e.g. tuberculosis.
 |

1. Mention six (6) rules that are applied in Hygiene Zone 2. (6)

|  |
| --- |
| * Objects of glass or ceramics are not allowed in the zone, if you find splinters immediately remove them and report to your superior or supervisor.
 |
| * Storage of personal items is not allowed.
 |
| * Cleaning procedures in certain areas may have to be documented. Ask your superior or supervisor
 |
| * Storage of materials of animal origin is not allowed
 |
| * Light fittings (whether for fluorescent tubes or glow lamps) and windows must be made of safety glass if there is a risk of glass splinters contaminating the products
 |
| * Skylights must be of safety glass
 |

1. In Hygiene Zone 3, the maintenance staff must do the following……(4)

|  |
| --- |
| * Use clean and protective clothing
 |
| * Consult the supervisor in charge before commencing work to ensure that the job can be done without contaminating the product
 |
| * Ensure that tools are cleaned before use
 |
| * Return all tools, spare parts etc. when the job is done and clean the production equipment and the working area.
 |

1. Mention four forms of equipment contamination. (4)

|  |
| --- |
| a) Gaseous  |
| b) Fluid |
| c) Semi-solid |
| d) Solid |

2.2 Knowledge Topic 2: Raw and refined sugar processing equipment and technology (30%)

Topic elements to be covered include:

* KT0201 Cane handling equipment
* KT0202 Cane preparation equipment
* KT0203 Juice processing equipment
* KT0204 Crystallisation and crystal recovery equipment
* KT0205 Ancillary boiler equipment

Internal Assessment Criteria and Weight

* IAC0201 Equipment components can be identified from diagrams of the equipment
* IAC0202 The working principles of the equipment can be explained
* IAC0203 The operating principles of the equipment can be explained
* IAC0204 Care for, cleaning and routine maintenance practices can be explained
* (Weight 30%)

**Learning activity 2.1: Individual Learning activity: 15 minutes (17 marks)**



**Learning Objective:** Equipment components can be identified from diagrams of the equipment.

**Task:** Read each question carefully and write your answer in the space provided.

1. Explain the weighing and off-loading process of the harvested cane. (4)

|  |
| --- |
| All harvested cane in the trucks is weighed on a regularly checked weigh-bridge before entering the factory yard. Once over the weigh bridge the cane is transported to the cane unloading yard, where cranes unload the trucks onto the upward inclined cane table or spiller table. This is a chain or slat conveyor, the speed of which can be regulated by an operator. The cane table carrier feeds the cane onto the cane carrier which is a steel slat carrier (apron) or rubber conveyor belt. Empty trucks are weighed again before leaving the yard. Gross and Nett weight, together with the name of the grower, are noted on the weighbridge ticket. |

1. What is a shredder? (1)

|  |
| --- |
| A shredder is a device that tears the cane apart using large metal bars known as hammers. |

1. What is the task of the diffuser or mills? (2)

|  |
| --- |
| It is to extract as much juice from the cane as possible, the walls of these cells must be ruptured before the juice can flow. This is done by exerting pressure on the cane, between rollers. |

1. What is the purpose of a leveller in cane preparation? (2)

|  |
| --- |
| The purpose of a leveller is to cut the cane into shreds and smaller pieces, which is a set of rotating knives above the carrier and two sets of rotating cane knives turning a few centimetres above the horizontal part of the carrier. |

1. Briefly describe the Cane Testing Services. (2)

|  |
| --- |
| The Cane testing services is a neutral bod that acts as an arbitrator to ensure the correct distribution of sucrose between the grower and the miller. It also analyses the mixed juice and the bagasse, to determine the total amount of sucrose entering the factory. On weekly basis this total amount of sucrose is distributed among the cane suppliers in proportion to the sucrose content of their consignment. |

1. What is the pulverised cane discharged by the shedder called? (1)

|  |
| --- |
| Prepared cane |

7. How many rollers are found in the extraction plant and how many rollers in each mill? (2)

|  |
| --- |
| The extraction plant consists of six or seven roller mills called the milling train or tandem. Each mill consists of three rollers |

1. How is the prepared cane fed to the mills? (2)

|  |
| --- |
| The prepared cane is fed to the mills by vertical Donnelly chutes and a feeder drums and enters the opening between the front and the top roller, where juice is extracted. |

9. What is the residue that leaves the last mill called? (1)

|  |
| --- |
| A bagasse. |

**Learning activity 2.2: Individual Learning activity: 10 minutes (14 marks)**



**Learning Objective:** The operating principles of the equipment can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. Define imbibition. (2)

|  |
| --- |
| Imbibition is a special type of diffusion when water is absorbed by solids colloids causing an enormous increase in volume. Examples include the absorption of water by seeds and dr wood. Water potential gradient between the absorbent and the liquid imbibed is essential for imbibition. |

1. What is the difference between a bagasse diffuser and cane diffuser? (2)

|  |
| --- |
| Bagasse diffuser has one or two extraction units (mills) between cane preparation and the diffuser has none. |

1. What is the advantage of a diffuser over that of a milling train? (2)

|  |
| --- |
| The advantage of a diffuser is the relatively low maintenance cost compared with that of a milling train, with a higher extraction. |

1. What colour is the mixed juice before purification? (1)

|  |
| --- |
| Is cloudy, greyish or greenish foaming liquid. |

1. List the five (5) steps that are followed to remove impurities from the mixed juice. (5)

|  |
| --- |
| * Heating to +/- 104°C
 |
| * Liming of mixed juice (defecation process)
 |
| * Settling of mud
 |
| * Decanting of the clear juice
 |
| * Filtration of the mud
 |

1. Mention two (2) stages of mixed juice heating. (2)

|  |
| --- |
| * Primary heating to 70°C
 |
| * Secondary heating to approximately 104°C
 |

**Learning activity 2.3: Individual Learning activity: 2 hours (82 marks)**



**Learning Objective:** Care for, cleaning and routine maintenance practices can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. What is a flocculant? (1)

|  |
| --- |
| A flocculant is a substance which promotes the clumping of particles |

1. What are the two essential things that need to be kept constant in order to obtain maximum purification? (2)

|  |
| --- |
| * pH
 |
| * Temperature
 |

1. Also used for manual pH controls are a)………………. and b)…………………..(2)

|  |
| --- |
| * Phenol red
 |
| * Bromothymol blue
 |

1. Mention two (2) disadvantages of using milk of lime with high concentration. (2)

|  |
| --- |
| * Part of lime does not dissolve
 |
| * These undissolved lime particles cause a high alkaline reaction in the clarifier, resulting in destruction of reducing sugars
 |

1. Name the two (2) functions of the rotating shaft. (2)

|  |
| --- |
| * Feeding the four compartments
 |
| * Scraping the mud from the sloping trays (4 scraper arms with scrapers are fitted to the shaft, one set for each of the four trays)
 |

1. For proper clarification the following points should be kept in mind. List four (4) points.(4)

|  |
| --- |
| * An alkaline reaction causes destruction of reducing sugars, coloured products are formed and it will increase viscosity in massecuites and molasses, causing poor curing, lower exhaustion and affecting the quality of the sugar.
 |
| * An acid reaction causes inversion of sucrose (the pH of clarified juice should always be kept at +/- 7.0)
 |
| * Higher temperature speeds up the two reactions above.
 |
| * Short retention times are desirable, as the reactions above are time dependent.
 |

1. Name and discuss the two (2) types of clarifiers found in South African factories. (4)

|  |
| --- |
| **The SRI Clarifier** is made up of a cylindrical tank in which circumferential launders are fitted. The juice is fed into the feed launder tangentially at one or more points. The feed launder encircles the feed well and by means of slots made on its inner edge, juice is distributed evenly. The feed-well extends downwards for a little more than one metre. Beneath the feed-well there is a deflector plate that directs the descending juice toward the centre and the periphery. A cone of separation is soon established in which the clear juice travels up to the outlet launders and the solids to the bottom where they are withdrawn. There are two or three juice outlet launders, one on each side of the feed launder. They are provided with slots on their inside and outside, to allow juice to be withdrawn from the entire surface area. The main advantage of the SRI Clarifier is its short retention time.  |
| **The Rapi-Dorr Clarifier** is operated on the counter-flow principle. The juice is admitted at the top centre and moves out towards the periphery where it is extracted at the point of lowest velocity. The separated mud is collected on the trays and is pushed by means of scrapers until it falls to a thickening chamber where it is compacted before being withdrawn. The main disadvantage of this clarifier is its long juice retention time which enhances sucrose losses. |

1. What are the two stages involved when removing considerable quantities of water by evaporation? (2)

|  |
| --- |
| * In the first stage, only water is evaporated. This is done by evaporators.
 |
| * In the second stage, water is evaporated and sugar is crystallised. For this second stage vacuum pans are required.
 |

1. What are the advantages of the Kestner evaporator? (2)

|  |
| --- |
| It has a much larger heating surface, higher juice velocities, hence less scaling and better heat transfer. |
| The retention time in the first vessel will be reduced. |

1. Define entrainment. (1)

|  |
| --- |
| Entrainment is the carrying over of small juice particles with and by the vapour.  |

1. Name the chemical that is used in cleaning the tubes of the evaporator. (1)

|  |
| --- |
| Sulphamic acid (a strong acid crystalline compound used in cleaning agents) with an inhibitor or Caustic Soda |

1. What causes entrainment? List three (3) points. (3)

|  |
| --- |
| * A high juice level
 |
| * A high vacuum (0.15 Bar absolute and higher)
 |
| * A sudden drop in pressure above the juice, causes flashing and heavy entrainment
 |
| * Poor pan boiling schedule, with two or more pans starting up at the same time causing a sudden increase of vapour extraction
 |
| * Irregular crushing, causing juice surges.
 |
| * Fluctuating steam pressures (in the 1st vessel)
 |

1. The evaporators consist of the following parts: The vapour pipe, the condenser, Injection water, Airline, The Calandria, The baffles and the Steam trap. Describe each of these parts. (14)

|  |
| --- |
| * **The vapour pipe:** It is the big pipe connecting the dome and the calandria of the next vessel. It carries the vapour from the vapour space of the proceeding evaporator to the steam chest of the calandria of the next evaporator.
 |
| * **The condenser:** In order to maintain the vacuum, the vapour liberated by the last bodies must be condensed. A condenser is a closed cylindrical vessel at the upper part of which is a cold water inlet.
 |
| * **Injection water:** This is cold water supplied to the condenser to condense the vapour and remove it together with its heat in order to maintain vacuum. The water is broken into a sheet to increase its surface area for coming into contact with the hot vapour. Cold water is pumped to the condensers of all the pans and evaporator and into the seal pit, drained to the cooling tower where it is cooled and re-used again.
 |
| * **Airline:** The airline which originates from a vacuum pump is connected to the condenser and helps to suck air or incondensable gas.
 |
| * **The Calandria:** Is the heating surface of the evaporator. It is fitted with tubes which provide the surface for heat exchange. Outside the tubes we have the steam and inside the tubes we have the juice which, on being heated, forms bubbles, which rise in the tube to the liquor belt. When these bubbles burst, the vapour discharged goes to the vapour belt and the juice flows slowly into the down take. The down take is a big hole at the centre of the calandria.
 |
| * **The baffles:** These are plates which are in the calandria with the tubes which help to guide the steam to get a fair distribution of steam to all the tubes and to guide the incondensable gases to where they are removed.
 |
| * **Steam trap:** The condensate lines of the Kestner and the first vessels are fitted with a steam trap. The steam trap allows water to go out but not the steam.
 |

15. What is the mixture of sugar crystals and mother liquor called? (1)

|  |
| --- |
| The mixture is called “massecuite” |

1. The problems of false grain cannot be over emphasized. List four (4) of the problems. (4)

|  |
| --- |
| * Time between the boiling is increased due to washing of the massecuite to eliminate false grains. (NB: Washing will dissolve small crystals and reduce in size the big ones)
 |
| * Poor mother liquor exhaustion due to failure to reach required brix, a common problem in the final strikes.
 |
| * Purging of strikes containing false grains lowers centrifugal capacity.
 |
| * Losses in final molasses are increased due to false grains passing through the screen apertures.
 |

1. Name two (2) types of centrifugals. (2)

|  |
| --- |
| * Batch centrifugals
 |
| * Continuous centrifugals
 |

1. Discuss three advantages of continuous centrifugal machines. (6)

|  |
| --- |
| * Capable of curing massecuites of a much higher viscosity and lower purity, which leads to better exhaustion of the massecuite. Some factories are able to cure “C” massecuites with an average purity of 45, against a purity of 58 with a batch type machine. A better exhaustion means less sucrose losses in the final molasses and more sugar in the bag.
 |
| * A poor quality massecuite, which is difficult to handle in a batch type centrifugal, may cure reasonably well in a continuous machine.
 |
| * They charge and discharge continuously, so there is no shock effect of molasses and sugar being discharged in batches
 |
| * It is a simple machine, so less maintenance costs.
 |
| * It has no frequent electrical peak loads from starting up as the batch type machine has.
 |
| * Maximum labour saving. For example:
* 4 batch type A centrifugals would require 3 attendants per day
* 15 continuous centrifugals require 3 attendants per day
 |

1. Crystals are found in molasses when the following occurs. (3)

|  |
| --- |
| * A centrifugal screen is worn or damaged
 |
| * Overfilling of a batch type centrifugal
 |
| * Poor pan boiling causing false grains (often very small) which might pass the screen
 |

1. Name the two (2) components found in the final molasses. (2)

|  |
| --- |
| Water content of 15% |
| Dry matter content of 50% consisting of sucrose, reducing sugars and salts |

1. Define the following: Pan, Batch pan, Continuous pan, Molasses, Seed magma, Proof stick, Vacuum breaker and Feed manifold. (16)

|  |
| --- |
| * Pan: A pan is a single effect evaporator in which boiling occurs under vacuum. There are two types of pans, namely batch and continuous pan.
 |
| * Batch pan: A batch pan is a vertical cylindrical vessel consisting of a calandria and a vapour space. During boiling, a set quantity of seed is introduced and syrup or molasses is fed until the pan is full. Once the boiling cycle is completed, the produce (massecuite) is discharged and another boiling cycle is started.
 |
| * Continuous pan: A continuous pan is a horizontal vessel with a number of compartments or cells (usually 12) connected in series. The seed is continuously fed to the first compartment and flows through ach compartment until it reaches the last compartment. Syrup or molasses is fed to each compartment and the product (massecuite) is continuously withdrawn from the last compartment. There are two types of continuous pans used in the SA Sugar Industry namely a horizontal tube type (e.g. FCB pan) and a vertical tube type (e.g. Tongaat-Hulett pan).
 |
| * Molasses: Mother liquor that is separated from the crystals in the centrifugal plant.
 |
| * Seed magma: Low grade sugar mingled with syrup, water or clear juice which can be drawn into a pan to start a high grade strike.
 |
| * Proof stick: This is placed on the pan to enable sample taking from the pan without allowing air to get into the pan. This is used by the pan boiler frequently during boiling to see the state of the crystals and the massecuite.
 |
| * Vacuum breaker: This is a valve used to break the vacuum during discharging or cutting of massecuite.
 |
| * Feed manifold: The feed distribution system is connected to the feed manifold, which is either in front of the pan or in some factories is below the molasses tanks. The feed manifold is provided with valves which are connected to the molasses and syrup supplies.
 |

1. What is the boiler? (2)

|  |
| --- |
| A boiler is an enclosed vessel that provides a means for combustion and transfers heat to water until it becomes hot water or steam. |

1. Mention and discuss the three (3) systems that boilers are made up of. (6)

|  |
| --- |
| * **Feed water system** provides water to the boiler and regulates it automatically to meet the steam demand. The water supplied to the boiler that is converted to steam is called feed water. The sources of feed water are:
* Condensate or condensed steam returned from the processes
* Makeup water which is the raw water which must come from outside the boiler room and plant processes
 |
| * The **steam system** collects and controls the steam produced in the boiler. Steam is directed through a piping system to the point of use. Throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges.
 |
| * The **fuel system includes** all equipment used to provide fuel to generate the necessary heat. The equipment required in the fuel system depends on the type of fuel used in the system.
 |

2.3 Knowledge Topic 3: Introduction to mechanical systems (25%)

Topic elements to be covered include:

* KT0301 Material handling equipment (actuators, elevators, conveyors)
* KT0302 Pumping systems (pipes, fittings, valves)
* KT0303 Drives (direct and indirect drivers) (motors, turbines, hydraulic, gear boxes, clutches)
* KT0304 Scales
* KT0305 Air moving equipment (fans, compressors, vacuum pump)

Internal Assessment Criteria and Weight

* IAC0301 Equipment components can be identified from diagrams of equipment
* IAC0302 The working principles of the equipment can be explained
* (Weight 25%)

**Learning activity 3.1: Individual Learning activity: 30 minutes (32 marks)**



**Learning Objective:** Equipment components can be identified from diagrams of the equipment.

**Task:** Read each question carefully and write your answer in the space provided.

1. What is the material handling equipment? (2)

|  |
| --- |
| Material handling equipment is all equipment that relates to the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. Material handling equipment is used to increase throughput, control costs, and maximize productivity. |

1. What is an actuator? (2)

|  |
| --- |
| An actuator is a motor that converts energy into torque which then moves or controls a mechanism or a system into which it has been incorporated. It can introduce motion as well as prevent it.  |

1. How do actuators operate? (2)

|  |
| --- |
| An actuator typically runs on electric power or on pressure (such as hydraulic or pneumatic).The control system can be controlled mechanically or electronically, software driven or human operated. |

1. Name and describe six (6) different types of actuators. (12)

|  |
| --- |
| * **Pneumatic motors** are air driven, using either vacuum or compressed air, which converts energy into linear or rotary motion. Air pressure and flow determine both speed and torque. These are used in applications in which positional accuracy is not a requirement.
 |
| * **Hydraulic motors** move a piston through a tube using pressurized fluid. The higher the fluid pressure, the higher the torque produced. Hydraulic motors output linear, rotary, or oscillating motion but acceleration is limited. Hydraulic motors are typically inefficient, can be a fire hazard and require more than usual maintenance.
 |
| * **Clutch/Brake** motors function by coupling a continuously rotating shaft with a load, stopping only when the load is uncoupled. While this motor is easy to apply, relatively inexpensive, and great for light loads, its acceleration is uncontrolled as well as inaccurate.
 |
| * [**Stepper motors**](http://www.tigertek.com/stepper-motor-repair.html) (DC motor) are electromechanical, converting a digital pulse into rotational movement or displacement. While stepper motors are not good for varying loads and are typically not energy efficient, they are great for constant loads and positional accuracy.
 |
| * **AC Motors** (induction type) use electric starters to provide connections, startup, and/or overload protection. While Induction motors are more commonly thought of as having constant speeds, the introduction of microprocessor technology provides some variable speed capabilities.
 |
| * [**Servo motors**](http://www.tigertek.com/servo-motor-repair.html) (DC motor) are extremely high performing with few weaknesses. Servos provide speed control and position accuracy due to its feedback device, are small, and priced relatively low.
 |

1. Name three (3) different types of elevators. (3)

|  |
| --- |
| * Building lift
 |
| * Capsule lift
 |
| * Hydraulic elevator
 |

1. What is a conveyor system? (2)

|  |
| --- |
| Conveyor systems are mechanical devices or assemblies that transport material with minimal effort |

1. Name two (2) types of conveyors used in the Sugar factory. (2)

|  |
| --- |
| * Slat type
 |
| * Rake type
 |

1. List seven (7) types of conveyors. (7)

|  |
| --- |
| * Belt
 |
| * Roller
 |
| * Powered Roller
 |
| * Slat/Apron
 |
| * Ball Transfer
 |
| * Magnetic
 |
| * Bucket
 |
| * Chute
 |
| * Drag/Chain/Tow
 |
| * Overhead
 |
| * Pneumatic/Vacuum
 |
| * Screw/Auger
 |
| * Vertical
 |
| * Vibrating
 |
| * Walking Beam
 |
| * Wheel
 |

**Learning activity 3.2: Individual Learning activity: 10 minutes (15 marks)**



**Learning Objective:** Equipment components can be identified from diagrams of equipment.

**Task:** Read each question carefully and write your answer in the space provided.

1. What is the function of pipes? (2)

|  |
| --- |
| Pipes transfer liquids or gases from one point to another, often with the help of pumps. |

1. Describe two kinds of material used to make different pipes and tubes in the Sugar industry. (2)

|  |
| --- |
| The most common material, in your field, would be galvanised or black piping |

1. Identify and name the following chain vices. (3)

|  |
| --- |
| Chain vice 1Top screw bench chain vice |
| Chain vice 2Portable tristand chain vice |
| Chain vice 4Bottom screw bench chain vice |

1. What do the following acronyms stand for? (4)

|  |
| --- |
| * NPT: National pipe taper
 |
| * BSPT: British standard pipe parallel
 |
| * NPSM: National pipe straight mechanical
 |
| * ISO: International standards organisation
 |

1. Sockets are available in two types. Name and state their functions. (4)

|  |
| --- |
| The equal socket and reducing socket |
| The equal socket is for joining pipe sections together, while the reducing socket is used for joining dissimilar pipes together. |

**Learning activity 3.3: Individual Learning activity: 15 minutes (19 marks)**



**Learning Objective:** Equipment components can be identified from diagrams of equipment.

**Task:** Read each question carefully and write your answer in the space provided.

1. What are valves used for? (2)

|  |
| --- |
| Valves are used to regulate, isolate, control and shut off the flow of liquids and gases in a pipe line |

1. List five (5) types of valves. (5)

|  |
| --- |
| * Gate valves
 |
| * Diaphragm valves
 |
| * Safety relief valves
 |
| * Non-return valves
 |
| * Globe valves
 |
| * Butterfly valves
 |
| * Ball valves
 |
| * Slide valves
 |
| * Float valves
 |

1. What is the most common type of diaphragm valve? (1)

|  |
| --- |
| Saunders valve |

1. What causes the safety relief valve to blow? (2)

|  |
| --- |
| A safety relief valve can be set to blow off when the pressure build up exceeds the safe working pressure of the system. |

1. Complete the following diagram of a safety relief valve. (9)



|  |
| --- |
| 1.Operating handle |
| 2.Valve body |
| 3.Top washer |
| 4.Bottom washer |
| 5.Operating lever |
| 6.Yoke |
| 7.Coil spring |
| 8.Pivot pin |
| 9.Valve cap |

**Learning activity 3.4: Individual Learning activity: 15 minutes (17 marks)**



**Learning Objective:** The working principles of the equipment can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. Define the hydraulic motor and its function? (3)

|  |
| --- |
| A hydraulic motor is a device that converts fluid energy to rotary motion and force. |
| The function of a motor is opposite that of a pump; oil under pressure is forced in and spilled out, converting fluid force into mechanical force. |

1. What is a turbine? (2)

|  |
| --- |
| A turbine is a device that harnesses the kinetic energy of some fluid such as water, steam, air, or combustion gases and turns this into the rotational motion of the device itself. These devices are generally used in electrical generation, engines, and propulsion systems and are classified as a type of engine. |

1. List four (4) types of turbines. (4)

|  |
| --- |
| * Water turbines
 |
| * Steam turbines
 |
| * Gas turbines
 |
| * Wind turbines
 |

1. Name and briefly discuss the functions of a hydraulic system. (8)

|  |
| --- |
| * **To transmit power**
	+ Power is transmitted by means of the hydraulic fluid
	+ A pump is used to create a pressure build up in the fluid
	+ This is energy in the fluid which can then be transferred
 |
| * **To lubricate**
	+ Mechanical hydraulic components are lubricated by the hydraulic oil through it, eliminating the need for external lubrication.
 |
| * **To cool the system**
* Circulation of hydraulic oil in a system allows it to be an effective heat dissipater.
 |

**Learning activity 3.5: Individual Learning activity: 1.5 hours (53 marks)**



**Learning Objective:** The working principles of the equipment can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. Name the five (5) basic components of a hydraulic circuit. (5)

|  |
| --- |
| * Reservoir,
 |
| * Pump,
 |
| * Actuator,
 |
| * Pressure relief valve,
 |
| * Piping,
 |
| * Hydraulic fluid
 |

1. The pressure accumulator can carry out many tasks in a hydraulic circuit, list them. (4)

|  |
| --- |
| * Fluid reserve
 |
| * Emergency unit
 |
| * Cushion vibrations
 |
| * Leakage compensation
 |

1. List 5 different types of accumulators. (5)

|  |
| --- |
| * Weight loaded accumulators
 |
| * Spring loaded accumulators
 |
| * Gas pressure
 |
| * Piston type accumulators
 |
| * Bladder accumulators
 |

1. What is a gear? (2)

|  |
| --- |
| A gear can be defined as a toothed wheel that works with others to alter the relation between the speed of a driving mechanism (such as the engine of a vehicle) and the speed of the driven parts (the wheels). |

1. Describe the different types of gears and the conditions under which they are used. (12)

|  |
| --- |
| * Spur gears
* Extensive use in motor vehicles
* Where medium speed reductions are required.
 |
| * Helical:
* Where quiet operation is required
* Where heavy loads are transmitted.
 |
| * Double:
* Where end thrust is to be eliminated.
 |
| * Worm and wheel:
* Dividing head of a milling machine
* Elevators
 |
| * Bevel:
* Used in the raising and lowering of tables in drilling, milling machines etc.
 |
| * Rack and pinion:
* Moving the saddle of the lathe.
* Electric gates
 |

1. Name two disadvantages of the cone clutch. (2)

|  |
| --- |
| A consideration axial force is needed to keep the clutch engaged which results in a high end thrust |
| Slip occurs between the engaging surfaces which results in wear |

1. Explain under what conditions a centrifugal clutch would be used? (2)

|  |
| --- |
| Centrifugal clutches are used where motors have to start against heavy loads. In order to reduce the starting current between an electric motor and the driven member, a centrifugal clutch is used. |

1. What are the advantages of using a multi-plate disc clutch? (3)

|  |
| --- |
| Engagement is possible while machine is in motion |
| A large torque can be transmitted |
| Can be used where space is limited |

1. Name three different types of mechanical balances used in the industry. (3)

|  |
| --- |
| * An analytical balance with a range from 0 to around 200g and a reading precision of 0,0001g.
 |
| * A light duty balance with a range from 0 to around 3000g and a reading precision of 0,01g.
 |
| * A heavy duty balance with a range from 0 to around 3000g and a reading precision of 0,1g.
 |

1. What precautions should be observed when using a balance? Name five. (5)

|  |
| --- |
| * The balance must be positioned in a permanent place on a firm foundation as free as possible from vibration. Specially constructed tables are usually used.
 |
| * The balance must be shielded from draughts and from heat.
 |
| * The balance must be level.
 |
| * If the balance must be moved it must be done by a competent person.
 |
| * The balance must be clean. All spillages must be cleaned up immediately. Powder spillages must be swept immediately. Liquor spillages must be wiped up at once. A damp cloth must be used to wipe the spill and then the balance must be dried well.
 |
| * The maximum load of the balance (capacity) must be checked. This is stated on the balance and must not be exceeded under any circumstances.
 |
| * Check that the accuracy required by the analysis is available from the balance being used.
 |
| * Check the zero position of the balance and if necessary reset.
 |
| N.B. The levelling and resetting are the only adjustments that a laboratory worker may make to the balance. If anything else is found to be wrong, it must be reported to the supervisor. |
| * The balance must always be used according to the manufacturer’s instructions.
 |
| * All movement of dials and the addition and removal of objects must be done gently.
 |
| * The object to be massed must be at the same temperature as the balance. Warm objects in the balance cause air currents which render the massing inaccurate. Unequal expansion of the beam will introduce errors.
 |
| * Powders and liquids must be massed in suitable containers.
 |
| * Desiccants must not be placed in the balance as the air inside and outside the case should be in equilibrium.
 |
| * After massing the balance must be reset. All the dials must be set to zero. All traces of spillages and all vessels must be removed from the balance.
 |
| * The doors of the balance must be closed after use (if applicable).
 |

1. What is the function of vacuum pumps? (2)

|  |
| --- |
| Vacuum pumps are required to remove the incondensable gases from evaporator and pan condensers. |

1. Name four ways in which a pump transfers liquid. (4)

|  |
| --- |
| * by a rotating impeller – in centrifugal pumps
 |
| * by means of gear teeth – in gear pumps
 |
| * by means of oscillation – in reciprocating pumps
 |
| * by a vacuum created – in a peristaltic pump
 |
| * by a rotating impeller – in centrifugal pumps
 |

1. Explain how a pump can be primed. (4)

|  |
| --- |
| * Open al pet-cocks. A pet cock allows all the air trapped inside a pump to escape whilst priming.
 |
| * Fill the pump with water, from an outside source, until it runs out of the pump through the pet cock in the delivery side of the pump.
 |
| * Close all the pet cocks
 |
| * Switch the pump on.
 |

2.4 Knowledge Topic 4: Introduction to process flow and control (5%)

Topic elements to be covered include:

* KT0401 Flow diagrams and symbols
* KT0402 Instrumentation and control systems
* KT0403 Process communication (Up-stream and down-stream)

Internal Assessment Criteria and Weight

* IAC0401 Equipment and process stages can be identified from a flow diagram
* IAC0402 Instrumentation and control systems can be identified and the uses explained
* (Weight 5%)

**Learning activity 4.1: Individual Learning activity: 10 minutes (17 marks)**



**Learning Objective:** Equipment and process stages can be identified from a flow diagram. **Task:** Read each question carefully and write your answer in the space provided.

1. List nine steps in the manufacturing process of sugar. (9)

|  |
| --- |
| * Cleaning
 |
| * Slicing
 |
| * Juice extraction
 |
| * Pressing
 |
| * Purification
 |
| * Evaporation
 |
| * Crystallization
 |
| * Refinery separation
 |
| * Packaging
 |
| * Cleaning
 |

1. How is each step of sugar production from cane monitored for quality and quantity parameters? (2)

|  |
| --- |
| By sampling and readings of meters, gauges and recorders. Every operator is constantly monitoring and recording the readings of motors, meters, recorders and gauges at his/her station regularly |

1. The goal of instrumentation and control is to improve……? (6)

|  |
| --- |
| * Productivity
 |
| * Optimization
 |
| * Stability
 |
| * Reliability
 |
| * Safety
 |
| * Continuity
 |

**Learning activity 4.2: Individual Learning activity: 30 minutes (29 marks)**



**Learning Objective:** Instrumentation and control systems can be identified and the uses explained**.**

**Task:** Read each question carefully and write your answer in the space provided.

1. Name and discuss the challenges to solid level measurement. (8)

|  |
| --- |
| * Shape of the material surface

The surface slope of solids may be flat and smooth but more often they have a sloped and irregular cone shape surface known as the angle of repose. This shape of the surface can be affected by many variables such as the location of filling or multiple fill points for example. Calculating the level of the material becomes difficult with the angle of repose. |
| * Material Characteristics

Particle size ranges from very fine powders like flour to very coarse materials like coal. The coarser the material, the more likely it is to clump, or leave space and pile up. Larger solid materials present an added challenge of multiple angles on the surface of the material. |
| * Internal vessel structure

It can be difficult to know the exact dimensions of the silo or tank the material is stored in. The vessel may also have ridges and other rough surfaces which could affect the ability of some technology to get an accurate level reading or calculate the correct volume or mass of the material. |
| * Dust

Many materials produce large amounts of dust during filling and discharging of the material which could cause interference with a level reading |

1. List 5 types of solid level measuring sensors. (5)

|  |  |
| --- | --- |
| * Vibrating point level sensors
 |  |
| * Paddle wheel sensors
 |
| * Ultrasonic level sensors
 |
| * Laser sensors
 |
| * Load cells
 |
| * Radar sensors
 |
| * Microwave level sensors
 |
| * Float level sensors
 |
| * Optical level sensors
 |

1. At the cane preparation stage the following is measured and controlled. (8)

|  |
| --- |
| * The flow rate of the cane towards the cutter – the flow rate will depend on the capacity of the cutter.
 |
| * The size of the pieces.
 |
| * The thickness of the cane blanket on the conveyor belt should be uniform.
 |
| * A representative sample of cane is taken after the shredder and analysed for sucrose content in the laboratory.
 |

1. List the variables that need to be controlled in the evaporator. (8)

|  |
| --- |
| * Feed flow rate
 |
| * Syrup Concentration (composition)
 |
| * Temperature of the juice
 |
| * Pressure of the vapour
 |
| * Steam flow rate
 |
| * Vacuum in the pans
 |
| * Steam pressure in the steam chest
 |
| * The condensates must be checked for sugar (it is very dangerous to have sugar in the boiler feed-water)
 |

2.5 Knowledge Topic 5: Introduction to mechanical systems (10%)

Topic elements to be covered include:

* KT0501 Tools and measuring equipment for lubricating and cleaning
* KT0502 Mechanical workshop safety
* KT0503 Basic engineering symbols
* KT0504 Use of equipment manuals
* KT0505 Properties and use of lubricants, sealants, fasteners and locking devices

Internal Assessment Criteria and Weight

* IAC0501 The use of technical manuals and engineering symbols can be demonstrated
* IAC0502 Workshop tools and measuring instruments can be identified and their uses explained
* IAC0503 Workshop safety practices can be explained
* IAC0504 Tools, equipment and materials used for lubrication and cleaning used for general equipment maintenance can be identified and their uses explained
* (Weight 10%)

**Learning activity 5.1: Individual Learning activity: 40 minutes (47 marks)**



**Learning Objective:** Tools, equipment and materials used for lubrication and cleaning used for general equipment maintenance can be identified and their uses explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. List 10 lubrication and cleaning tools and measuring equipment. (10)

|  |
| --- |
| * Grease guns
 |
| * Grease packer
 |
| * Grease filler pumps
 |
| * Grease pumps
 |
| * Oil levellers
 |
| * Oil handling containers
 |
| * Bearing packer
 |
| * Grease meter
 |
| * Disposable grease resistant gloves
 |
| * Grease fitting caps and tags
 |
| * Broom
 |
| * Brush
 |
| * Floor scrubber
 |
| * Vacuum cleaner
 |
| * Wash rack
 |
| * Soap shaker
 |
| * Mop
 |
| * Hot water
 |

1. What are the employee’s responsibilities toward safety? (4)

|  |
| --- |
| Employees should avail themselves of the safety and health rules of the workshop. |
| Each employee should be aware of and avoid unsafe conditions and be aware of the regulations applicable to his work environment to control or eliminate any hazards or other exposures to illness or injury. |

1. What should be considered when one assesses machinery and equipment for possible mechanical hazards? (8)

|  |
| --- |
| * Machinery and equipment with moving parts that can be reached by people
 |
| * Machinery and equipment that can eject objects (parts, components, products or waste items) that may strike a person with sufficient force to cause harm
 |
| * Machinery and equipment with moving parts that can reach people, such as booms or mechanical appendages (arms)
 |
| * Mobile machinery and equipment, such as forklifts, pallet jacks, earthmoving equipment, operated in areas where people may gain access.
 |

1. What are examples of unsafe conditions in the workplace? (7)

|  |
| --- |
| * Machines with **unguarded** pulleys, gears or other dangerous moving parts.
 |
| * **Slippery** floors.
 |
| * **Sharp** objects.
 |
| * Unsafe **storage**.
 |
| * Poor **lighting**.
 |
| * Improper **ventilation**.
 |
| * Noise.
 |

1. True or False: Engineering drawings, electrical instructions and tool instruction manuals all use different symbols to denote universal concepts within each field. (1)

|  |
| --- |
| True |

1. What do manufacturer instructions provide us with? (6)

|  |
| --- |
| They provide with the technical information that you require helping you assess the level of risk associated with that piece of equipment. This information then assists you to decide what PPE to wear, what environmental conditions should be adhered to and what would be considered an unsafe practice. Manufacturer’s instructions explain what the equipment is used for, what the technical information regarding the piece of equipment is, and how to maintain that piece of equipment. |

1. Name three types of lubricants available for commercial use. (3)

|  |
| --- |
| * liquids
 |
| * semi-solids
 |
| * solids
 |

1. List two types of mechanical locking devices and they function. (4)

|  |
| --- |
| * split washers and nylon nuts
 |
| were invented to solve the common problem of loosening that occurs in most threaded assemblies |

1. List 4 shortcomings of Mechanical Locking Devices. (4)

|  |
| --- |
| * Loosen under vibration, thermal expansion and/or improper torque
 |
| * Do not seal threads
 |
| * Require extensive inventory of several shapes and sizes
 |
| * Prone to rust
 |

2.6 Knowledge Topic 6: Maintenance (10%)

Topic elements to be covered include:

* KT0601 Preventative maintenance
* KT0602 Care for assets

Internal Assessment Criteria and Weight

* IAC0601 The importance of preventative maintenance and care for assets can be explained
* (Weight 10%)

**Learning activity 6.1: Individual Learning activity: 45 minutes (37 marks)**



**Learning Objective** The importance of preventative maintenance and care for assets can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. The preventive maintenance function is sub-divided into….? (2)

|  |
| --- |
| Preventive maintenance of production departments and |
| Preventive maintenance of plant services. |

1. Name and discuss 4 forms of preventive maintenance. (8)

|  |
| --- |
| **Time-based preventive maintenance:** This refers to conducting maintenance at regular intervals, e.g., every two months, etc. It is easy to monitor time and this form is used when deterioration is likely to be time rather than usage-dependent, or when usage cannot easily be measured. |
| **Work-based preventive maintenance:** Maintenance performed after a set number of operating hours of volume of work produced, e.g., every 40,000 photocopies in a xerox machine, etc. Usage can be more difficult than time to monitor and some form of ‘auto-counting’ of output should be used, if possible. |
| **Opportunity-based preventive maintenance:** Repair or replacement takes place when the equipment or system is devoid of work, e.g., during a holiday. |
| **Condition-based preventive maintenance:** This method often relies on planned inspection to reveal when maintenance is prudent, e.g., replacement of a brake pad when it has worn to 2mm thickness. This is dependent on monitoring the equipment condition which can be difficult, and impractical if a time-consuming strip-down precedes any examination or inspection. |

1. Several other terms which are often used as synonyms for preventive maintenance are? (12)

|  |
| --- |
| * **Running Maintenance:** In running maintenance the preventive maintenance work is carried out while the equipment is in service.
 |
| * **Shutdown Maintenance:** In shutdown maintenance the preventive maintenance work is carried out when the equipment is out of service.
 |
| * **Servicing:** In servicing, the minor activities like cleaning, lubrication, etc., are carried out at planned intervals.
 |
| * **Scheduled Maintenance:** Scheduled maintenance system provides for inspection, overhauling, lubrication, and servicing of certain machines at predetermined dates. For example, overhauling of machines, cleaning of tanks and white washing of buildings are normally done in this manner. This type of maintenance is, therefore, practiced to a certain extent, even in those companies where breakdown maintenance is otherwise a rule. Pre-determination of dates of commencement of maintenance work ensures comparatively better allocation of manpower, keeping in view the requirements of production and other activities of the maintenance crew. Mere scheduling, however, is not sufficient. It cannot ensure completion of work in time because the nature and details of work required to be done remain unknown. It consequently leads to an increased down-time due to non-availability of requisite skill and materials. For the same reason, allocated manpower may also remain underutilized.
 |
| * **Planned Maintenance:** Planned maintenance represents advancement over the above mentioned types of maintenance practices. Briefly stated, planned maintenance visualizes the work contained in a future job, determines the best method to be adopted and skills required for its execution, estimates the time, material and costs involved in assigned jobs and programmes that work to specific time periods on the basis of priority. Planned maintenance also provides for a system of feedback of information for necessary changes in the original plan.
 |
| * **Predictive Maintenance:** A new type of preventive maintenance known as predictive maintenance is becoming popular. It involves the use of sensitive instruments to predict trouble. Such maintenance helps in determining the need for and time of overhauling.
 |

1. What are the various elements of a preventative maintenance system in an industry? (10)

|  |
| --- |
| * An [inventory](https://accountlearning.com/risks-cost-holding-inventory-firm/) of all the plant and equipment that need to be maintained.
 |
| * Categorization of equipment to assess the relative importance and thereby determine the equipment requiring preventive maintenance
 |
| * A well-designed inspection system.
 |
| * A good lubrication system i.e., regular cleaning, greasing and oiling of the moving parts
 |
| * Maintenance of adequate records and analysis of the same.
 |
| * Planning of maintenance work.
 |
| * Control of maintenance stores and spares.
 |
| * Organization for preventive maintenance work.
 |
| * Replacement of worn-out parts before they fail to operate.
 |
| * Provision of stand-by machines for critical equipment.
 |

1. List the important objectives of preventative maintenance. (5)

|  |
| --- |
| * To minimize the possibility of unanticipated production interruptions by locating or uncovering any condition which may lead to it.
 |
| * To make plant equipment and machines always available and ready for use.
 |
| * To maintain the value of the equipment and machinery by conducting periodic inspection, repairs, overhauling, etc.
 |
| * To reduce the work content of maintenance jobs.
 |
| * To ensure safety of life and limbs of the workmen.
 |

2.7 Knowledge Topic 7: Energy, utilities and services (10%)

Topic elements to be covered include:

* KT0701 Steam
* KT0702 Electricity
* KT0703 Compressed air
* KT0704 Water

Internal Assessment Criteria and Weight

* IAC0701 The uses of energy, utilities and steam in the processing lines can be explained
* (Weight 10%)

**Learning activity 7.1: Individual Learning activity: 1 hour (49 marks)**



**Learning Objective:** The uses of energy, utilities and steam in the processing lines can be explained.

**Task:** Read each question carefully and write your answer in the space provided.

1. Mention two (2) uses of steam in the sugar mill. (4)

|  |
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| The first is as the driver of several of the processes directly, such as the heating of the juice in the evaporators |
| The second use is for power generation, as the driver of some of the equipment such as turbines and power generators. |

1. List the two (2) drums of a sugar mill boiler connected by the tubes. (2)

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| The top drum (steam drum) |
| The bottom drum (mud drum) |

1. True or False: The forced draft fan (FD Fan) blows air into the combustion chamber where a fuel (bagasse/coal) is burned to produce hot gases. (1)

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| True |

1. What are the two (2) common evaporator vessels? (2)

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| shell and tube heat exchangers |

1. List twelve (12) places where electricity is used in the sugar mill. (12)

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| It is used in the Sugar Mill **crane system**, **cutters**, and **various kinds of motors**, **centrifuga**l **machines**, **juice clarifiers**, **driers**, **bucket elevators**, **air compressors**, **magnetic separators**, **pump house**, **work shop facilities** and **lighting.** |

1. How is electricity generated in the sugar mill? (2)

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| Very often this electricity is generated by the burning of bagasse coming out of the milling process. |

1. List two (2) uses of compressed air. (2)

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| Compressed air is used in the pneumatic control systems of the factory. It is especially used in the vacuum filters to create vacuums of different levels. |

1. What are the water requirements in the sugar process? (7)

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| Water requirements are the following: **Imbibition**, **process water use**, **lime make-up water**, **flocculants make-up water**, **filter wash**, **pan house requirements** and **service water requirements**. |

1. Draw a diagram showing streams containing water entering and leaving a sugar mill. (17)

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1. CONCLUSION OF KNOWLEDGE MODULE 2: SUGAR PROCESSING EQUIPMENNT AND TECHNOLOGY

Throughout this knowledge module you have been provided opportunities to complete formative learning activities. You have captured your results in this Learner Workbook.

The total marks for this Knowledge Module are as follows:

|  |  |  |
| --- | --- | --- |
| **Knowledge Module** | **Total Marks** | **Marks attained** |
| KM-02-KT01: Equipment hygiene and cleaning (10%) | 84 |  |
| KM-02-KT02: Raw and refined sugar processing equipment and technology (30%) | 113 |  |
| KM-02-KT03: Introduction to mechanical systems (25%) | 136 |  |
| KM-02-KT04: Introduction to process flow and control (5%) | 46 |  |
| KM-02-KT05: Mechanical workshop practices (10%) | 47 |  |
| KM-02-KT06: Maintenance (10%) | 37 |  |
| KM-02-KT07: Energy, utilities and services (10%) | 49 |  |
| **Total Marks** | **512 marks** |  |

1. WRITTEN ASSESSMENT

**Candidate instruction:** Complete the following multiple-choice questionnaire by marking the most appropriate response with an x in the space provided.

|  |  |  |
| --- | --- | --- |
| **Scope of Assessment** | **Exit Level Outcome/s** | **Module/s** |
|  | **2.** **Sugar processing equipment and technology** | **2** |
| **Alignment – Learning Outcome** **Award four marks for selection of valid “x”. Four marks = Competent** |
| **2.1** | **Which of the following steps are part of sugar processing?** | **Mark Allocation** |
| **a** | 🞎 | Extraction of juice |  |
| **b.** | 🞎 | Concentration and Crystallization |  |
| **c.** | 🞎 | Refining of sugar |  |
| **d.** | 🗷 | All of the above |  |
| **e.** | 🞎 | None | 4 |

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| **2.2** | **What does CIP stand for?** | **Mark Allocation** |
| **a.** | 🞎 | Cleaning in processes |  |
| **b.** | 🞎 | Compulsory Induction Programme |  |
| **c.** | 🗷 | Cleaning in place |  |
| **d.** | 🞎 | All of the above |  |
| **e.** | 🞎 | None | 4 |

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| **2.3** | **Which of the following parameters are used in cleaning?** | **Mark Allocation** |
| **a.** | 🞎 | Mechanical force |  |
| **b.** | 🞎 | Thermal force |  |
| **c.** | 🞎 | Chemical force |  |
| **d.** | 🞎 | The time the forces act |  |
| **e.** | 🗷 | All of the above | 4 |

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| **2.4** | **Which of the following cane biosecurity zones covers areas for production of food products with normally no direct access to the products?** | **Mark Allocation** |
| **a.** | 🞎 | Zone 1 |  |
| **b.** | 🞎 | Zone 2 |  |
| **c.** | 🗷 | Zone 3 |  |
| **d.** | 🞎 | Zone 4 |  |
| **e.** | 🞎 | None  | 4 |

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| **2.5** | **The evaporator consists of?** | **Mark Allocation** |
| **a.** | 🞎 | The dome |  |
| **b.** | 🞎 | Air line |  |
| **c.** | 🞎 | The condenser |  |
| **d.** | 🞎 | Injection water |  |
| **e.** | 🗷 | All of the above | 4 |

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| **2.6** | **Which of the following is the definition of a continuous pan?** | **Mark Allocation** |
| **a.** | 🞎 | A single effect evaporator in which boiling occurs under vacuum |  |
| **b.** | 🞎 | A vertical cylindrical vessel consisting of a calandria and a vapour space |  |
| **c.** | 🞎 | A heating element of the pan and consists of a large number of cylindrical tubes fixed to the tube plate at both ends. |  |
| **d.** | 🗷 | A horizontal vessel with a number of compartments or cells (usually 12) connected in series |  |
| **e.** | 🞎 | A valve used to break vacuum during discharging or cutting of massecuite | 4 |

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| **2.7** | **The boiler system is made up of?** | **Mark Allocation** |
| **a.** | 🞎 | Feed water system |  |
| **b.** | 🞎 | Steam system |  |
| **c.** | 🞎 | Fuel system |  |
| **d.** | 🗷 | All of the above |  |
| **e.** | 🞎 | None | 4 |

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| **2.8** | **What is a conveyor?** | **Mark Allocation** |
| **a.** | 🞎 | a vertical transport vehicle that efficiently moves people or goods between floors of a building |  |
| **b.** | 🗷 | mechanical devices or assemblies that transport material with minimal effort |  |
| **c.** | 🞎 | a motor that converts energy into torque which then moves or controls a mechanism or a system into which it has been incorporated |  |
| **d.** | 🞎 | steel or wooden slats mounted on chains |  |
| **e.** | 🞎 | a flat steel table with channels in which chains with spikes (welded to the chain) run | 4 |

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| **2.9** | **What is black piping?** | **Mark Allocation** |
| **a.** | 🗷 | Uncoated steel pipe |  |
| **b.** | 🞎 | Pipes that are portable or attached to a workbench |  |
| **c.** | 🞎 | Piping that has been coated with zinc for protection against corrosion |  |
| **d.** | 🞎 | It is a relatively new pipe joining system |  |
| **e.** | 🞎 | Pipes used for holding pipes in position | 4 |

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| **2.10** | **What are valves used for?** | **Mark Allocation** |
| **a.** | 🞎 | transferring liquids or gases from one point to another, often with the help of pumps |  |
| **b.** | 🞎 | converting fluid power energy to rotary motion and force |  |
| **c.** | 🗷 | To regulate, isolate, control and shut off the flow of liquids and gases in a pipe line. |  |
| **d.** | 🞎 | harnesses the kinetic energy of some fluid such as water, steam, air, or combustion gases and turns this into the rotational motion of the device itself |  |
| **e.** | 🞎 | To transmit power, lubricate and to cool the system. | 4 |

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| **2.11** | **Which of the following is the correct definition of a motor?** | **Mark Allocation** |
| **a.** | 🞎 | a device that tears the cane apart using large metal bars known as hammers |  |
| **b.** | 🞎 | A storage place for the hydraulic fluid until it is required for the operation of the system. |  |
| **c.** | 🞎 | a device that harnesses the kinetic energy of some fluid such as water, steam, air, or combustion gases and turns this into the rotational motion of the device itself |  |
| **d.** | 🞎 | a storage chamber in which fluid energy is accumulated and from which it can be withdrawn |  |
| **e.** | 🗷 | A machine, especially one powered by electricity or internal combustion that supplies motive power for a vehicle or for another device with moving parts. | 4 |

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| **2.12** | **A simple hydraulic system can operate with the following basic components?** | **Mark Allocation** |
| **a.** | 🞎 | Reservoir |  |
| **b.** | 🞎 | Actuator |  |
| **c.** | 🞎 | Pump |  |
| **d.** | 🞎 | Pressure relief valve |  |
| **e.** | 🗷 | All of the above | 4 |

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| **2.13** | **Bevel gears are described as follows?** | **Mark Allocation** |
| **a.** | 🞎 | A flat piece of material with gear teeth cut into it. |  |
| **b.** | 🞎 | the axes of the shafts are parallel and the teeth are cut straight across the blanks |  |
| **c.** | 🗷 | Are shaped like sections of cones, they are spur gears where the intersecting angle that the shaft makes is 90°. |  |
| **d.** | 🞎 | are inclined to the axis of rotation and create axial thrust |  |
| **e.** | 🞎 | They vary in ratio from 5:1 to 60:1 | 4 |

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| **2.14** | **What is a definition of a clutch?** | **Mark Allocation** |
| **a.** | 🞎 | A devise that provides and accommodate a large flow of air or gas to various parts of a building or other structures |  |
| **b.** | 🞎 | A devise used for accurate massing (weighing) to an accuracy of four decimal places |  |
| **c.** | 🗷 | It is a device that allows two components to be engaged or disengaged, whilst one or both of the components is in motion |  |
| **d.** | 🞎 | a machine that squeezes a gas into a smaller volume and (often) pumps it somewhere else at the same time |  |
| **e.** | 🞎 | A device that uses mechanical force and motion to rise, transport, or compress fluids. | 4 |

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| **2.15** | **Which of the following are the three types of balances used in the laboratories of sugar mills?** | **Mark Allocation** |
| **a.** | 🞎 | An analytical balance with a range from 0 to around 200g and a reading precision of 0,0001g. |  |
| **b.** | 🞎 | A light duty balance with a range from 0 to around 3000g and a reading precision of 0,01g. |  |
| **c.** | 🞎 | A heavy duty balance with a range from 0 to around 3000g and a reading precision of 0,1g. |  |
| **d.** | 🞎 | None |  |
| **e.** | 🗷 | All of the above | 4 |

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| **2.16** | **What is the function of the vacuum pumps?** | **Mark Allocation** |
| **a.** | 🞎 | They allow liquid to flow in a single direction |  |
| **b.** | 🞎 | It moves a fluid (either liquid or gas) from one place to another |  |
| **c.** | 🗷 | They are required to remove the incondensable gases from evaporator and pan condensers |  |
| **d.** | 🞎 | It squeezes a gas into a smaller volume and (often) pumps it somewhere else at the same time |  |
| **e.** | 🞎 | It delivers the volume of liquid that is present in the cylinder every stroke | 4 |

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| **2.17** | **Which of the following are energy, utilities and services for sugar mill?** | **Mark Allocation** |
| **a.** | 🞎 | Steam |  |
| **b.** | 🞎 | Electricity  |  |
| **c.** | 🞎 | Water |  |
| **d.** | 🞎 | Compressed air |  |
| **e.** | 🗷 | All of the above | 4 |

**TRUE OR FALSE QUESTIONS:**

**Award one mark for each selection of valid “T/F”.**

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| **2.18** | **True or False: The following are some of the sugar processing equipment’s used in a sugar mill?** | **Mark Allocation** |
| **a.** | ⓣ | Centrifugals |  |
| **b.** | ⓕ | Molasses |  |
| **c.** | ⓣ | Evaporators |  |
| **d.** | ⓣ | Shredders |  |
| **e.** | ⓣ | Refinery machinery | 5 |

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| **2.19** | **True or False: The following is a procedure used for cleaning a plant?** | **Mark Allocation** |
| **a.** | ⓣ | Pre-rinse |  |
| **b.** | ⓣ | Alkali circulation |  |
| **c.** | ⓣ | Rinse |  |
| **d.** | ⓣ | Acid circulation |  |
| **e.** | ⓣ | Final rinse | 5 |

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| **2.20** | **True or False: Cane handling involves?** | **Mark Allocation** |
| **a.** | ⓣ | Cane transport |  |
| **b.** | ⓕ | Cane shredding |  |
| **c.** | ⓣ | Weighing and off-loading |  |
| **d.** | ⓕ | Cane testing |  |
| **e.** | ⓕ | Diffusion | 5 |

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| **2.21** | **True or False: The following are criteria’s of a good filter operation?** | **Mark Allocation** |
| **a.** | ⓣ | Good retention |  |
| **b.** | ⓕ | The Ph |  |
| **c.** | ⓣ | Low pol % filter cake |  |
| **d.** | ⓕ | Higher temperature |  |
| **e.** | ⓕ | The time | 5 |

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| **2.22** | **True or False: Molasses removal is more efficient when?** | **Mark Allocation** |
| **a.** | ⓣ | The time for spinning at high speed is longer |  |
| **b.** | ⓣ | The size of the crystals is uniform |  |
| **c.** | ⓕ | A centrifugal screen is worn or damaged |  |
| **d.** | ⓣ | The crystals are bigger |  |
| **e.** | ⓣ | The thickness of the massecuite wall is smaller | 5 |

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| **2.23** | **True or False: The following is done to create a vacuum in a pan?** | **Mark Allocation** |
| **a.** | ⓣ | Open the vacuum breaker |  |
| **b.** | ⓣ | Open the steaming valve fully and the blower and let the temperature rise to about 100°C |  |
| **c.** | ⓣ | Close the discharge door and the vacuum breaker |  |
| **d.** | ⓣ | Open the airline |  |
| **e.** | ⓣ | Close the steaming our valve and steam blower | 5 |

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| **2.24** | **True or False: The several types of actuators include?** | **Mark Allocation** |
| **a.** | ⓕ | Slat type |  |
| **b.** | ⓣ | Hydraulic motors |  |
| **c.** | ⓣ | Clutch/Brake |  |
| **d.** | ⓕ | Rake type |  |
| **e.** | ⓣ | Stepper motors | 5 |

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| **2.25** | **True or False**: **The several types of conveyors include?** | **Mark Allocation** |
| **a.** | ⓕ | Pneumatic motors |  |
| **b.** | ⓣ | Belt |  |
| **c.** | ⓣ | Ball Transfer |  |
| **d.** | ⓕ | [Servo motors](http://www.tigertek.com/servo-motor-repair.html) |  |
| **e.** | ⓣ | Walking Beam | 5 |

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| **2.26** | **True or False: The following are types of valves?** | **Mark Allocation** |
| **a.** | ⓣ | Gate valves |  |
| **b.** | ⓣ | Diaphragm valves |  |
| **c.** | ⓣ | Slide valves |  |
| **d.** | ⓕ | Water valves |  |
| **e.** | ⓕ | Wind valves | 5 |

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| **2.27** | **True or False: The following safety measures are done when dismantling equipment (valves, gearbox or pumps)?** | **Mark Allocation** |
| **a.** | ⓣ | Make sure that the supervisor or plant operator knows that you are working on the equipment. |  |
| **b.** | ⓣ | Isolate the equipment, remove appropriate fuses and lock-off the fuse box. |  |
| **c.** | ⓣ | Disconnect all other services (e.g. gas, water, air) and ensure that these are sealed off. |  |
| **d.** | ⓣ | Drain oil coolant sumps |  |
| **e.** | ⓕ | leave partially dismantled equipment in a dangerous condition | 5 |

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| **2.28** | **True or False: The following are the main functions of hydraulic fluids in the hydraulic system?**  | **Mark Allocation** |
| **a.** | ⓣ | To transmit power |  |
| **b.** | ⓣ | To cool the system |  |
| **c.** | ⓕ | To converts fluid energy to rotary motion and force |  |
| **d.** | ⓣ | To lubricate |  |
| **e.** | ⓕ | To harnesses the kinetic energy of some fluid such as water, steam, air, or combustion gases. | 5 |

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| **2.29** | **True or False: The following is the application for Spur gears?** | **Mark Allocation** |
| **a.** | ⓕ | Where quiet operation is required |  |
| **b.** | ⓣ | Extensive use in motor vehicles |  |
| **c.** | ⓣ | Where medium speed reductions are required. |  |
| **d.** | ⓕ | Where end thrust is to be eliminated |  |
| **e.** | ⓕ | Used in the raising and lowering of tables in drilling, milling machines etc. | 5 |

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| **2.30** | **True or False: The advantages of a multi-plate clutch are?** | **Mark Allocation** |
| **a.** | ⓕ | A considerable axial force is needed to keep the clutch engaged which results in a high end thrust |  |
| **b.** | ⓣ | Engagement is possible while machine is in motion |  |
| **c.** | ⓕ | Slip occurs between the engaging surfaces which results in wear |  |
| **d.** | ⓣ | A large torque can be transmitted |  |
| **e.** | ⓣ | Can be used where space is limited | 5 |

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| **2.31** | **True or False: During inspection of clutches the following should be noted?** | **Mark Allocation** |
| **a.** | ⓣ | Excessive wear |  |
| **b.** | ⓣ | Worn clutch shaft |  |
| **c.** | ⓕ | Maximum Load Capacity |  |
| **d.** | ⓣ | Weak spring tension |  |
| **e.** | ⓕ | Drive Location | 5 |

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| **2.32** | **True or False: The goal of instrumentation and control is to improve?** | **Mark Allocation** |
| **a.** | ⓣ | Productivity |  |
| **b.** | ⓣ | Optimization |  |
| **c.** | ⓣ | Stability |  |
| **d.** | ⓣ | Reliability |  |
| **e.** | ⓣ | Safety | 5 |

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| **2.33** | **True or False: The following are different types of liquid lubricants?** | **Mark Allocation** |
| **a.** | ⓣ | Lubricity |  |
| **b.** | ⓕ | Thickener |  |
| **c.** | ⓣ | Viscosity Index |  |
| **d.** | ⓕ | Oxides |  |
| **e.** | ⓣ | Pour Point | 5 |

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| **2.34** | **True or False: The Important objectives of preventative maintenance are as follows.** | **Mark Allocation** |
| **a.** | ⓣ | To minimize the possibility of unanticipated production interruptions by locating or uncovering any condition which may lead to it. |  |
| **b.** | ⓣ | To make plant equipment and machines always available and ready for use. |  |
| **c.** | ⓣ | To maintain the value of the equipment and machinery by conducting periodic inspection, repairs, overhauling, etc. |  |
| **d.** | ⓣ | To reduce the work content of maintenance jobs. |  |
| **e.** | ⓣ | To ensure safety of life and limbs of the workmen. | 5 |

1. FINAL MARKS

**TOTAL MARKS: 153**

**PASS MARK: 122**

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| --- | --- |
| **LEARNER MARKS** |  |
| **PERCENTAGE** |  |
| **ASSESSOR SIGNATURE:** |