**FACILITATOR FORMATIVE AND SUMMATIVE ASSESSMENT TOOLS AND MODEL ANSWERS: KNOWLEDGE MODULE 2: SUGAR MANUFACTURING PROCESS**

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

**Occupational Certificate: Sugar Processing Controller**

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

**KNOWLEDGE MODULE 2: SUGAR MANUFACTURING PROCESS**

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**OCCUPATIONAL CERTIFICATE: SUGAR PROCESSING CONTROLLER**

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**TABLE OF CONTENTS**

[1. INTRODUCTION TO THE FACILITATOR ASSESSMENT TOOLKIT OF THE OCCUPATIONAL CERTIFICATE: SUGAR PROCESSING CONTROLLER 6](#_Toc8892806)

[2. KNOWLEDGE MODULE 2: THE SUGAR MANUFACTURING PROCESS 7](#_Toc8892807)

[2.1 Knowledge Topic 1: The sugar manufacturing process (55%) 8](#_Toc8892808)

[2.2 Knowledge Topic 2: Rework and recycling (15%) 15](#_Toc8892809)

[2.3 Knowledge Topic 3: Sugar and By-Products Analysis (30%) 18](#_Toc8892810)

[3. CONCLUSION OF KNOWLEDGE MODULE 2: THE SUGAR MANUFACTURING PROCESS 56](#_Toc8892811)

[4. SUMMATIVE ASSESSMENT AND MODEL ANSWERS 57](#_Toc8892812)

[5. FINAL MARKS 81](#_Toc8892813)

1. INTRODUCTION TO THE FACILITATOR ASSESSMENT TOOLKIT OF THE OCCUPATIONAL CERTIFICATE: SUGAR PROCESSING CONTROLLER

Dear Facilitator

This Toolkit has been created to assist you to assess the Formative Learning Activities of learners undertaking the NQF 5 Occupational Certificate: Sugar Processing Controller 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 is 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: THE SUGAR MANUFACTURING PROCESS

**NQF LEVEL: 5**

**CREDITS: 12**

**PURPOSE OF THE KNOWLEDGE MODULE: The main focus of the learning in this knowledge module is to build an understanding of the sugar manufacturing process.**

The learning will enable learners to demonstrate an understanding of:

* KM-02-KT01: The sugar manufacturing process (55%)
* KM-02-KT02: Rework and recycling (15%)
* KM-02-KT03: Sugar and By-Products Analysis (30%)

* 1. Knowledge Topic 1: The sugar manufacturing process (55%)

Topic elements to be covered include:

* KT0101 Process flow diagram
* KT0102 Instrumentation and process flow (DSC, SCADA)

Internal Assessment Criteria and Weight

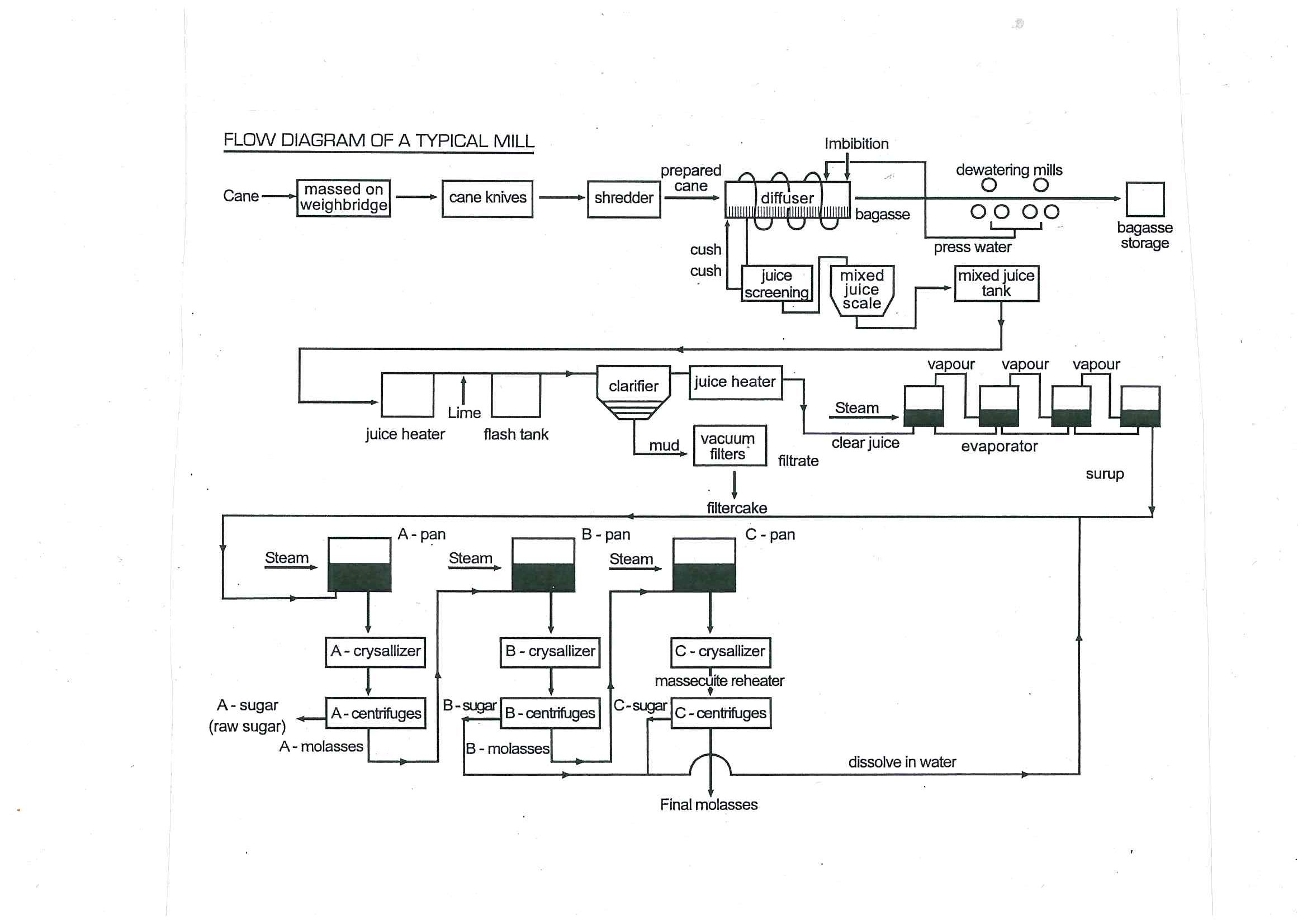
* IAC0101 The process steps of cane to crystal can be identified on a flow diagram and explained
* IAC0102 An understanding of control systems used to control specific production areas can be demonstrated
* IAC0103 An understanding of the relationship between instrument and product flow and quality can be demonstrated
* (Weight 55%)

**Learning activity 1.1: Individual Learning activity: 1 hour (25 marks)**



**Learning Objective: Correctly identify and explain the process steps of cane to crystal on a flow diagram.**

**Task: Provide labels for the flow diagram of sugar manufacturing below.**



**Learning activity 1.2: Individual Learning activity: 15 minutes (26 marks)**



**Learning Objective:** Demonstrate an understanding of control systems used to control specific production areas.

**Task:** Read the following questions carefully and write your answers in the space provided.

1. Name the six (6) goals of instrumentation and control. (6)

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

1. List eight (8) process variables that need to be checked constantly. (8)

|  |
| --- |
| Vessel height, diameter, shape |
| Material properties |
| Bulk density |
| Dielectric properties (radar or guided wave radar) |
| Build up potential, or stickiness |
| Accuracy required |
| Mounting location/size options for the sensor |
| Continuous or point level measurement |

1. List and describe four (4) 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. Name four (4) types of solid level measuring sensors. (4)

|  |
| --- |
| 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 |

**Learning activity 1.3: Individual Learning activity: 30 minutes (33 marks)**



**Learning Objective:** Demonstrate an understanding of the relationship between instrument and product flow and quality.

**Task:** Read the following questions carefully and write your answers in the space provided.

1. List the measurements that are taken at the cane preparation stage. (4)

|  |
| --- |
| 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 measurements and control measures taken at the milling train where juice extraction takes place. (6)

|  |
| --- |
| Before the milling train an electric magnet removes any metallic parts present in the raw material. |
| The steam pressure of the turbines |
| The revolution of the engines (driven by electric motors). |
| The lift of the top rollers (controlled by hydraulic devices). |
| Mixed juices from the first, second and last mill are sampled and analysed. |
| Mixed juice (screened to remove fine bagasse particles) leaving the diffuser is massed in the mixed juice scale. |

1. What needs to be removed from the juice clarification tank? (4)

|  |
| --- |
| Sand particles |
| Fine bagasse particles |
| Cane wax |
| Air bubbles |

1. What is the pH of cane juice and what pH does it need to be adjusted to with the addition of milk of lime? (2)

|  |
| --- |
| Sugar cane juice has a pH of about 4.0 to 4.5 thus milk of lime is added to the cane juice to adjust its pH to 7. |

1. What variables need to be controlled during juice clarification? (2)

|  |
| --- |
| Temperature (should not be too high because higher temperatures speeds up unwanted reactions such as inversion – at low pH – and destruction of reducing sugars – at high pH) |
| pH (should always be kept at around 7.0 – 7.2) |

1. What samples are taken at the juice clarification stage for analysis? (2)

|  |
| --- |
| Clear juice |
| Filter cake |

1. Name 6 variables that need to be controlled in the evaporator. (6)

|  |
| --- |
| 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) |

1. Name four (4) variables that are controlled at the crystallisation and centrifuging stage. (4)

|  |
| --- |
| Feed controlling |
| Brix value |
| Concentration (composition) |
| Temperature |

1. Name three (3) variables that are controlled at the drying stage. (3)

|  |
| --- |
| Feed flow rate |
| Hot air flow rate |
| Moisture |

* 1. Knowledge Topic 2: Rework and recycling (15%)

Topic elements to be covered include:

* KT0201 Effects and potential losses from over flows and leaks
* KT0202 Effects and potential losses from carry-overs
* KT0203 Effects and potential losses from recirculation of processed product
* KT0204 Effects and potential losses from rework of substandard products

Internal Assessment Criteria and Weight

* IAC0201 The effects of rework and recycling of specific production flows and targets can be explained
* (Weight 15%)

**Learning activity 2.1: Individual Learning activity: 1 hour (34 marks)**



**Learning Objective:** Explain the effects of rework and recycling of specific production flows and targets.

**Task:** Read the following questions carefully and write your answers in the space provided.

1. Name the two types of losses that occur in a sugar mill. (2)

|  |
| --- |
| Final molasses |
| Bagasse. |

1. Undetermined losses can be categorized into 3 parts. Name them. (3)

|  |
| --- |
| Chemical losses |
| Mechanical losses |
| Administrative losses |

1. Chemical losses, such as high POL and sucrose losses, could be measured because of these 5 factors….(10)

|  |
| --- |
| Too low pH (clarified juice, remelt) |
| Too high temperature (juice heaters, vacuum plant) |
| Too long retention time of juices (long mill stops, irregular crushing, too large tanks) |
| Poor mill sanitation, causing bacteriological infection (Leuconostoc) and breaking down of sugar molecules |
| Poor sampling |

1. Chemical losses could be picked up in the calculations due to laboratory errors. Name some causes of these laboratory errors. (4)

|  |
| --- |
| Bad sample taking |
| Dirty sample buckets |
| No preservative dosage (Mercury chloride) |
| Poor analyzing |

1. Mechanical losses are often due to leaks in the system. Name four (4) places where mechanical losses could occur. (4)

|  |
| --- |
| Drains (evaporators, pans, clarifier etc.) |
| Leaking pumps |
| Leaking blank flanges |
| Leaking crystallisers and tanks |
| Cooling water lines on pumps |
| Holes in lines |
| Dust sugar from sugar drier blowing away |
| Leaking tubes (evaporators, pans) |

1. Define entrainment. (2)

|  |
| --- |
| Mechanical loss through, evaporation, vacuum plant, filtration plant and flash tank. |

1. What could cause administrative losses? (5)

|  |
| --- |
| Bad analysis   * Incorrect weighing * Incorrect reading of pol and brix * Incorrect interpolation of tables * Wrong calculations |
| Mixed juice scale, final molasses scale or sugar scale |
| Wrong amount of filter cake |
| Wrong taxation |
| Daily and weekly reports etc. |

1. What reduces chemical losses, a faster or slower milling speed? Justify your answer. (4)

|  |
| --- |
| The faster the milling speed, the shorter the retention time of the different juices and molasses in the various vessels, resulting in less inversion, hence lower chemical (or undetermined) losses. |

* 1. Knowledge Topic 3: Sugar and By-Products Analysis (30%)

Topic elements to be covered include:

* KT0301 Sucrose Molecule
* KT0302 Chemical Reactions
* KT0303 Constituents of Sugarcane
* KT0304 Brix
* KT0305 Apparent Sucrose (pol)
* KT0306 Moisture
* KT0307 pH
* KT0308 Ash
* KT0309 Phosphate
* KT0310 Colour & Turbidity
* KT0311 Starch
* KT0312 Grain Size
* KT0313 Reducing Sugars
* KT0314 Sugar Trace

Internal Assessment Criteria and Weight

* IAC0301 An understanding of mechanical and chemical breakdown of sucrose can be demonstrated in terms of factory efficiencies
* IAC0302 Calculations are accurately performed
* (Weight 30%)

**Learning activity 3.1: Individual Learning activity: 10 minutes (6 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: THE SUCROSE MOLECULE**

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

1. Why is sugar known as a “dissacharide”? (2)

|  |
| --- |
| Sucrose is a disaccharide, meaning that its molecules consist of two simple sugars (called monosaccharides) joined together. In the case of sucrose, glucose and fructose join to form sucrose. |

1. Give the formulae for the following molecules (3)
2. Glucose

|  |
| --- |
| C6H12O6 |

1. Fructose

|  |
| --- |
| C6H12O6 |

1. Sucrose

|  |
| --- |
| C12H22O11 |

1. What is the function of sucrose in the cane plant? (1)

|  |
| --- |
| Sucrose is formed in the cane plant and forms an essential part of the plant’s growth cycle. |

**Learning activity 3.2: Individual Learning activity: 10 minutes (11 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: CHEMICAL REACTIONS**

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

1. (a) Explain the term inversion. (2)

|  |
| --- |
| Inversion involves the decomposition of sucrose into glucose and fructose. |

(b) What conditions increases the amount of inversion? (3)

|  |
| --- |
| Increase in acidity (pH < 7) |
| Increase in temperature |
| Increase in the time of exposure to the above mentioned conditions. |

(c) Why is inversion highly undesirable in the sugar mill? (2)

|  |
| --- |
| This reaction is highly undesirable since glucose and fructose cannot be converted back into sucrose by man-made processes. |

1. (a) Explain the term “alkaline degradation”. (2)

|  |
| --- |
| Under alkaline (basic) conditions the reducing sugars (glucose and fructose) that are naturally present in cane juice undergo degradation reactions to yield darkly coloured compounds. |

(b) Why is this reaction(s) undesirable? (2)

|  |
| --- |
| This reaction is highly undesirable since it causes darkly coloured sugar to be produced. |

**Learning activity 3.3: Individual Learning activity: 10 minutes (16 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: CONSTITUENTS OF SUGAR CANE**

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

1. (a) Give the percentage composition of cane. (3)

Dissolved substances (%)

|  |
| --- |
| 15% |

Insoluble fibre (%)

|  |
| --- |
| 15% |

Water (%)

|  |
| --- |
| 70% |

(b) Give the percentage composition of the dissolved substances in cane. (3)

Sucrose (%)

|  |
| --- |
| ± 13% |

Other substances (%)

|  |
| --- |
| ± 2% |

(c) What compounds constitute the “other substances” found dissolved in cane juice. (10)

|  |
| --- |
| Organic salts |
| Organic acids |
| Polysaccharides |
| Starch (dextran) |
| Gums |
| Proteins |
| Amides and Amino Acids |
| Pigments |
| Coloured compounds |
| Waxes |

**Learning activity 3.4: Individual Learning activity: 30 minutes (35 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: PERCENTAGE DISSOLVED SUBSTANCES (BRIX)**

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

1. Give the formula for percentage dissolved substances (BRIX). (2)

|  |
| --- |
| **% Dissolved Substances = × 100** |

1. 25 g of pure sucrose is dissolved in 50 g water. Calculate the percentage dissolved substances. (3)

|  |
| --- |
| 25g of pure sucrose in 50 g water  %Dissolved substance= × 100 = 50% |

1. State 2 ways in which the percentage dissolved substances can be measured. (2)

|  |
| --- |
| Drying |
| Refractometer |

1. Complete the following sentences.
2. A refractometer uses the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of light as it enters a solution as a measure of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of that solution. (2)
3. The percentage dissolved substances in a solution is measured by refractometer is known as the Degrees brix (°Bx)/ **apparent dissolved substances**” of the solution. (1)
4. The unit of percentage dissolved substances as measured by refractometer is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1)
5. A refractometer is calibrated using pure \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ solutions of known \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (2)
6. Brix can be used as an important indicator by factory staff. State the areas where knowledge of the brix is particularly important/ useful. (5)

|  |
| --- |
| * Mixed juice brix gives an indication of the amount of imbibition water being used and of the cane quality. |
| * Syrup brix gives an indication of steam pressure, mill crushing rate and the operation of the evaporator. |
| * Massecuite brix will indicate the quality of the pan boiling. |
| * Molasses brix will indicate the amount of water used in the centrifugals. |
| * Brix is used to calculate purity. |

1. (a) Why is filtration important before the brix of a sample can be read? (2)

|  |
| --- |
| It is because the measurement of brix is affected by the presence of suspended matter. |

(b) Explain the filtering procedure. (5)

|  |
| --- |
| * Pour ± 100 cm3 of juice into a 200-250 cm3 bottle and add 1 g filter aid. The industry uses only Celite 577 as a filter aid. |
| * Fit a clean dry stopper and shake. |
| * Pour into the folded filter paper (Whatman No. 6) resting in the funnel, supported by the beaker. |
| * Cover with a watch glass to minimise evaporation losses. |
| * Discard the first 10 cm3 of filtrate and transfer the funnel to a clean dry beaker. Do NOT pour this back into the funnel as errors will result. |

(c) Give the dilutions for:

Syrup 1:4 dilution

Molasses 1:5 dilution (2)

1. Write the procedure for determining the brix of a juice sample. (6)

|  |
| --- |
| * To 100 cm3 juice in the bottle, add about 1 g filter aid, stopper and shake to disperse the filter aid. |
| * Filter through a fluted filter paper supported in the funnel which rests directly in the mouth of the squat beaker. Pour the mixture while the Celite 577 is still in suspension. Cover the funnel with a watch glass to minimise evaporation. |
| * Discard the first 10 cm3 of filtrate by transferring the funnel to a clean, dry beaker. |
| * Collect sufficient filtrate to measure its refractometer brix. |
| * Note the reading: Also record the temperature reading of the thermometer located on the prism mount if this differs from 20±0.1°C. |
| * If necessary, convert the instrument reading to brix using the table supplied with the instrument. |

1. Explain the procedure to be followed if a reading is taken and the refractometer is not at 20°C. (2)

|  |
| --- |
| * The appropriate temperature correction should be applied. |

**Learning activity 3.5: Individual Learning activity: 2 hours (80 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: PERCENTAGE APPARENT SUCROSE (POL)**

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

1. Give the formula for the sucrose % solution. (2)

|  |
| --- |
| **Formula: Sucrose % = × 100** |

1. A solution is prepared by dissolving 8 g sucrose, 12 g salt and 30 g water in a flask.
2. Calculate the brix of the solution. (2)

|  |
| --- |
|  |
|  |
|  |

1. Calculate the sucrose % of the solution. (2)

|  |
| --- |
|  |
|  |
|  |
|  |

3(a) The amount of sucrose in a sample is found by projecting a beam of ordinary light through the solution and measuring the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the light. A greater sucrose content will result in the greater angle of rotation. (4)

(b) What instrument is used to perform the analysis described in (a) above. (1)

|  |
| --- |
| Polarimeter |

1. The result from the analysis is called the apparent sucrose % (or pol %). Why is the answer not the true sucrose %? (3)

|  |
| --- |
|  |
|  |
|  |

4. Explain why the difference between pol % and sucrose % is small for juice but quite large for molasses. (4)

|  |
| --- |
| It is because the concentration of glucose and fructose is low is so that the pol % equals to sucrose %. |
| For a product like refined sugar the amount of glucose and fructose is so low that the pol % = sucrose %. |

5. State where the pol % is used in the sugar mill to facilitate control of the process. (5)

|  |
| --- |
| * Pol in cane and mixed juice will indicate cane quality. * Pol in bagasse will indicate mill efficiency. * Pol in clear juice will indicate if inversion has taken place. * Pol in massecuite and molasses will indicate pan floor efficiency. * Pol in sugar and molasses will indicate centrifugal efficiency. |

6. Explain the procedure for using a saccharimeter (non flow-through tube). (5)

|  |
| --- |
| * Check the zero of the saccharimeter by rinsing a clean pol tube 3 times with distilled water, filling the tube with water and reading in the saccharimeter.   + The reading must be 0.00°Z.   + Note: If the saccharimeter does not read zero when the cell compartment is empty, press the reset button before a tube is inserted. |
| * Rinse the tube 3 times with portions of filtrate. |
| * Fill the tube with filtrate making sure no air bubbles are entrapped. |
| * Place the tube in the saccharimeter and take the reading. Turn the pol tube around (180° turn) and again take the reading on the saccharimeter. The two readings must be the same. If not, it is probably because one of the ends of the tube has not been tightened correctly. Measure the temperature of the juice in the tube before emptying. |
| * If further measurements are to be made, rinse the tube twice with each new solution.   On completion of the readings wash the tube well with distilled water and store full of water. Note: Always hold the pol tube at the bottom of the bulb using only the thumb and first two fingers. |

1. Give the dilutions necessary for the following products.
2. Syrup 1:4 (1)
3. Massecuite 1:5 (1)
4. Final molasses 1:5 (2)

8. Complete the following:

1. All saccharimeters are calibrated in sugar degrees (°Z) which are established so that….(3)

|  |
| --- |
| a “normal” weight of 26.000 g of pure sucrose in 100.00 ml of solution will read 100.00 sugar degree (100.00°Z) in a 2 dm tube. |
| * A solution of 26.00 g of pure sucrose made up to a 100 ml solution and read in the saccharimeter will read 100°Z. |
| * 26 g of impure sugar containing 13 g sucrose and 13 g salt and made up to 100 ml solution will thus read 50°Z. |
| Note: 50% of 26 g sucrose = 13 g sucrose. |
| * 26 g of impure sucrose containing 6.5 g of pure sucrose and 19.5 g salt and made up to 100 ml solution will thus read 25°Z. |
| Note: 25% of 26 g sucrose = 6.5 g sucrose |

1. The saccharimeter thus reads the percentage of …….(1)

|  |
| --- |
| 26 g of sucrose that is present in 100 ml of solution (i.e. g/100 ml). |

9. Give the formula used to calculate Pol %. (2)

|  |
| --- |
| **Pol % = × 100** |

10. Complete the following (19):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | 1 | 2 | 3 | 4 | 5 |
| Refractometer reading | 80,8 | 81,2 | 79,5 | 80,5 | 79,3 |
| Temperature | 22 | 15 | 20 | 26 | 20 |
| Brix@ refractometer temp. Temperature correction  Brix @ 200C |  |  |  |  |  |
| Saccharimeter reading Temperature | 45,0  25 | 46,0  21 | 44,5  23 | 44,2  29 | 29,5  23 |
| Brix adjustment  Brix @ sacch temp. |  |  |  |  |  |
| Pol from Schmidtz’s table |  |  |  |  |  |
| Dilution ratio | 5 | 5 | 5 | 5 | 5 |
| Corrected pol  Corrected brix  Purity |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | 6 | 7 | 8 | 9 | 10 |
| Refractometer reading | 80,3 | 81,3 | 90,9 | 91,1 | 91,2 |
| Temperature | 23 | 16 | 20 | 14 | 27 |
| Brix@ refractometer temp. Temperature correction  Brix @ 200C |  |  |  |  |  |
| Saccharimeter reading Temperature | 28,4  27 | 31,0  19 | 65,8  23 | 65,4  18 | 67,2  30 |
| Brix adjustment  Brix @ sacch temp. |  |  |  |  |  |
| Pol from Schmidtz’s table |  |  |  |  |  |
| Dilution ratio | 3 | 1 | 5 | 3 | 1 |
| Corrected pol  Corrected brix  Purity |  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | 11 | 12 | 13 | 14 |
| Refractometer reading | 92,0 | 91,9 | 92,0 | 92,6 |
| Temperature | 18 | 21 | 21 | 27 |
| Brix@ refractometer temp. Temperature correction  Brix @ 200C |  |  |  |  |
| Saccharimeter reading Temperature | 54,0  21 | 53,4  23 | 53,6  25 | 55,0  30 |
| Brix adjustment  Brix @ sacch temp. |  |  |  |  |
| Pol from Schmidtz’s table |  |  |  |  |
| Dilution ratio | 5 | 5 | 3 | 1 |
| Corrected pol  Corrected brix  Purity |  |  |  |  |

11. Explain the procedure for the analysis of a raw sugar for pol %. (15)

|  |
| --- |
| * Weigh out 26 ±0.002 g sugar rapidly into a pol dish. |
| * Transfer the sugar by washing with distilled water into the sugar flask (using approximately 60 ml water) |
| * Dissolve using the flask shaker and wash down the neck of the flask. |
| * For sugars having a pol below 99°Z add 1 ml of lead sub acetate to clarify. For VHP sugars use 0.5 ml. |
| * Mix thoroughly by gentle swirling and add water from a wash bottle swirling continuously until the bulb of the flask is filled (i.e. 0.5 cm below the mark). |
| * It is most important that the solution is homogeneous at this stage so that the error due to the volume contraction which occurs when a sugar solution is mixed with water is minimal. |
| * Place in the water bath at 20°C for 30 minutes. If a water bath is not available, measure the temperature of the solution in the pol tube after reading the pol (hold the thermometer in the pol tube for at least half a minute). |
| * Clear the meniscus with 1 drop of ether. |
| * Make exactly to the mark with water at 20°c using a fine dropper (or small pipette). Particular care must be taken to ensure that the bottom of the meniscus and the line coincide exactly. |
| * Dry the inside of the neck of the flask above the liquid with a rolled filter paper if necessary. Stopper the flask. |
| * Shake thoroughly and stand for 5 minutes. |
| * Filter through a fluted paper using a stemless funnel. Cover the funnel immediately with a watch glass to minimise evaporation. Discard the first 10 ml of filtrate. |
| * Rinse the pol tube at least three times with the filtrate. |
| * Fill the tube with the filtrate making sure no air bubbles are entrapped. |
| * Put the tube in the saccharimeter and when the reading is steady, read the pol % in °Z to 0.01°Z or highest precision on the instrument. In this analysis the saccharimeter reading is actually the pol % since the normal mass of 26.000 g of sugar was used. |
| * Calibrate the saccharimeter by reading a standard quartz plate for every series of samples or once per shift. |
| Correct the readings obtained on the samples by algebraically adding the nominal value of the plate minus the instrument reading of the plate. If the readings were made at a temperature other than 20°±0.2°C, correct this reading according to the formula below.  For a quartz wedge saccharimeter correct the readings for the effect of temperature according to:  P20 = Pt + 0.033 (tr – 20)  where P20 = pol at 20°C |

12. Explain the procedure for the analysis of juice for pol %. (8)

|  |
| --- |
| * Take approximately 150 ml of the sample in the bottle provided with a stopper. |
| * Add sufficient lead sub-acetate powder for clarification. The amount added should be the minimum for clarification as over-leading will introduce errors.   + For the first expressed juice, first mill juice, mixed juice, clear juice, limed juice and filtrate, 1.3 g lead sub-acetate per 100 ml is usually sufficient. To clarify 150 ml of juice, 1.5 g of lead sub-acetate is required.   + It is most convenient to add the 1.5 g lead sub-acetate to the bottle before the juice is added. This is easily done by taring the bottle on a balance and adding 1.5 g. |
| * Shake vigorously to disperse the lead sub-acetate completely and then let stand to permit flocculation of the precipitate (usually about 0.5 minutes). |
| * Filter through a fluted filter paper held in the funnel which rests directly in the beaker. Hold the filter paper down when pouring the juice in. Cover the funnel with a watch glass to minimise evaporation. |
| * Discard the first 25 ml of filtrate by transferrin g the funnel to a new beaker. |
| * Obtain the reading on the filtrate. |
| * Measure the brix of the juice as described. |

**Learning activity 3.6: Individual Learning activity: 30 minutes (15 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: MOISTURE ANALYSIS**

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

1. Why is the moisture % of raw sugar important? (2)

|  |
| --- |
| The moisture % of a sugar is a very important value/ parameter since it determines the shelf-life or “keeping-quality” of the sugar. The greater the moisture content of a sugar the greater the risk of the sugar spoiling during storage |

1. (a) Explain in detail the procedure for analysing a raw sugar for its moisture content. (9)

|  |
| --- |
| * Dry the clean moisture dish with lid removed, in the oven for 1 hour. |
| * Place in the desiccator and allow to cool to ambient temperature (ca. 1 hour) |
| * Weigh the empty dish and lid to the nearest 0.1 mg (i.e. to 4 decimal places). |
| * Add 10±1 g raw sugar to the dish, spread in an even layer, replace the lid immediately and reweigh to the nearest 0.1 mg. Do this quickly but accurately.   + Unnecessary delays at this stage will allow the sugar to absorb (or release) the moisture from the atmosphere. |
| * Place the dish in the oven. Remove the lid and place the moisture dish inside its lid. |
| * Dry for 3 hours exactly. |
| * Replace the lid on the dish and remove both from the oven. |
| * Place in a desiccator and allow to cool to ambient temperature (ca. 1 hour) |
| * Weigh the dish and lid and sugar to the nearest 0.1 mg. |

(b) The following results were obtained.

Mass of empty dish + lid 67,3371 g

Mass of sugar, dish and lid before drying 75,8936 g

Mass of sugar, dish and lid after drying 75,8792 g

Calculate the moisture % sugar. (4)

|  |
| --- |
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**Learning activity 3.7: Individual Learning activity: 1 hour (38 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: pH MEASUREMENT**

**Task:** Read each question carefully and write your answer in the space provided. Complete the practical exercise in the laboratory thereafter.

1. Explain the following terms.
2. Atoms (2)

|  |
| --- |
| An atom is the smallest particle of an element that can exist. Atoms are extremely small and cannot be seen by the naked eye. Atoms are represented by symbols e.g. O (Oxygen), H (Hydrogen), N (Nitrogen), Fe (iron), Al (Aluminium), Cu (Copper) etc. |

1. Compounds (2)

|  |
| --- |
| When different atoms combine they form compounds that differ completely from the atoms from which they were formed. Example: hydrogen gas + oxygen gas→water, or simply,  **2H2 + O2** → **H2O** |

1. Ions (2)

|  |
| --- |
| Ions are atoms or groups of chemically combined atoms which carry an electric charge. For example: Table salt is a compound called sodium chloride and represented as NaCl. |

1. (a) Define the pH of a solution (2)

|  |
| --- |
| pH can be defined as the degree of acidity or alkalinity of a substance on a scale from 0 to 14. |

1. What term do we use when the pH is
2. Less than 7: **Acidic**
3. Greater than seven: **Basic or Alkaline**
4. Seven exactly: **Neutral** (6)
5. Explain how an indicator works. (3)

|  |
| --- |
| Universal indicator solution can be prepared by using several indicators that each change colour at a specific pH. As the pH changes the universal indicator then changes colour. The exact colour is matched with standards of known pH. The pH of the solution can thus be determined. In the sugar industry we use indicator only when we perform titrations. |

1. Explain the basic principle ion which the operation of a pH meter is based. (3)

|  |
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1. Why can pH measurements only be compared if measured at room temperature? (1)

|  |
| --- |
| Because temperature affects pH. |

1. (a) What is a buffer solution? (3)

|  |
| --- |
| A buffer solution is a solution of exactly known pH that does not change its pH easily (i.e. the pH is stable). |

1. Which buffer solution do we use to standardise our pH meters. (2)

|  |
| --- |
| pH 4 and pH 10 |

1. Give the procedure to be followed when standardising a pH meter. (4)

|  |
| --- |
| * Ensure that the electrode is filled with the correct solution. Most modern electrodes are filled with saturated potassium chloride solutions (KCl) but some use other solutions. |
| * Some modern electrodes are filled with a gel during manufacture and never require filling. |
| * Rinse the electrodes by immersing in de-ionised water. |
| * Dry the electrode gently with soft tissue paper. |
| * Immerse in the buffer solution. |
| * Adjust the pH on the meter to read the same as that of the buffer solution using the adjusting knob. |
| * Modern pH meters will automatically standardise on the required pH once the standard button is pressed. |
| * The pH meter is now ready for use. |
| * Standardise the pH meter using another buffer solution. |
| * If the pH meter gives an incorrect reading with one range buffer (say pH 4), after being set with say pH 7, a responsible person should be informed so that the fault can be determined.   **Note:** Always keep electrodes clean and immersed in distilled water. Gel filled electrode are however, stored dry. |

1. Complete the following practical exercise in the laboratory (8)

Cut 4 strips of filter paper. Dip two strips into phenolphthalein solution, remove the strip and allow to dry. Dip the other two strips into Cresol Red indicator and allow to dry.

Dip each filter paper into either hydrochloric acid or sodium hydroxide solution as indicated in the table below. Record your results by completing the table.

|  |  |  |
| --- | --- | --- |
|  | **Colour in Acid** | **Colour in Base (Alkali)** |
| Phenolphthalein paper strip 1 |  |  |
| Phenolphthalein paper strip 2 |  |  |
| Cresol red paper strip 1 |  |  |
| Cresol red paper strip 2 |  |  |

**Learning activity 3.8: Individual Learning activity: 2 hours (48 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: ASH DETERMINATIONS**

**Task:** Read each question carefully and write your answer in the space provided. Complete the practical exercise in the laboratory thereafter.

1. Explain what is meant by the term ash. (3)

|  |
| --- |
| The organic content of the product decomposes into gases and is removed leaving the inorganic salts as a white /grey ash. This is the origin of the term “ash” when referring to inorganic salts. |

1. Give the most common
2. Cations in sugar cane (4)

|  |
| --- |
| K+, Na+, Ca2+, Mg2+, Fe3+ |

1. Anions in sugar cane (3)

|  |
| --- |
| SO42-, Cl-, PO43- and SiO44- |

1. State the procedure that must be followed to determine the ash % of a sample of raw sugar

(12)

|  |
| --- |
| * Heat the crucible in the muffle furnace for 10 minutes, then remove and place in a desiccator for 1 hour. |
| * Weigh the crucible on the analytical balance and record the mass to 0.1 mg. |
| * Place about 10 g of sugar in the crucible and record the mass to 0.1 mg. |
| * Add about 3 cm3 of concentrated sulphuric acid to the sugar. |
| * Heat gently (in a fume cupboard) over a Bunsen burner until carbonised. |
| * When fuming has ceased place in a muffle furnace with free access of air until unburnt carbon is no longer visible (until ash is completely white). |
| * Remove the crucible and allow to cool in a protected place to prevent draughts from blowing the ash away. |
| * When cool add a few drops of sulphuric acid to moisten the ash thoroughly. |
| * Heat gently in a fume cupboard over a Bunsen burner (until all acid fumes have been expelled). |
| * Place in the muffle furnace for 2 hours with free access of air. |
| * Remove the crucible, cool in a desiccator for about 1 hour. |
| * Weigh to 0.1 mg |

1. After conducting a sulphated ash analysis on a raw sugar sample, the following results were found.

Mass of crucible and sugar sample 75,6871 g

Mass of crucible 65,6871 g

Mass of crucible and ash 65,7133 g

Determine the ash % sugar. (3)

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| --- |
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1. Complete the following sentence:

The greater the number of ions in solution the lower the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the solution and the greater the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (2)

1. State the procedure to determine the conductivity ash % of a sample of raw sugar. (6)

|  |
| --- |
| * Weigh 5±0.01 g sugar into a 100 ml volumetric flask. |
| * Dissolve in the de-ionised water and make almost to the mark. |
| * Stand in the water bath at 20±0.2°C for 30 minutes. |
| * Make to volume with deionised water at 20°C. |
| * Rinse the conductivity cell at least twice with de-ionised water. Record the conductance of the water in µS (CWATER) to the highest precision of the instrument. |
| * Ensure that the electrodes in the cell are properly immersed in the water. |
| * Rinse the cell at least twice with solution. Record the conductance of the solution in µS (CSOLUTION). |

1. A raw sugar sample is analysed for its conductivity ash % and the following results were found.

CWATER at 23°C = 1.15 µ

CSOLUTION at 23°C = 138.73 µS

Cell constant = 0,818 cm-1

Calculate the conductivity ash % (7)

|  |
| --- |
| CWATER at 23°c = 1.15 -  = 1.03 µS  CSOLUTION at 23°C = 138.73 -  = 124.85 µS  A = 1.03x0.818  = 0.84 µS.cm-1  B = 124.85 × 0.818  = 102.12 µS.cm-1  Conductivity ash % sugar = (B - A) × 0.0018  = (102.12 – 0.84) × 0.0018  = 0.182  Report as 0.18% |

1. Complete the following practical exercise in the laboratory (8)

Your Training Officer will supply you with a sample of raw sugar (±20 g)

Analyse portion of the sugar for its sulphated ash and another portion for its conductivity ash.

Show all your calculations and workings.

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**Learning activity 3.9: Individual Learning activity: 1 hour (22 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: PHOSPHATE DETERMINATIONS**

**Task:** Read each question carefully and write your answer in the space provided. Complete the practical exercise in the laboratory thereafter.

1. Why is it important that the phosphate content of mixed juice be determined? (2)

|  |
| --- |
| Because phosphate content is the most important factor affecting efficient clarification. |

1. What is the critical phosphate level below which phosphate is added to mixed juice? (1)

|  |
| --- |
| 200 ppm |

1. Describe the steps in preparing a standard phosphate graph. (6)

|  |
| --- |
| Prepare some phosphate solutions of different concentration i.e. 0.05 mg/100 ml, 0.1 mg/100 ml, 0.15 mg/100 ml, 0.2 mg/100 ml, 0.25 mg/100 ml, 0.3 mg/100 ml, 0.35 mg/100 ml, 0.40 mg/100 ml, 0.45 mg/100 ml and 0.50 mg/100 ml. |
| To each solution in turn add the required amount of ammonium molybdate solution and “reducing solution” to cause the solution to become blue according to its phosphate content. |
| Read the optical density of each solution at 700 nm in a spectrophotometer to measure the intensity of the blue solution. |

1. Describe the steps in measuring the phosphate content of a mixed juice sample. (9)

|  |
| --- |
| Filter the juice. Reject the first runnings (about 10 ml) and collect about 20 ml clear filtrate in the case of mixed juice or about 150 ml if testing clarified juice. If the mixed juice is very dirty, wait for the first clear drops before discarding the first runnings. If the quality of the filtrate is still very poor, mix a teaspoon of Celite 577 with the juice before filtering. |
| The aliquot used will depend on the concentration of phosphate. As a guide: mixed juice in S.A. contains about 200 – 300 ppm P2O5. Clarified juice contains about 40 ppm P2O5. For mixed juice pipette 10 ml filtered sample into a 200 ml volumetric flask.  For clarified juice pipette 100 ml filtered sample into a 200 ml volumetric flask |
| Make to the mark with distilled water and mix thoroughly. |
| Pipette 20 ml of the diluted solution into each of the two 100 ml volumetric flasks. Dilute one to about 60 ml with distilled water and make the other to the mark with distilled water for use as a blank. |
| Add 10 ml ammonium molybdate to the first flask and mix by swirling. |
| Add 10 ml reducing solution, make to the mark with distilled water and mix by shaking. Note the time at which the reducing solution is added. |
| Measure the intensity of the blue colour developed using the spectrophotometer exactly 10 minutes after the addition of the reducing solution. Use a 10 mm cell and measure at 700 nm on the spectrophotometer. The reference is a 10 mm cell containing distilled water. |
| Measure the absorbance of the blank sample also against the distilled water. |
| From the calibration graph read the quantity of P2O5 corresponding to the absorbances obtained under both (g) and (h) above. |

1. During a phosphate determination conducted on mixed juice the following results were obtained.

mg P2O5 in solution = 0,379

mg P2O5 in blank solution = 0,034

Calculate the ppm P2O5 in the mixed juice. (4)

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**Learning activity 3.10: Individual Learning activity: 1 hour (25 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: COLOUR AND TURBIDITY MEASUREMENTS**

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

1. What does a spectrophotometer measure? (merely stating “colour” is not the correct answer) (2)

|  |
| --- |
| When a beam of light is sent through a glass prism, it is split into its 7 pure component colours – red, orange, yellow, green, blue, indigo and violet |

1. State the factors that affect the colour of a sugar solution (4)

|  |
| --- |
| Concentration of dissolved substance(s) |
| pH |
| Turbidity / Clarity |
| Wavelength of light used |

1. Describe how to use a spectrophotometer. (6)

|  |
| --- |
| 1. To switch on the instrument rotate the power switch clockwise which will cause the pilot light to glow. Leave the instrument for 15 minutes to warm up. |
| 1. Adjust the wavelength control to desired value (i.e. 420 nm) as indicated on the scale. |
| 1. With no cell in the holder and the lid closed adjust the zero control until the meter reads zero transmittance. |
| 1. Put the cell with reference solution (usually distilled water) in the sample holder, and close the cover. |
| 1. Adjust the light control until the meter reads 0 absorbance. |
| 1. Put the cell containing the sample into the instrument, close the cover and take the reading. |

1. Describe the procedure to determine the colour and turbidity of clear juice. (10)

|  |
| --- |
| 1. Prepare a 5°Bx solution. |
| 1. Divide the prepared solution between two 250 ml beakers marked S1 and S2. |
| 1. Prepare a filter pad in the Buchner funnel using filter paper and 4kg Kieselguhr made into a slurry with a little of the S2 solution. |
| 1. Filter the solution S2 under vacuum, discarding the first cloudy runnings. Filtration using a membrane filter (0.45 µm) is preferred for more reproducible analyses. |
| 1. Collect the filtrate in a clean dry Buchner flask. |
| 1. Transfer to a 100 ml beaker marked S2 and cover with a watch glass. |
| 1. Adjust the pH to 7.0±0.02 using hydrochloric acid or sodium hydroxide. Use a magnetic stirrer during this operation. |
| 1. Measure the optical density in a 10 mm cell at 420 nm against distilled water reference and record the optical density as OD. |
| 1. Adjust the pH of solution S1 to 7.00±0.02 using hydrochloric acid or sodium hydroxide. Use a magnetic stirrer during this operation. |
| 1. Measure the optical density in 10 mm cell at 420 nm against distilled water as reference and record the optical density as OD1 |

1. A colour determination is performed in a raw sugar sample and the results obtained are as follows:

Brix reading at 200C = 51,30

Optical density at 420 nm = 0,650

Determine the ICUMSA 420 colour (3)

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**Learning activity 3.11: Individual Learning activity: 1 hour (30 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: STARCH MEASUREMENT**

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

1. What is “starch”? (2)

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| --- |
| Starch is a polymer molecule consisting of glucose molecules strung together |

1. Why do we need to ascertain the starch content of raw sugar? (2)

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1. Describe the procedure for creating a standard starch graph (20)

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1. A sample of raw sugar is analysed for its starch content.

The results were as follows:

OD solution 0,188

OD blank 0,021

Calcium chloride factor: 0,295

(i.e. optical density of 1 mg / 50 ml solution)

Determine the starch content of the sugar in ppm. (6)

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**Learning activity 3.12: Individual Learning activity: 1 hour (50 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: GRAIN SIZE DETERMINATIONS**

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

A raw sugar was analysed for grain and the information listed in the table below was noted:

Complete the table and find /calculate

1. The specific grain size (SGS)
2. The mean aperture (Ma)
3. The co-efficient of variation (CV)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Mass of sugar samples = 100,47 g | | | | | | | |
| Sieve size (mm) | 1,7 | 1,18 | 1,00 | 0,6 | 0,355 | Pan | Total |
| Sieve + sugar (g) | 462,23 | 458,81 | 517,74 | 468,52 | 387,23 | 370,44 | - |
| Sieve (g) | 461,99 | 455,72 | 508,87 | 396,69 | 376,48 | 634,36 | - |
| Mass of sugar (g) |  |  |  |  |  |  |  |
| % total mass of sugar |  |  |  |  |  |  |  |
| Factor |  |  |  |  |  |  |  |
| Product |  |  |  |  |  |  |  |
| Cumulative % values |  |  |  |  |  |  |  |

**Learning activity 3.13: Individual Learning activity: 1 hour (47 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: REDUCING SUGAR ANALYSIS**

**Task:** Read the questions carefully and write your answers in the spaces provided.

1. When we refer to “reducing sugars”, which sugars do we mean? (2)

|  |
| --- |
| Glucose and fructose. |

1. The basic reaction employed in analysing for reducing sugars is reacting the reducing sugars with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ions to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ions which exists as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. (3)
2. A raw sugar sample was analysed for its reducing sugar % sugar and the following information was noted:

Titre of blank =

Titre of solution =

Difference, V =

Calculate the reducing sugar % sugar. (5)

|  |
| --- |
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1. A sample of mixed juice was analysed by the Lane and Eynon method to determine its reducing sugar %

The 50 g sample of juice used had a pol % of 13% and the titre required to reach the end point was 28.5 cm3

1. What column in Table 7 in the Laboratory Manual must be consulted?(2)

|  |
| --- |
|  |
|  |

1. Calculate the reducing sugars % mixed juice (14)

|  |
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1. A sample of syrup was analysed to determine its reducing sugar %.

It was found that:

The syrup had a pol % of 60% and the titre required to reach the end point was 36.5 cm3.

1. What column in Table 7 in the Laboratory Manual must be consulted? (2)

|  |
| --- |
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|  |

1. Calculate the reducing sugar % stock solution. (3)

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| --- |
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1. A 4.25 g sample of molasses was analysed to determine its reducing sugar %.

The 4.25 g sample was dissolved in water, quantitatively transferred to a 250 cm3 flask and made to the mark. 100 cm3 was pipetted and diluted to 200 cm3. This solution was used in the burette.

It was found that:

The molasses had a pol % of 30% and the titre required to reach the end-point was 35.80 cm3.

1. What column in Table 7 in the Laboratory Manual must be consulted? (2)

|  |
| --- |
|  |
|  |

1. Calculate the reducing sugars % molasses. (3)

|  |
| --- |
|  |
|  |
|  |
|  |

1. A 7.9982 g sample of syrup was analysed for its reducing sugar % and for its total invert %.

The results obtained were as follows:

Titre obtained for reducing sugars = 41.79 cm3

Titre obtained for total invert = 19.72 cm3

1. What column in Table 7 in the Laboratory Manual must be consulted? (2)

|  |
| --- |
|  |
|  |

1. Calculate the reducing sugars % syrup. (3)

|  |
| --- |
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1. Calculate the total invert % syrup. (3)

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1. Calculate the sucrose % syrup. (3)

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**Learning activity 3.14: Individual Learning activity: 30 minutes (25 marks)**



**Learning Objective:** Demonstrate an understanding of mechanical and chemical breakdown of sucrose in terms of factory efficiencies.

**DESCRIPTION: SUGAR TRACE ANALYSIS**

**Task:** Read the questions carefully and write your answers in the spaces provided.

1. Explain why it is important to check for the presence of trace amounts of sugar in water? (3)

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| --- |
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1. If given a sample of boiler feedwater, explain how you would:
2. Quickly test to ascertain if it contains sugar-traces or not. (5)

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1. Use the Resorcinol method top determine the exact concentration of sugar in ppm.(7)

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1. Explain how one would use the phenol sulphuric acid method to determine the amount of sugar in vapour 2 condensate. (10)

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1. CONCLUSION OF KNOWLEDGE MODULE 2: THE SUGAR MANUFACTURING PROCESS

Throughout this knowledge module the learners has been provided opportunities to complete formative learning activities. They will have captured their results in their Learner Workbook: 2.

The total marks for this Knowledge Module are as follows:

|  |  |  |
| --- | --- | --- |
| **Knowledge Module** | **Total Marks** | **Marks attained** |
| KM-02-KT01: The sugar manufacturing process (55%) | 84 |  |
| KM-02-KT02: Rework and recycling (15%) | 34 |  |
| KM-02-KT03: Sugar and By-Products Analysis (30%) |  |  |
| * KT0301 Sucrose molecule | 6 |  |
| * KT0302 Chemical Reactions | 11 |  |
| * KT0303 Constituents of Sugarcane | 16 |  |
| * KT0304 Brix | 35 |  |
| * KT0305 Apparent Sucrose (pol) | 80 |  |
| * KT0306 Moisture | 15 |  |
| * KT0307 pH | 38 |  |
| * KT0308 Ash | 48 |  |
| * KT0309 Phosphate | 22 |  |
| * KT0310 Colour and turbidity | 25 |  |
| * KT0311 Starch | 30 |  |
| * KT0312 Grain size | 50 |  |
| * KT0313 Reducing sugars | 47 |  |
| * KT0314 Sugar trace | 30 |  |
| **Total Marks** | **571 marks** |  |

1. SUMMATIVE ASSESSMENT AND MODEL ANSWERS

The learner is now required to complete the Summative Assessment (Multiple choice/ True or False questions).

**Facilitator instructions:**

Once the facilitation of this Knowledge Module is completed:

1. Hand out the Summative Assessment Guide to each learner and the Summative Assessment is done (4 hours)
2. Tally the total marks and complete the Summative Assessment Guide of each learner.
3. Hand out each Summative Assessment Guide for final learner feedback and signing.
4. Prepare certificates for the programme as required.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scope of Assessment** | | | **Exit Level Outcome/s** | **Module/s** | |
|  | | | 1. Phosphate, colour, starch, grain size, reducing sugars, sugar traces | **1** | |
| **Alignment – Learning Outcome 1:** Phosphate, colour, starch, grain size, reducing sugars, sugar traces | | | | | |
| **Award one mark for selection of valid “x”. One mark = Competent** | | | | | |
| **2.1** | **Choose the correct definition for sucrose** | | | | **Mark Allocation** | |
| **a.** | 🞎 | A monosaccharide. | | |  | |
| **b.** | 🞎 | Glucose. | | |  | |
| **c.** | 🞎 | Fructose. | | |  | |
| **d.** | 🗷 | Disaccharide. | | |  | |
| **e.** | 🞎 | Simple sugar. | | | 2 | |

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| **2.2** | **What happens during inversion** | | | **Mark Allocation** | |
| **a.** | 🞎 | Decomposition of glucose and fructose. |  | |
| **b.** | 🞎 | Alkaline degradation. |  | |
| **c.** | 🗷 | Decomposition of sucrose. |  | |
| **d.** | 🞎 | Decomposition of glucose. |  | |
| **e.** | 🞎 | Decomposition of fructose. | 2 | |

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| **2.3** | **Brix can be defined as:** | | **Mark Allocation** |
| **a.** | 🞎 | Mass of dissolved substances in every factory stream. |  |
| **b.** | 🞎 | Total purity in every factory stream. |  |
| **c.** | 🞎 | Dry solids. |  |
| **d.** | 🞎 | Refractive index. |  |
| **e.** | 🗷 | Percent dissolved substances in every factory stream. | 2 |

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| **2.4** | The percentage of dissolved substances is arrived at by the formula,  % Dissolved substances = Mass of dissolved substance(s) X 100  Mass of solution 1  **What is the Brix of a sugar solution that has a total mass of 35g with 5.25 g of sugar?** | | **Mark Allocation** |
| **a.** | 🞎 | 35 oB |  |
| **b.** | 🞎 | 12 oB |  |
| **c.** | 🞎 | 10 oB |  |
| **d.** | 🗷 | 15 oB |  |
| **e.** | 🞎 | 5.25 oB | 2 |

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| **2.5** | **When light moves from air through a solution, the amount that the light deviates is called?** | | **Mark Allocation** |
| **a.** | 🞎 | Optical density. |  |
| **b.** | 🗷 | Refraction. |  |
| **c.** | 🞎 | Brix. |  |
| **d.** | 🞎 | Prism. |  |
| **e.** | 🞎 | Percentage. | 2 |

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| **2.6** | **What will cause the light to deviate more when passing from air through a solution?** | | **Mark Allocation** |
| **a.** | 🞎 | A solution with a higher optical density. |  |
| **b.** | 🞎 | A solution with more dissolved solids. |  |
| **c.** | 🞎 | A solution with a higher Brix content. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🗷 | All the above (except d.). | 2 |

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| **2.7** | **A Refractometer is calibrated using:** | | **Mark Allocation** |
| **a.** | 🞎 | Diluted syrup. |  |
| **b.** | 🞎 | Sugar solution. |  |
| **c.** | 🞎 | Mixed juice. |  |
| **d.** | 🗷 | Pure sucrose solution. |  |
| **e.** | 🞎 | Dry solids. | 2 |

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| **2.8** | **Which will have the higher Brix? A 10% sugar solution or a 10% salt solution?** | | **Mark Allocation** |
| **a.** | 🞎 | The sugar solution because sugar will bend the light more than salt. |  |
| **b.** | 🞎 | The sugar solution because sugar will bend the light less than salt. |  |
| **c.** | 🞎 | There will be no difference. |  |
| **d.** | 🞎 | The salt solution because salt will bend the light less than sugar. |  |
| **e.** | 🗷 | The salt solution because salt will bend the light more than sugar. | 2 |

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| **2.9** | **The correct definition of Pol is:** | | **Mark Allocation** |
| **a.** | 🞎 | Rotation of light. |  |
| **b.** | 🗷 | Apparent sucrose. |  |
| **c.** | 🞎 | Saccharimeter reading. |  |
| **d.** | 🞎 | Percent dissolved solids in a factory stream |  |
| **e.** | 🞎 | Polarised light. | 2 |

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| **2.10** | **The principle operation of a polarimeter is the use of;** | | **Mark Allocation** |
| **a.** | 🞎 | Light. |  |
| **b.** | 🞎 | Heat. |  |
| **c.** | 🞎 | Absorption. |  |
| **d.** | 🗷 | Polarised Light. |  |
| **e.** | 🞎 | Infra-red Light. | 2 |

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| **2.11** | **In a Saccharimeter with a fixed length of sample tube, constant temperature and a standard light source, choose the correct statement below:** | | **Mark Allocation** |
| **a.** | 🗷 | Rotation of light is proportional to the sucrose % solution. |  |
| **b.** | 🞎 | The sample reading will fluctuate. |  |
| **c.** | 🞎 | Rotation of light is disproportionate to the sucrose % solution. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.12** | **How can a reading of 100** o**Z be achieved on a Saccharimeter?** | | **Mark Allocation** |
| **a.** | 🞎 | 100 g sugar in a solution. |  |
| **b.** | 🞎 | 13 g sugar plus 13 g salt made up with distilled water to a total of 100 g. |  |
| **c.** | 🞎 | 26 g sugar made up with distilled water to a total of 100 g. |  |
| **d.** | 🗷 | 26 g sugar made up with distilled water to a total of 100 ml. |  |
| **e.** | 🞎 | 13 g sugar plus 13 g salt made up with distilled water to a total of 100 ml. | 2 |

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| **2.13** | The percentage of pol (sucrose) in a solution is arrived at by the formula,  % Pol (sucrose) = Mass of pol (sucrose) X 100  Mass of solution 1  **What is the pol (sucrose) of a sugar solution that has 25 g sugar dissolved in 75 g of distilled water?** | | **Mark Allocation** |
| **a.** | 🗷 | 25 % |  |
| **b.** | 🞎 | 75 % |  |
| **c.** | 🞎 | 20 % |  |
| **d.** | 🞎 | 15 % |  |
| **e.** | 🞎 | 100 % | 2 |

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| **2.14** | **Today, readings are captured directly from the equipment into a LIMS system and there is no need to look up information on tables. However, what is the name of the table that was used to look up pol results from a Saccharimeter reading?** | | **Mark Allocation** |
| **a.** | 🞎 | A Brix table with refractometer readings across the top and Saccharimeter readings on the sides. |  |
| **b.** | 🞎 | A Schmidtz’s table with refractometer readings across the top and Saccharimeter readings on the sides. |  |
| **c.** | 🞎 | A Schmidtz’s table with Saccharimeter readings across the top and refractometer readings on the sides. |  |
| **d.** | 🞎 | A Schmidtz’s table with refractometer readings across the top and Saccharimeter readings on the sides. |  |
| **e.** | 🗷 | A Schmidtz’s table with Brix percent across the top and Saccharimeter readings on the sides. | 2 |

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| **2.15** | **What is the best definition of sucrose purity?** | | **Mark Allocation** |
| **a.** | 🞎 | The ratio of sucrose % to the total dissolved solids %. |  |
| **b.** | 🞎 | The indication of the amount of sucrose in the solution as a percentage of the whole. |  |
| **c.** | 🞎 | Purity = (sucrose divided by Brix) X 100. |  |
| **d.** | 🞎 | A pure sugar solution will be close to 100 purity. |  |
| **e.** | 🗷 | All the above. | 2 |

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| **2.16** | **If the Brix of mixed juice is 15.85% and the sucrose is 12.33 % what would the purity of mixed juice be?** | | **Mark Allocation** |
| **a.** | 🞎 | 75.25 |  |
| **b.** | 🞎 | 77.97 |  |
| **c.** | 🞎 | 76.89 |  |
| **d.** | 🗷 | 77.79 |  |
| **e.** | 🞎 | 77.00 | 2 |

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| **2.17** | **Which process will determine the moisture content of a sample?** | | **Mark Allocation** |
| **a.** | 🞎 | Balance |  |
| **b.** | 🞎 | Drying oven. |  |
| **c.** | 🗷 | Evaporation. |  |
| **d.** | 🞎 | Analyst |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.18** | **What is the correct definition of an ion?** | | **Mark Allocation** |
| **a.** | 🞎 | The smallest particle of an element that can exist. |  |
| **b.** | 🞎 | A compound. |  |
| **c.** | 🞎 | A molecule. |  |
| **d.** | 🞎 | Atoms, molecules and compounds. |  |
| **e.** | 🗷 | An atom that carries an electrical charge. | 2 |

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| **2.19** | **If a compound is high in hydroxide ions, what would the possible pH be?** | | **Mark Allocation** |
| **a.** | 🞎 | 7. |  |
| **b.** | 🞎 | 0. |  |
| **c.** | 🞎 | 5. |  |
| **d.** | 🗷 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.20** | **If a solution is known to be basic, what would the possible pH be?** | | **Mark Allocation** |
| **a.** | 🞎 | 7. |  |
| **b.** | 🞎 | 0. |  |
| **c.** | 🞎 | 5. |  |
| **d.** | 🗷 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.21** | **A pH meter can be standardized in the sugar industry by using;** | | **Mark Allocation** |
| **a.** | 🞎 | Litmus paper at 3 and 11 pH. |  |
| **b.** | 🞎 | Indicator solution at 4 and 10 pH. |  |
| **c.** | 🗷 | Buffer solution at 4 and 10 pH. |  |
| **d.** | 🞎 | Buffer solution at 3 and 9 pH. |  |
| **e.** | 🞎 | Buffer solution at 4 and 12 pH. | 2 |

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| **2.22** | **What is the purpose of measuring pH in the sugar manufacturing process?** | | **Mark Allocation** |
| **a.** | 🗷 | Sucrose will breakdown into glucose and fructose in acidic and basic conditions. |  |
| **b.** | 🞎 | To ensure that there is the correct pH of sugar made. |  |
| **c.** | 🞎 | To help with the evaporation process. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.23** | **When should a pH meter be switched off?** | | **Mark Allocation** |
| **a.** | 🞎 | To get correct readings, it should be switched off once per shift. |  |
| **b.** | 🗷 | It should always be left on, in the standby position if not in use. |  |
| **c.** | 🞎 | When the electrodes get dirty and need cleaning. |  |
| **d.** | 🞎 | When the pH Meter is not in use. |  |
| **e.** | 🞎 | To get correct readings, it should be switched off and on between samples. | 2 |

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| **2.24** | **If a pH electrode contains a solution, what is the precaution taken?** | | **Mark Allocation** |
| **a.** | 🗷 | Ensure that it is always filled with the appropriate solution, usually KCl. |  |
| **b.** | 🞎 | Ensure that it is always filled with the appropriate solution, usually NaCl. |  |
| **c.** | 🞎 | Ensure that it is always filled with the appropriate solution, usually de-ionised water. |  |
| **d.** | 🞎 | Ensure that it is immersed in KCl. |  |
| **e.** | 🞎 | Ensure that it is immersed in de-Ionised water. | 2 |

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| **2.25** | **What is the best definition for Ash in a sugar manufacturing environment?** | | **Mark Allocation** |
| **a.** | 🞎 | The soil that is found under the cane carriers. |  |
| **b.** | 🞎 | The organic compounds of a product. |  |
| **c.** | 🞎 | The sulphuric acid residue after the analysis. |  |
| **d.** | 🗷 | The inorganic salts in factory streams. |  |
| **e.** | 🞎 | The decomposed oxides. | 2 |

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| **2.26** | **When measuring conductivity ash, what causes an increase in the reading?** | | **Mark Allocation** |
| **a.** | 🞎 | Lower resistance of the solution. |  |
| **b.** | 🞎 | Increased concentration of ions. |  |
| **c.** | 🞎 | Higher conductivity of the sample. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🗷 | All the above (except d.). | 2 |

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| **2.27** | **Why would the conductivity of pure water be zero?** | | **Mark Allocation** |
| **a.** | 🞎 | The ion content is too high for a reading. |  |
| **b.** | 🞎 | The water may contain sucrose molecules. |  |
| **c.** | 🞎 | The resistance in the water is too high for a reading. |  |
| **d.** | 🗷 | Water contains neutrally charged molecules. |  |
| **e.** | 🞎 | All the above. | 2 |

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| **2.28** | **What is the advantage of adding sulphuric acid to the sample for sulphated ash analysis?** | | **Mark Allocation** |
| **a.** | 🗷 | The sulphates are stable and do not readily decompose. |  |
| **b.** | 🞎 | Allows a result to be achieved within one hour. |  |
| **c.** | 🞎 | Reacts with the sugar sample, reducing it to ash. |  |
| **d.** | 🞎 | Improves the repeatability of the analysis. |  |
| **e.** | 🞎 | All the above. | 2 |

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| **2.29** | The ash % is arrived at by the formula, % ash = Mass of ash X 100  Mass of sample 1  **Given a mass of the crucible plus sugar of 70.4352g and a mass of crucible and ash after ashing of 60.4439g, what is the ash % of the sample? The mass of the empty crucible is 60.4320g.** | | **Mark Allocation** |
| **a.** | 🞎 | 0.0119 %. |  |
| **b.** | 🞎 | 10.0032 %. |  |
| **c.** | 🞎 | 0.011 %. |  |
| **d.** | 🗷 | 0.012 %. |  |
| **e.** | 🞎 | 0.021 %. | 2 |

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| **2.30** | **Why is a thermometer required in the conductivity ash analysis?** | | **Mark Allocation** |
| **a.** | 🞎 | To take the temperature of the water bath. |  |
| **b.** | 🞎 | To apply a correction if the sample is read at 20 oC. |  |
| **c.** | 🞎 | To add +- 2 % per degree if the sample is read above 20 oC. |  |
| **d.** | 🗷 | To subtract +- 2 % per degree if the sample is read above 20 oC. |  |
| **e.** | 🞎 | All the above. | 2 |

**TRUE OR FALSE QUESTIONS**

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

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| **2.31** | **TRUE or FALSE: for the following statements.** | | **Mark Allocation** |
| **a.** |  | Cane enters the shredder then cane knives before entering the diffuser for extraction. |  |
| **b.** |  | The screened juice leaving the diffuser is called clear juice. |  |
| **c.** |  | Juice is concentrated by evaporating water, to a thick syrup. |  |
| **d.** |  | B-sugar is packaged as speciality sugar. |  |
| **e.** |  | C-molasses is too thick for further boiling’s and is a by-product. | 5 |

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| **2.32** | **TRUE or FALSE: The constituents of sugar cane are:** | | **Mark Allocation** |
| **a.** |  | Insoluble fibre – 25%. |  |
| **b.** |  | Water – 70%. |  |
| **c.** |  | Dissolved substances – 15% |  |
| **d.** |  | Sucrose - +- 13% |  |
| **e.** |  | Gums – 5% | 5 |

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| **2.33** | **TRUE or FALSE: The difference between % dissolved solids and % dry solids is:** | | **Mark Allocation** |
| **a.** |  | Very different for low Brix factory products. |  |
| **b.** |  | Marginal difference for mixed juice. |  |
| **c.** |  | Not very different for high Brix factory products. |  |
| **d.** |  | Big difference for molasses. |  |
| **e.** |  | Not different at all. | 5 |

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| **2.34** | **TRUE or FALSE: The Brix of factory products is obtained by:** | | **Mark Allocation** |
| **a.** |  | Mixed juice can be filtered and read directly. |  |
| **b.** |  | Syrup and Remelt require a dilution of 1:5 before being read. |  |
| **c.** |  | Massecuites and molasses require a 1:4 dilution before being read. |  |
| **d.** |  | Syrup and Remelt require a dilution of 1:4 before being read. |  |
| **e.** |  | Massecuites and molasses require a 1:5 dilution before being read. | 5 |

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| **2.35** | **TRUE or FALSE: The following can impact a Brix reading:** | | **Mark Allocation** |
| **a.** |  | Temperature. |  |
| **b.** |  | pH. |  |
| **c.** |  | Turbidity. |  |
| **d.** |  | Sample Evaporation. |  |
| **e.** |  | Sample Dilution. | 5 |

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| **2.36** | **TRUE or FALSE: Sucrose can be measured using:** | | **Mark Allocation** |
| **a.** |  | Near infrared spectroscopy. |  |
| **b.** |  | Gas chromatograph. |  |
| **c.** |  | Saccharimeter. |  |
| **d.** |  | pH Meter. |  |
| **e.** |  | Conductivity Meter. | 5 |

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| **2.37** | **TRUE or FALSE: For the following statements:** | | **Mark Allocation** |
| **a.** |  | Sucrose is much higher than pol in mixed juice. |  |
| **b.** |  | Pol is higher than sucrose. |  |
| **c.** |  | Molasses pol is much lower than sucrose. |  |
| **d.** |  | Mixed juice has a low difference between pol and sucrose. |  |
| **e.** |  | The difference between pol and sucrose does not vary much for different products. | 5 |

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| **2.38** | **TRUE or FALSE: The angle of rotation in a Saccharimeter is effected by:** | | **Mark Allocation** |
| **a.** |  | Concentration of the sample. |  |
| **b.** |  | Monochromatic light. |  |
| **c.** |  | Length of the sample tube. |  |
| **d.** |  | Temperature. |  |
| **e.** |  | Refraction. | 5 |

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| **2.39** | **TRUE or FALSE: Today the use of dry lead sub-acetate is not used to clarify samples for pol readings. What is the reason for this?** | | **Mark Allocation** |
| **a.** |  | Lead sub-acetate is a hazardous chemical and is difficult to dispose of. |  |
| **b.** |  | Technology has advanced that allows equipment the ability to analyse darker solutions, |  |
| **c.** |  | Lead sub-acetate gives inaccurate results versus the modern equipment. |  |
| **d.** |  | Lead sub-acetate is not manufactured any more. |  |
| **e.** |  | NIR can give accurate sucrose results without clarifying the sample at all. | 5 |

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| **2.40** | **TRUE or FALSE: Which factory products listed below contain moisture?** | | **Mark Allocation** |
| **a.** |  | Final molasses. |  |
| **b.** |  | Sugar cane. |  |
| **c.** |  | Sugar. |  |
| **d.** |  | Mixed juice. |  |
| **e.** |  | Remelt. | 5 |

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| **2.41** | **TRUE or FALSE: pH can be measured in the following ways:** | | **Mark Allocation** |
| **a.** |  | Conductivity meter. |  |
| **b.** |  | Indicator solution. |  |
| **c.** |  | Titrations. |  |
| **d.** |  | Indicator paper |  |
| **e.** |  | pH meter. | 5 |

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| **2.42** | **TRUE or FALSE: The primary methods for determining the ash % of a factory stream:** | | **Mark Allocation** |
| **a.** |  | Sulphated ash. |  |
| **b.** |  | Spectrophotometer ash. |  |
| **c.** |  | pH ash. |  |
| **d.** |  | Conductivity ash. |  |
| **e.** |  | Incineration ash. | 5 |

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| **2.43** | **Which factory process is affected by phosphate content?** | | **Mark Allocation** |
| **a.** | 🗷 | Clarification. |  |
| **b.** | 🞎 | Pan boiling. |  |
| **c.** | 🞎 | Juice heating. |  |
| **d.** | 🞎 | Evaporation. |  |
| **e.** | 🞎 | Curing. | 2 |

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| **2.44** | **What is the critical level of phosphate content?** | | **Mark Allocation** |
| **a.** | 🞎 | 150 ppm. |  |
| **b.** | 🞎 | 220 ppm. |  |
| **c.** | 🗷 | 200 ppm |  |
| **d.** | 🞎 | 100 ppm |  |
| **e.** | 🞎 | 300 ppm | 2 |

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| **2.45** | **What is added to increase the phosphate content to the desired level?** | | **Mark Allocation** |
| **a.** | 🞎 | Hydrogen peroxide. |  |
| **b.** | 🞎 | Potassium dihydrogen. |  |
| **c.** | 🞎 | Sulphuric acid. |  |
| **d.** | 🞎 | Super phosphates. |  |
| **e.** | 🗷 | Phosphoric acid. | 2 |

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| **2.46** | **There are three solutions used to generate a standard phosphate graph. Which is the correct combination?** | | **Mark Allocation** |
| **a.** | 🞎 | Phosphate solution, Sodium sulphite solution, Reducing solution. |  |
| **b.** | 🗷 | Phosphate solution, Ammonium molybdate solution, Reducing solution. |  |
| **c.** | 🞎 | Phosphate solution, Ammonium molybdate tetrahydrate, Reducing solution. |  |
| **d.** | 🞎 | Potassium dihydrogen solution, Sodium metabisulphite solution, Reducing solution. |  |
| **e.** | 🞎 | Phososulphonic solution, Ammonium molybdate solution, Reducing solution. | 2 |

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| **2.47** | **The Spectrophotometer is the instrument used to measure phosphate content. At what light wavelength is the measurement done?** | | **Mark Allocation** |
| **a.** | 🞎 | 320 nm. |  |
| **b.** | 🞎 | 600 nm. |  |
| **c.** | 🞎 | 480 nm. |  |
| **d.** | 🞎 | 420 nm. |  |
| **e.** | 🗷 | 700 nm. | 2 |

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| **2.48** | **The spectrophotometer will give a reading of a sample called optical density. What process does the spec use to arrive at this reading?** | | **Mark Allocation** |
| **a.** | 🞎 | Refraction. |  |
| **b.** | 🗷 | Absorbance. |  |
| **c.** | 🞎 | Reflection. |  |
| **d.** | 🞎 | Absolution. |  |
| **e.** | 🞎 | Conductance. | 2 |

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| **2.49** | **How many pure colours are there when a beam of light is sent through a glass prism?** | | **Mark Allocation** |
| **a.** | 🞎 | 5. |  |
| **b.** | 🞎 | 8. |  |
| **c.** | 🞎 | 3. |  |
| **d.** | 🗷 | 7. |  |
| **e.** | 🞎 | 6. | 2 |

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| **2.50** | **Which is the correct statement relating to phosphate determination?** | | **Mark Allocation** |
| **a.** | 🞎 | The false phosphate reading is obtained from the blank. |  |
| **b.** | 🞎 | The addition of ammonium molybdate and reducing solutions develops a blue colour in the sample. |  |
| **c.** | 🞎 | The sample must be read in the spectrophotometer exactly10 minutes after the addition of the reducing solution. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🗷 | All the above (except d.) | 2 |

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| **2.51** | **Which is the closest colour in the colour spectrum that can measure the colour of raw sugar?** | | **Mark Allocation** |
| **a.** | 🗷 | Yellow. |  |
| **b.** | 🞎 | Green. |  |
| **c.** | 🞎 | Red. |  |
| **d.** | 🞎 | Blue. |  |
| **e.** | 🞎 | Brown. | 2 |

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| **2.52** | **Which product streams are colour and turbidity measured?** | | **Mark Allocation** |
| **a.** | 🞎 | Mixed juice and sugar. |  |
| **b.** | 🗷 | Clarified juice and sugar. |  |
| **c.** | 🞎 | Mixed juice and clarified juice. |  |
| **d.** | 🞎 | C-Molasses and sugar. |  |
| **e.** | 🞎 | Clarified juice and A-molasses. | 2 |

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| **2.53** | **Why is it important for colour to be measured at the correct pH?** | | **Mark Allocation** |
| **a.** | 🞎 | Acidity will cause the sample to get darker. |  |
| **b.** | 🞎 | An alkaline solution will cause the colour to get lighter. |  |
| **c.** | 🗷 | At a neutral pH there will be no development of colour. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.54** | **What Brix percent must raw sugar be for a colour analysis?** | | **Mark Allocation** |
| **a.** | 🞎 | 10 oBx. |  |
| **b.** | 🞎 | 5 oBx. |  |
| **c.** | 🞎 | 13.25 oBx. |  |
| **d.** | 🗷 | 50 oBx. |  |
| **e.** | 🞎 | 80 oBx. | 2 |

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| **2.55** | **Starch is an impurity comprising of glucose molecules strung together. Where does this impurity come from?** | | **Mark Allocation** |
| **a.** | 🞎 | Developed in the extraction process. |  |
| **b.** | 🞎 | Developed during clarification. |  |
| **c.** | 🗷 | Developed in the sugar cane. |  |
| **d.** | 🞎 | Developed during evaporation. |  |
| **e.** | 🞎 | Developed during pan boiling. | 2 |

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| **2.56** | **What is the impact of high starch content of raw sugar?** | | **Mark Allocation** |
| **a.** | 🗷 | Causes severe filtration problems in carbonation refineries. |  |
| **b.** | 🞎 | Causes severe filtration problems in sulphation refineries. |  |
| **c.** | 🞎 | Causes severe filtration problems in the refinery clarification process. |  |
| **d.** | 🞎 | Causes severe filtration problems in the raw house. |  |
| **e.** | 🞎 | Causes severe problems with the storage of sugar. | 2 |

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| **2.57** | **How is starch precipitated for analysis?** | | **Mark Allocation** |
| **a.** | 🞎 | Using hot water. |  |
| **b.** | 🞎 | Under a vacuum. |  |
| **c.** | 🞎 | Acetic acid. |  |
| **d.** | 🗷 | Alcohol. |  |
| **e.** | 🞎 | Calcium chloride. | 2 |

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| **2.58** | **In preparing a starch graph, which is the unstable reagent that must be prepared immediately prior to use?** | | **Mark Allocation** |
| **a.** | 🞎 | Potassium Iodate. |  |
| **b.** | 🗷 | Potassium Iodide. |  |
| **c.** | 🞎 | Calcium chloride. |  |
| **d.** | 🞎 | Acetic acid. |  |
| **e.** | 🞎 | All the above. | 2 |

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| **2.59** | **The Spectrophotometer is the instrument used to measure starch content. At what light wavelength is the measurement done?** | | **Mark Allocation** |
| **a.** | 🞎 | 320 nm. |  |
| **b.** | 🗷 | 600 nm. |  |
| **c.** | 🞎 | 480 nm. |  |
| **d.** | 🞎 | 420 nm. |  |
| **e.** | 🞎 | 700 nm. | 2 |

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| **2.60** | **When conducting a starch determination in raw sugar, how many grams of raw sugar are required for the analysis?** | | **Mark Allocation** |
| **a.** | 🞎 | 30 g. |  |
| **b.** | 🗷 | 25 g. |  |
| **c.** | 🞎 | 20 g. |  |
| **d.** | 🞎 | 100 g. |  |
| **e.** | 🞎 | 50 g | 2 |

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| **2.61** | **Raw sugar grain size is important because:** | | **Mark Allocation** |
| **a.** | 🞎 | A crystal size that is consistent has better storage qualities. |  |
| **b.** | 🞎 | Smaller grains can get trapped by bigger grains, trapping moisture. |  |
| **c.** | 🞎 | A low scatter from the mean is preferable. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🗷 | All the above (except d.) | 2 |

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| **2.62** | **If raw sugar is not washed prior to grain size analysis, what will happen?** | | **Mark Allocation** |
| **a.** | 🞎 | The sample not be representative. |  |
| **b.** | 🗷 | The raw sugar will stick to the screens. |  |
| **c.** | 🞎 | Smaller grains fill the gaps and get stuck. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.63** | **In the grain size analysis. What reagents are the raw sugar washed with?** | | **Mark Allocation** |
| **a.** | 🞎 | Add methanol and shake hard to dissolve the sugar. |  |
| **b.** | 🞎 | Add distilled water and shake gently, not dissolving the sugar. |  |
| **c.** | 🞎 | Add methanol and distilled water and slosh the solution around to lift the molasses off the crystal. |  |
| **d.** | 🗷 | Add methanol and slosh the solution around to lift the molasses off the crystal. Use ether in the final washing. |  |
| **e.** | 🞎 | None of the above. | 2 |

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| **2.64** | **What sugar molecules make up what is referred to as Reducing Sugars?** | | **Mark Allocation** |
| **a.** | 🞎 | Sucrose, glucose and fructose. |  |
| **b.** | 🞎 | Sucrose and fructose. |  |
| **c.** | 🗷 | Glucose and Fructose. |  |
| **d.** | 🞎 | Sucrose and glucose |  |
| **e.** | 🞎 | Sucrose. | 2 |

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| **2.65** | **What is the feature of reducing sugars?** | | **Mark Allocation** |
| **a.** | 🗷 | They can add electrons to other substances under certain conditions. |  |
| **b.** | 🞎 | They are characterised by reducing cupric salt. |  |
| **c.** | 🞎 | They help maintain an alkaline environment. |  |
| **d.** | 🞎 | None of the above. |  |
| **e.** | 🞎 | All the above (except d.). | 2 |

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| **2.66** | **What laboratory process is used for the determination of reducing sugars?** | | **Mark Allocation** |
| **a.** | 🞎 | Mass difference. |  |
| **b.** | 🞎 | Fehling’s A & B. |  |
| **c.** | 🞎 | Lane and Eynon. |  |
| **d.** | 🗷 | Titration. |  |
| **e.** | 🞎 | Trace test. | 2 |

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| **2.67** | **Why should factory waters be tested for sugar content?** | | **Mark Allocation** |
| **a.** | 🞎 | To indicate if there are any problems with heating vessels. |  |
| **b.** | 🞎 | To make sure that no sugar is being lost. |  |
| **c.** | 🞎 | To ensure that the cooling towers operate efficiently. |  |
| **d.** | 🞎 | To prevent sugar getting into the boiler feed water. |  |
| **e.** | 🗷 | All the above. | 2 |

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| **2.68** | **Which test will determine the actual amount of sugar present in water?** | | **Mark Allocation** |
| **a.** | 🞎 | The quantitative Alpha-naphthol test. |  |
| **b.** | 🗷 | The quantitative phenol-sulphuric acid method. |  |
| **c.** | 🞎 | The qualitative Alpha-naphthol test. |  |
| **d.** | 🞎 | The qualitative resorcinol method. |  |
| **e.** | 🞎 | All the above. | 2 |

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| **2.69** | **The expression of concentration is given in:** | | **Mark Allocation** |
| **a.** | 🞎 | Ph. |  |
| **b.** | 🞎 | G/l |  |
| **c.** | 🞎 | Mg. |  |
| **d.** | 🗷 | Ppm. |  |
| **e.** | 🞎 | Ml/l. | 2 |

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| **2.70** | **What reagents are used when making a standard sugar trace graph for the resorcinol method?** | | **Mark Allocation** |
| **a.** | 🞎 | Refined sugar, distilled water and 0,01% benzoic acid. |  |
| **b.** | 🞎 | Raw sugar, distilled water and 0,01% benzoic acid. |  |
| **c.** | 🞎 | Refined sugar, distilled water and 0,01% ethyl alcohol. |  |
| **d.** | 🗷 | Refined sugar and 0,01% benzoic acid. |  |
| **e.** | 🞎 | Refined sugar and 0,01% ethyl alcohol. | 2 |

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| **2.71** | **When conducting a trace test of factory waters, what is the wavelength that the optical density muse be read for the phenol – sulphuric method?** | | **Mark Allocation** |
| **a.** | 🞎 | 320 nm. |  |
| **b.** | 🞎 | 600 nm. |  |
| **c.** | 🗷 | 480 nm |  |
| **d.** | 🞎 | 420 nm. |  |
| **e.** | 🞎 | 700 nm. | 2 |

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| **2.72** | **How is sugar found in factory waters recovered?** | | **Mark Allocation** |
| **a.** | 🞎 | By re-introducing the water into the mixed juice. |  |
| **b.** | 🞎 | By using the water in the boilers. |  |
| **c.** | 🞎 | By using the water to produce Remelt. |  |
| **d.** | 🞎 | By using the water to wash out the pans. |  |
| **e.** | 🗷 | None of the above. | 2 |

**TRUE OR FALSE QUESTIONS: (One mark for each correct answer.)**

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| **2.73** | **TRUE or FALSE: The primary colours are made up as follows:** | | **Mark Allocation** |
| **a.** |  | Red, orange, yellow. |  |
| **b.** |  | Green, blue and violet. |  |
| **c.** |  | Red, green and blue. |  |
| **d.** |  | Orange, yellow and green. |  |
| **e.** |  | Red, blue and yellow. | 5 |

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| **2.74** | **TRUE or FALSE: Answer the following relating to colour and turbidity determination:** | | **Mark Allocation** |
| **a.** |  | The spectrophotometer measures colour. |  |
| **b.** |  | Filtrations are done under vacuum. |  |
| **c.** |  | Turbidity is the difference between the absorbency index of the filtered sample less the ICUMSA - SA colour. |  |
| **d.** |  | The wavelength for colour measurement is 420 nm |  |
| **e.** |  | Measurement of total dissolved solids is not important. | 5 |

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| **2.75** | **TRUE or FALSE: What could a high turbidity of clear juice indicate?** | | **Mark Allocation** |
| **a.** |  | A problem with the clarification process. |  |
| **b.** |  | That the mixed juice has a low purity. |  |
| **c.** |  | Potential losses in the juice heaters. |  |
| **d.** |  | Too much imbibition on the extraction line. |  |
| **e.** |  | Problems with the evaporator station. | 5 |

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| **2.76** | **TRUE or FALSE: How are the starch levels controlled in sugar production?** | | **Mark Allocation** |
| **a.** |  | Starch levels are not controlled. |  |
| **b.** |  | An enzyme called amylose is added to the syrup. |  |
| **c.** |  | An enzyme called amylopectin is added to the syrup. |  |
| **d.** |  | An enzyme called amylase is added to the syrup. |  |
| **e.** |  | A product called amylose is added to the clear juice. | 5 |

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| **2.77** | **TRUE or FALSE: Which filtration methods are used for starch analysis?** | | **Mark Allocation** |
| **a.** |  | Filter under vacuum, washing the cake with distilled water. |  |
| **b.** |  | Filter under gravity, using a filter aid. |  |
| **c.** |  | Filter under vacuum, washing the cake with alcohol. |  |
| **d.** |  | No filtration. |  |
| **e.** |  | Filter under gravity and retain the cake for analysis. | 5 |

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| **2.78** | **TRUE or FALSE: Answer the following statements in relation to grain size analysis:** | | **Mark Allocation** |
| **a.** |  | Co-efficient of variation gives an indication of the distribution scatter. |  |
| **b.** |  | Fines percent is important for refined sugar. |  |
| **c.** |  | Specific grain size (S.G.S.) is an important indicator for raw sugar. |  |
| **d.** |  | MA is an abbreviation for Most Apertures. |  |
| **e.** |  | Most of the sugar will be caught in the first pan of the mechanical shaker. | 5 |

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| **2.79** | **TRUE or FALSE: Answer the following in connection with determining reducing sugars in juice.** | | **Mark Allocation** |
| **a.** |  | Filter the sample using filter paper, discarding the first runnings. |  |
| **b.** |  | Pipette 5ml A and 5ml B Fehling’s solution into a flat bottomed narrow neck boiling flask. |  |
| **c.** |  | Add 20ml diluted juice from the burette into the flask. |  |
| **d.** |  | After 10 – 15 minutes of boiling the flask, add diluted juice, 5ml at a time until the original colour of the reagents returns. |  |
| **e.** |  | Add 3 – 4 drops of methylene blue for the next colour change process. | 5 |

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| **2.80** | **TRUE or FALSE: Answer the following relating to the Alpha – naphthol sugar trace test.** | | **Mark Allocation** |
| **a.** |  | Use 2ml of a clear sample in a test tube. |  |
| **b.** |  | Add 5 drops of alpha – naphthol at 20% and mix. |  |
| **c.** |  | Run 5ml of concentrated sulphuric acid gently down the test tube. Once done mix well. |  |
| **d.** |  | A violet colour will develop within 30 seconds if sugar is present. |  |
| **e.** |  | A violet colour will develop within 50 seconds if sugar is present. | 5 |

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| **2.81** | **TRUE or FALSE: When conducting sugar trace analysis, what laboratory instrument is used to obtain the optical density?** | | **Mark Allocation** |
| **a.** |  | Refractometer. |  |
| **b.** |  | Spectrophotometer. |  |
| **c.** |  | Saccharimeter. |  |
| **d.** |  | Ph meter. |  |
| **e.** |  | Conductivity meter. | 5 |

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| **2.82** | **TRUE or FALSE: Answer the following in connection with the phenol – sulphuric test for sugar trace in water:** | | **Mark Allocation** |
| **a.** |  | Only accurate as an indicator of the presence of sugar. |  |
| **b.** |  | Is accurate from 0 – 200 ppm. |  |
| **c.** |  | Is only accurate above 80 ppm. |  |
| **d.** |  | Is accurate up to a maximum if 80 ppm. |  |
| **e.** |  | Is accurate from 0 – 200 ppm, but only for condensate. | 5 |

1. FINAL MARKS

**TOTAL MARKS: 230**

**PASS MARK: 184**

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