Examiners Report: 2018

INSTITUTE OF BREWING & DISTILLING

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Board of Examiners

Chair of the IBD Board of Examiners – **Angus Steven**

Diploma in Brewing	Module 1	David Cook Tobin Eppard Alistair Dickson Jayne Hewitt Christian Holbrook Marc Schmitt Aaron Golston
	Module 2	Alastair Pringle George Ritchie Yahia Chabane Dawn Maskell Aldo Lentini
	Module 3	Phil Worsley Andrew Barker Jean-Michel Gualano Tony Cook Graeme Hall Rob Zuccollo Michael Hannigan

Diploma in Distilling	Module 1	Douglas Murray Shernell Layne Mike Partridge Matt Strickland
	Module 2	Douglas Murray Jeremy Stephens Kirsty Black
	Module 3	Mike Partridge George Blair

Diploma in Packaging	Module1	Graeme Hall Gavin Duffy Rob Zuccollo Tracy Adie
	Module 2	Gavin Duffy Robin Cooper Ruth Bromley Dick Charlton
	Module 3	Thomas Shellhammer Robin Cooper

Master Brewer	Module1	Robert Illingworth
	Module 2	Derek Orford Shiona Kamermans
	Module 3	Andrew Mieleniewski
	Module 4	Robin Cooper Deborah Kennedy
	Module 5	Richard Westwood Jens Voigt

Master Distillers	Module 1-4	Douglas Murray Alan Wolstenholme

EXAMINATION CENTRES

Algeria	Alger - SARL Tango Heineken
Argentina	Buenos Aires – British Council
Australia	Brisbane QLD-Language Affairs Bundaberg QLD-Language Affairs Cairns College of English & Business Griffith NSW-Language Affairs Hobart TAS-Language Affairs Launceston TAS-Language Affairs Lidcombe - Tooheys Pty. Melbourne VIC-Language Affairs Perth WA-Language Affairs Regency Park - TAFESA
Barbados	St Michael - Ministry of Education
Belgium	Brussels - ECB Examination Centre
Canada	Calgary AB - University of Calgary Charlottetown PEI - Holland College Creston BC - College of the Rockies Halifax - Dalhousie University Kamloops BC-Thompson Rivers University London ON - Fanshawe College Montreal QC-ILSC Montreal Nanaimo BC-Vancouver Island University Niagara-on-the-Lake - Niagara College Ottawa ON-Academy of Learning Saskatoon SK-Saskatchewan Polytechnic St John's NL-Memorial University Toronto ON-Centennial College Vancouver BC- BCIT Vancouver BC-Langara College Vancouver BC - Simon Fraser University Winnipeg MB - Canadian Malting Barley Tech Cen Winnipeg MB-Red River College

Botswana	Gaborone - British Council
Brazil	Sao Paulo-British Council
Burundi	Bujumbura - Brarudi (Heineken)
Cambodia	Phnom Penh-Cambodia Brewery Ltd
Cameroun	Douala - Guinness Cameroun SA
Congo	Brazzaville-Brasco (Heineken) Bukavu-Bralima (Heineken) Kinshasa - Bralima (Heineken) Kisangani-Bralima (Heineken) Lubumbashi - Bralima (Heineken) Pointe Noire - BrasCo.(Heineken)
Croatia	Zagreb - British Council
Czech Republic	Prague - British Council
Denmark	Copenhagen - Scandinavian School of Brewing
Dominica	Roseau - University of West Indies
Egypt	Cairo - Alahram Beverages Company
England	Bristol - City of Bristol College Bristol-International House Bristol Burton on Trent - Molson Coors Brewers Ltd Ipswich-Pitman Training London - Institute of Brewing & Distilling Middlesbrough - Pitman Training Northampton-Pitman Training Nottingham - Central College Nottingham Nottingham-ILS English Plymouth-Pitman Training Southampton-Pitman Training Warrington-Pitman Training Worcester-Pitman Training York-Experience English Language Centre
Ethiopia	Addis Ababa-British Council
Fiji	Lautoka - Paradise Beverages Ltd Suva - Paradise Beverages Ltd
Finland	Helsinki-Finnish British Society
France	Lyon-CFPPA de Macon-Davaye Mons en-Baroeul-Heineken Paris-British School of Paris Schiltigheim-Heineken Sophia Antipolis-Group Set
Germany	Berlin-Berlin School of English Hamburg-Cambridge Examinations Centre
Ghana	Accra-British Council
Gran Canaria	Las Palmas-Comp.Cervecera de Canarias
Greece	Athens-British Council Thessaloniki - British Council
Guyana	Demerara-Demerara Distillers Limited
Haiti	Port au Prince-Brana Heineken
Chile	Santiago-Instituto Chileno Britanico de Cult
China	Hong Kong-British Council Shanghai - British Council
Columbia	SABMiller Latin America
Ivory Coast	Abidjan-Brassivoire Heineken
Jamaica	Kingston-Overseas Examinations Commission
Japan	Tokyo - Temple University Japan Campus Yokohama - Kirin Brewery Co.
Jordan	Amman-British Council
Kenya	Nairobi -British Council
Korea	Seoul-Susubori Academy
Lebanon	Beirut-British Council
Lesotho	Maseru - Lesotho Brewing Company
Malaysia	Kuala Lumpur - British Council
Mexico	Guadalajara-Cerveceria Del Pacifico
Mozambique	Maputo - Cervejas de Mozambique SA
Myanmar	Yangon-British Council
N.Ireland	Belfast-Conway Education Centre
Namibia	Windhoek-Institute of Information Tech.
Nepal	Kathmandu-British Council
Netherlands	Rotterdam-Masterclass Academy of Lang. Zoeterwoude – Heineken
New Caledonia	Noumea-The Noumea School of English
New Zealand	Auckland-Language Affairs Christchurch-Language Affairs Dunedin-Language Affairs Nelson-Language Affairs Wellington-Language Affairs
Nigeria	Ibadan - Nigerian Breweries Lagos-Pitman Training Osun State - SAB International Breweries
Panama	Panama City-Florida State University
Papua New Guinea	Port Moresby- SP Breweries
Peru	Lima-Asociacion Cultural Peruano Britanica
Philippines	Manila-British Council
Reunion	Saint-Denis - Brasseries de Bourbon (Heineken)
Romania	Bucharest-British Council

Iceland	Akureyri - University of Akureyri
India	Bangalore-British Council Khordha Odisha State-United Breweries New Delhi-British Council
Indonesia	Sampang Agung-PT Multi Bintang Tangerang - PT Multi Bintang
Ireland	Cork-The Training Centre Dublin-The Exam Centre
Israel	Tel Aviv-British Council
Italy	Milan - British Council Rome-British Council
Russia	Moscow – Language Link
Solomon Islands	Honiara-Solomon Breweries Ltd
South Africa	Cape Town- EC English Durban-Univ.Of Kwa Zulu-Natal Johannesburg-British Council Johannesburg - SAB World of Learning Port Elizabeth – SABMiller
Spain	Barcelona-British Council Barcelona-Exams Catalunya Madrid-British Council
St Lucia	Vieux Fort - Heineken
Swaziland	Matsapha-Swaziland Beverages (SABMiller)
Switzerland	Bern-British Council
Tanzania	Dar Es Salaam - University of Dar Es Salaam
Thailand	Bangkok-British Council
Trinidad	Laventille – Angostura
Tunisia	Grombalia-Sonobra Heineken
UAE	Dubai - African & Eastern BVI Ltd
Uganda	Kampala-British Council
USA	Albany GA – MillerCoors Ann Arbor MI-Washtenaw Community College Arcata CA - Humboldt State University Arlington TX-University of Texas Boone NC-Appalachian State University Boston MA - University of Massachusetts Boston Cincinnati OH-UC Testing Services Columbia MO-University of Missouri Davis CA - University of California (Davis) Edwardsville IL - Southern Illinois University Farmington ME- University of Maine Fayetteville AR-University of Arkansas Florida FL - Florida International University Fort Worth TX – MillerCoors Fort Lauderdale FL-Nova Southeastern University Glen Ellyn IL-College of DuPage Golden CO.- MillerCoors Harrisburg PA-Harrisburg Area Comm. College Holland MI - New Holland Brewing Co.
Rwanda	Gisenyi-Bralirwa Heineken Kigali-Bralirwa Heineken
Samoa	Apia-Samoa Breweries
Scotland	Edinburgh-Pitman Training Elgin-Elgin Library Learning Centre Elgin-Moray College UHI Ellon-Brewdog Forres-Moray Council, Forres Library Inverness - Inverness College UHI Islay-Islay Learning Centre Jura - Jura Distillery Orkney-Orkney College
Seychelles	Mahe - Ministry of Education
Singapore	British Council
Vietnam	Ho Chi Min City - British Council
Wales	Cardiff-Cardiff and Vale College
Zambia	Lusaka-British Council Ndola - Zambian Breweries (SABMiller)
Zimbabwe	Bulawayo-Delta Beverages (SABMiller) Harare-Delta Beverages (SABMiller)

Honolulu HI-Hawaii Pacific University
Houston TX-University of Houston Clear Lake
Inver Hills MN-Inver Hills Community College
Kingshill VI - University of Virgin Islands
Louisville KY-University of Louisville
Madison WI - University of Wisconsin-MBAA
Maryland MD - Frederick Community College
Milwaukee WI-University of Wisconsin
Missoula MT-University of Montana
New York NY-Brooklyn College
Northridge CA-California State University Nort
Oregon OR - Oregon State University
Philadelphia PA-Temple University
Portsmouth NH - Craft Brew Alliance, Inc.
Provo UT-Brigham Young University
Riverside CA-La Sierra Testing Centre
Roanoke VA - Roanoke Higher Education Center
Sacramento CA-Sacramento Test Proctoring Serv.
Salt Lake City UT-SLCC Testing Services
San Diego CA-UC San Diego Extension
San Jose CA-San Jose State University
Schenectady NY-Schenectady County Comm. College
Seattle WA-University of Washington

The Statistics

Number of exams/modules graded for each qualification

Exam	Module	2018	2017	2016
Diploma in Brewing	Module 1	496	428	468
	Module 2	361	285	298
	Module 3	335	270	251
	Pass in all modules	**154**	**119**	**101**
Diploma in Distilling	Module 1	57	42	47
	Module 2	43	43	54
	Module 3	36	42	29
	Pass in all modules	**28**	**29**	**23**
Diploma in Packaging	Module 1	104	55	46
	Module 2	31	28	29
	Module 3	18	21	20
	Pass in all modules	**6**	**13**	**12**

Exam	Module	2018	2017	2016
Master Brewer	Module 1	19	19	27
	Module 2	18	22	25
	Module 3	13	20	16
	Module 4	13	15	22
	Module 5	10	13	11
	Pass in all modules	**10**	**7**	**7**
Master Distiller	Module 1	3		
	Module 2	6		
	Module 3	1		
	Module 4	2		

Percentage of candidates passing each module

Exam	Module	2018	2017	2016
Diploma in Brewing	Module 1	75%	56%	52%
	Module 2	68%	72%	65%
	Module 3	53%	60%	52%
Diploma in Distilling	Module 1	73%	76%	80%
	Module 2	83%	74%	87%
	Module 3	75%	79%	65%
Diploma in Packaging	Module 1	76%	51%	62%
	Module 2	87%	68%	64%
	Module 3	50%	65%	65%

Exam	Module	2018	2017	2016
Master Brewer	Module1	53%	63%	52%
	Module 2	45%	50%	32%
	Module 3	92%	45%	69%
	Module 4	76%	100%	73%
	Module 5		70%	64%

REPORT FROM THE CHAIR OF THE BOARD OF EXAMINERS

Examination Year 2018

2018 has been a year of massive change for the Diploma examinations based on the need to

- Further align with the industry needs and have a contemporary syllabus;
- Be respected throughout the distilling and brewing industry with a global focus;
- Examinations to have a simplified and common logical approach; and
- Strong examiner and examination support team.

To achieve this the format of the examinations changed so that brewing, distilling and packaging all now have a 'Short Answer' section to test breadth of knowledge and a 'Long Answer' section to test the depth of knowledge. The syllabus was simplified with the removal of some parts e.g. barley agronomy and the reconfiguration of others to a more structured examination. The Module 3 examination now follows a generic structure across all three examinations. The Board of Examiners has been extended to include examiners with a wider knowledge of different breweries and distilleries from around the world and this is something we will continue to do to reflect the changes in the industry.

This year also saw the introduction of on-line marking for the first time. This proved to be really successful despite putting a time constraint on examiners as we understood the system and I would like to thank all the examiners for their hard work, flexibility and patience with this. This will give us benefits in the future through security of papers and the ability to better analyse examination questions and answers.

So despite all the significant change 2018 has been another successful year, with a record 3959 examinations entered across the IBD certification process.

All candidates were notified of their results in September and the award winners will be notified and their names published after any potential appeals have been considered at the end of the examination cycle in November. The Board of Examiners sends it congratulations to all those candidates who successfully passed their respective examinations and hopes that those candidates who were not successful on this occasion will endeavour to continue with their studies and be successful in the future.

The following report for each examination highlights the number of candidates, the percentage pass rate for each module and feedback on the questions answered to allow future candidates to prepare fully for the examination process. Considering all the modules, the pass rates and average candidate marks are in line with expectations and in some cases more candidates have passed the examinations than last year which I believe reflects the quality of training and clarity of exams. I would like to thank all the trainers for the work they do to make this happen and I am keen that this is even further developed through the direction from Simon Wade, Learning Development Manager here at the IBD. This is an area which is also going through significant change with much improved distance learning training material being developed combined with certified tutoring which I am sure will be reflected in candidates having an even greater knowledge of brewing , distilling and packaging.

Examiner Feedback

The 'Examiner Feedback' which follows should be used by candidates to help shape their studies in conjunction with the Syllabus, IBD Learning Materials, Journals, personal experience, brewery and distillery visits etc. to ensure the individual is fully prepared to pass the examination. I have not included top tips as these can be found on the website and through comments in the report from various examiners.

2019 Activity

2019 will see a continuation of the direction set to achieve the examination strategy with the General Certificate examinations being further reviewed with the introduction of more contemporary material and the diploma examinations will continue to develop. We will also review the Masters examinations to ensure they fit Industry requirements.

Examiners

I would like to take this opportunity to thank all the examiners who continue to do a magnificent job setting exam questions, marking papers and ensuring the examination process is fair and candidates are rewarded for the hard work they undertake when they sit an exam. None of this would happen without the support and coordination from the IBD examination team of Francesca, Estella and Rob.

Angus Steven
(angus.steven@icloud.com)

EXAMINERS REPORTS

Master Brewer

Module 1: Materials and Wort Production

Nineteen candidates sat the papers, ten passed, which is a pass rate of 53%. The five-year rolling average pass rate has decreased slightly, now standing at 51.8% (last year 52.6%).

This year's candidates were not well prepared for taking Paper Two (the essay paper of this exam), though once again all candidates answered the requisite four questions. Paper One (the multiple choice/short answer paper) was much better answered.

89% of candidates passed Paper One an improvement on last year (79%) whereas 63% passed Paper Two, which is a similar result to last year. These figures indicate that candidates have perhaps a good breadth of knowledge but are lacking the essential depth to that knowledge.

Paper 1: Multiple Choice and Short Answer Questions

The marks for Paper One ranged from 42 to 84 out of 100.

Barley, the malting process and adjuncts
This was the worst section answered, 40% was the average mark gained. 95% of candidates, however, were able to identify the factor used to measure the potential of a new strain to be a satisfactory malting variety; the other answers in this section were in the range between 21% and 42%. The questions about barley agronomy were answered particularly badly.

Supply and treatment of water supplies
This section was the best-answered group, with an average mark of 71%. The question about legislation as it applies in most countries to water used for brewing gained an average mark of 89%. Pairing up ions with their perceived effects on beer quality only achieved 37% of marks available. Questions about reverse osmosis plant and the implications of finding *E. coli* in water samples were well answered.

Hops and hop products
Candidates were well acquainted about the differing requirements of the various players in the hop supply chain as well as factors that can affect the availability of hops in any one year which gained 95% and 96% respectively. Less well answered, at 11%, was the question about the climatic conditions which are vital for the satisfactory cultivation of hops.

Brewhouse operations
This section accrued 67% of the marks available. The question about the cost of raw materials for brewing 1000hl of wort only gained 32% though the quantities of hops required for a brew were well calculated at 79% correct. The sizing of the lauter tun was correctly calculated by just over half of candidates. The question about kettle evaporation rates varying over time was very well answered with total marks of 96%.

Brewhouse Management
The average marks attained in this section was 65%. Good answers were given for the purpose of HACCP, energy efficiency and the purpose of financial accounts. The question about the number of brews possible in one week's programme continues to elude many.

To help candidates the answer can be calculated as follows: The number of hours available is 133 and the rate-limiting step is the lauter tun with a cycle time of two hours. The lauter tun doesn't start operating until the first mash is converted, which takes 85 minutes and it must cease early enough to allow the finished wort to boil and, fill and empty from the whirlpool; those operations take 180 minutes. The actual time the lauter tun can be operating is 115hr minus 1hr 25min minus 3hr = 110hr 35min. Dividing this figure by the lauter tun cycle time of two hours returns 55 as the number of brews with 35 minutes in hand.

The final question about the Paris Agreement of 2015 was not well answered at 5%. Brewhouses are energy intensive environments so it should be incumbent on all brewers to understand their wider responsibilities towards an internationally recognised agreement that is looking forward to a carbon-free future.

Paper 2: Long Answer Questions

The marks for Paper 2 ranged from 33 to 71 out of 100. As mentioned above all candidates answered the requisite four questions though quite often the last answer on a script looked to have been rushed, at least judging by its length, quality and legibility.

Question 1

Describe one cereal adjunct and one speciality malt that are suitable for use in the brewhouse. Outline briefly how each is made. How are they used in brewing and what are the advantages and disadvantages of each?

The most popular of this year's paper this question was attempted by 15 candidates (79%) and of those 9 (60%) passed. The range of marks was 8 to 15 (out of 25) and the average mark was 12.

Not very well answered question as can be seen from the average mark. The brief outlines of the manufacture of the chosen materials were too often sketchy and inaccurate. Some answers did not explain the advantages and disadvantages of their chosen malt and adjuncts; these are qualities which predicate the decision to use them in a particular circumstance.

Question 2

Compare the use of water from a town's (municipal) supply, groundwater (typically from a borehole) and upland surface water (typically from a reservoir) for brewing. Discuss the advantages and disadvantages of each and describe treatment methods which would make each of these supplies suitable for brewing.

This question was answered by 13 candidates (68%) with 9 achieving a pass mark (69%). The range of marks was 8 to 18 (out of 25) and the average mark was 12.

The question invited a discussion of how to adjust ionic composition, but not to describe in detail the effects of individual ions, as was the case in two of the examination scripts. Very little discussion was evident about chlorine in towns water and how and why to get rid of it. In general, candidates were knowledgeable about the properties of water from boreholes but less aware of potential issues with surface and municipal supplies. The latter is an important consideration for craft brewers.

Question 3

Evaluate the general trends in global hop crops and markets that have been evident over the last two or three years. How has the introduction and availability of hop products affected brewhouse operations?

This question was answered by 13 candidates (68%) with 10 achieving a pass mark (77%). The range of marks was 10 to 19 (out of 25) and the average mark was 14.

There were two excellent scripts which both gained over 19 marks. Many answers were let down by not discussing, or only briefly touching on how hop products have affected brewhouse operations. Extra marks were gained by mentioning the possible future effect on the hop market of imminent regulations restricting pesticide residues in hops.

Question 4

Assess the various types of malt mills now available in the market. Summarise the advantages and disadvantages and indicate how and why each one is appropriate to a particular mashing procedure and mash separation system.

This question was answered by 11 candidates (58%) and of those 5 (45%) passed. The range of marks was 8 to 13 (out of 25) and the average mark was 11, which is below the pass mark level.
This was the least popular question of this paper and it was not well answered despite the fact that there was an excellent article in the IBD magazine, *Brewer & Distiller International* which covered all the points raised in this question. Many scripts focussed on roller mills either four or six varieties to the exclusion of other types of mill such as a hammer mill or a disc mill. A good sketch is worth several lines of text, but a sketch of a six-roll mill should include the sieves and an indication of how the various grist fractions are separated and a note to say why that is important.
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Question 5

Describe and evaluate techniques that have been used successfully to reduce the energy consumption in a brewhouse. Assess how such techniques could improve a company's progress toward sustainable operations and argue the importance of this ambition.

This question was answered by 12 candidates (63%) with 4 achieving a pass mark (33%). The range of marks was 7 to 18 (out of 25) and the average mark was 11, which is below the pass mark level.

Many answers gave a list of suggestions for reducing energy, but without explaining the process needed to ensure these improvements were implemented or monitored. Switching off lights was a popular answer although this is not enough detail when there are eg low-wattage lighting systems available.

The point of this question was to elicit techniques to ensure that a list of brainstormed ideas, which is essentially what many answers came down to, is evaluated as being practicable, implemented in a timely manner and monitored to ensure efficacy. In other words, measure and monitor energy usage; energy usage targeting; targeted investigations and action plans.

Question 6

Outline the process of devising an audit to check on health and safety provisions for the operation of a brewhouse and illustrate your answer with relevant examples. Discuss how such an audit would ensure that risk and hazard are correctly identified and how these factors must be evaluated in order to recommend changes that would improve safety.

This question was answered by 12 candidates (63%) with 9 achieving a pass mark (75%). The range of marks was 8 to 19 (out of 25) and the average mark was 13.

Similar to question five, an excellent answer to this question examined the process of designing

an audit and how it might be implemented with a few germane examples to help to elucidate the principles.

The second part of the question was not well answered by many, but without correctly identifying risk and estimating hazard it is impossible to eliminate or ameliorate potential danger.

Module 2: Fermentation and Beer Processing

18 candidates submitted scripts for the two papers.

Paper 1: Multiple Choice and Short Answer Questions

There were no outstanding papers, some good papers and the remainder either clustered around the minimum standard or a fail. This paper covers the whole syllabus. The better candidates were able to answer questions across the whole paper with a wider spread of knowledge. It was good to see that the safety question was again answered well by the majority of the candidates.

In the question related to a large part of making a beer brand reproducible it was noted that very few candidates mentioned the importance of specifications, procedures and standards (standard operating procedures). The question related to equipment key performance indicators (KPI) in the beer processing area was, in general, poorly answered. More thought should be given to "operational excellence" concepts at the Master Brewer level in supporting candidates with continuous improvement.

Also the questions relating to engineering concepts (i.e. pitting & refrigeration performance) were poorly answered. Be wary of only using brand names, e.g. Clarex, in answers. The candidates should mention enzymes (like Papain) as a stabilisation process. Candidates should note that where a question asks for a specific number of responses, and more are offered, they will be marked in the order supplied up to the required number and extra answers will be ignored. Candidates should therefore read the questions carefully.

The Master Brewer is looking for evidence of practical knowledge, good practices and experience so still more attention is required to reflect these aspects in the answers. This makes the difference between an average papers and an outstanding one.

Paper 2: Long answer Questions

Compared to previous years there was a welcome improvement in exam technique, although the following pointers may be helpful: a few candidates provided poor answers for their fourth question, indicating that time planning may have gone awry. Similarly, where a question is broken into sections, for example, giving, 10, 5 and 10 marks respectively for each part, the better candidates were able to provide insightful content in proportion to the marks available.

Question 1

Explain how beer losses between cold wort collection in fermentation vessel and filtered beer tank are most effectively measured at a brewery and how they are controlled. Put together an action plan to reduce these losses by 10%

This was the most popular question, answered by 15 out of 18 candidates, although it was far from being the best answered. Good answers provided the "how" of measurement and control of losses in some detail, with references to practical installations and systems. The second part was not well answered, as few plans recognised the requirement to write a plan for approval by the senior site leader. A good plan would refer to the resources needed to carry it out, including time, people, and money.

Question 2

Describe in detail a typical specification and process profile for the fermentation and conditioning of a lager beer. Within the process list the most important parameters influencing beer quality, justifying their selection along with their specifications. How is the process controlled to maintain quality?

Two thirds of candidates answered this question. There was one outstanding answer that got close to full marks, assisted by the use of a table. There were ten marks available for describing how fermentation and conditioning are controlled, which few answers were able to do at the level required. The outstanding answer demonstrated detailed plant and process knowledge which can only be gained by experience, backed up by study.

Question 3

A Gram-positive infection has been detected in filtered beer tank. Describe the process of investigation, and the steps to be taken to eliminate the infection and prevent recurrence.

Fourteen candidates attempted this one. A small number did not demonstrate that they knew what kind of organism would be gram positive. This was essentially a problem-solving scenario, and the best answers included descriptions and use of problem-solving techniques as well as the technical aspects of responding to a beer spoilage infection. The problem had to be eliminated and prevented from reoccurrence, requiring both the corrective actions to be taken in the short term, as well as the longer-term systemic action that would maintain sterility over time.

Question 4

Illustrate, using a diagram, all key plant items in a filter room capable of processing five hundred thousand hectolitres per annum of multiple beer types and package formats. Stating all assumptions, indicate the capacity of each item. Describe the key operational considerations to produce beer of the desired quality and at best cost.

Twelve candidates accepted the challenge to draw a diagram. The examiner was happy to accept any type of filter and a wide range of calculated throughputs, providing a sound justification was made, based on clearly defined assumptions. A couple of candidates would be very popular with suppliers of filtration equipment, whilst the majority understood that capital is a precious resource that is not to be spent lightly. Better answers understood the cost drivers in a filtration operation, a part of the syllabus that needs attention alongside the better known quality aspects.

Question 5

A brewery is required to maintain four different yeast strains (3 lager, 1 ale) for its portfolio of beer types. How will these strains be managed to ensure consistent fermentation performance and flavour development?

This was the least popular and most poorly answered question. Although this was couched in the context of multiple yeast strains, it was essentially a yeast management question. Management of yeast propagation, pitching, cropping and storage is fairly standard throughout the industry and there are many written resources available to back up practical know-how. Candidates intending to take the exam over the coming years would do well to study this critical subject in more detail.

Question 6

For a recognised type of beer select, with justification, the three most critical physical/chemical quality parameters in filtered beer tank. Using a table, indicate how each of these three parameters is to be controlled from fermentation vessel through to filtered beer tank, giving specifications at each stage.

Eleven candidates attempted the question, which was generally well answered. Physical/chemical parameters do not include microbiology. The justifications for the selection of the three most critical quality parameters were somewhat sketchy in many answers. Candidates who explained their selection with reference to the end consumer got higher marks. Our beer has to be legal (and safe) and most candidates recognised this, although again the examiner was prepared to acknowledge justifications for any quality parameters if they were well argued.

Module 3: Packaging of Beer

There were 13 candidates this year compared with 20 candidates in 2017 and 16 candidates in 2016. The pass rate was significantly higher, at 92.3.0%, compared to 35.0% in 2017 and 68.8% in 2016. The average mark for all candidates was 63.3% compared with 52.1% for 2017 and 57.1% for 2016.

Paper 1: Multiple Choice and Short Answer Questions

The marks for the MCQ ranged from 47 to 74 out of 100. The average was 65.7% which is a significant increase on 2017.

Questions involving calculations were often poorly answered with some candidates skipping calculation questions altogether.

Questions requiring a drawing were not particularly clear in some cases, again making it difficult to interpret clearly. Some drawings were extremely basic – which was disappointing for candidates at this level.

Paper 2: Long Answer Questions

The long answer questions were generally adequately answered with some good answers. Reviewing the results and scripts, it is clear that some candidates presented very good answers for their first couple of questions then ran out of time for the final questions. Regarding time management, it is appreciated that a lot of information can be shared by a knowledgeable candidate, but time spent thinking about how that information can be presented in a time-efficient format will pay dividends.

As noted last year, some candidates picked up more marks in two pages of clear structured bullet points (or tables) than other candidates did in 7-8 pages of dense (and often hard to read) script. The other time management tip is to allocate time/effort in proportion to the mark allocation in multi-part questions. Additional marks were always allocated for relevant examples from the candidate's experience.

Question 1 – Line Capacity Calculations

The provisional annual packaging production plan for a new bottle filling facility is as follows:
Year 1-2 Bottling 550,000hl per year
Year 3-4 Bottling 1,200,000hl per year
Year 5-6 Bottling 1,800,000hl per year
Year 7-8 Bottling 2,400,000hl per year.
Assume there is no other bottling on the site. The bottling container split is approximately 50% 330ml non-returnable bottles and 50% 500ml non-returnable bottles. Multiple brands will be packaged in each format.

Stating any assumptions made and showing any calculations, comment on the packaging line equipment recommended including manning levels, shift patterns, equipment upgrades, and operational schedules required to meet best practice quality and cost objectives.

This question was answered by 77% of the candidates. Marks ranged from 32% to 80% – the average was 63%.

Good answers would focus on calculating data and relating this to the base design using sensible assumptions to justify the decisions taken. Consideration of seasonality, downtimes, changeovers, efficiencies, shift patterns, staffing, reflecting practical knowledge is key to this answer.

Question 2

A brewery has acquired a smaller brewery and as a consequence has also acquired the smaller brewery's population of kegs. Although the kegs sizes are the same, the two keg populations have slightly different keg dimensions and different spear types. Describe, with justifications, an action plan to be implemented.

This less popular question was answered by 33% of the candidates. Marks ranged from 64% to 80% – the average was 71%.

This question was answered well by those candidates who attempted the question. Good answers described a clear and logical approach to the issues and addressed key points such as inspection of kegs, tagging & identification implications, performance of containers, and impact of different spear/couplers.

Question 3

A can line is moving away from tunnel pasteurisation. Recommend and justify an alternative technology. Describe the equipment and process changes that would need to be implemented.

Explain the changes to quality assurance processes that would be required including the management information to be collected.

This very popular question was answered by 92% of the candidates. Marks ranged from 44% to 80% – the average was 63%.

Interestingly no candidates recommended sterile filtration technology, with all recommending flash pasteurisation as the alternative. Descriptions of the core equipment were generally good however some candidates failed to accompany the description with a justification of their choice. Narrow answers concentrated only on the benefits of the choice and did not adequately address the QA and management procedures that need to bolster the inherent weaknesses of the technology recommended.

Question 4

The outsourcing of packaging of some small volume bottled products to a third party packager with surplus capacity is being considered. Describe a process to approve the outside packaging company as part of the supply chain.

How would the ongoing conformance of the third party packager be maintained?

This question was answered by 69% of the candidates. Marks ranged from 36% to 80% – the average was 60%.

Good answers clearly described a process that might be followed with establishing capability/ability of potential 3rd parties to undertake outsourced task and assessing the risks involved (review and audit of key systems - QMS, HACCP, ISO, environmental, safety, GMP, etc).

Question 5

Describe how traceability information on a small pack line can be used in conjunction with data from other information systems to trace batch history and prevent recurrence in each of the following situations:
-A consumer complaint of a metallic taint in a canned product.
-Recall of stock due to a glass defect in a batch of recently filled bottles.
-An incorrect barcode on a tray of bottles.

This question was answered by 54% of the candidates. Marks ranged from 16% to 72% – the average was 52%.

This question was generally not answered well, with the exception of a few good answers. A logical approach about correlating line production data with batch code data to trace the source of problem is required. Some candidates failed to consider how the reoccurrence of the problem could be prevented.

Question 6

With the aid of diagrams, describe a complete dispense system suitable for serving keg beer to several bars at different levels within a building. Define the cellar space and bar positions, refer to hygiene and quality requirements and justify the choice of materials and overall design.

This question was answered by 77% of the candidates. Marks ranged from 40% to 76% – the average was 58%.

The key to this question is good diagrams illustrating the fundamentals of a dispense system (cellar and dispense equipment). These diagrams should be annotated with additional detail and key specifications. A description of 'long-draw' type dispense technology is required as well as consideration of alternatives (e.g. stand-alone satellite bars).

Module 4: Resource Management and Regulatory Compliance

A total of thirteen candidates attempted both examination papers.

Paper 1: Multiple Choice and Short Answer Questions

Scores ranged from 50 to 84 with an average of 68.

Once again, questions on the environment, health and safety, quality assurance and resource planning were generally answered more strongly than finance and supply chain.

Q1 (Stages in the water cycle) was not answered fully by many. The examiner was seeking: water taken from the environment, water treatment(s), water use(s), waste water treatment(s), water returned to environment as evaporation, steam etc and treated waste water returned to the environment via groundwater, stream, rivers, sea.

For Q3 (meaning of "fugitive" emissions into the environment) clearly candidates either knew the answer or guessed by interpreting the term literally. The best answers were along the lines "polluting fluids (harmful gases or liquids) entering the environment (to air, water or ground) due to loss of containment".

Q8 ("intrinsically safe" and "fail safe") saw several candidates confusing intrinsically safe with conditions such as inherently safe. Intrinsically safe is highly specific and is a protection technique for safe operation of electrical equipment in hazardous areas by limiting the energy available for ignition.

Q12 (defences which the employer may put forward when an employee is injured) was a fair question for this level of exam but was not answered by the majority. The examiner was hoping to see three examples which might have included: incident was not reasonably foreseeable, accident was plaintiff's own fault, plaintiff's contributory negligence, act of god, necessity to avoid more serious consequences, "volant non fit injuria" (to one who volunteers no harm is done) - plaintiff agreed to carry out the task in full knowledge and acceptance of the risk.

For Q17 (advantages of using a standard form of contract for plant installation) could have included: Institute backing, thoroughly tested by countless applications, International recognition, all relevant areas covered, saves time and cost preparing own contract.

Q18 (meaning of an accrual) was not well understood. Explanations might have included "an entry in the accounts allowing for anticipated expenditure which has not yet taken place. e.g. material supplies, utility bills".

Q22 (the advantage of building up production costs using a standard costing model) saw few correct answers which could have been something like "smooths out short term variances and give a target to compare against".

For Q27 (main steps in organising a product recall) several candidates surprising ranked quarantining product and stopping further distribution very low down their list of actions. Generally most candidates listed appropriate steps although the examiner would have liked to see much more urgency in dealing with the issue.

Q37 (difference between "awareness training" and "competence training") was not answered as well as in previous years. A good answer might have been: awareness training – providing an appropriate level of knowledge and familiarity with a subject (often a regulatory requirement) e.g. environmental, asbestos, noise; competence training – providing skill and experience in a particular discipline e.g. welding, operating a fork lift truck, operating a can filler etc.

Paper 2: Long Answer Questions

Question 1

Use the guiding principles of sustainability to explain how the brewing industry can achieve sustainable development.

11 candidates chose to answer this question, with marks ranging between 9 and a very good 19, with an average score of 12.

Rather than providing an explanation woven into a persuasive essay type answer, too many candidates produced a bulleted list of often unrelated points, certainly not related to the guiding principles of sustainability. The six guiding principles are detailed in the syllabus and extensively covered elsewhere. They are:

Compliance with legislation and regulation. The design, operation and maintenance of processes and plants to optimise the use of all resources and minimize the potential impact on the environment. Assessment of environmental impacts and setting of targets for continuous improvement.

Minimization of the use of substances which may cause potential harm to the environment and the means of ensuring they are used and disposed of safely.

The encouragement of a culture of awareness on sustainability issues amongst employees and how this is achieved.

The procedures and management systems to implement the principles.

The examiner weighted marks for explanations around each principle as 2, 5, 4, 5, 3, 2 respectively (the balance of the marks being for overall structure of the answer and the persuasiveness / impact).

The one very good answer stood out which covered each of the six guiding principles and skillfully used each to develop the arguments. Poorer answers often simply referred to (albeit good) practices such as energy conservation, water use minimization and the recycling of materials.

Question 2

a) Explain the difference between 'active' and 'reactive' monitoring of health and safety performance.

b) Explain the changes to quality assurance processes that would be required including the management information to be collected.

This question was attempted by five candidates with marks ranging from 9 to a good 18 with an average of 12.

The first part of the question produced one excellent answer where the candidate explained that 'active' systems monitor the design, development, installation and operation of management arrangements, Risk Control Systems (RCSs) and workplace precautions. The candidate also explained that 'reactive' systems monitor accidents, ill health, incidents and other evidence of deficient health and safety performance and included good examples of each to illustrate the difference.

The examiner marked Part (b) as either a H & S answer or a Quality Assurance answer. The majority of candidates treated the second part of the question as the requirements for a H & S management system and answered accordingly.

Question 3

Describe policies and procedures the brewery should have in place to assure customers and consumers that the beers are safe.

This question was answered by all 13 candidates with marks ranging from 7 to 18 with an average of 12.

The best answers to this question included comprehensive details of the importance of having a quality policy, key elements of what this is and the important considerations for senior management in setting and maintaining a quality policy. The more complete answers also detailed the difference between quality policies and standards, different types of accreditation and the benefits of and challenges with each of these elements.

Several of the answers focused solely on HACCP and whilst this is a really important element in answering the question, it is only one aspect. Most of the answers around HACCP demonstrated good knowledge however ongoing review of the CCPs was missed by most candidates and this was required to get the full marks for this area.

The most complete answers for this question also included references to employees training plans and records and the importance of these and not just the policies and procedures

Question 4

Describe how best to effectively implement and efficiently operate a sales and operations planning cycle across all areas of a business to optimise the cost of goods, cash flow and customer service as well as enable sales growth. Include critical success factors for all stages and areas

Just 2 candidates answered question 4 with marks of 6 and 16. To answer this question candidates, needed to be able to demonstrate a broader awareness and understanding of planning cycles within all functions of a business including how production planning fits in and supports the company goals. The better answer was able to demonstrate elements of this.

Marks were awarded for describing the key business process elements of the S&OP cycle including;
demand review (including new product development)
supply review (including production plan)
financial review
exec S&OP

Other marks were available for describing an effective implementation methodology including how to achieve buy-in to the concept, business engagement and stakeholder management. Further marks were awarded for describing overall business benefits of having S&OP fully implemented including alignment across businesses enabling sales and financial targets being achieved and driving customer service (including KPIs)

Question 5

In order to optimise asset utilisation and overhead recovery, a brewery has identified possible opportunities to produce beer brands for other companies as well as producing private label beers for supermarket chains and other retailers. Describe the key processes to be followed in setting up, securing and successfully managing these contracts including the ways in which the planning, production and supply chain teams can support their commercial colleagues in this venture.

Eight candidates attempted this question with marks ranging from 8 to 20 with an average of 15. The best answers to this question contained a holistic business view on how this should be approached and setup whereas several of the candidates answered purely from a brewing function basis which is one dimension only. Marks were available for describing in detail:

- Identification of and engagement with new customers
- Production set up including internal sign off, trials process and customer approval processes.
- Review of available capacity, capability and resources including business case for any required capex or additional resources.
- Planning input and optimal scheduling and prioritisation including managing any possible conflicts between internal commercial teams and external customers
- Contract set up and management with customer

- Engagement and communication with key stakeholders and staff
- Optimal collaborative ways of working cross functionally

Question 6

a) List the overall processes of employee recruitment from the identification of the business need to appointment.

b) Explain the differences between recruiting a new Chief Financial Officer and an Engineering Technician.

All 13 candidates submitted answers to this question with marks ranging from 6 to 20 with an average of 15.

There were a number of good, high scoring answers with the candidates clearly being very familiar with the recruitment process. For the first part, the very best answers included additional selection techniques over the normal interview(s) including practical tests (where appropriate), psychometric and psychological tests and assessment centres. The weaker candidates failed to make clear exactly who makes the selection decision.

For Part (b), a number of the candidates cleverly used a table to explain the differences between recruiting a new Chief Financial Officer and an Engineering Technician. The better answers included the possible role of non-executive directors and head hunters in finding a CFO and background searching into his / her career record. Few candidates fully covered the probable relative timescales for each recruitment.

Master Distiller

Master Distiller Module 1

The Master Distiller qualification is a new examination and the report gives details that hopefully will encourage and assist other candidates in the future. 2018 was sat by three candidates. In general candidates gave answers that focused on the physical operations and marks were lost when the management component of the subject was ignored. The Master level candidate needs to know not just the practical knowledge but what management tools are available to allow management of operations.

Marks were also lost by not reading what was required in the answer and a lack of clarity. Examples are giving a single figure when a range was required and giving numerical answers without quoting the unit of the measure. Candidates are reminded that a pass on both the short and long questions is required to gain an overall pass.

Paper 1: Multiple Choice and Short Answer Questions

This section counts for 50% of the final mark and is designed to check a candidate's width of knowledge. Marks ranged from 39-67%.

There were two main areas where marks were not gained. Firstly candidates clearly were not able to answer questions outside normal distillery operations. A review of the syllabus shows that candidates need to be familiar with associated services and design. This area includes water treatment, effluent management, quality assurance. Secondly candidates require to know about production of a range of types of distilled spirits.

Paper 2: Long Answer Questions

This section requires candidates to answer 4 questions from 6 and makes up 50% of the overall mark. Questions require candidates to show a depth of knowledge on specific parts of the syllabus. Again candidates need to show how they use management and quality tools to impact on areas of operation. To protect individual score the number of candidates attempting each question is not given.

Question 1

As a distillery manager, you have arranged a **meeting with a supply company to discuss and agree a carbohydrate feedstock specification. State the feedstock, five key specifications and discuss the impact of these discussions on your distillery in the year ahead.**
[15 marks]

Outline your actions if the delivered feedstock does not meet the agreed specifications.
[10 marks]

The first part was well presented. The key specifications were given however a number was not sufficient as ether the range or minimum / maximum level was needed. The question focused on the discussions but candidates tended to focus on the reason for the inclusion of the key specifications. Good answers included comment on supply, single supplier impacts, storage and transport. Requirement to audit the feedstock in storage also gained marks.

The second part required a discussion on two aspects, firstly the procedures to discuss and mitigate the impact with the supplier on delivery. Secondly if accepted the impact on the process. Most candidates concentrated on the process impact. Renegotiation of the contract, increased audits and cost modification should be included to gain a high mark.

Question 2

Summarise typical water quality characteristics for distillery water sources. Give examples of water treatments that can be used in the preparation of water for different distillery applications.
[12 marks]

Define a water usage schedule for a distillery, and recommend strategies to optimise and reduce water usage. Include typical usage rates.
[13 marks]

This question was well answered. Candidates gave key quality characteristics and importantly gave the difference expected from the various sources. The best candidates included temperature and volume. Written or schematic water treatment techniques were given and acceptable. Candidates fell down by not giving why the treatment was selected and the area of operations this water would be used. The second part of the question was where candidates lost most marks by not giving a complete schedule and by giving little detail on how water would be optimised or reduced. The best answer included a discussion on monitoring and reviewing departmental usage.

Question 3

Design, from raw material intake to the filling of the fermentation vessel, the equipment needed for a facility capable of producing the equivalent of 5 million litres of alcohol, at 100% conversion efficiency, per annum. Assume 24 hour operation over 50 weeks. Discuss the options available and provide reasons for your design choice, including the impact on efficiencies and spirit quality.
[25 marks]

Candidates were able to calculate the production rate required to produce this volume of alcohol and therefore the size of the equipment needed. Though

easier to then show the design in a schematic form a written explanation was acceptable. Candidates wasted time by providing information on distillation, maturation and bottling which was not required. Good answers needed to include CIP, energy, air, water requirements. There is no single answer and marks were gained for explaining the choices made. Credit was given when equipment was not included providing a logical reason for its exclusion was given.

Question 4

Discuss the principles of Quality Control and create a quality control sampling plan for a distillery from raw materials to distilled spirit.
[15 marks]

Summarise the actions required if a non-conforming spirit is detected.
[10 marks]

This question gave a wide range of answers. The first part required a knowledge of QC and importantly how to transfer this knowledge into a plan.

Candidates either knew this or not. At Master Distiller level this should be understood and the ability to implement is a basic requirement. Part two builds on the answer required in part one. Time was lost by giving lots of information on what these non-conforming issues were and the impact on operations. The question was looking for the actions, based on QC techniques, to minimise impact and importantly preventing recurrence.

Question 5
As part of a new distillery build, you have been tasked with providing technical strategies to minimise the aqueous discharge impact to the environment. State your choice of substrate and justify your reasoning behind the strategies you would recommend.
[25 marks]

This question was not attempted by a candidate. As candidate numbers increase then hopefully this of question will become popular.

The model answer would include a list of aqueous discharges, different for different substrates and the makeup of each in terms of environmental impact. Following this a discussion on which available strategies best suits each discharge would be required. As well as technical suitability the discussion would include, capital cost, operating cost, physical size, reliability and potential revenue streams created. The need to ensure the discharges were treated in a manner that meets with environmental legal and company standards would also be required.

Question 6

Identify the components that contribute to the cost of production of a distilled spirit. Explain how you would control these costs without compromising quality.
[25 marks]

For a Master Distiller candidate this question should be relatively simple to answer and structured in an open way. It was therefore a surprise that candidates gained only about half the marks on offer. This may be in part due to it being the last question answered when attempted. Candidates provide part lists of costs but missed some key costs. This resulted from concentration on the physical production cost. There was confusion in when a cost was “fixed” or “variable”. marks were lost by giving a brief overview of control of costs rather than the detail required. This again may be due to a lack of time.

Master Distiller Module 2

The Master distiller qualification is a new examination and the report gives details that hopefully will encourage and assist other candidates in the future. 2018 was attempted by 6 candidates. Candidates in their answers focused on the physical operations and marks were lost when the management component of the subject was ignored.

The Master level candidate needs to know not just the practical knowledge but how to apply the knowledge gained in the diploma as well as what management tools are available to allow management of operations. Marks were also lost by not reading what was required in the answer.

Paper 1: Multiple Choice and Short Answer Questions

This section counts for 50% of the final mark and is designed to check a candidate’s width of knowledge. Marks ranged from 44 - 67%.

Candidates gave good answers for subjects that they were familiar with but lost marks by not being able to answer questions showing a breadth of knowledge of the whole distilled spirits industry. Candidates should be familiar with the whole syllabus and prepare themselves to answer questions on each part rather than rely on the long answer questions. It is a requirement that candidates pass both parts of the exam.

Paper 2: Long Answer Questions

This section requires candidates to answer 4 questions from 6 and makes up 50% of the overall mark. Questions require candidates to show a depth of knowledge on specific parts of the syllabus. Again candidates need to show how they use management and quality tools to impact on areas of operation. To protect individual scores the number of candidates attempting each question is not given.

Question 1

Compare and contrast the equipment and processes required for receiving, storing and pitching for a liquid yeast and a dried yeas.
[17 marks]

Discuss the relative benefits of using each type of yeast.
[8 marks]

Candidates who attempted this question gave a good answer in relation to the equipment needed to handle liquid yeast. The best answers included a schematic and text. Some marks were lost due to lack of detail on storage conditions especially for dried yeast. Dried yeast still needs consideration of storage conditions such as temperature, humidity and cleanliness. Marks were also missed by not giving detail on how pitching would be carried out. The answer should include when in the fermentation vessel filling the yeast is pitched, temp of liquid and where pitched i.e. direct into vessel or in line.

The second part of the question allowed candidates to show knowledge of the two types of yeast and this part was well answered. Marks were lost by not mentioning "management" considerations such as reduced handling cost, ordering and scheduling differences. A discussion on the relative cost of capital investment, cleaning and ease of use needed to be mentioned to gain full marks.

Question 2

At your distillery the fermentation ethanol yield has dropped by 10%. Describe how you would identify the potential root causes. List the causes, and for two of these , formulate an action plan to restore the ethanol yield back to the normal efficiency.
[25 marks]

This question was designed to allow candidates to show knowledge of fermentation efficiency control points as well as an understanding of a quality system. The list of causes is numerous and time did not allow all to be recorded. Marks were gained by listing the most likely causes and putting them in some type of order. Either in order of where they occur in the process or what type of cause such as materials, process, operator, environment etc. Marks were awarded for mention of HACCP or a similar quality system.

Good candidates covered all aspects of the question while others who provided only a list of the causes only gained a percentage of the marks. The action plan aspect was answered well by most candidates but marks were lost by not providing detail on a sampling regime, analytical requirements and need for a feedback loop to check the impact of the action plan.

Question 3

Discuss the key considerations and their potential impact on overall cost at a distillery when changing from EITHER wheat to maize OR from cane juice to molasses.
[25 marks]

The candidates who answered this question provided answers where wheat was replaced with maize. The marking scheme was divided into three areas, delivery/storage, process and co-product removal. The delivery /storage was not covered well and for instance did not include consideration of haulage cost. The process considerations were mentioned but detail on process impact and therefore impact on costs was not provided.

Candidates gave information on the quality impact and though it was party relevant to much time was spent on this and was not in general related to cost. Changes in co-product handling, potential value of residue and impact on the environment was if mentioned only in a general sense.

Question 4

Describe the best available techniques for monitoring and controlling all utility services for a distillery that has a steam boiler and compressed air.
[25 marks]

The question required candidates to list the main utilities, describe a monitoring and control system and frequency of monitoring. The best answers included electricity and water as well as the obvious, from the question, steam and air. The question also required mention of metering systems and target usage measures. The question asked for the best available techniques so a description of what the candidate had at a particular plant did not get full marks.

Question 5

The performance of a batch still is being effected by the build-up of organic solids on the internal surfaces including the steam coil. Discuss methods of minimising this fouling.
[12 marks]

Provide a design and an operating regime for an in-place cleaning system to control any residual build-up
[13 marks]

This question was asking candidates to provide an answer to a question that is highly likely to have been experienced. The question was therefore answered well but marks were not gained as follows
Part A, not providing information on the root cause, ie filtration, mashing, milling and increased sugars/yeast in the fermenter etc.

The methods of minimising fouling was covered by discussing the obvious causes, full marks required mention of changing CIP, steam flow and pressure.

Part B again was answered well but marks were lost due to a lack of detail and concentrated on cleaning of the heating element only. Marks were allocated for discussing health and safety requirements for an in-place cleaning system. Gas liquid temperature, cleaning agent and venting need to be mentioned.

Question 6

Determine the feed rate from a rectifying column to a fusel oil column for a still with the following parameters.
[17 marks]

Discuss the potential impact on chemical and sensory character of a non-neutral spirit when changing from an open-topped flat bottomed wooden fermentation vessel to a temperature controlled closed –top stainless steel cylindro-conical vessel

[8 marks]

This question was not attempted by any candidate. Part A was a straight calculation which a master distilling candidate should be able to solve. Marks were allocated for each part of the calculation and for stating any assumptions made.

Part B allowed candidates to show knowledge of the advantages/disadvantages in having different vessel designs and materials of construction. Again this is a topic a master distiller should be able to discuss.

Module 1: Raw Materials and Wort

Question 1

Define the term 'adjunct' and give reasons for their use in the brewhouse. Using a table, outline the types of adjuncts available and give examples. Include in your table typical methods of use and the advantages and disadvantages of using each type of adjunct.

Key elements required:

- Definition of term "adjunct" - in context of wort production
- Adjuncts as carbohydrate source in the brewhouse, not other varieties of additions (finings included in one paper)
- Tabulated - not applied in many cases, and for those who did, many were disjointed, advantages listed with disadvantages – not separated.
- Usage point in brewhouse – many wrote about production method of adjunct – not asked for
- Advantages/disadvantages – too many repeated and generalised points - does not gain any more marks
- When giving a disadvantage, i.e. Liquids storage, don't just state storage – explain why; heated pipework / tanks, mass flow measurement required, potential micro issues, energy intensive.

Question 2

Using a table, list ten key parameters that should be included within a Certificate of Analysis for a shipment of a pale lager malt. For each parameter, include typical units and acceptable ranges (specifications), and explain the significance of these parameters to brewing performance.

Some candidates listed more than the requested 10 parameters. Lack of use of table format – some listed parameters and values then wrote up significance afterwards – not losing marks – just time consuming.

Significances – use bullet points in a table. Does not require a paragraph to explain why moisture levels are important – especially if not actually giving the answer required.

Some candidates mixed up their lager parameter values with ale values – could be related to local experience. Was overall the better answered of all 6 LAQs'.

Question 3

List the cations which contribute to permanent hardness in brewing water. Explain the typical chemical reactions expected between these cations and malt derived components, and the significance of permanent hardness to wort production processes. List the other main cations and anions typically found in brewing water. Briefly describe their effects on the brewing process and finished beer quality – do not include the cations mentioned and described in part a.

Question split into 2 sections with equal weight given to each. Generally part b was better answered with many candidates achieving the maximum allowable.

Good answers for part b included the full element name, abbreviated name and showing correct charges. Marks were lost if incomplete or incorrect charges shown.

Part a was specific to cations and to wort production so no marks were given for downstream effects, such as yeast flocculation, or for anions. Good answers for part a identified Calcium and Magnesium and showed their correct charges and chemical interactions with proteins and phosphates to reduce pH.

A list of process interactions (specific to wort production) showing the effects of reduced pH in the mash (eg reduces hop utilisation) and other non-pH dependant interactions (eg reduces colour formation in the boil) could pick up ½ mark each.

Better candidates commented on the similar effects of Magnesium but with lower effectiveness. No marks were given for Calcium and Magnesium in part b.

Question 4

Draw a process flow diagram including at least eight key equipment components of a bulk malt intake and storage facility. Summarise the function of each component and why it is important.

Draw either a labelled diagram of a six-roll malt mill to supply a lauter tun or a hammer mill to supply a mash filter. On this diagram, indicate the key internal and external operating components that help determine grist quality and material flow.

Provide a specification of the typical range for grist particle size distribution normally provided for a lauter tun and a mash filter, giving reasons for any significant difference.

Some excellent answers given by some candidates who had a clear understanding of a malt intake and storage system for a larger brewery site, able to identify the lay components of a mill and give grist fractions.

In part A many listed the key components but then failed to summarise their function or to state

why it is important. Key considerations would have been removal of contaminants, avoiding damaging the malt, keeping pests and moisture out, reducing explosion risks etc.

In part B some good clear diagrams were provided by many which identified the key components in their chosen mill. The best answers showed the flow of product through the mill.

Part B was less well answered by some candidates; many understood why a grist specification would be different for a mash filter vs a lauter tun, but not all were able to support this with a sensible grist particle size distribution.

Many candidates achieved a high mark for this question. A clearly labelled process flow or block diagram which was supported with reasoning for each component was pleasing to see. Knowing the grist fractions for 2 key types of brewhouse was key to gaining good marks later in the question- something all candidates should be capable of. Examiners are not expecting textbook level drawings- but ones that are clear and labelled.

Question 5

Draw diagrams of both an external and an internal wort boiler, indicating the product and steam flows. Describe the purpose of each functional component for both types of wort boiler. Define the term 'hop utilisation'. List the range of different hop products which can be added during the wort boiling process, giving the expected utilisation rates for each.

Model Responses for Part 1 would include the following key elements present in the drawings, and would be marked per the following – ½ mark for each correct boiling system component, and ½ mark for each correct description of component function (up to 6 marks each, 12 marks total possible for Part 1):

Internal Calandria –

- Tube Bundle – enclosed bundle where wort flows, steam condenses, and energy is transferred.
- CIP provision – how is the device cleaned?
- Deflector/Spreader – surface area creation for improved removal of volatiles.
- Correct depiction of wort flow path through device.
- Steam Inlet
- Condensate return.
- Wort level & why – DMS removal, tube bundle operation.

External Calandria –

- Temperature Probe & location
- Deflector/Spreader
- Correct depiction of wort flow through device.
- Steam inlet & condensate return
- Wort Level & why.
- Correct pump location and purpose.
- Wort entry & exit

Model responses for Part 2 would include the following key elements:correct hop utilization formula; correct hop product and utilization range; and justification/rationale.

Key hop product, utilization range and rationale we were looking for are as follows:

- Whole Hops; 25 – 30%; contact time, poor wetting
- Type 90 pellets; 25 – 30%, up to 33%; contact time, easy/faster wetting vs. whole hops.
- Type 45 pellets; 50 – 60%; added later in boil, IAA not as readily bound to hot trub/break as with Type 90 or whole hops.
- Kettle extract; 30 – 35%; high solubility, easy dispersion.
- Isomerized Kettle extract; 50 – 60%; high solubility, isomerization time not required.

For some answers, clearly the wrong product was listed. An example would be the listing of hop oils, or other aroma products that do not impart bitterness.

Question 6

Describe the objectives of wort clarification & cooling. Explain the significance of each component process, to downstream processes & beer quality. Describe the methods and instrumentation (both in-line and off-line) which are used to assess cold wort quality. For each of these described measures, list typical cold wort quality specifications expected for a single pale malt derived Pale Ale.

Part i: A table listing the objectives (critical processes that must occur during wort clarification and cooling) and their impact on process and quality was expected.

The removal of solids from the wort was well noted but the types of solids were not commonly separated (protein flocs vs hop debris).

Strong answers showed a strong grasp of the basics of wort clarification and cooling and the many impact of time. Total wort cooling time impacts overall vessel residency, equipment availability, and potentially has flavour impacts on the hot side.

Energy consumption and effluent generation is important to consider in every brewing process as it increases the overall cost of the product waste generation and energy losses.

Part ii: A table listing the quality parameter being measured, the method, and the specification range for the parameter was expected.

Excellent answers captured the sterility of the wort from the whirlpool to the fermenter. Successful candidates had a strong grasps on wort specifications.

Overall, there were some excellent answers but some candidates were challenged by the combination of processing and quality parameters. When studying a unit, candidates are encouraged to consider processing and quality simultaneously. Given the new exam format, questions asking candidates to recall both are likely to become more common. Generally, part i was answered better than part ii.

Module 1: Yeast and Beer

Question 1

Describe one method, and the scientific principles behind the measurement of each of the following parameters

- **Dissolved carbon dioxide**
- **Dissolved oxygen**
- **Alcohol**
- **Apparent attenuation limit**
- **pH**
- **Outline where in the brewing process each of those parameters are measured**

Part a): Scientific basis that each test was based on, for example this often meant a description of the chemical reactions taking place or the individual stages/changes taking place that would elicit a response from equipment to give a reading. Just stating the piece of equipment was not enough.

Carbon dioxide (CO_2) - candidates may have discussed equipment such as the manometer or measurement using thermal conductivity methods

Dissolved Oxygen (DO) – candidates could have discussed colour change reactions, optical sensors or membrane sensors.

Alcohol – it was important to note that many of these methods only provide an estimate of the alcohol content. Methods that would have gained marks included distillation, gas chromatography (GC), enzymatic, refractometer, catalytic combustion or near infra-red (NIR) technology.

Attenuation – candidates should have discussed the inoculation of wort with excess yeast to achieve maximum consumption of carbohydrates from wort.

pH – marks were available for the discussion of litmus paper, indicator dyes or the use of a pH meter.

Part b): For this section any reasonable recommendation of a location where it would be appropriate to take a reading for the identified parameter was credited with marks.

In part A, many candidates provided very vague answers and did not show the depth of understanding that the examiners were looking for. Part b was generally answered comprehensively with the majority of candidates gaining the maximum number of marks available.

Question 2

Using a table, describe the composition, structure and function of the following components of the yeast cell

- **Cell wall**
- **Cell membrane**
- **Periplasmic space**
- **Nucleus**

Write brief notes on each of the stages of yeast growth during a brewery fermentation.

Part a): Cell wall: made of glucans, mannans and chitin, the enriched layers in which these are found and that the main function is to give rigidity to the cell.

Cell membrane: made of phospholipids, proteins and sterols as a bilayer which controls the transport of nutrients and acts as a semi-permeable membrane.

Periplasmic space: no structure as it is the space between the wall and the membrane, but that it is an important site of enzymic activity.

Nucleus: bound by a double membrane featuring pores connecting it with the cytoplasm, contains DNA in the form of 16 chromosomes. Store of genetic information and site of RNA synthesis.

Part b): No marks for naming the stages as this was a question in Section A of the paper.
For each stage candidates needed to discuss the changes taking place in terms of:

- Cell number
- FAN content
- Dissolved oxygen
- pH change
- sugar content reduction and alcohol production.

In Part A, Candidates who answered this well designed their tables so that each requirement of the question was a column, allowing them to ensure that they had answered the question comprehensively. Generally, this part of the question was answered well.

In Part B, it was not sufficient to refer back to the question in Part A of the paper. The longer questions in Part B were designed to allow the candidates to demonstrate a further depth of understanding in a variety of topic areas. Overall this part of the question was answered poorly by a substantial number of candidates who failed to connect the changes taking place during fermentation with the biochemical and physiological activity of the yeast cells.

A common mistake that candidates were found to make was to assume that the examiners were not really asking a question about the yeast cell growth in Part A and Part B. There were a number of candidates who therefore answered the question by drawing the cell cycle (Mitosis, G1, S phase, G2) and gained no marks for this part of the question.

Question 3

Describe the principles behind three laboratory methods for determining the total cell concentration of pitching yeast. What are the consequences of over pitching on fermentation and beer flavour? Describe the principles of four methods of determining either viability or viable biomass of pitching yeast.

Part A:

- Absorbance at 600nm
- Haemocytometer
- Coulter counter e.g Coulter counter
- Cellometer, Nucleocounter or other automated systems
- Wet or dry solids

Part B

- Faster fermentations
- Autolysis leading to higher acetaldehyde and yeasty flavors.
- Lower acetaldehyde and diacetyl due to high yeast counts at the end of primary fermentation.
- Over-attenuation of the beer
- Low SO_2 due to faster fermentation
- Part c
- Methylene blue or methylene violet
- Automated methods using fluorescent dyes
- Capacitance e.g. ABER
- Slide culture
- Only partial credit for NAD and ATP, as these methods are not practical

Candidates who understood the basis of each of the methods and were able to describe their principle did well: those who only provided the name of a method picked up a minimum of points. Some candidate's confused total cell counts with viability resulting in fewer points being awarded. Some answers fully described the effects of overpitching, while others incorrectly assumed there would be too little oxygen / cell and a slower fermentation.

Question 4

Describe the causes and mechanisms of beer flavour staling during beer production and after packaging.

Briefly discuss the process and procedures, which can be employed during brewing and packaging to minimise beer staling and extend shelf life.

Part A: Oxygen radicals - and the factors affecting them such as metal ions.

- Lipid oxidation – chemical and enzymatic lipid oxidation producing trans-2-nonenol.
- Melanoidin reactions – kilning and boiling impacts, chemical reactions that produce melanoidins.
- Hop degradation – through photochemical reactions producing MBT.

Part B: Oxygen minimization in the process e.g. transfers, purging vessels, seal maintenance, use of antioxidants

- Packaging – use oxygen scavenging/oxygen barrier packaging, no metal exposure in cans, rho hops , brown colour bottles.
- Storage – cool temperatures in brewery tanks, cool temperatures in warehouses protection from light and practice FIFO
- Materials – Low LOX barley, mash at 60°C to deactivate LOX, Low iron and copper DE

Candidates who understood all the mechanisms and also were familiar with the practical aspects of preventing staling were able to obtain the majority of the points. Answers that provided information only on oxygen were only able to get a partial number of points.

Question 5

Detail the Ten steps required to develop and implement a HACCP program within a brewery as part of a Quality Management System.

Identify five critical control points in the fermentation area related to microbial contamination, and outline how each of these may be monitored and controlled.

Part A: Defining the process (Start to Finish) – Normally involving a flow diagram

- Identifying all the Hazards (eg. Product formulation, Process Stages, Product Life, Raw Materials
- Asses the Risk of Hazard occurring at each stage (High, Medium or Low)
- Identify the Critical Control Points (CCP) and Prepare Decision Tree for Action (location, stage, operation, raw materials).
- Establish critical limits for each CCP
- Establish Monitoring Procedures for each CCP
- Establish corrective actions for each CCP
- Establish Record Keeping and Documentation
- Establish and Audit Procedures for verification
- Review the HACCP system each time there is a change in the process

Part B:

- CCP: Wort (ex Kettle, ex Heat Exchanger) - Monitor: Bacterial and Wild Yeast Contamination. Control: Kettle Boiling (Temperature and time), Heat Exchanger – Cleaning program
- CCP: Fermentation Vessel: inner surface, Sampling and micro points: Monitor: Bacterial and Wild Yeast Contamination, ATP Testing for effectiveness of CIP: Control: Effective CIP cleaning
- CCP: Yeast Pitching: Monitor: Bacterial and Wild Yeast contamination, Control: Correct CIP of Yeast holding Tank, Possible use of Acid washing of pitching yeast
- CCP: Air/Oxygen: Monitor: Bacterial and Wild yeast Contamination: Control: Sterile filter prior to addition to wort, Clean Lines:
- CCP: Pipes and Values: Monitor Bacterial and Wild yeast contamination of wort being transferred to fermenter. Control: Effective CIP cleaning

For Part A, most candidates were able to state the 10 steps involved in developing and implementing a HACCAP plan within a brewery. Most candidate just listed a short answer for each step without any clear indication if they understood what the statement meant, as such were given partial marks. Candidates that were able to further explain the reasoning behind each step were given full marks.

For Part B, this second part of the question was not well answered by most candidates. The

examiner was seeking an understanding from the candidates on where the critical control points within the fermentation processing area that impacts on microbiological control. A number of candidates used this section to give a detail explanation of CIP systems and cleaning programs in relation to fermenters, neglecting that there are other areas within the fermentation process (especially wort, yeast and oxygen/air as well as pipes and values) that can result in microbial contamination.

A number of good candidates were able to understand the whole fermentation process and the various inputs that can influence microbial contamination and list them.

Question 6

Name and describe the mechanism of action for four chill proofing aids, and give the advantages and disadvantages of their use.

Overall most candidates attempted this question and performed well. Most candidates realized that using a table format for their answers was very beneficial. There were candidates that listed various grades of silica gel as part of listing four chill proofing agents. These candidates were only marked once for silica gel recognition.

Some candidate had mentioned various other components that could be added to beer but these were not chill proofing agents and as such were not given any credit for their answers. As in some other questions, candidatures tended to use brand names to identify an agent (e.g. Brewers Clarex) but if they were able to state that it is a protein specific endoprotease, then full marks were given.

Processing aid	Functionality	Advantages	Disadvantages
Silica Hydrogels (H) and Xerogels (X)	Adsorb haze sensitive proteins. Into pores of gel structure.	Easily handled (H) Quick to disperse (H) High adsorbency (X) Form tank bottoms (H, X) Used as filter bodyfeed (H)	Expensive (X) Low bulk density, harder to handle (X)
Tannic acid	Precipitate protein	Effective against haze sensitive proteins Add at maturation Perceived as 'natural'	Large volumes of tank bottoms
Papain	Enzymic activity reducing the size of protein molecules	Effective	Poss adverse effect on foam Can introduce adverse flavor if used in excess
Proline Specific Endoprotease	Enzymic activity reducing the size of protein molecules targeting proline.	Haze specific – targets proline Reduce size of glutens as well – 'gluten free' Claim to reduce C footprint	Cost May not be able to claim gluten free
PVPP	Removal of polyphenols	Can be added to maturation vessel or added during filtration Recoverable	Expensive. Regenerative version requires additional filter
Combined products (PVP and Silica)	Removal of proteins and polyphenols	Most effective for long shelf life, shipping beer	Cost and additional equipment

Module 3: Process and Packaging Technology

Question 1

With the aid of labelled diagrams describe the sequence of operations for both aerobic and anaerobic treatment of effluent for legally compliant discharge into a river. Discuss the advantages and disadvantages of each system.

This question specifically requested the use of diagrams to aid an operational description of the two effluent treatments. The best answers contained two detailed diagrams of the main types of effluent system, namely aerobic and anaerobic treatments. Reference to specific brewing effluent issues was expected.

Poorer answers referenced only one type of system or detailed a single combined aerobic and anaerobic system. This limited the candidate's opportunity to describe the two individual systems key points and operating principles. Maximum marks were obtained by detailing each system separately, thus allowing candidates to highlight key differences. e.g Bioreactor is fundamentally different in each system

The best approach to obtaining good marks was a good diagram, naming key equipment and its purpose, followed by detail on operating parameters e.g temperature, pH, utilities and an understanding of common operating issues relevant to a brewery.

Legal compliance was to be considered and the best answers demonstrated a knowledge of sensible values regards key performance measures such as BOD; COD and suspended solids which would allow a brewing related operation to achieve its purpose regards compliance values.

Advantages and disadvantages were well answered referencing a comparison table which is available in revision notes. This covers performance regards legal compliance values, energy consumption, revenue and capital costs, flexibility in terms of operating cycles, ease of use and plant footprints.

Poorer answers were general lists with little or no explanation of benefit and lack of clarity on sensible values.

Overall a good answer on this question covered all the above points and demonstrated a good practical understanding regards operational setting issues and solutions, Poorer answers tended to ignore complete sections of the question and contain few or incorrect practical operating values

Question 2

In the context of pumping liquids. Define the term 'Net Positive Suction Head' (NPSH). Liquid is pumped from a buffer tank to a filter. Identify the physical conditions of the system and applied process variables that ensure efficient operation of the pump and describe the consequences of incorrect positioning of the pump within the system.

The buffer tank is under liquid level control. With the use of a block diagram identify the elements of the process control loop. Recommend a level sensor for the buffer tank which can be interfaced with a PLC control system and describe its principle of operation.

Define NPSH mentioning: head value at suction side of pump preventing cavitation and influence of fluid temperature

Elements required: Height of tank relative to pump: Pressure / vacuum within tank: Temperature of fluid: Diameter of suction pipework: Length of pipework: Material of construction e.g. stainless steel vs cast iron: No section of suction pipework below the level of the pump inlet: No flow restrictions, e.g. orifice plate, small diameter valves: Filter positioned at excessive height above pump: Filter not cleaned regularly.

Air locking within pipework causing no flow: High fluid temperatures and excessive pressure drop on pump suction side causing cavitation leading to mechanical damage to pump, high noise levels.

Elements of a process control block diagram: Set-point: Measured variable: Error from comparison of set-point and measured variable: Controller to determine control output to actuator or VSD depending on magnitude and rate of change of the error: Actuator or VSD to change process variable (fluid flow): Process reacts to change: Sensor (liquid level measurement) determines new measured variable.

For any level measurement sensor discussed, the following elements should be considered: Influence of variations in fluid density: Influence of variations in fluid temperature: Changes in tank pressure (if not atmospheric): Ability to cope with suspended solids in fluid: Range of sensor relative to height of tank: Access to sensor and calibration: Ability to generate a 4-20 mA signal for control purposes: High / low level alarm generation, which could initiate a sequence to shutdown processing to avoid tank overflow or tank emptying (unless desired).

The use of on/off level switches will not provide smooth flow control or indicate tank level and ball-cocks have a range limited to the top of the tank. These would not be considered suitable.

The above marking scheme was used to apportion the marks but provided the element was covered in the answer the marks were gained. Some candidates referred to the Bernoulli equation with respect to section b), this did not describe practically the requirements of the system.

Marks were awarded in section c) where the control system was described by means of a schematic diagram. Most candidates selected a radar gauge as a suitable level sensor. This was a valid answer with marks awarded on the depth of detail given on its' principle of operation.

Question 3

Describe three different ways of increasing the CO2 concentration in beer to a desired level for packaging. Compare the methods including advantages and disadvantages of each.

Define supersaturation and describe the conditions that lead to CO2 supersaturation.

Discuss the factors that lead to gas breakout and their effect on beer quality.

The first part of the question requires the candidate to identify three different approaches to carbonating beer and accurately describe each technique. Four potential methods to select from:

- Bunging the tank at the end of fermentation
- Top gas on a sealed tank post fermentation
- Sparging CO_2 via a fritted stone
- In-line carbonation via a venture orifice or some variant thereof.

Compare and contrast with a focus on speed, control, cost, complexity, and beer quality. Accurate definition of CO_2 supersaturation required correct description of the condition. Answers should include how elevated temperature as well as decreased pressure can lead to CO_2 supersaturation.

The final part focused on beer quality and how gas breakout can impact packaging filling operations (fill volume and TPO) and insufficient pasteurization when it occurs during within a pasteurizer.

Question 4

Draw a labelled diagram of a shell and tube boiler used to raise steam to show all the key components. Illustrate the main fluid and energy flows and the means of control of the steam production.

Natural gas is burned in the shell and tube boiler to raise 5.0 tonnes per hour of dry saturated steam at 4.0 bar g. Condensate is returned to the boiler at 4.0 bar g., 100°C. Calculate:

i. the mass flow rate of natural gas that is required (kgs-1)
ii. the steady state heat supplied to the heating application (MW)

Net enthalpy of combustion of natural gas = 45.6 MJ kg-1
Boiler thermal efficiency = 76%
Enthalpy of dry saturated steam at 4.0 bar g. = 2748 kJ kg-1
Enthalpy of dry saturated steam at 0 bar g. = 2676 kJ kg-1
Enthalpy of dry saturated water (152°C) = 637 kJ kg-1
Enthalpy of dry saturated water at 0 bar g. (100°C) 419 kJ kg-1

The key elements required on an annotated diagram: For the main fluid and energy flows - Burner with gas supply and combustion air fan: Water feed pump: Steam isolation (crown) valve

Other elements – Fire tube and smoke tubes, showing multiple passes: Stack outlet connection: Pressure relief safety valve: Pressure gauge: Water level sight glasses: Blowdown valve: Water level control: Total dissolved solids (TDS) measurement, controls blowdown: Steam flow meter: Stack O_2 sensor for efficiency measurement: Feed water treatment, e.g. ion exchange.

Control of steam production depends on the process demand and should consider the following: Boiler pressure reduces as demand increases, firing rate increased. If the maximum continuous rating (MCR) is attained then steam quality may deteriorate and risk of low water level.

Boiler pressure increases as demand falls, firing rate decreased. If the limit of the boiler's turndown ratio is reached then the burner is shutdown.

Answers:
i. 0.09 $kg.s^{-1}$
ii. 3.23 MW

Key elements of the calculation:
Enthalpy required to raise steam = 2,329 $kJ.kg^{-1}$
Correctly applying the steam flow and the boiler efficiency to determine the boiler heat requirement = 4.26 MW

Deriving the natural gas mass flow using the net calorific value = 0.09 $kg.s^{-1}$
Calculating the heat to process from the steam pressure given and taking into account the sub-cooling of the returned condensate = 3.23 MW

The above marking scheme was used to apportion the marks but provided the element was covered in the answer the marks were gained. There were significant variations in the quality and detail of the annotated diagrams, with several candidates not providing any information on controlling steam production.

The second part of the question was only answered completely by one candidate. A lot of candidates almost used the correct methodology but missed out some details, e.g. boiler efficiency, sub-cooling of condensate.

Question 5

Water in an insulated hot water tank is maintained at a temperature of 80°C. The total external area of the insulated tank is 35m2. Using the data provided, calculate the heat loss (W) from the surface of the insulation by:

i. Convection
ii. Radiation

Ignoring the thermal resistance to heat transfer through the walls of the tank and assuming the

mean surface area for heat transfer through the insulation is approximately the same as the external surface area of the tank, calculate:

iii. The thickness (cm) of insulation required.

With the aid of a diagram, specify the insulation system best suited to the insulation of the tank and explain the reasons for the choice of material used.

In general this question was not well answered by candidates. Many tended to start it or write down an equation but did not fully complete all the questions. In general candidates did not demonstrate a full understanding of the methods of heat transfer and their ability to apply the equations correctly.

Key elements required:

a) Answers:
i. 1,050 W
ii. 643 W
iii. 4.1 cm

Key elements of the calculations:
i. Use of the heat transfer equation – Q = U.A.deltaT
With the driving force for the rate of heat transferred being the temperature difference between the surface of the insulation and the ambient temperature.

ii. Use of the Stefan-Boltzmann equation
The temperatures used must be absolute values in K.

iii. Requires the use of the total heat loss as the sum of the answers to i and ii above.
Rearranges the equation for heat conducted through the insulation
Q = (k.A.deltaT)/x, where x is the insulation thickness in m and Q is the heat loss in W.m2.

b) The diagram should show a cross-section of the insulation system showing the tank wall, a barrier or membrane to protect the tank wall, the insulation material chosen, supports welded to the tank to hold the insulation material in place, an outer skin sealed against water ingress. Additional details could include showing the temperature profile used in this question.

In discussion mention should be made of the importance of keeping insulation material dry. Particular attention should be paid to sealing around tank connections or hatches. Provision should be made for access to instruments.

In considering insulation systems generally, condensation on a cold tank may be an issue.

There was some confusion around the temperature difference to be used for heat loss. Some candidates used the tank wall temperature which resulted in calculating the “bare metal” heat loss. With the Stefan-Boltzmann equation absolute temperature values in K were not always used and taking the individual temperature values to the power of four proved problematic.
Wide variations were seen in the quality and detail of the diagrams. Most candidates selected mineral wool and there was always clear emphasis on the need to keep it dry.

In Part B the reasons for choosing the choices of material lacked technical detail, some answers did specify the protective layer to prevent stainless corrosion and breather barrier but this was the exception.

Question 6

For a defined type of bottle filler, explain with the aid of diagrams each stage of the bottle filling process.

For each stage of the process explain the effect on finished product quality if process parameters are incorrectly set or there are deviations in the operation at this stage.

Full diagram of the bottle filling process. Minimal requirement a plan drawing of the filler bowl, extra marks for showing the effect on the bottle, side view. Some candidate described a whole bottling line, from Depalletiser to palletiser.

Full description of the Pre - Evacuation process. Vacuum pump removing O2 and what percentage per evacuation. Why this is done.

Full description of Pressurisation of bottle x 2 and what it achieves and why it is required.

Description of filling either short tube or long tube, not differences between. Where the beer enters the bottle and how CO2 escapes.

Description of snift process and what it does to the beer/bottling filling process.

Description of water jetting, why it is used and what it achieves.

Minor additional marks for water rinsing pre filling. Minor additional marks for crowning process.

Some candidates described a whole bottling line rather than specific to a bottle filler.
Some descriptions were like a can or PET filler where purging by flushing with CO2 was described but no evacuation.

Module 1: Packaging Operations I

Question 1

Explain the functions and basic properties of primary, secondary and tertiary packaging materials and list three examples of each type of material.

Select one material from each of the three groups above and explain the specific storage requirements for each of the materials to ensure they are kept in the best condition in readiness for use on the production line.

On a glass bottle filling line , explain the various pre-production and on-line packaging quality checks which are carried out to verify that the various packaging materials being used are within the specification and correct for the product , including where these checks are carried out on the line and their frequency.

Primary containers hold the product or are the sealing method. Products cannot be sold without these. Examples include Can, end, bottle, crown, label, cask, keg, shive,

Secondary packaging is the collation of primary pack into a saleable format. Examples include Hi-cone, multi pack, box/case, film, crate.

Tertiary packaging protects the product and supports it during transportation. Examples include pallet, stretch wrap, locator boards, tray/shrink wrap, Key storage concerns – coverage, housekeeping, hygiene, weather proofing, pest management, temperature control, humidity control, FIFO and management of part used stocks.

We expected to see material standards checks at receipt v Bill of Materials and eg print quality, grain direction on labels, bottles free from imperfections, crowns not scratched, printing on shrink etc.

A lot of candidates concentrated too much on product spec based irrespective of the fact that this is a packaging materials question. We were not looking for Analytical checks on the beer in tank and then samples removed from the line. This is where some people lost marks.

Question 2

Explain why you would choose sterile filtration instead of pasteurisation as an alternative method for achieving microbiological stability in package.

Describe what are the key product and process requirements for ensuring sterile product. Explain what operational and/or media changes can be made to the sterile filtration system to prolong cartridge life?

List some common faults associated with sterile filters and explain how they can be resolved and/or prevented from occurring?

The first part required you to explain why you would choose sterile filtration instead of pasteurisation. A good answer would list and explain the benefits of sterile filtration, mainly focusing on how it avoids heat treatment and therefore any possible flavour deterioration.

The second part was looking for a description of at least five key product and process requirements for ensuring sterile product, such as: feedstock to be below maximum micro and non micro load and to give examples to back up the statements.

There are many reasons that could have been listed and explained. To get full marks, at least five reasons should have been fully explained so it was completely clear to the examiner why this operational or media change could prolong the cartridge life on the sterile filter system.

An example is: install a pre-filter which is sized correctly to decrease microbiological load (> 0.45 micron is not sufficient).

There were several parts to this section – list some common sterile filter faults and then for each fault listed also explain how the issue could be resolved and/or prevented from occurring.

For example, a common fault is a blocked septum which results in reduced flow rates and increased pressure drops. This can be resolved by cleaning and/or replacing the septum. A further explanation of preventative measures such as defined cleaning schedule would also be expected.

Don't just list reasons which address the question – you need to also provide an explanation of each point you write about to justify the answer.

Question 3

The filler is the prime machine on a modern packaging line and optimum efficiencies are achieved by reducing waste and losses to a minimum.

Identify four areas of waste/loss on a filling operation with which the candidate is familiar. Outline how each of these four areas have been determined and measured.

Select two of the areas identified and discuss how these can be improved /corrected to reduce or prevent re-occurrence.

In Part (a) the candidates were expected to identify four areas of waste/loss experienced on a filling operation and cover relative examples in the areas of downtime/equipment failure, speed losses, quality/defect losses, start-up, and brand/pack change losses.

The majority of the responses covered and focused on actual filling losses – product waste,

bottle breakage, crown loss/waste and filler stoppages, whereas the higher scoring responses covered the broader spectrum of waste/loss impacting on overall operating efficiency/performance (O.E.E) of the filling operation.

In Part (b) the candidates were expected to demonstrate how these four areas identified were determined and measured, and, demonstrate an understanding of the key measures, KPI's., and, monitoring and management processes and systems used. This part of the question was in the main not well covered with the majority of the responses restating the loss aspects identified in Part (a) with little quantification or dimensioning of the processes used to monitor and measure the respective aspects identified – "improper crimping", "mains dump due to high oxygen", "CO2 loss determined by flow of CO2"; with no elaboration of the reason, methodology or key performance indicators applied.

In Part (c) the candidates were expected to select two of the areas identified and discuss how these could be improved/corrected to reduce or prevent re-occurrence, which in the main was not well covered. The higher scoring responses provided a good summation of root cause analysis, with well dimensioned performance measures and related improvement solutions, including proposing systemic procedures to prevent re-occurrence e.g. reduction of set up and changeover times, staff coaching and training ,root cause analysis of deviations and preventative maintenance.

The lower scoring candidates have broadly covered the theory as part of their preparation, but have not taken time to fully evaluate and understand how the concept of O.E.E is used and applied in the workplace. These candidates require more in-depth exposure to the concept of O.E.E. and how this is actually applied in practice.

Question 4

Draw a simple block diagram highlighting the key inspection points on a glass bottle packaging line.

Identify the three most important primary pack inspection points for the line above in order of importance. Describe their purpose , what benefits they deliver and what makes them most important.

Detail what is inspected in each of the inspection points chosen above and the technology used for each.

Diagram
A block diagram of the packaging line highlighting the inspection points and highlighting the 3 most important with correct flow and layout.

Purpose and Benefits

- Corporate due diligence and product quality benefits.
- Upstream machine performance monitoring.
- Losses/waste management of the entire line.
- Machine maintenance practices and schedule.
- Machine short interval control by operators.
- Downstream benefits as in far as pasteuriser water quality is concerned.

Technology
Detailed technology used per inspection aspect per machine on the line.

Candidates were generally weak on presenting benefits and purpose other than quality issues that could face the consumer.

Question 5

List the typical requirements, standards and measures for three of the four key line design requirements for container handling stated below.
• noise levels
• line profile/ machine speeds
• conveyor controls
• accumulation standards

Briefly outline the new line design, commissioning and performance acceptance tests that would be undertaken with the original equipment manufacturer (OEM)/turnkey supplier of the line.

For three of the glass bottle design requirements stated below, list typical requirements, standards and measures for each.
• container capacity
• container protection
• container coatings
• container trip life
• inspection technology for container integrity including finish
• palletization
• transportation.

Briefly outline the functionality/performance tests that would be undertaken with your glass supplier to formally accept the new container before final sign-off and commercial production.

Part A
The issues I would have expected to be covered would have been :-

- Noise level; bottle stability which is reliant of conveyor level, speed, guide rail height and position; Conveyor speed/control in relation to the bottle and other conveyors around; accumulation to optimise line efficiency and measuring OEE Overall Equipment Effectiveness.

Part B

- Container capacity – Volumetric sampling checks
- Container protection – Tray & Shrink wrap and box design. Crate design

- Container coatings – lubricity COATING, slip on conveyors. incline
- Container trip life – 1 trip lighter weight more elaborate embossing, returnable universal design.
- Container inspection - EBI especially neck area along with crown/cap inspection, FLD if tunnel pasteurised.

Part C
2D design, 3D printer or acrylic, pilot mould production and line trials, filling to E mark standards, palletisation, impact damage analysis at varying line speeds or set time period, filling & pasteurisation internal pressure testing, sealing integrity via a transit trial of bottle in pack to virtual customer.

Part D
Individual machines checked that they can produce at the specified output over a period of time at the correct quality.

Overall line to be run at a set speed for a set period of time. Quality of product to be inspected for given time period.

Handover of all operational and engineering training, documentation including maintenance and intervals as well as ideal spares stockholding. Contractual sign off.

Question 6

Describe what quality parameters need to be controlled as beer is transferred from filtered beer tank to filler to ensure beer quality is maintained within specification. Explain how these are measured, what are the possible reasons for any changes, and the corrective measures to be taken.

Using a table, compare and contrast the filling operation for a short tube versus a long tube bottle filler from container in-feed to bottle sealing.

Part A
There are four questions to address within part a. One – identify a quality parameter that needs to be controlled as beer is transferred from bright beer tank to filler to ensure beer quality is kept within specification. Two - explain how this parameter is measured. Three – describe possible reasons for any changes in the value during transfer. Four – what corrective measures can be taken to correct for these changes.

Answers could have been clearly presented using a table format, or clearly presented with sub section headings such as measurement, corrective action, etc.

At least four reasons were expected with full explanations addressing each part of the question to achieve full marks.

Part B
The question asked you to use a table to present you answer. The filling operation from container in-feed to bottle sealing was to be considered.

No marks were given for addressing process stages out with this scope. Each filling cycle stage per filler type should have been listed in a table and the differences between them are explained. Benefits of one system versus the other should have also been clearly explained at each step.

Particular points to be addressed include filling tube operation, oxygen pick-up, pre-evacuation and fill levels.

Don't just list reasons which address the question – you need to also provide an explanation of each point you write about to justify the answer.

Module 2: Packaging Operations II (Beer)

Question 1

a) Explain the principles of the milling operation for both a 6-roll and a hammer mill. Include a sketch of each mill.

b) Using a table, indicate what would be expected for both a 6-roll and a hammer mill against each of the following headings:
• Degree of malt modification
• Mash separation system
• Grist composition

c) Describe what problems may be encountered downstream in the brewing process if there are problems with milling and what preventative checks can be put in place to avoid this happening.

Part A
A clear sketch of each milling system (six-roll and hammer mill) was required. A sketch should include labelling of all key parts. For the six roll this should include the malt infeed, roller pairs, sieves, grain outfeed and direction of grain flow (identifying where the differences in milled components ie husk, grits and flour). For the hammer mill it should include the malt infeed, wheel with hammers, direction of rotation, screen, grain outfeed.

The sketch can then be referred to in the explanation of the milling operation of each system. Any key differences between the systems should be clearly identified in the explanation. A great explanation will have also included details about screen oscillation speed, size of mesh screen, speed of hammer rotation in addition to how the malt enters whole and exits milled.

Part B
A table was required to clearly identify what is associated with a six-roll and hammer mill for each of the following parameters: degree of malt modification, mash separation system, grist composition.

Part C
There are two parts to this section. One – describe what problems may be encountered downstream in the brewing process if there are problems with milling. Two – explain what preventative checks can be put in place to avoid this happening.
At least four problems should have been described and full explanation given, i.e why might this problem occur and what can be done to ensure it doesn't happen again in future.

Don't just list reasons which address the question – you need to also provide an explanation of each point you write about to justify the answer. Answer all parts of the question – read it carefully.

Question 2

a) Describe the process of the internal cleaning and filling of a keg, including in your answer the different times, temperatures and materials at each stage of the process.

b) Provide brief notes on all of the steps that the filled keg must go through from leaving the keg filler until palletisation, clarifying for each step how this helps provide compliance to all legal and food safety requirements.

The first part of this question was initially looking for a candidate to identify whether they were providing details for either an in-line or rotary washer/filling machine. Whilst a diagram was not required some candidates chose to add a simple diagram with numbers to highlight the different actions taking place.

Fully complete answers in this section initially dealt with the cleaning cycle of the keg – including detergents used, times and temperatures – as well as dealing with the key safety aspects of the process e.g. management of keg pressures, the integrity of any keg contents etc.

After covering all of the cleaning aspects, candidates should have then moved on to a more descriptive process of the filling cycle – including times and temperatures appropriate to the keg size being filled, as well as details as to the type of fill monitoring being used – e.g. brim fill, flow meter etc.

For the second part of the question, candidates needed to cover all of the different legal and safety compliance for the post filling part of the line. Strong answers here included the following topics:-

- Weighing : details of local legislation around weights and measures and rejection criteria – including the use of "top-up"
- Labelling or Coding : providing the legal compliance on elements such as Best Before Date, Brand & Production site information in order to provide traceability
- Inspection : validation for leakage from the spear – either manually or via a vision system / camera
- Capping / Sealing : application of cap or heat shrink cover to give brand information as well as proving hygiene protection and demonstration of tampering

For each of the above elements, candidates also needed to link to their local legislation for each of the elements – recognising food hygiene standards, legal declaration requirements and also safety elements to protect the workforce e.g. manual handling, safe FLT driving

Overall the weakest point in this question was the level and detail of the description of the cleaning and filling process – with the keg filling descriptors generally being significantly lacking in the detail expected within a Diploma paper.

Question 3

a) Describe the concept of Total Quality Management and identify the key principles applied.

b) Briefly explain how five of these principles would be incorporated in application on a key packaging process for a can or bottle line.

In Part (a) the candidates were expected to describe the concept of TQM, where the higher scoring candidates highlighted the key components of TQM - employee training and investment, problem solving teams and the use of statistical methods.
The majority of candidates were able to list most of the key Principles applied with the lower scoring responses providing little to no elaboration or substantiation on the principles; e.g. "problems must be prevented, not just fixed" – how, what systemic aspects? – Measures, checks, F.M.E.A., problem solving, and corrective action processes.

In Part (b) the candidates were expected to provide a more in-depth explanation of how the five principles selected would be incorporated, used, and applied on a packaging process. The responses here were more varied in content with the lower scoring candidates not providing good plausible examples of how these are applied and managed, whereas the higher scoring candidates provided good application examples of the principles tabled with more in-depth substantiation of how used at both the situational/operational and systemic/managerial levels.

Lower scoring candidates were able to list the principles but were not able to demonstrate a full understanding of the key reasons for their use and how these are applied in a packaging process.

Question 4

a) List the range of managerial competences exhibited by a world class production team leader.

b) For two of these competences, describe behaviours which demonstrate their use in everyday brewery operations.

c) For the same two competences, explain what training might be given to aspiring team leaders and managers to assist them in gaining these competences.

Eighteen candidates attempted this question with the highest marking being 14, the lowest 3 with an average of 9.

For the first part the one good answer quoted a fair range of managerial competences. A fuller range could have included:

- Managing tasks: Analysis, Creativity, Planning, Decision making.
- Managing people: Leadership, Persuading/Influencing, Coaching
- Self management: Communication, Drive and energy
- Environment: Business awareness, Customer and Supplier Orientation
- Technical: H & S, Business systems, Finance, Human Resources, Manufacturing, Logistics.

In the second part of the question candidates often confused "behaviours" with tasks e.g. holding meetings. The examiner was seeking examples such motivating / coaching individuals to improve their own performance and thereby the whole team's performance.

The examiner had, for the final part of the question, hoped to also see the means of delivering the competence training e.g. classroom, on-the-job, coaching; shadowing, on-line etc.

Question 5

a) Identify five key quality/analytical measures applied during filling and sealing for a can or bottle line. Include a brief description of the methodology used and respective performance indicators/targets applied.

b) Haze is one of the key in-package measures assessed post-filling. Outline the methodology used to determine haze in package and the typical units to report haze.

c) Discuss what preventative measures can be taken to avoid the presence of haze in packaged beer, considering both the process and raw materials in the answer.

Key elements required:

Crown crimps and torques, seam integrity checks, in-package D.O.-head space/total, fill levels/volume, CO2 content, hygiene/micro and cleaning, foreign object detection, alcohol content, total packed product assessment . IBD Learning material 2.1.5 and 2.5.5.

Question 6

a) Using the data provided below, calculate the expected annual output of the keg line in hl. Show all working and state any assumptions made.

- **Keg size = 50 litre**
- **Filler rating = 480 kegs per hour**
- **Line performance = 80%**
- **Shift pattern = 2 x 8 hour shifts, 5 days per week**
- **All CIP and maintenance completed at night**
- **Single brand production**

b) Brand success in the market is driving a 25% increase in demand, so there is a need to change the shift pattern to 3 x 8 hour shifts, still on 5 days per week.
Calculate the new annual output of the line in hl, and state clearly the assumptions made regarding both CIP and maintenance activities to maintain quality and line performance.

c) Explain how the above changes to the shift pattern will affect the following areas of the budget for the keg operation.
i. People costs
ii. Maintenance
iii. Losses

The first part of this question was a calculation designed to ensure that a candidates were able to demonstrate how all of the data provided came together in order to provide the line output. Here the only surprise was how many candidates assumed that plant operations were for 52 weeks – rather than recognising the details of downtime, overhaul, holidays etc.

In the second part of the question, and accepting the assumptions and answer which was provided in the first part of the question, the candidates were also required to undertake a revised calculation – but with different assumptions required. Key assumptions in this section should have included elements to address the following areas:-

- Changes to CIP regimes to maintain a required quality level
- Changes to the maintenance activities given different working hours
- Different shift patterns to meet required production volumes

In the final part of the question, candidates were requested to highlight the financial impact on the following areas:-

People: Recognition that this is a fixed cost, and that any change to the number of people, or the different shift patterns has a different impact in terms of premium payments.

Maintenance: Recognition that this is also a fixed cost which will need a different way of treating how maintenance is carried out e.g. changes to wear levels with increased production, differing time windows for maintenance may require different approaches if the maintenance is carried out using internal or contract personnel. Better candidates also raised the option of using different contracting systems to minimise costs e.g. use of annual hours agreements.

Losses: Recognition that this is a variable cost where the key contributor is likely to be beer loss. Increased start up and shut down activity is likely to lead to an increase in this element – but longer runs can also positively reduce loss levels. Some candidates also considered the management

of the utilities and chemicals as part of this topic which again strengthened the answer.

Whilst the first two sections of the question were reasonably well answered, the finance section was very poorly answered overall, with very high level answers provided to each topic and very limited information and knowledge displayed.

Module 2: Packaging Operations II (Soft Drinks)

Question 1

a) Draw and label flow diagrams for two of the following processes for the treatment of incoming water supply for soft drinks manufacturing:-

- **Chemical coagulation**
- **Reverse Osmosis**
- **Ion exchange**

b) Detail relevant quality checks that need to be conducted to ensure that the incoming water treatment processes are providing resultant water of the necessary quality for the manufacture of carbonated soft drink.

c) List the key differences between the two processes, and explain any advantages or disadvantages that one process may have over the other.

Of 13 candidates who attempted this question, an average score of 9 marks out of 20 was attained, with a wide range of 1-17. Two candidates presented a very poor set of answers, whilst three achieved marks in the top quartile.

a) The answer was looking for two annotated flow diagrams of water treatment processes - chemical coagulation, ion exchange, reverse osmosis.
marks were awarded for this part question.

b) The answer was looking for detail of the correct operation of a typical plant, ensuring that the plant is trimmed for any variation in the raw water supply ,and that the whole operation should be monitored regularly. Key areas to monitor include floc concentration, residual alkalinity, chlorine dosing, residual chlorine and microbiological testing. All covered in revision notes.
6 marks were awarded for this part question.

c) List the key differences between the two processes, and explain any advantages or disadvantages that one process may have over the other.

The answer was fully covered in revision notes, under 'Water treatment appendices'
6 marks were awarded for this part question

Question 2

a) Describe the process of the internal cleaning and filling of a keg, including in your answer the different times, temperatures and materials at each stage of the process.

b) Provide brief notes on all of the steps that the filled keg must go through from leaving the keg filler until palletisation, clarifying for each step how this helps provide compliance to all legal and food safety requirements.

The first part of this question was initially looking for a candidate to identify whether they were providing details for either an in-line or rotary washer/filling machine. Whilst a diagram was not required some candidates chose to add a simple diagram with numbers to highlight the different actions taking place.

Fully complete answers in this section initially dealt with the cleaning cycle of the keg – including detergents used, times and temperatures – as well as dealing with the key safety aspects of the process e.g. management of keg pressures, the integrity of any keg contents etc.

After covering all of the cleaning aspects, candidates should have then moved on to a more descriptive process of the filling cycle – including times and temperatures appropriate to the keg size being filled, as well as details as to the type of fill monitoring being used – e.g. brim fill, flow meter etc.

For the second part of the question, candidates needed to cover all of the different legal and safety compliance for the post filling part of the line. Strong answers here included the following topics:-

- Weighing : details of local legislation around weights and measures and rejection criteria – including the use of "top-up"
- Labelling or Coding : providing the legal compliance on elements such as Best Before Date, Brand & Production site information in order to provide traceability
- Inspection : validation for leakage from the spear – either manually or via a vision system / camera
- Capping / Sealing : application of cap or heat shrink cover to give brand information as well as proving hygiene protection and demonstration of tampering

For each of the above elements, candidates also needed to link to their local legislation for each of the elements – recognising food hygiene standards, legal declaration requirements and also safety elements to protect the workforce e.g. manual handling, safe FLT driving

Overall the weakest point in this question was the level and detail of the description of the cleaning and filling process – with the keg filling descriptors generally being significantly lacking in the detail expected within a Diploma paper.

Question 3

a) Describe the concept of Total Quality Management and identify the key principles applied.

b) Briefly explain how five of these principles would be incorporated in application on a key packaging process for a can or bottle line.

In Part (a) the candidates were expected to describe the concept of TQM, where the higher scoring candidates highlighted the key components of TQM - employee training and investment, problem solving teams and the use of statistical methods.
The majority of candidates were able to list most of the key Principles applied with the lower scoring responses providing little to no elaboration or substantiation on the principles; e.g. "problems must be prevented, not just fixed" – how, what systemic aspects? – Measures, checks, F.M.E.A., problem solving, and corrective action processes.

In Part (b) the candidates were expected to provide a more in-depth explanation of how the five principles selected would be incorporated, used, and applied on a packaging process. The responses here were more varied in content with the lower scoring candidates not providing good plausible examples of how these are applied and managed, whereas the higher scoring candidates provided good application examples of the principles tabled with more in-depth substantiation of how used at both the situational/operational and systemic/managerial levels.

Lower scoring candidates were able to list the principles but were not able to demonstrate a full understanding of the key reasons for their use and how these are applied in a packaging process.

Question 4

a) List the range of managerial competences exhibited by a world class production team leader.

b) For two of these competences, describe behaviours which demonstrate their use in everyday brewery operations.

c) For the same two competences, explain what training might be given to aspiring team leaders and managers to assist them in gaining these competences.

Key elements required:

For the first part good answers quoted a fair range of managerial competences. A fuller range could have included:

- Managing tasks: Analysis, Creativity, Planning, Decision making.
- Managing people: Leadership, Persuading/Influencing, Sensitivity, Coaching
- Self management: Communication, Drive and energy
- Environment: Business awareness, Customer and Supplier Orientation
- Technical: H & S, Business systems, Finance, Human Resources, Manufacturing, Logistics.

In the second part of the question candidates often confused "behaviours" with tasks e.g. holding meetings. The examiner was seeking examples such motivating / coaching individuals to improve their own performance and thereby the whole team's performance.
The examiner had, for the final part of the question, hoped to also see the means of delivering the competence training e.g. classroom, on-the-job, coaching; shadowing, on-line etc.

Question 5

a) Draw a flow diagram of the rinsing, filling and closing/sealing processes of a counterpressure filler for the manufacture of a carbonated soft drink, highlighting the key elements where quality checks are carried out, including fill-level detection and closing/sealability checks.

b) Using a table, list the key quality checks that are carried out in the aforementioned processes, the frequency of each check, a brief outline of the methodology/analysis used and the measures or key performance indicators used to monitor product quality against specification.

c) Calibration activities or metrology must be carried out as part of a HACCP programme in this area of the filling line. Give two examples of these activities, outlining how often the tests are carried out. What is the consequence of failure to carry out metrology?

Only 5 of the 14 candidates chose to answer this question, with an average score of 10 marks out of 20 and a range of 5-15.

Part A
Draw a flow diagram of the rinsing, filling and closing/sealing processes of a counterpressure filler for the manufacture of a carbonated soft drink, highlighting the key elements where quality checks are carried out, including fill-level detection and closing/sealability checks.

The answer should have presented a clearly annotated diagram featuring the key equipment involved ie rinser, filler, capper/sealer, carbonator/proportioner, positioning of fill-level and closure detection equipment and associated in-feed and discharge star wheels.
6 marks were awarded for this part question.

Part B
In a tabular format, list the key quality checks that are carried out in the aforementioned processes, the frequency of each check, a brief outline of the methodology/analysis used and the measures or key performance indicators used to monitor product quality against specification.

This question was looking for the following in a table – rinse water testing (at start-up after hygiene/product changeover), product taste testing, carbonation (hourly), fill level checks (hourly), brix/acid testing (hourly), cap/seal integrity (twice shiftly at least). A brief outline of the test and/or equipment used the KPIs used are to confirm that quality analysis results are undertaken to ensure trade metrology integrity.

This is all referenced in Revision Notes, Product Integrity Unit 2.6.4.2 and 2.6.4.3, pages 19-25

10 marks were awarded for this part question

Part C

Calibration activities or metrology must be carried out as part of a HACCP programme in this area of the filling line. Give TWO examples of these activities, outlining how often the tests are carried out. What is the consequence of failure to carry out metrology?

The answer should have covered testing of instruments against standards eg pressure gauges,(at start of production after line hygiene/CIP and/or once per day during production whenever routine testing of carbonation), fill level equipment eg weighing scales, cap torque testing equipment, brix measurement equipment. Failure to carry out metrology could lead to the manufacture of non-standard product, ie under or over carbonated, under-filling detection, leaking containers and subsequent product spoilage risk, all of which could lead to prosecution.

This is all referenced in Revision Notes, Product Integrity Unit 2.6.4.2 and 2.6.4.3, pages 19-25

4 marks were awarded for this part question

Question 6

a) Using the data provided below, calculate the expected annual output of the keg line in hl. Show all working and state any assumptions made.

- **Keg size = 50 litre**
- **Filler rating = 480 kegs per hour**
- **Line performance = 80%**
- **Shift pattern = 2 x 8 hour shifts, 5 days per week**
- **All CIP and maintenance completed at night**
- **Single brand production**

b) Brand success in the market is driving a 25% increase in demand, so there is a need to change the shift pattern to 3 x 8 hour shifts, still on 5 days per week.

Calculate the new annual output of the line in hl, and state clearly the assumptions made regarding both CIP and maintenance activities to maintain quality and line performance.

c) Explain how the above changes to the shift pattern will affect the following areas of the budget for the keg operation.

i. People costs
ii. Maintenance
iii. Losses

The first part of this question was a calculation designed to ensure that candidates were able to demonstrate how all of the data provided came together in order to provide the line output. Here the only surprise was how many candidates assumed that plant operations were for 52 weeks – rather than recognising the details of downtime, overhaul, holidays etc.

In the second part of the question, and accepting the assumptions and answer which was provided in the first part of the question, the candidates were also required to undertake a revised calculation – but with different assumptions required. Key assumptions in this section should have included elements to address the following areas:-

- Changes to CIP regimes to maintain a required quality level
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In the final part of the question, candidates were requested to highlight the financial impact on the following areas:-

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Losses: Recognition that this is a variable cost where the key contributor is likely to be beer loss. Increased start up and shut down activity is likely to lead to an increase in this element – but longer runs can also positively reduce loss levels. Some candidates also considered the management of the utilities and chemicals as part of this topic which again strengthened the answer.

Whilst the first two sections of the question were reasonably well answered, the finance section was very poorly answered overall, with very high level answers provided to each topic and very limited information and knowledge displayed.

Module 3: Packaging Technology

Question 1

a) With the aid of labelled diagrams describe the sequence of operations for both aerobic and anaerobic treatment of effluent for legally compliant discharge into a river.

b) Discuss the advantages and disadvantages of each system.

This question specifically requested the use of diagrams to aid an operational description of two effluent treatments. The best answers contained two detailed diagrams of the main types of effluent system, namely aerobic and anaerobic treatments. Reference to specific distillation effluent issues was expected.

Poorer answers referenced only one type of system or detailed a single combined aerobic and anaerobic system. This limited the candidate's opportunity to describe the two individual systems key points and operating principles. Maximum marks were obtained by detailing each system separately, thus allowing candidates to highlight key differences. e.g Bioreactor operation is fundamentally different in each system

The best approach to obtaining good marks was a good diagram, naming key equipment and its purpose, followed by detail on operating parameters e.g temperature, pH, utilities and an understanding of common operating issues relevant to a distillation plant.

Legal compliance was to be considered and the best answers demonstrated a knowledge of sensible values regards key performance measures such as BOD; COD and suspended solids which would allow the operation to achieve its purpose regards compliance values.

Advantages and disadvantages were well answered referencing a comparison table which is available in revision notes. This covers performance regards legal compliance values, energy consumption, revenue and capital costs, flexibility in terms of operating cycles, ease of use and plant footprints. Poorer answers were general lists with little or no explanation of benefit and lack of clarity on sensible values.

Overall a good answer on this question covered all the above points and demonstrated a good practical understanding regards operational setting issues and solutions, Poorer answers tended to ignore complete sections of the question and contained no specific process values.

Question 2

a) Explain the terms 'prevention' and 'mitigation' in relation to health and safety. Give two examples of each.

b) How and why are risks quantified? Explain the benefits of this when considering occupational safety hazards.

Thirteen candidates chose to answer this question with scores ranging from 5 to15 with an average of 8.5.

For the first part of the question 'prevention' and 'mitigation' were not well understood. In general, prevention tries to stop the event from happening in the first place i.e. prevents harm or damage. Mitigation tries to limit the damage when the event takes place.

Too many candidates thought prevention meant eliminating the risk altogether. There may be risks which are unavoidable but with safe working practices and appropriate PPE, harm / injury can be avoided or, at the very least, the risk minimised. Working at height is but one example. In this case preventive measures might include (as appropriate) elevating platforms, scaffolding, harnesses, safety nets as well as intense competence training.

There were some good examples of preventive measures including key interlock systems for working on palletisers, permits to work, most PPE etc. The examples of mitigation were not as good with many quoted still being preventive e.g. much PPE. Good examples were a building sprinkler system and ear defenders (which may not totally prevent damage to hearing over a long exposure).

For the second part of the question the examiner was seeking a brief explanation such as "the severity" and "likelihood" of the risk which are each given a score with the product producing an overall weighting for the particular risk. This then leads to the construction of a risk grid with the axes being severity and likelihood.

For the final part, the main benefits of quantifying risks and hence producing weightings allow the objective targeting of time and financial resources to those risks exposing people / property to most harm / damage.

Question 3

a) In the context of pumping liquids. Define the term 'Net Positive Suction Head' (NPSH).

b) Liquid is pumped from a buffer tank to a filter. Identify the physical conditions of the system and applied process variables that ensure efficient operation of the pump and describe the consequences of incorrect positioning of the pump within the system.

c) The buffer tank is under liquid level control. With the use of a block diagram identify the elements of the process control loop.

d) Recommend a level sensor for the buffer tank which can be interfaced with a PLC control system and describe its principle of operation.

Correct definition of Net Positive Suction Head that includes available suction-side head and the liquid vapour pressure

Sketch of pumping configuration with pump located in proper location, closest to the buffer tank

Discussion of mechanisms to increase the suction-side head such as maximal static head, minimal frictional losses via short, large diameter inlet with minimal fittings.

Discussion of consequences of improper set up which leads to cavitation

Process control section includes a block diagram with key features of the process, measured variable, controller, controlled variable placed in proper sequence.

The level sensor description and principle of operation must be accurate for the sensor chosen.

Question 4

a) Describe three different ways of increasing the CO2 concentration in beer to a desired level for packaging. Compare the methods including advantages and disadvantages of each.

b) Define supersaturation and describe the conditions that lead to CO2 supersaturation.
c) Discuss the factors that lead to gas breakout and their effect on beer quality.

The first part of the question requires the candidate to identify three different approaches to carbonating beer and accurately describe each technique.
Four potential methods to select from bunging the tank at the end of fermentation top gas on a sealed tank post fermentation sparging CO_2 via a fritted stone in-line carbonation via a venture orifice or some variant thereof. Compare and contrast with a focus on speed, control, cost, complexity, and beer quality.

Accurate definition of CO_2 supersaturation required correct description of the condition. Answers should include how elevated temperature as well as decreased pressure can lead to CO_2 supersaturation.

Final part focused on beer quality and how gas breakout can impact packaging filling operations (fill volume and TPO) and insufficient pasteurization when it occurs during within a pasteurizer.

Question 5

a) Draw a labelled diagram of a shell and tube boiler used to raise steam to show all the key components. Illustrate the main fluid and energy flows and the means of control of the steam production.

b) Natural gas is burned in the shell and tube boiler to raise 5.0 tonnes per hour of dry saturated steam at 4.0 bar g. Condensate is returned to the boiler at 4.0 bar g., 100°C.

Calculate:
i. the mass flow rate of natural gas that is required (kgs-1)
ii. the steady state heat supplied to the heating application (MW)
Net enthalpy of combustion of natural gas = 45.6 MJ kg-1
Boiler thermal efficiency = 76%
Enthalpy of dry saturated steam at 4.0 bar g. = 2748 kJ kg-1
Enthalpy of dry saturated steam at 0 bar g. = 2676 kJ kg-1
Enthalpy of dry saturated water (152°C) = 637 kJ kg-1
Enthalpy of dry saturated water at 0 bar g. (100°C) 419 kJ kg-1

First part of the question asks the candidate to draw a diagram of a shell and tube boiler that includes components such as:

- Water inlet handling
- Steam pressure monitoring and control
- Combustion burner and flue gas path
- Isolating and blowdown valves
- Correct overall general design

The second part of the question asked the candidate to perform some energy use calculations surrounding the boiler.

Mass flowrate calculation required the correct selection of points of the steam table enthalpies to identify the enthalpic input required to raise steam from water at 100°C.
Combining boiler efficiency and calorific value of the fuel lead to gas flowrate

Question 6.

a) Water in an insulated hot water tank is maintained at a temperature of 80°C. The total external area of the insulated tank is 35m2. Using the data provided, calculate the heat loss (W) from the surface of the insulation by:
i. Convection
ii. Radiation

Ignoring the thermal resistance to heat transfer through the walls of the tank and assuming the mean surface area for heat transfer through the insulation is approximately the same as the external surface area of the tank, calculate:
iii. The thickness (cm) of insulation required.

Data:
Surface temperature of the insulation = 30°C
Ambient temperature of surroundings = 20°C
Average natural convective heat transfer coefficient for surface
of insulation = 3Wm-2K-1
Emissivity coefficient of the surface of insulation = 0.3
Stefan-Boltzmann constant for radiation = 5.67 x 10-8 Wm-1K-1
Thermal conductivity of the insulation = 0.04 Wm-1K-1
N.B. 0°C = 273 K
[12]
b) With the aid of a diagram, specify the insulation system best suited to the insulation of the tank and explain the reasons for the choice of material used.

The first part asks the candidate to calculate convection heat loss using the temperatures, area, and convective heat transfer coefficients.

Radiant heat loss required the candidate to convert temperatures from °C to K and perform a radiant heat transfer calculation.

Using the combined convective and radiant heat loss plus the specified surface temperature on the exterior to the tank insulation, the insulation thickness could be calculated from a straightforward conductive heat loss calculation using Fourier's law.

The final part asked the candidate choose insulation for the tank, which would most commonly be fibre glass wool, and justify the selection.

Diploma in Distilling

Module 1

Question 1

For one of the following raw materials:
• Malted barley
• Maize
• Blackstrap molasses
• Wheat

a) List five parameters that should be included on a delivery specification and for each parameter state typical units of measurement and acceptable range (specifications). [5]

b) Explain why these parameters are included in the specification and discuss potential causes of the parameter values being above or below the stated range. [15]

One candidate answered for blackstrap molasses. All others answered for malted barley. Overall the parameters selected were acceptable. Several candidates went into detailed discussions on the impact of being out with specification on the process and how to mitigate this in the plant. Though the impact was required for the first part of "b" time was wasted in too much detail and also giving detail on the mitigation steps. This was not required as the key point was the selection not on how you would handle the material in the plant.

Question 2

Discuss the importance of water quality for use in different applications within a distillery. [20]

State sources including "processed" sources
Discuss the term quality in relation to water with detail on measurable parameters that are used to measure quality

Identify different applications and for each discuss appropriate quality considerations. Areas to be covered mashing, cooling, substrate dilution, fermentation, distillation, steam generation, CIP, cooling and reducing product.

Most marks were lost by not providing detail on the different requirements for each area of use. A list of where water was used did not provide enough to gain a pass.

Question 3

Describe the action of enzymes and the optimum conditions for enzymolysis during the mashing process.
[20]

Key elements required:

- Name enzymes found in malt
- Detail action of each on substrate
- Optimum conditions , main = temperature, time, pH
- Other considerations such as substrate concentration, impact on level through malting process

This question could answered as a discussion on the action and conditions. Provided the element was mentioned and discussed in the answer the marks were gained. The most time efficient way was provided by some candidates using a table listing the name and optimum condition with a discussion on the action. Several candidates gave high levels of detail on a few enzymes therefore only gaining a proportion of the marks. At diploma level candidates need to show breadth of knowledge and know more than the 3 main enzymes.

Question 4

a) Name common microbial contaminants and identify the source of these in distilleries.
[8]

b) Discuss the positive and negative contributions of bacteria in production of different distilled spirits. [12]

Part A
Common contaminants can be bacteria and wild yeasts.

Names include species such as Lactobacillus brevis (bacterial contaminant) and Dekkera bruxellensis (wild yeast contaminant). Other species can also be given (eg. Zymomonas mobilis in molasses distilleries; Legionella pneumophilia in cooling towers; Acetobacter aceti in washbacks; Asperigillus fumigatus and other fungi on cereals

Sources of these microbial contaminants are mainly raw materials (cereals, sugars), mashing/dilution water, pitching yeast, vessels/pipes/pumps.

Part B
Positive contributions can range from pH control/flavour development with lactic acid bacteria.

Answers may also include "sour mashing" in bourbon distilleries with lactic acid bacteria for particular congener synthesis

Other positive contributions include metabolism due to late lactic acid bacteria during traditional malt whisky fermentations using wooden washbacks

Negative contributions include detrimental effects on spirit yield due to severe bacterial contamination during fermentation

Production of undesirable metabolites that contribute to off-flavours/aromas (eg. sulphur compounds, diacetyl etc.) are also negative contributions

Some detrimental contaminant bacteria may use sugars/dextrins that yeast leaves behind and generate off-flavours

Question 5

a) Name the sugars available to yeast during fermentation of both cereal worts and molasses. [4]

b) Detail the metabolic pathway of how these sugars are converted into ethanol. [16]

For malt wort, the principal fermentable sugars are glucose, maltose and maltotriose (and maltodextrins which are not well utilised by yeast).

For molasses they are sucrose, glucose and fructose.

Candidates should outline how the various sugars are firstly translocated into the yeast cell (eg. facilitated diffusion for glucose, active transport for maltose).

Mention of yeast invertase cleaving sucrose extracellularly to glucose and fructose would also be relevant.

The glycolytic pathway should then be given (up to pyruvate) naming the intermediates, enzymes and the involvement of ATP and NAD.

Conversion of pyruvate via acetaldehyde to ethanol by terminal fermentative enzymes should also be given (naming enzymes and highlighting NAD regeneration).

Coverage of the Krebs Cycle is superfluous.

Question 6

a) Describe the practical methods used in distillery yeast management. [12]

b) Discuss the importance of good yeast management in a distillery. [8]

Part A

The methods to be described should include the use of cream, cake, dried or in-house cultured yeast

Methods of storage/handling, bubbing, rehydration and pitching

Use of brewer's yeast could may be included

Hygienic practices need to be stressed

Important role of oxygen may also be covered as well as control of wort temperature

Tracking batches/stock control of yeast also relevant

Mention of yeast QC laboratory methods also appropriate (eg. viability/contaminant assays)

Part B

Candidates should stress the need to ensure consistently performing yeast fermentations in terms of alcohol yields and flavour congener production. Strain purity is important.

Maintenance of high yeast viability (eg. correct storage conditions) important and avoidance of stress.

Good yeast management also important for control of contaminating microbes (eg. correct pitching rates to give yeast competitive advantage).

Mention of QC (eg. yeast viability) here also pertinent.

Module 2

Question 1

a) Draw a McCabe-Thiele equilibrium curve graph for an ethanol water mixture.
Indicate a feed with mole fraction of 0.25 and operating lines for a distillate with maximum strength below the azeotrope and a waste steam with zero ethanol. Indicate how the above graph can be used to determine the number of theoretical plates. [12]

b) Explain the impact on the number of plates required when the value of R (reflux ratio) is changed. [8]

Key elements required:

- Axes well labeled
- Reasonable curves
- Stripping and rectifying lines
- Stepping off plates between operating line and equilibrium curve
- Reference to any of Raoult's, Henry's, Dalton's laws
- Reflux ratio
- Effect on number of plates
- No enrichment upon unity

Curves were generally well drawn with operating lines, feed, azeotrope, and waste stream in the right places. Explanations of theoretical plates varied in quality with top marks including a discussion on binary mixtures and stepping off. Reflux ratio was generally well explained in relation to the number of plates, and better answers included a discussion on gradients and plates, approaching unity.

Question 2

Describe, with the aid of diagrams, the design features and operation of a batch spirit still system intended to produce a distillate which is:
a) Light in character
[10]
b) Heavy in character
[10]

Features:

- Well drawn diagram
- Lyne arm orientation and length
- Condenser type
- Still shape / height
- Charge volume / fill height
- Reflux
- Type of heating
- Purifier / after cooler
- Sight glass

Operation:

- Distillation rate
- Copper contact
- Condenser / distillate temperature
- Cut points
- Cleaning

- Emissivity
- Feints recycling / charge strength
- Copper resting
- Further distillation step or type

Most popular answer with everyone attempting it. Many lyne arms orientated wrongly. Marks were awarded only if relevant to spirit quality so no marks were awarded for safety features. While most candidates rightly mentioned sulphur removal, few mentioned esterification. Reflux was generally well understood.

Only about half mentioned cut points. Good candidates drew volatility graphs to show when light, medium and heavy congeners accumulate in the condensate.

Almost no-one mentioned direct heating - this is an international exam so some knowledge of world spirit processes is expected. Some candidates described a triple distillation system, which scored marks only if the features of the system were explained.

It was not enough simply to describe the operation as this would have carried equally few marks had double distilling been described without features.

It was encouraging to see so many candidates describe emissivity as a way of influencing spirit character.

Question 3

Describe, with the aid of diagrams, a multi-column system designed to produce a neutral spirit. Include ancillary equipment, and the flows of each liquid and vapour in the system. Indicate where appropriate the temperature and spirit strength. [20]

For each column, marks were awarded for:

- Name
- Function
- Flow of liquids and vapours, and orientation
- Energy / temperature inputs
- Ethanol strengths
- Further marks were awarded for pertinent ancillary equipment

This should have been the most straightforward question in the paper, essentially asking 'how do you make neutral spirit?' As this process is described widely, there is little point in defining it here.

Many candidates did not detail the operation of the analyser or rectifier, simply saying, 'the usual 2-column system' then detailing only the operation of the further columns.

Question 4

a) Outline the complete manufacturing process of an oak cask suited to maturing spirit, from the point of felling the tree until filling with spirit. [8]

b) Describe the main chemical reactions that influence spirit quality during maturation in an oak cask. [12]

Part A

- Saw into bolts, saw into stave lengths
- Prevent leaks - sapwood, heartwood, knots, medullary rays
- Air dried (fungal growth, flavour) versus kiln dried
- Fit staves into hoop
- Steam soften stave, bend into shape
- Croze, other feature
- Hoops, no metal contact with spirit
- Charring versus toasting
- Fit ends, reeds, plugs
- Bung hole
- Leak test

Part B

- Lignin degradation
- Tannins, gallotannins, ellagic acid, gallic acid, higher strength, bitter
- Lactones coconut
- Eugenol cloves, other compounds
- Wood colour
- Chemical equations unless described in words
- Cellulose degradation - wood sugars
- Esterification
- Oxidation (including donation of oxygen from tannins)
- Sulphur removal by activated carbon
- Absorption of compounds to activated carbon / cask or evaporation through cask
- Evaporation of ethanol and water
- Acrolein breakdown

Question 5

a) Provide a detailed analytical specification for a neutral spirit intended for use in the production of a distilled gin, and explain the impact on a gin distillery if the neutral spirit is delivered out of specification. [12]

b) Describe two sensory difference tests used in assessing spirit quality and give the advantages and disadvantages of each test. [8]

Part A

- Alcohol strength, reasonable spec
- Methanol concentration, reasonable spec
- Isoamyl alcohol concentration (or higher alcohols), reasonable spec
- Any pertinent, including diacetyl, sulphur, (acet)aldehyde(s), esters, furfural, clarity, solvents, EC, pH - and reasonable spec
- Free from taint
- Legality risk, bad for health, not true to type, risk to brand, contaminating still

- Costs of labour, returning to supplier, blending into spec with existing GNS, not meeting sales demand
- Redistil - most gin distilleries not set up to do this

Part B
Any common test - Triangle, A not A, Paired comparison, Duo trio, 2 from 5, Tetrad

Overview of test, set-up, lab conditions, 'identical' samples, expertise of panel, reduced alcohol strength, sample volume, cobalt

Advantages and disadvantages: ease of set-up, time, statistical usefulness, sensory fatigue, number of panellists, known sample, panel training tool.

Question 6

a) Explain the principles of HACCP and how these can be used to minimise risk in spirit production. [10]

b) Outline the modes of action of a detergent and explain why good hygiene practice in spirit production is important. [10]

Part A
- HACCP multi-disciplinary team
- Pre-requisites (suppliers - raw material specs - e.g. moulds, GN, NDMA, pesticides, allergens)
- Flow diagram
- Identify hazards
- Identify CCPs - decision tree
- Control measures / critical limits
- Corrective actions
- Procedures and records
- Training / stakeholder awareness
- Review / audit / continuous improvement
- Protects product quality
- Increased focus on Quality culture / good practice
- Increased food safety / reduced contamination
- Examples - physical - glass, dust, insects
- Examples - chemical - detergents, dilution
- Examples - micro - low risk (distillation CCP), potential for taint if volatile
- Consumer - brand image
- Customer assurance
- Reduced claims

HACCP process well described by some candidates, but marks were lost for how this can be used to minimise risk, and with few examples.

Part B
- Removes soil, not a sterilant
- Wet
- Dissolve
- Disperse
- Rinse
- Temperature
- Time
- Detergent strength
- Scrubbing action / flow-rate
- Consistent quality / flavour / product
- Reduces contamination risk
- Yield / efficiency
- Safer working environment / best practice
- Longevity / safety of plant
- Examples - solids, liquids

Some candidates described the action of sterilants, which received no marks.

Module 3

Question 1

a) With the aid of labelled diagrams describe the sequence of operations for both aerobic and anaerobic treatment of effluent for legally compliant discharge into a river. [14]
b) Discuss the advantages and disadvantages of each system. [6]

This question specifically requested the use of diagrams to aid an operational description of two effluent treatments. The best answers contained two detailed diagrams of the main types of effluent system, namely aerobic and anaerobic treatments. Reference to specific distillation effluent issues was expected.

Poorer answers referenced only one type of system or detailed a single combined aerobic and anaerobic system. This limited the candidate's opportunity to describe the two individual systems key points and operating principles. Maximum marks were obtained by detailing each system separately, thus allowing candidates to highlight key differences. e.g Bioreactor operation is fundamentally different in each system

The best approach to obtaining good marks was a good diagram, naming key equipment and its purpose, followed by detail on operating parameters e.g temperature, pH, utilities and an understanding of common operating issues relevant to a distillation plant.

Legal compliance was to be considered and the best answers demonstrated a knowledge of sensible values regards key performance measures such as BOD; COD and suspended solids which would allow the operation to achieve its purpose regards compliance values.

Advantages and disadvantages were well answered referencing a comparison table which is available in revision notes. This covers performance regards legal compliance values, energy consumption, revenue and capital costs, flexibility in terms of operating cycles, ease of use and plant footprints.

Poorer answers were general lists with little or no explanation of benefit and lack of clarity on sensible values.

Overall a good answer on this question covered all the above points and demonstrated a good practical understanding regards operational setting issues and solutions, Poorer answers tended

to ignore complete sections of the question and contained no specific process values.

Question 2

a) Explain the terms 'prevention' and 'mitigation' in relation to health and safety. Give two examples of each. [10]

b) How and why are risks quantified? Explain the benefits of this when considering occupational safety hazards. [10]

Fundamental to this answer is a clear understanding within a Health and safety framework of the difference between prevention, the complete removal of risk from an operating system and mitigation, the management of risk to minimise and limit any harm or damage. A clear statement regards the above and two good examples related to distillation provided a sound foundation to achieve pass marks in this question.

Weaker answers detailed extremely general risks applicable to life in general , such as slips and trips, better answers provided good detail of specific distillation risks, such as vapour and dust control. Many papers failed to give any examples thus reducing overall marks available.

The identification of hazards should reference risk management techniques and demonstrate knowledge of risk analysis terminology such as severity and likelihood.

The better answers referenced quantification techniques such as a risk assessment grid using practical distilling related examples which covered the range of categories from insignificant to unacceptable. Then detailed how this information can be used to identify resource and apply preventative measures to eliminate or reduce the risk to an acceptable level.

The practical use of this information was explained in respect to employee involvement and awareness through their involvement in quantifying risk, the use of standardised working practices, competency assessments, PPE usage and regular reassessment in the event of process, plant and personnel changes.

Question 3

a) In the context of pumping liquids. Define the term 'Net Positive Suction Head' (NPSH). [3]

b) Liquid is pumped from a buffer tank to a filter. Identify the physical conditions of the system and applied process variables that ensure efficient operation of the pump and describe the consequences of incorrect positioning of the pump within the system. [7]
c) The buffer tank is under liquid level control. With the use of a block diagram identify the elements of the process control loop. [5]

d) Recommend a level sensor for the buffer tank which can be interfaced with a PLC control system and describe its principle of operation. [5]

Define NPSH mentioning: head value at suction side of pump preventing cavitation and influence of fluid temperature.

Height of tank relative to pump: Pressure / vacuum within tank: Temperature of fluid: Diameter of suction pipework: Length of pipework: Material of construction e.g. stainless steel vs cast iron: No section of suction pipework below the level of the pump inlet: No flow restrictions, e.g. orifice plate, small diameter valves: Filter positioned at excessive height above pump: Filter not cleaned regularly.

Air locking within pipework causing no flow: High fluid temperatures and excessive pressure drop on pump suction side causing cavitation leading to mechanical damage to pump, high noise levels.

Elements of a process control block diagram. Set-point: Measured variable: Error from comparison of set-point and measured variable: Controller to determine control output to actuator or VSD depending on magnitude and rate of change of the error: Actuator or VSD to change process variable (fluid flow): Process reacts to change: Sensor (liquid level measurement) determines new measured variable.

For any level measurement sensor discussed, the following elements should be considered:

- Influence of variations in fluid density Influence of variations in fluid temperature
- Changes in tank pressure (if not atmospheric)
- Ability to cope with suspended solids in fluid Range of sensor relative to height of tank
- Access to sensor and calibration
- Ability to generate a 4-20 mA signal for control purposes
- High / low level alarm generation, which could initiate a sequence to shutdown processing to avoid tank overflow or tank emptying (unless desired).

The use of on/off level switches will not provide smooth flow control or indicate tank level and ball-cocks have a range limited to the top of the tank. These would not be considered suitable.

Some candidates referred to the Bernoulli equation with respect to section b), this did not describe practically the requirements of the system. Marks were awarded in section c) where the control system was described by means of a schematic diagram.

Most candidates selected a radar gauge as a suitable level sensor. This was a valid answer with marks awarded on the depth of detail given on its' principle of operation.

Question 4

a) Draw a labelled diagram of a shell and tube boiler used to raise steam to show all the key components. Illustrate the main fluid and energy flows and the means of control of the steam production. [10]

b) Natural gas is burned in the shell and tube boiler to raise 5.0 tonnes per hour of dry saturated steam at 4.0 bar g. Condensate is returned to the boiler at 4.0 bar g., 100°C.

Calculate:
the mass flow rate of natural gas that is required (kgs-1)
the steady state heat supplied to the heating application (MW)
Net enthalpy of combustion of natural gas = 45.6 MJ kg-1
Boiler thermal efficiency = 76%
Enthalpy of dry saturated steam at 4.0 bar g. = 2748 kJ kg-1
Enthalpy of dry saturated steam at 0 bar g. = 2676 kJ kg-1
Enthalpy of dry saturated water (152°C) = 637 kJ kg-1
Enthalpy of dry saturated water at 0 bar g. (100°C) 419 kJ kg-1. [10]

The key elements required on an annotated diagram. For the main fluid and energy flows - Burner with gas supply and combustion air fan:

- Water feed pump:
- Steam isolation (crown) valve
  Other elements – Fire tube and smoke tubes, showing multiple passes:
- Stack outlet connection:
- Pressure relief safety valve:
- Pressure gauge:
- Water level sight glasses:
- Blowdown valve:
- Water level control:
- Total dissolved solids (TDS) measurement, controls blowdown:
- Steam flow meter: Stack O_2 sensor for efficiency measurement:
- Feed water treatment, e.g. ion exchange

Control of steam production depends on the process demand and should consider the following:
Boiler pressure reduces as demand increases, firing rate increased. If the maximum continuous rating (MCR) is attained then steam quality may deteriorate and risk of low water level.

Boiler pressure increases as demand falls, firing rate decreased. If the limit of the boiler's turndown ratio is reached then the burner is shutdown.

Answers:
i. 0.09 $kg.s^{-1}$
ii. 3.23 MW

Key elements of the calculation:
Enthalpy required to raise steam = 2,329 $kJ.kg^{-1}$
Correctly applying the steam flow and the boiler efficiency to determine the boiler heat requirement = 4.26 MW

Deriving the natural gas mass flow using the net calorific value = 0.09 $kg.s^{-1}$

Calculating the heat to process from the steam pressure given and taking into account the sub-cooling of the returned condensate = 3.23 MW

There were significant variations in the quality and detail of the annotated diagrams, with several candidates not providing any information on controlling steam production.

The second part of the question was only answered completely by one candidate. A lot of candidates almost used the correct methodology but missed out some details, e.g. boiler efficiency, sub-cooling of condensate.

Question 5

a) Water in an insulated hot water tank is maintained at a temperature of 80°C. The total external area of the insulated tank is 35m2. Using the data provided, calculate the heat loss (W) from the surface of the insulation by:
i. Convection
ii. Radiation

Ignoring the thermal resistance to heat transfer through the walls of the tank and assuming the mean surface area for heat transfer through the insulation is approximately the same as the external surface area of the tank, calculate:
iii. The thickness (cm) of insulation required.
Data:

Surface temperature of the insulation = 30°C
Ambient temperature of surroundings = 20°C
Average natural convective heat transfer coefficient for surface
of insulation = 3Wm-2K-1
Emissivity coefficient of the surface of insulation = 0.3
Stefan-Boltzmann constant for radiation = 5.67 x 10-8 Wm-1K-1
Thermal conductivity of the insulation = 0.04 Wm-1K-1
N.B. 0°C = 275 K. [12]

b) With the aid of a diagram, specify the insulation system best suited to the insulation of the tank and explain the reasons for the choice of material used. [8]

Answers:
i. 1,050 W
ii. 643 W
iii. 4.1 cm

Key elements of the calculations:

i. Use of the heat transfer equation – Q = U.A.deltaT
With the driving force for the rate of heat transferred being the temperature difference between the

surface of the insulation and the ambient temperature.

ii. Use of the Stefan-Boltzmann equation
The temperatures used must be absolute values in K.

iii. Requires the use of the total heat loss as the sum of the answers to i and ii above.
Rearranges the equation for heat conducted through the insulation Q = (k.A.deltaT)/x, where x is the insulation thickness in m and Q is the heat loss in $W.m^2$.

The diagram should show a cross-section of the insulation system showing the tank wall, a barrier or membrane to protect the tank wall, the insulation material chosen, supports welded to the tank to hold the insulation material in place, an outer skin sealed against water ingress. Additional details could include showing the temperature profile used in this question.

In discussion mention should be made of the importance of keeping insulation material dry. Particular attention should be paid to sealing around tank connections or hatches. Provision should be made for access to instruments.
In considering insulation systems generally, condensation on a cold tank may be an issue.

There was some confusion around the temperature difference to be used for heat loss. Some candidates used the tank wall temperature which resulted in calculating the “bare metal” heat loss. With the Stefan-Boltzmann equation absolute temperature values in K were not always used and taking the individual temperature values to the power of four proved problematic.

Wide variations were seen in the quality and detail of the diagrams. Most candidates selected mineral wool and there was always clear emphasis on the need to keep it dry.

Question 6

a) For a defined type of bottle filler, explain with the aid of diagrams each stage of the bottle filling process. [10]

b) For each stage of the process explain the effect on finished product quality if process parameters are incorrectly set or there are deviations in the operation at this stage. [10]

The question required the candidate to focus on bottle filling and illustrate their answer through the use of diagrams and description covering relevant operational process parameters which effect spirit bottling. Diagrams are a simple and quick way to demonstrate knowledge of the process highlighting key stages and critical control points.

Many answers focused on generic filling and packaging, although the latter was not requested and is out with the scope of the current syllabus. No marks were withheld if this was the case however no marks were awarded for labelling and secondary packaging operational descriptions.

The scope of the answer required consideration of spirit, materials and processes from bright vat to capped bottle.

Regards bottle filling the question was generally answered poorly with few candidates being able to explain the operation on a simple rotary filler. Many answers simply reference manual filling. The question was best answered by those who understood the workings of a rotary filler, its key stages and operating principles and the risks to product when run incorrectly

The best answers demonstrated knowledge of the product, materials, equipment, manpower and process control including quality values and checks. The key areas include spirit supply, ABV and contamination risks, material supply controls , glass and caps, spirit supply lines, filters and recovery systems, process control values, HACCP awareness and sensible critical control points, spirit quality checks, fault finding and legislative requirements regards strength and fill level.

This list illustrates areas where knowledge could be demonstrated in respect to problem solving the main quality issues. Contamination, strength variation, Fill level control and package integrity.

FUNDAMENTAL AND GENERAL CERTIFICATE EXAMS

FUNDAMENTAL AND GENERAL CERTIFICATE EXAMINATIONS

Fundamentals of Brewing and Packaging of Beer
FBPB Nov 2017 - May 2018

The pass rate of 91% compares l favourably to the pass rate of 67% from the same period last time.

	Fail	Pass	Credit	Distinction	Total
FBPB CF	5	11	16	17	49
FBPB CASK	1	6	10	7	24
FBPB Total	**6**	**17**	**26**	**24**	**73**

Fundamentals of Distilling
FD Nov 2017- May 2018

The pass rate of 59% compares favourably with the pass rate of 57% from the previous period.

	Fail	Pass	Credit	Distinction	Total
FD Total	**31**	**33**	**10**	**2**	**76**

The Learning Material from both the FBPB and the FD qualifications can be purchased in book form from the IBD's bookshop at http://www.lulu.com/spotlight/IBD

General Certificate in Brewing
GCB Nov 2017- May 2018

The pass rate of 51% was slightly down from 56% last year.

	Fail	Pass	Credit	Distinction	Total
GCB Mainstream	251	181	33	5	470
GCB Craft	207	184	65	4	460
GCB Total	**458**	**365**	**98**	**9**	**930**

General Certificate in Packaging (Beer)
GCP Nov 2017- May 2018

The pass rate of 52% was lower than the 63% from the same period last time.

	Fail	Pass	Credit	Distinction	Total
GCP CAN	25	13	11	2	51
GCP KEG	7	6	1	1	15
GCP NRB	27	22	14	3	66
GCP RB	43	34	10	0	87
GCP (All options)	23	18	1	0	42
GCP Total	**125**	**93**	**37**	**6**	**261**

General Certificate in Distilling
GCD Nov 2017- May 2018

The pass rate of 63% was lower than the 68% from the same period last time.

	Fail	Pass	Credit	Distinction	Total
GCD Cereal	110	142	47	3	302
GCD Grape	8	15	4	1	28
GCD Molasses	11	11	0	0	22
GCD Total	**129**	**168**	**51**	**4**	**352**

General Certificate in Packaging (Spirits)
GCP(S) Nov 2017- May 2018

The pass rate of 67% is lower than the 74% from the same period last time.

	Fail	Pass	Credit	Distinction	Total
GCP(S)	**8**	**12**	**2**	**2**	**24**

General Certificate in Malting
GCM Nov 2017- May 2018

The pass rate of 47% compares less favourably to the 67% pass rate last year.

	Fail	Pass	Credit	Distinction	Total
GCM	**33**	**19**	**8**	**2**	**62**

LIST OF SUCCESSFUL CANDIDATES

Aaron	Kennedy	International	Diploma in Brewing Completed
Adebola Ilemobayo	Iyaomolere	Africa	Diploma in Brewing Completed
Alain Franck	Hobamahoro	Africa	Diploma in Brewing Completed
Alberto Maria	Marzaioli	International	Diploma in Brewing Completed
Alessandro	Alunni	Africa	Diploma in Brewing Completed
Alexander	Hinds	UK Great Northern	Diploma in Brewing Completed
Alexander	Zeiser	International	Diploma in Brewing Completed
Alexander	Ikhimwin	Africa	Diploma in Brewing Completed
Andrew	Hoppe	International	Diploma in Brewing Completed
Andrew	Francis	International	Diploma in Brewing Completed
Anisa Flavia	Chang-Lai-Seng	Africa	Diploma in Brewing Completed
Anneliese	Renner	International	Diploma in Brewing Completed
Anton	Averin	International	Diploma in Brewing Completed
Barry Hunter	Turnbull	UK Scottish	Diploma in Brewing Completed
Bartfai	David	International	Diploma in Brewing Completed
Belly-Ange	Nininahazwe	Africa	Diploma in Brewing Completed
Benjamin	Seese	International	Diploma in Brewing Completed
Benjamin	Einhaus	International	Diploma in Brewing Completed
Berhan Zewdie	Nakew	Africa	Diploma in Brewing Completed
Brandon	Means	International	Diploma in Brewing Completed
Bridget	Lysaght	Asia Pacific	Diploma in Brewing Completed
Bryan	Druhan	International	Diploma in Brewing Completed
Caitlin	Hanson-Waid	Asia Pacific	Diploma in Brewing Completed
Callum	Turner	UK Midland	Diploma in Brewing Completed
Cecilia	Bennett	International	Diploma in Brewing Completed
Cecilia Maitha	Malii	Africa	Diploma in Brewing Completed
Chase Mackenzie	Gordon	International	Diploma in Brewing Completed
Christian Brayson	Tarimo	Africa	Diploma in Brewing Completed
Christopher	Pisney	International	Diploma in Brewing Completed
Christopher John	Byrom	UK Great Northern	Diploma in Brewing Completed
Claire	Botwright	UK Southern	Diploma in Brewing Completed
Clay	Brynestad	International	Diploma in Brewing Completed
Cleto Richardo	Modesto	Africa	Diploma in Brewing Completed
Corey David	Stevens	Asia Pacific	Diploma in Brewing Completed
Daniel	Williams	UK Scottish	Diploma in Brewing Completed
Daniel	Spas	International	Diploma in Brewing Completed
David	Wyndham	Asia Pacific	Diploma in Brewing Completed
David	Hosking	UK Midland	Diploma in Brewing Completed
David	Carpenter	International	Diploma in Brewing Completed
Dawn	Mogane	Africa	Diploma in Brewing Completed
Dhika	Lesmana	Asia Pacific	Diploma in Brewing Completed
Dustin	Moore	International	Diploma in Brewing Completed
Dwight	Monohon	International	Diploma in Brewing Completed
Edith	Duran-Robles	International	Diploma in Brewing Completed
Edwin	Shapard	International	Diploma in Brewing Completed
Edwin Johannes	Brabander	International	Diploma in Brewing Completed
Ellen	McGrane	Irish	Diploma in Brewing Completed
Elliot Anthony	Murphy	UK Southern	Diploma in Brewing Completed

Francine	Kamariza	Africa	Diploma in Brewing Completed
Fraser	Watts	UK Southern	Diploma in Brewing Completed
George	Odong Nono	Africa	Diploma in Brewing Completed
Graeme Paul	Roigard	Asia Pacific	Diploma in Brewing Completed
Hayley	Marlor	UK Southern	Diploma in Brewing Completed
Helvi	Fotolela	Africa	Diploma in Brewing Completed
Henry Robert	Uwizeye	Africa	Diploma in Brewing Completed
Hugh	Colbert	International	Diploma in Brewing Completed
Ishaan	Kovoor	Asia Pacific	Diploma in Brewing Completed
Jacek Aleksander	Jaros	UK Midland	Diploma in Brewing Completed
Jake	Meyer	International	Diploma in Brewing Completed
James	Cary	International	Diploma in Brewing Completed
James Albert	Hunter	Asia Pacific	Diploma in Brewing Completed
James Mclaren	Rabagliati	UK Southern	Diploma in Brewing Completed
James Robert	Taylor	UK Midland	Diploma in Brewing Completed
Jamie Isaias	Mendoza Loayza	International	Diploma in Brewing Completed
Jane	Nicholson	Asia Pacific	Diploma in Brewing Completed
Jean Paul	Hakizimana	Africa	Diploma in Brewing Completed
Jean-Claude	Hatungimana	Africa	Diploma in Brewing Completed
Jennifer	Hagyard	UK Midland	Diploma in Brewing Completed
Jeremy Denis	Swainson	UK Southern	Diploma in Brewing Completed
Joaquin	Imparatta Mescia	International	Diploma in Brewing Completed
John	Humphrey	International	Diploma in Brewing Completed
John	Musselman	International	Diploma in Brewing Completed
John Daniel	O'Shea	Irish	Diploma in Brewing Completed
Jonas	Kankam Boadu	Africa	Diploma in Brewing Completed
Jonathan James	King	Asia Pacific	Diploma in Brewing Completed
Jonny	Park	UK Southern	Diploma in Brewing Completed
Josef	Cerveny	International	Diploma in Brewing Completed
Juan Sebastian	Vargas Munevar	International	Diploma in Brewing Completed
Kai Cheng	Hii	Asia Pacific	Diploma in Brewing Completed
Katey Jane	McNulty	Asia Pacific	Diploma in Brewing Completed
Ken-Ichi	Enomoto	Asia Pacific	Diploma in Brewing Completed
Kenrick	Chau	International	Diploma in Brewing Completed
Kevin	Clark	International	Diploma in Brewing Completed
Kristiaan	Sannen	International	Diploma in Brewing Completed
Kristian	Nielsen	Asia Pacific	Diploma in Brewing Completed
Lambert	Nahimana	Africa	Diploma in Brewing Completed
Laura	Hill	International	Diploma in Brewing Completed
Leneve	Mannel	Africa	Diploma in Brewing Completed
Liam Ainsley	Cowburn	UK Midland	Diploma in Brewing Completed
Lidia	De Petris	UK Southern	Diploma in Brewing Completed
Ligia	Gomes Souto De Souza	International	Diploma in Brewing Completed
Lucas	Fachine Dato	International	Diploma in Brewing Completed
Ludilyn	Cayas Sandoval	International	Diploma in Brewing Completed
Luke	Holderfield	International	Diploma in Brewing Completed
Luzuko	Maqungu	Africa	Diploma in Brewing Completed
Malcolm	Goode	Irish	Diploma in Brewing Completed
Mandy	Ryan	Africa	Diploma in Brewing Completed

Manuel	Suarez-Abelenda	International	Diploma in Brewing Completed
Martyn Paul	Whittaker	UK Great Northern	Diploma in Brewing Completed
Matjeka Irene Precious	Mabitsi	Africa	Diploma in Brewing Completed
Matthew	Higginbotham	Asia Pacific	Diploma in Brewing Completed
Matthew	Atkins	International	Diploma in Brewing Completed
Matthew John	Hayes	UK Southern	Diploma in Brewing Completed
Maxim	Moisan	International	Diploma in Brewing Completed
Michael	Akman	Africa	Diploma in Brewing Completed
Michael	Browne	Irish	Diploma in Brewing Completed
Michael	Willis	International	Diploma in Brewing Completed
Michael	Byers	International	Diploma in Brewing Completed
Monewa	Matlwa	Africa	Diploma in Brewing Completed
Narathip	Thongngok	Asia Pacific	Diploma in Brewing Completed
Neo	Phao	Africa	Diploma in Brewing Completed
Nicholas Peter	Keith	UK Midland	Diploma in Brewing Completed
Nicholas William Andrew	Piper	UK Great Northern	Diploma in Brewing Completed
Ntombi-Zanele	Chinyanta	Africa	Diploma in Brewing Completed
Onyinye Ugochi	Nwizu	Africa	Diploma in Brewing Completed
Opeyemi Oladele	Kehinde	Africa	Diploma in Brewing Completed
Pawel	Kwarciak	UK Midland	Diploma in Brewing Completed
Phillip	Fuemmeler	International	Diploma in Brewing Completed
Praise	Avornyo-Keledorme	Africa	Diploma in Brewing Completed
Pranita	Bigun	Africa	Diploma in Brewing Completed
Precious Masusu	Mmofsoa	Africa	Diploma in Brewing Completed
Rachel Sarah	Morris	UK Scottish	Diploma in Brewing Completed
Raj	Kumar	International	Diploma in Brewing Completed
Reid	Laking	International	Diploma in Brewing Completed
Rene	du Toit	Africa	Diploma in Brewing Completed
Richard	Cooper	International	Diploma in Brewing Completed
Richard David	Applegate	UK Southern	Diploma in Brewing Completed
Richard Olatunde	Fakunle	Africa	Diploma in Brewing Completed
Robert	Businge	Africa	Diploma in Brewing Completed
Roberto	Calzavara	International	Diploma in Brewing Completed
Sarah	Astley	International	Diploma in Brewing Completed
Sarah	Chambers	Asia Pacific	Diploma in Brewing Completed
Scott	Durnin	International	Diploma in Brewing Completed
Scott Davis	Peterson	International	Diploma in Brewing Completed
Selamihun Girma	Sisay	Africa	Diploma in Brewing Completed
Semeneh Berehe	Gebreegziabehare	Africa	Diploma in Brewing Completed
Shane	Butterly	Irish	Diploma in Brewing Completed
Shonagh	Dowd	Irish	Diploma in Brewing Completed
Siyabonga Mncedisi	Ndwandwe	Africa	Diploma in Brewing Completed
Stephen Chukwuma	Nnoruga	Africa	Diploma in Brewing Completed
Steve	Schofield	International	Diploma in Brewing Completed
Stuart	Korch	Asia Pacific	Diploma in Brewing Completed
Surafel Bogale	Lemma	Africa	Diploma in Brewing Completed
Sybren	Bakker	International	Diploma in Brewing Completed
Terio Necas	Bila	Africa	Diploma in Brewing Completed
Thenusha	Pillay	Africa	Diploma in Brewing Completed

Timothy	Seitz	International	Diploma in Brewing Completed
Trevor	Giacomelli	Asia Pacific	Diploma in Brewing Completed
Uloma	Chukwu	Africa	Diploma in Brewing Completed
Viateur	Munyaneza	International	Diploma in Brewing Completed
Vicky	Dine	Asia Pacific	Diploma in Brewing Completed
William	Hartley	UK Southern	Diploma in Brewing Completed
Yleni	De Neve	International	Diploma in Brewing Completed
Zhizhuang	Su	Asia Pacific	Diploma in Brewing Completed
Alasdair	Punton	UK Scottish	Diploma in Distilling Completed
Alastair James	Cooke	UK Scottish	Diploma in Distilling Completed
Alec	McDowall	Asia Pacific	Diploma in Distilling Completed
Alexander Martin	Whyte	UK Scottish	Diploma in Distilling Completed
Andrew	Walsh	Irish	Diploma in Distilling Completed
Ashley	McVeigh	UK Scottish	Diploma in Distilling Completed
Christopher	Clinton-Baker	Asia Pacific	Diploma in Distilling Completed
Craig	Webster	UK Scottish	Diploma in Distilling Completed
Craig Michael	Stewart	UK Scottish	Diploma in Distilling Completed
Elizabeth	Rhoades	International	Diploma in Distilling Completed
Fearghal Patrick	O'Connor	Irish	Diploma in Distilling Completed
Gerard	Hurley	Irish	Diploma in Distilling Completed
Greg	McEntee	Irish	Diploma in Distilling Completed
Hugh Richard	Holds	UK Scottish	Diploma in Distilling Completed
Ian Andrew	Stuart	UK Scottish	Diploma in Distilling Completed
Jennifer	Turkington	UK Scottish	Diploma in Distilling Completed
Jennifer	Watson	UK Scottish	Diploma in Distilling Completed
Jennifer	Riffkin	UK Scottish	Diploma in Distilling Completed
Jillian	Boyd	UK Scottish	Diploma in Distilling Completed
Matthew Brent	Hambright	International	Diploma in Distilling Completed
Peter James	Cockburn	UK Scottish	Diploma in Distilling Completed
Renaldo	Fourie	Africa	Diploma in Distilling Completed
Robert	Rohla	International	Diploma in Distilling Completed
Roddy	MacKay	UK Scottish	Diploma in Distilling Completed
Rupert	Egan	Irish	Diploma in Distilling Completed
Shane	Casey	Asia Pacific	Diploma in Distilling Completed
Shernell Renee	Layne	International	Diploma in Distilling Completed
Ulrich	Dyer	Irish	Diploma in Distilling Completed
Ecima	Jairo	Africa	Diploma in Packaging Completed
Emmanuel	Etyang	Africa	Diploma in Packaging Completed
Keduse	Mendaye	Africa	Diploma in Packaging Completed
Ngqabutho Godknows	Ncube	Africa	Diploma in Packaging Completed
Shenkutie	Redie	Africa	Diploma in Packaging Completed
Vaughn	King	Asia Pacific	Diploma in Packaging Completed
David James	Hill	UK Midland	Master Brewer Completed
Fred Akoko	Oluoch	Africa	Master Brewer Completed
Gareth Simon Austin	Bateman	UK Southern	Master Brewer Completed
Gavan Brendan	O'Halloran	Irish	Master Brewer Completed
Georgina Margaret	Young	UK Southern	Master Brewer Completed
Jason Satch	Hignett	Asia Pacific	Master Brewer Completed
Liam	Brown	UK Midland	Master Brewer Completed
Matthew	Barr	UK Great	Master Brewer Completed

		Northern	
Michael John	Stonier	Asia Pacific	Master Brewer Completed
Robert Carl Osmond	Jacobson	UK Southern	Master Brewer Completed