



UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE : CFB31203
COURSE TITLE : CHEMICAL FOOD ANALYSIS
PROGRAMME NAME : BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY (FOOD)
WITH HONOURS
DATE : 03 FEBRUARY 2026
TIME : 2:00PM - 5:00PM
DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☒ *Tick if applicable*

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

A tuna canned food manufacturer routinely monitors the mercury concentration (mg/kg) in raw tuna received from suppliers to ensure compliance with food safety standards. The mercury levels measured from 11 tuna samples are shown below. The regulatory standards reference value is 0.5 ± 0.05 mg/kg.

0.42, 0.55, 0.38, 0.60, 0.55, 0.47, 0.52, 0.55, 0.63, 0.40, 0.48

- (a) Determine the mode.
(2 marks)
- (b) Determine the median.
(2 marks)
- (c) Summarise the accuracy of the test results in comparison with the regulatory standards.
(5 marks)
- (d) Summarise the precision of the test results.
(5 marks)
- (e) Calculate the confidence interval using the t-critical value with a 95% confidence level.
(3 marks)

- (f) Calculate the confidence interval using the z-critical value with a 95% confidence level.

Note:

- 90% Confidence Level: Z-critical value ≈ 1.645
- 95% Confidence Level: Z-critical value ≈ 1.96
- 99% Confidence Level: Z-critical value ≈ 2.576

(3 marks)

Question 2

NutriPure Food Sdn. Bhd., a nut-based food manufacturer. As part of their quality control, the company is required to determine the folic acid content in the peanuts to support product labelling. The folic acid is extracted and then analysed using a UV-Vis spectrophotometer. Table 1 shows the absorbance values for the folic acid standard solutions of known concentrations, measured at 282 nm using a 1.00 cm quartz cuvette.

Refer Below - Table1 : Absorbance values for the 7 samples, measured at 510 nm .

Table 1: Absorbance values for the 7 samples, measured at 510 nm

Concentration (mg/L)	Absorbance (A)
10	0.198
20	0.357
30	0.556
40	0.742
50	0.908
60	1.135

- (a) Construct a standard calibration curve using the data provided in Table 1. (4 marks)
- (b) A random sampling was carried out from a batch produced on 12 December 2025. Seven samples were taken. The samples were ground separately. Ground peanuts underwent an identical UV-Vis spectroscopy analysis separately. Table 2 shows the absorbance of the ground peanut samples from a random sampling of the same batch. Based on the information in Table 2 and the standard curve from Question 2(a), determine the mean folic acid concentration and its standard deviation for this batch.

Refer Below - Table2 : Absorbance of ground peanut samples from the same batch .

(10 marks)

Table 2: Absorbance of ground peanut samples from the same batch

Sample	Absorbance (A)
1	0.548
2	0.561
3	0.572
4	0.555
5	0.566
6	0.549
7	0.559

- (c) Given the benchmark folic acid for the peanuts extract is 30.0 ± 1.0 mg/L. Conclude the accuracy of this peanuts batch.

(3 marks)

- (d) Using the mean value of the folic acid determined in Question 2(b), calculate the percentage of the NRV of folic acid if one serving corresponds to 10 mL (0.010 L) of the extract.

(3 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

DairyPure Milk Industries Sdn. Bhd., a manufacturer of milk. One of their products, UHT Low Fat Milk, is packed in either 220 mL or 1 L. According to the product label, each 1 L pack of UHT low-fat milk contains a calcium content of $1,200 \pm 100$ mg per serving. A production batch of 20,000 one-litre packs of UHT low-fat milk was manufactured on 10 May 2025. To verify compliance with nutritional labelling requirements, a sample of 200 packs was taken from the batch for calcium analysis. Based on the company's acceptance criteria, the batch will be accepted if 10 packs or fewer are found to contain a calcium content of a minimum value of 1,100 mg per litre; otherwise, the batch will be rejected.

- (a) A random investigation by the food authority revealed that 15 sampled packs contained calcium levels below 1,100 mg per litre, indicating that the batch did not comply with the acceptance criteria. Point out the type of sampling risk.

(2 marks)

- (b) The 200 packs were taken randomly only from pallets stored near the warehouse exit because they were easiest to access. 10 mL was taken from the bottom of the sampled 200 packs using sterile pipettes. Distinguish TWO (2) biases in the sampling plan.

(2 marks)

- (c) Explain in detail in your answer in (b).

(4 marks)

- (d) Based on your answer in (c), determine the suitable sampling plan.

(2 marks)

- (e) A titration was performed to determine the calcium content of the sampled product. 10 mL sampled from the 200 packs was mixed, and a triplicate of 15 mL was pipetted into three separate conical flasks. The pH was adjusted to an alkaline pH of approximately 10 using an ammonia–ammonium chloride buffer. A small amount of Eriochrome Black T (EBT) indicator was then added. Ethylenediaminetetraacetic acid (EDTA) titrant was used. It is expected that the calcium ions (Ca^{2+}) in the sample will react with EDTA to form a stable 1:1 complex. The endpoint was identified by a clear colour change from wine red to blue, indicating that all calcium ions in the sample had reacted. Based on the description given, distinguish the type of titration by justifying.

(2 marks)

- (f) Titration was conducted in triplicate. Volume of EDTA (with concentration of 0.0100 mol/L) used is 12.40 mL, 12.55 mL and 12.45 mL. Calculate the calcium concentration (in mg/L).

Note:

1 mole EDTA reacts with 1 mole Ca^{2+}

Molar mass of calcium = 40.08 g/mol

(8 marks)

Question 2

Golden Harvest Cereal Sdn. Bhd., a manufacturer of breakfast cereals. One of its products is breakfast cereal fortified with vitamin A. The cereal is available in two packaging sizes, 225 g and 680 g packs. According to the nutritional label, a 30 g serving provides 15% of the Daily Value (DV) of vitamin A. A production batch of 25,000 cereal packs of 225 packing size was manufactured on 17 July 2025. For quality control purposes, a sample of 250 packs was randomly selected from the batch to verify the vitamin A content. Vitamin A is analysed using High-Performance Liquid Chromatography (HPLC) after saponification and extraction. The general procedure for sample preparation is outlined below:

- 20 g was collected from each of the 250 packs, which were randomly selected. The collection is performed on the same day as production using sterile tools.
- All the samples collected were ground and mixed homogeneously.
- A triplicate of 5 g was taken from the ground and mixed samples.
- For each triplicate, the ground and mixed cereal sample is weighed and mixed with 50 mL of 95% (v/v) ethanol using a 250 mL transparent conical flask.
- The transparent conical flasks were left uncovered on the laboratory bench under fluorescent lighting for 15 minutes before saponification.
- 50 mL of 10% (w/v) potassium hydroxide is added to the same conical flask, and the mixture is heated at 60 °C for 30 minutes.
- The saponified mixture is transferred to a separating funnel and extracted with hexane, with the funnel shaken vigorously.
- The organic layer is washed repeatedly with distilled water until a neutral pH is achieved, allowing residual moisture to remain in the extract.
- The extract is collected in a clear glass vial, capped, and stored at room temperature before HPLC analysis.

- (a) Vitamin A is sensitive to UV light, air, high temperatures, and moisture. These will lead to the degradation or oxidation of vitamin A. Based on the information provided, explain in detail **FOUR (4)** steps performed which might lead to the degradation or oxidation of vitamin A.

(12 marks)

- (b) Explain in detail **FOUR (4)** corrective actions based on your answers in (a).

(8 marks)

Question 3

Proximate analysis is a method used to determine the basic nutritional components of food, specifically moisture, ash, protein, fat, carbohydrate, and fibre content.

- (a) Table 3 summarises the Biuret Method and the Lowry Method. These two methods are commonly used to determine the protein content. Based on the description provided in each scenario and the information from Table 3, appraise (with justification) on whether the Biuret Method or the Lowry Method will be more suitable.

Refer Below - Table3 : Comparison of the Biuret Method and the Lowry Method .

Table 3: Comparison of the Biuret Method and the Lowry Method

Aspect	Biuret Method	Lowry Method
Principle	Cu^{2+} reacts with peptide bonds, ~540 nm	Biuret + Folin-Ciocalteu reaction, ~650–750 nm
Sensitivity	Low (~1–10 mg/mL)	High (~10–1000 $\mu\text{g/mL}$)
Procedure Time	~10–30 minutes	~30–60 minutes
Complexity	Simple, single step	Complex, two-step with precise timing
Interference	Minimal (nucleic acids, sugars)	High (reducing agents, detergents, etc.)
Reagent Stability	High (stable Biuret reagent)	Moderate (Folin-Ciocalteu less stable)
Dynamic Range	Narrow (high concentrations needed)	Wide (suitable for low concentrations)
Specificity	Peptide bonds (broad protein detection)	Tyrosine/tryptophan (protein-dependent)
Applications	High-protein samples	Low-protein samples

- i. A dairy manufacturer analyses the protein content of milk powder as part of routine quality control. Since milk contains a high concentration of protein. The sample matrix also contains sugars such as lactose, which should not interfere significantly with the analysis. The laboratory handles a large number of samples daily and requires a fast and reliable method.

(4 marks)

- ii. A snack bar manufacturer is formulating a protein-fortified snack bar. As part of the research and development process, the protein content needs to be verified to support label claims. The snack bars have a complex food matrix that includes sugars, flavouring agents, and processing aids. After extraction and dilution, the protein concentration in the test solution is relatively low.

(4 marks)
 - iii. A manufacturer analyses protein content in ready-to-drink soy beverages, and moderate protein content is expected. The product contains plant proteins and processing additives that may interfere with certain analytical methods. The company prefers a simple method with minimal susceptibility to interference.

(4 marks)
- (b) You are a quality control scientist tasked with determining the moisture content of a heat-sensitive food product that must be analysed quickly and accurately to ensure product stability. The product contains volatile organic compounds and requires non-destructive testing to preserve the sample for further analysis.
- i. Based on the description, analyse the suitability of the distillation method, such as the Dean and Stark method.

(4 marks)
 - ii. Identify a suitable moisture content method based on the description provided.

(4 marks)

Question 4

Both the soy flour and corn flour are sources of both protein and potassium. Adding soy flour significantly increases protein, fat, fibre, and minerals (calcium, iron, magnesium, potassium) while slightly reducing carbohydrates compared to plain corn cereal.

- (a) Knowing the benefits of having soy flour, a food technologist is formulating a breakfast cereal blend from soy flour (protein content of 48%) and corn flour (protein content of 8%). The cereal blend of 250 kg he is formulating is expected to contain 12% protein. Using the Pearson Square method, calculate the weights of soy flour and corn flour required to achieve the desired protein content.

(10 marks)

- (b) The food technologist also needs to determine the potassium content of the formulated breakfast cereal blend.

- i. Redox titration involves the oxidation and reduction in solution, for example, $\text{Fe}^{2+} \leftrightarrow \text{Fe}^{3+}$, $\text{I}^- \leftrightarrow \text{I}_2$. Potassium in food exists as K^+ , already in its highest oxidation state (+1) in aqueous solution. Criticise the suitability of using redox titration to determine the potassium content.

(4 marks)

- ii. In complexometric titration using ethylenediaminetetraacetic acid (EDTA) as a chelating agent, it binds directly to divalent and trivalent metal ions, such as Ca^{2+} , Mg^{2+} , and Fe^{3+} , forming stable metal-ligand complexes. EDTA, however, does not bind efficiently to a monovalent cation. Explain the suitability of using EDTA in complexometric titration to determine the potassium content.

(4 marks)

- iii. Suggest an alternative method to determine the chloride content. Explain your answer.

(2 marks)

END OF EXAMINATION PAPER

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APPENDIX

$$\% \text{ NRV} = \frac{\text{Nutrient content in sample (per serving)}}{\text{NRV for the nutrient}} \times 100$$

$$\text{Mean, } \mu = \frac{\sum x_i}{n}$$

$$\text{Standard deviation, } S = \sqrt{\frac{\sum (X - \bar{x})^2}{n - 1}}$$

$$\text{Coefficient of Variation} = \frac{S}{\mu}$$

$$\text{Confidence Interval} = \bar{x} \pm t \left(\frac{s}{\sqrt{n}} \right)$$

$$\text{Confidence Interval} = \bar{x} \pm Z \left(\frac{s}{\sqrt{n}} \right)$$

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{volume of solution (in liter)}}$$

$$\text{Normality} = \frac{\text{gram equivalents of solute}}{\text{volume of solution (in liter)}}$$

$$\text{Weight percentage} = \frac{\text{weight of solute in gram}}{\text{weight of solution in gram}} \times 100$$

$$\text{Volume percentage} = \frac{\text{volume of solute in ml}}{\text{volume of solution in ml}} \times 100$$

$$\text{Parts per million} = \frac{\text{mass of solute}}{\text{mass of solvent}} \times 10^6$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = -\log [\text{H}^+]$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$\text{Titrateable acidity } \left(\frac{\text{g}}{100\text{ml}} \right) = \frac{(\text{Volume of NaOH in mL}) (\text{Normality of NaOH}) (75) (100)}{1000 (\text{sample volume in mL})}$$

$$\text{Vitamin C (mg)} =$$

$$\text{Titrant volume (mL)} \times \text{iodine concentration (mol/L)} \times \text{molar mass of ascorbic acid (g/mol)}$$

LIST OF NUTRIENT REFERENCE VALUE (NRV)

NUTRIENT	UNIT	NRV
Vitamin A	µg RE	800
Vitamin D	µg	15
Vitamin C	mg	100
Vitamin E	mg	10
Vitamin K	µg	60
Thiamin/ Vitamin B ₁	mg	1.2
Riboflavin/ Vitamin B ₂	mg	1.2
Niacin/ Vitamin B ₃	mg NE	15
Vitamin B ₆	mg	1.3
Folate	µg DFE	400
Vitamin B ₁₂	µg	2.4
Panthenate	mg	5
Biotin	µg	30
Calcium	mg	1000
Magnesium	mg	310
Iron	mg	14
Zinc	mg	11
Iodine	µg	150
Copper	µg	900
Selenium	µg	60
Manganese	mg	3
Molybdenum	µg	45
Phosphorus	mg	700
Choline	mg	550
Protein	g	50
Carbohydrate	g	300
Fat	g	67
Energy	kilocalorie	2000

MINIMUM LEVEL OF CLAIM 'SOURCE OF' OR 'HIGH IN'

NO	NRV	UNIT	5% NRV	SOURCE / 1100G@ML		HIGH / 1100G@ML	
				SOLIDS	LIQUIDS	SOLIDS	LIQUIDS
1	Vitamin A	800 micrograms RE	40	120	60	240	120
2	Vitamin D	15 micrograms	0.75	2.25	1.125	4.5	2.25
3	Vitamin C	100 miligram	5	15	7.5	30	15
4	Vitamin E	10 miligram	0.5	1.5	0.75	3	1.5
5	Vitamin K	60 micrograms	3	9	4.5	18	9
6	Thiamine	1.2 miligram	0.06	0.18	0.09	0.36	0.18
7	Riboflavin	1.2 miligram	0.06	0.18	0.09	0.36	0.18
8	Niacin	15 miligram NE	0.75	2.25	1.125	4.5	2.25
9	Vitamin B ₆	1.3 miligram	0.065	0.195	0.0975	0.39	0.195
10	Folate	400 micrograms DFE	20	60	30	120	60
11	Vitamin B ₁₂	2.4 micrograms	0.12	0.36	0.18	0.72	0.36
12	Panthotenate	5 miligram	0.25	0.75	0.375	1.5	0.75
13	Biotin	30 micrograms	1.5	4.5	2.25	9	4.5
14	Calcium	1,000 miligram	50	150	75	300	150
15	Magnesium	310 miligram	15.5	46.5	23.25	93	46.5
16	Iron	14 miligram	0.7	2.1	1.05	4.2	2.1
17	Zinc	11 miligram	0.55	1.65	0.825	3.3	1.65
18	Iodine	150 micrograms	7.5	22.5	11.25	45	22.5
19	Copper	900 micrograms	45	135	67.5	270	135
20	Selenium	60 micrograms	3	9	4.5	18	9
21	Manganese	3 miligram	0.15	0.45	0.225	0.9	0.45
22	Molybdenum	45 micrograms	2.25	6.75	3.375	13.5	6.75
23	Phosphorus	700 miligram	35	105	52.5	210	105
24	Choline	550 miligram	27.5	82.5	41.25	165	82.5
25	Protein	50 grams	2.5	7.5	3.75	15	7.5

CONDITIONS FOR NUTRIENT CONTENT CLAIMS "LOW IN" OR "FREE OF"

COMPONENT	CLAIM	NOT MORE THAN
Energy	Low	40kcal (170 kJ) per 100g (solid) or 20kcal (80kJ) per 100ml (liquids)
	Free	4kcal per 100g (or 100ml)
Fat	Low	3g per 100g (solid) or 1.5g per 100ml (liquids)
	Free	0.15g per 100g (or 100ml)
Saturated fat	Low	1.5g per 100g (solid) or 0.75g per 100ml (liquids) and 10% of total energy of the food
	Free	0.1g per 100g (solids) or 0.1g per 100ml (liquids)
Cholesterol	Low	0.02g per 100g (solids) or 0.01g per 100ml (liquids)
	Free	0.005g per 100g (solids) or 0.005g per 100ml (liquids)
Trans fatty acids	Low	1.5g per 100g (solids) or 0.75g per 100ml (liquids) and 10% of total energy of the food
	Free	0.1g per 100g (solids) or 0.1g per 100ml (liquids)
Sugars*	Low	5g per 100g (solid) or 2.5g per 100ml (liquid)
	Free	0.5g per 100g (solid) or 0.5g per 100ml (liquid)
Sodium	Low	0.12g per 100g(solid) or 0.06g per 100ml (liquid)
	Very low	0.04g per 100g(solid) or 0.02g per 100ml (liquid)
	Free	0.005g per 100g(solid) or 0.005g per 100ml (liquid)
Gluten	Reduced	0.01 g per 100 g (solids or liquids)
	Free	0.002 g per 100 g (solids or liquids) The claim of "reduced gluten" is only permitted in food consisting of one or more ingredients from wheat, rye, barley, oats or their crossbred varieties, which have been specially processed to reduce the gluten content

* Refer to all monosaccharides and disaccharides

cum. prob one-tail two-tails	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681</									

Confidence Level