CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN INDUSTRIAL CHEMISTRY

CHEM 351: FORENSIC CHEMISTRY

STREAMS: BSc Industrial Chem **TIME: 2 HOURS**

DAY/DATE: TUESDAY 19/12/2023 **8.30 A.M. – 10.30 A.M.**

INSTRUCTIONS:

- Answer Question **ONE** (Compulsory) and **Any Other Two** Questions
- Do not Write on this Paper

QUESTION ONE (30 MARKS)

(a) Define the following terms as used in quality control procedures (4 marks)

(i) Blank samples

(ii) Blinds

(iii) Spikes

(iv) Open controls

(b) Some drugs are grouped together on the basis of how they are used and how they are abused. State and explain three such examples (6 marks)

(c) A woman weighing 135 lb takes two codeine tablets of 20 mg each as directed by her dentist to alleviate the pain associated with minor dental surgery. Assuming that the peak plasma concentration is reached in 1 hour, V_d of codeine is 3.0 L/kg, F = 50%, and $t_{½}$ for codeine in plasma is 3.0 hours, complete the following tasks;

(i) Sketch the ADME curve (2 marks)

(ii) Calculate the peak plasma concentration (2 marks)

(iii) Calculate the plasma concentration 2 hours after the woman took the bills (2 marks)

(iv) Determine when the plasma concentration of codeine will become too small to be detected by a mass spectrometry method with an LOD/LOQ of 1.0 ppb. Assume that the blood sample is injected directly into the instrument (3 marks)

(d) Differentiate between the following terms as used in Forensic Chemistry (6 marks)

(i) Quality control and Quality assurance

(ii) Direct evidence and Circumstantial evidence

(iii) Chain of custody and Destructive testing

(e) As part of a method validation study, three forensic chemists made 10 replicate injections each in a GC-MS experiment and obtained the following data for area counts of a reference peak

Injection No.	A	B	C
1	9995	10640	9814
2	10035	10118	10958
3	10968	10267	10285
4	10035	10873	10915
5	10376	10204	10219
6	10845	10593	10442
7	10044	10019	10752
8	9914	10372	10211
9	9948	10035	10676
10	10316	10959	10057

Assume that analyst technique is the only significant contribution to the spread of the data, which chemist had the most reproducible injection technique? (5 marks)

QUESTION TWO (20 MARKS)

(a) Differentiate between the following terms (6 marks)

(i) Accreditation and Certification

(ii) Drug and Medicine

(iii) Standard deviation and Percent relative standard deviation

(b) To focus attention of metrology in forensic chemistry, NUSAP system is applied;

(i) State the meaning of NUSAP (2 marks)

(ii) Given the net weight of a white powder as 77.56 g ± 0.3 g at the 95% confidence levels, briefly interpret the net weight provided using the NUSAP system (4 marks)

(iii) A drug analysis is performed with Gas chromatography/Mass spectrometry (GC-MS) and requires the use of a reliable standards. The lab purchases 1.0 mL commercial standards that is certified to contain the drug of interest at a concentration of 1.00 mg/mL with a reported uncertainty of ± 1.0%. to prepare the stock solution for the calibration, an analyst uses a syringe with an uncertainty of ± 0.5% to transfer 250 µL of the commercial standard to a class-A-250 mL volumetric flask with an uncertainty of ± 0.08mL. Using the NUS portions of the NUSAP model;

i) Calculate the final concentration of the diluted calibration solution (4 marks)

ii) Calculate the propagated uncertainty (4 marks)

QUESTION THREE (20 MARKS)

(a) State four stages of drug movement through the body (4 marks)

(b) Briefly discuss the Analytical approach for the analysis of acidic drugs such as Gamma hydroxybutyric acid (GHB) and Gamma butyrolactone (GBL) (5 marks)

(c) Briefly explain how a sample evidence collection and processing scheme is carried out by criminalists (11 marks)

QUESTION FOUR (20 MARKS)

(a) Explosion can be categorized as deflagration and detonation. Explain the meaning of deflagration and detonation (2 marks)

(b) Calculate the oxygen balance for nitroglycerin whose formula is $C_3H_5N_3O_9$ (2 marks)

(c) Explain the three stages of forensic toxicology (6 marks)

(d) A trainee in Forensic Chemistry laboratory is tasked with determining the concentration of cocaine in a white powder. The following data is obtained from a trainee's 10 replicate analysis. The true value of mean is 13.2 ± 0.1%

Sample	Value
1	12.7
2	13.0
3	12.0
4	12.9
5	12.6

6	13.3
7	13.2
8	11.5
9	15.0
10	12.5

(i) Calculate the mean (2 marks)

(ii) Calculate the standard (absolute) error (1 mark)

(iii) Calculate the standard deviation of the sample (2 marks)

(iv) Calculate the variance (1 mark)

(e) Use the spring hall Roberts rules to predict the products of an explosion of nitroglycerin (NG) ($C_3H_5N_3O_9$) (4 marks)

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