BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF CHEMISTRY

MCH504: ANALYTICAL CHEMISTRY V

JAN 2025

DURATION: THREE (3) HOURS
ANSWER QUUESTION ONE AND ANY THREE OTHER QUESTIONS. EACH QUESTION CARRIES 25 MARKS

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Q1 a) Describe in detail the classification of chromatographic techniques. **[5 marks]**

b) Explain what one would consider when purchasing an HPLC pump. **[5 Marks]**

c) Explain what determines the ionization method in mass spectrometry. **[4 Marks]**

d) With the help of a diagram, explain the functioning of a flame atomizer. **[4 Marks]**

e) Since the discovery of X-rays, XRF as an instrumental techniques has become more popular than AAS.
   i. Give reasons for its popularity. **[3 Marks]**
   ii. What is the disadvantage of this technique? **[3 Marks]**

Q2 a) Calculate the energy of an X-ray photon with an initial energy of 20 keV after a Compton scattering over an angle of 80°. **[5 Marks]**

b) Explain the meaning of the following transitions in XRF:
   i. K-Lines
   ii. M-Lines and
   iii. L-lines

[3x3 Marks]

c) With the help of an illustration explain the functioning of X-ray tubes. **[5 Marks]**

d) State the types of detectors used in XRF. Explain the functioning of one in detail. **[6 Marks]**

Q3 a) Describe the benefits of coupling an LC or GC to mass spectrometer. **[13 Marks]**

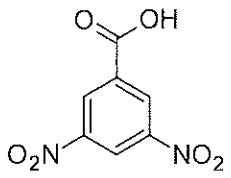
b) Describe with the help of an illustration the principle behind the following detectors
   i. Multi-channel plate
   ii. Secondary electron multiplier.
   What determines the sensitivity of these detectors?

[2x12 Marks]

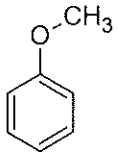
Q4 a) Explain the principle behind the following chromatographic techniques.
   i. Size exclusion chromatography
   ii. Affinity chromatography

[2x5 Marks]

b) Predict the sequence of elution in HPLC for the separation of the analytes whose chemical structures are shown below under reversed phase conditions. Give reasons for your answers.



A



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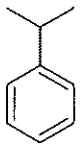

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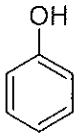

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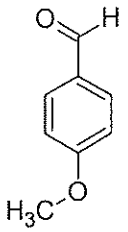

E

[5 Marks]

c) Gradient elution is a common elution mode. Explain with the help of ilustrations how this elution mode can be used to optimize separations in HPLC. **[5 Marks]**

d) Peaks that can be encountered in chromatography are either symmetric or asymmetric. Explain any five causes of asymmetric peaks. **[5 Mark]**

Q5 a) Describe the classification of GC detectors. Give two examples in each case. **[12 marks]**

b) What is the purpose of GC derivatization and how is it achieved? **[5 Marks]**

c) Explain how the following parameters may influence GC separation.

i. Column length

ii. Column temperature

[2x4 Marks]

Q6 a) Explain the principle and atomization process in graphite furnace. **[5 Marks]**

b) What are the advantages and disadvantages of graphite furnace? **[5 Marks]**

c) Compare and contrast the grating systems used in sequential and Simultaneous Multi-element Analysis AES Spectrometers. **[10 Marks]**

d) How does an echelle spectrophotometer differ from either sequential or simultaneous multi-element AES spectrophotometers? **[5 Marks]**

END OF PAPER