

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

FIRST SEMESTER EXAMINATION

CH431 – INSTRUMENTAL ANALYSIS IV

MONDAY 22ND JUNE 2020 8:20 AM

TIME ALLOWED: 2 HOURS

INFORMATION FOR CANDIDATES:

1. You will have 10 minutes to read the question paper. You **MUST NOT** begin writing in the answer book during this time.
2. **ANSWER ALL QUESTIONS.**
3. All answers **MUST** be written on the answer book provided
4. Calculators are permitted in the examination room. Lecture notes, notebooks plain papers and textbooks are **NOT** allowed.
5. Mobile phones are not allowed. **SWITCH OFF THE MOBILE PHONES.**
6. Show all workings and calculations in the answer book.
7. **DRAW the STRUCTURES** clear and visible.
8. **DO NOT** over write.
9. Write your name and number clearly on the front page. **DO IT NOW.**

MARKING SCHEME: [Total 60 marks]

1. (a) Define the following terms:
(i) Siegbahn notation
(ii) Atomic Packing Factor (APF) [4 marks]
- (b) Give mathematical expression for the following (*NO DERIVATION*):
(i) relationship between the index of refraction and the dielectric constant.
(ii) unit cell edge length for a body centered cubic (BCC) structure. [2 marks]
- (c) What is the function of a collimator? Name two X-ray crystal monochromators. [4 marks]

(Total = 10 marks)

2. (a) Name TWO disadvantages of Laue photographic method. [2 marks]
- (b) What do you mean by *Bremsstrahlung* radiation or explain in your own words what *Bremsstrahlung* radiation means? [4 marks]
- (c) Can X-rays from a tungsten target be used to excite copper atoms? Can X-rays from a copper target be used to excite tungsten atoms? Explain. [4 marks]

(Total = 10 marks)

3. (a) Explain how X-ray absorption technique is useful in the detection of broken bones in the human body?
- (b) The fraction of non-reflected radiation that is transmitted through a 200 mm thickness of glass is 0.98. Calculate the absorption coefficient of this material?
- (c) Explain the energy band structures of Cu and Mg metal at 0K.
- (d) Distinguish between pneumatic and ultrasonic nebulizer.

(20 marks)

4. (a) Draw a simple schematic diagram of a Coolidge X-ray tube, with major parts labelled. [2.5 marks]

- (b) The mass absorption coefficient for Ni, measured with the CuK_α line is $49.2 \text{ cm}^2/\text{g}$. Calculate the thickness of a nickel foil that was found to transmit 60% of the incident power of a beam of CuK_α radiation. Assume that the density of Ni is 8.9 g/cm^3 . [5 marks]
- (c) For zirconium the cut off wavelength λ_{min} for excitation of K-level electron is about 0.70 \AA . Calculate the minimum voltage necessary to excite K electrons in an X-ray tube with a Zirconium target. [2.5 marks]

(Total = 10 marks)

5. (a) For the infrared radiation of $5 \text{ }\mu\text{m}$, what is the wavenumber in cm^{-1} ?
- (b) What are the advantages of a continuous flow analyzer?
- (c) Suggest any TWO drawbacks of Geiger-Muller tube method.
- (d) Describe the principle of operation of a scintillation detector.
(NO DIAGRAM REQUIRED)

(10 marks)

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