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						
			[4 marks]						
		(Total = 10 marks)							
2.	(a)	Name TWO disadvantages of Laue photographic method.	[2 marks]						
	(b)	What do you mean by <i>Bremsstrahlung</i> radiation or explain in your own words what <i>Bremsstrahlung</i> radiation means?							
	(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 cm ² /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 Å. 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 μ 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)	

DATA SHEET

Conversion table and physical constants

Planck constant,

$$h (in J s) = 6.63 \times 10^{-34} J s$$

$$h (in eV s) = 4.13 \times 10^{-15} eV s$$

h (in **erg-sec**) =
$$6.62 \times 10^{-27}$$
 erg-sec

Speed of light (in vacuo), $c = 3 \times 10^8 \text{ m/s}$

$$1 J = 6.24 \times 10^{18} \text{ eV}$$

$$1 \text{ Å} = 10^{-10} \text{ m}$$

$$1 \mu m = 10^{-6} m$$

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