

MICHAEL AND CECILIA IBRU UNIVERSITY, AGBARHA-OTOR
FIRST SEMESTER EXAMINATIONS, 2017/2018 ACADEMIC SESSION
COURSE CODE: PHY 201 (3 UNITS) COURSE TITLE: ELEMENTARY MODERN PHYSICS
INSTRUCTION: Answer Question 1 and Any Three Other Questions.

TIME ALLOWED: 2 ½ Hours

CONSTANTS: speed of light $c = 3.0 \times 10^8$ m/s, Planck's constant $h = 6.63 \times 10^{-34}$ J.s
Rydberg constant $R_H = 1.097 \times 10^7$ m⁻¹, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg Charge
of electron, $e = 1.6 \times 10^{-19}$ C, $\pi = 3.14$

QUESTION ONE:

- (a) Define each of the following concepts:
- (i) Work function; [2marks]
- (ii) Threshold frequency; [2 marks]
- (iii) Stopping potential. [2 marks]

- (b) When a certain photoelectric surface is illuminated with light of different wavelengths, the following stopping potentials are observed:

Wavelength λ (nm)	366	405	436	492	546	579
Stopping potential V_s (V)	1.48	1.15	0.93	0.62	0.36	0.24

- (i) Prepare a table of values for the frequency of the light. [3 marks]
- (ii) Plot a graph of the stopping potential on the vertical axis against the frequency of the light on the horizontal axis. [8 marks]
- (iii) using the information contained in the graph, determine the
- (I) threshold frequency; [2 marks]
- (II) threshold wavelength; [2 marks]
- (III) photoelectric work function; [2 marks]
- (IV) value of the Planck's constant. [2 marks]

QUESTION TWO:

- (a) Explain the special theory of relativity. Hence, write down the two postulates of Einstein's theory of special relativity. [5 marks]
- (b) explain or define each of the following:
- (i) length contraction; [2¹/2 marks]
- (ii) time dilatation. [2¹/2 marks]

- (c)
- (i) Write down the expression representing the Einstein factor and explain the meaning of each term in it. [2 marks]
 - (ii) Find the value of the Einstein for which the speed of a relativistic particle $v = 0.6c$, where c is the speed of light. [3 marks]

QUESTION THREE:

- (a) State the set of equations giving the Lorentz transformation. Hence, give a brief explanation of the terms in the equations. [5 marks]
- (b) Give a vivid discussion on Newtonian mechanics. [5 marks]
- (c) Calculate the real length of a ship which observers outside the ship measure as 60 m if it moves at a speed of $0.8c$ m/s. [5 marks]

QUESTION FOUR:

- (a) Explain blackbody radiation, stating what you know about an ideal blackbody. [5 marks]
- (b) State the following:
 - (i) Stefan-Boltzmann law; [2¹/2 marks]
 - (ii) Wien's displacement law. [2¹/2 marks]
- (c) The surface temperature of the sun is about 6000 k. if the sun is assumed to be a blackbody radiator, at what wavelength would its spectrum be peak given that the constant = 2.898×10^{-3} m.k? [5 marks]

QUESTION FIVE:

- (a) State any two of the postulates of the Bohr model of the hydrogen atom. [5 marks]
- (b) Calculate the shortest and longest wavelengths in the Paschen series of hydrogen. [5 marks]
- (c)
 - (i) Explain or define de Broglie hypothesis. [2 marks]
 - (ii) Calculate the de Broglie wavelength of an electron moving at 40 m/s. [3 marks]

QUESTION SIX:

- (a) Write down the time-dependent Schrödinger wave equation, and explain the meaning of the terms in it. [4 marks]
- (b)
- (i) How are X-rays produced? [2 marks]
- (ii) List three properties of X-rays. [3 marks]
- (c) Write a short note on each of the following:
- (i) Compton effect; [2 marks]
- (ii) Thermionic emission; [2 marks]
- (iii) Radioactivity [2 marks]