UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	INTRODUCTION TO MODERN PHYSICS
COURSE CODE	:	DAU 24202
PROGRAMME CODE	:	DAU
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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Q1 (a) Astronaut in **Figure Q1(a)** travels from Earth to the nearest star system, Alpha Centauri, distance at 4.30 light year at speed 0.99944c. (Given 1 light year=9.461×10^{15}m)

(i) Calculate how long does it take (in year) as measured by the earthbound observer?

(3 Marks)

(ii) Calculate how long does it take (in year) according to the astronaut?

(3 Marks)

(b) Two spaceships if one fires a missile at the other at $0.750c$ and the other observes it to approach at $0.950c$?

(i) Find is the relative velocity of

(3 Marks)

(ii) Convert the speed in c.

(1 Mark)

(c) An electron traveling at a speed 0.985c. Given the rest mass of the electron is 9.11×10^{-31}kg.

(i) Sketch the graph for relation between relativistic momentum versus velocity.

(3 marks)

(ii) Determine the momentum of electron.

(3 marks)

(iii) Calculate kinetic energy of the electron

(3 marks)

(iv) Find the total energy of electron according to relativistic theory.

(4 marks)

(v) Convert your value in **Q1(c)(iv)** into unit eV

(2 marks)

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Q2 (a) An electron with a kinetic energy of 120 eV move across cathode ray.

(i) Define de Broglie relation and write the relation.

(4 marks)

(ii) Calculate the momentum of the electron.

(4 marks)

(iii) Find de Broglie wavelength of the electron.

(3 marks)

(b) (i) Write the wave function $\Psi(x) = \Psi_0 e^{ikx}$ in the form of $\Psi(x) = a + ib$ where a and b are real quantities.

(2 marks)

(ii) State Heisenberg's uncertainty principle and write the relation.

(4 marks)

(iii) Explain why is the wave-like nature of matter not observed every day for macroscopic objects?

(2 marks)

(iv) State the radiation is most suitable for the observation of diffraction patterns on crystalline solids. Explain your answer.

(2 marks)

(v) A proton is vibrating and trapped inside nucleus, which is 20,000 smaller than Bohr atomic radius 0.4 nm. Determine the energy that would be required to contain a proton inside nucleus.

(4 marks)

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Q3 (a) Electron with energy 0.1 eV has been seen ejected on potassium (K) metal surface after being illuminated by certain radiation. Given the work function for potassium is 2.24 eV.

(i) Describe the concept of photon.

(2 marks)

(ii) Write relation of photoelectric effect.

(3 marks)

(iii) Calculate wavelength of incident radiation using photoelectric relation.

(5 marks)

(iv) Is the photoelectric effect a consequence of the wave character of radiation or is it a consequence of the particle character of radiation? Explain briefly.

(5 marks)

(b) Electron in an X-ray tube be accelerated so that it can produce X-rays. Given that X-ray generated at wavelength 0.100 nm.

(i) Write principle of X-ray production.

(1 mark)

(ii) Find minimum potential difference applied on the X-ray tube.

(3 marks)

(iii) State **two (2)** effects may occur by interaction of X-rays with matter.

(2 marks)

(iv) Explain the effects mentioned in **Q3 (b)(iii).**

(4 marks)

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Q4 (a) Hydrogen lamp has been deployed to study spectral lines.

(i) Write Bohr postulate of atomic model.

(4 marks)

(ii) Explain briefly the maximum number of electron *f* orbital subshell.

(2 marks)

(iii) Find the shortest wavelength present in Brackett series of spectral lines.

(4 marks)

(iv) Write **three (3)** main differences between classical and modern theory of light radiation.

(6 marks)

(v) Explain briefly the findings of Rutherford and Geiger Experiment.

(4 marks)

(b) (i) Sketch particle distribution as speed vary according to Maxwell-Boltzmann statistics

(3 marks)

(ii) Explain the behavior of particle according to your graph

(2 marks)

-END OF QUESTIONS –

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LIST OF FIGURES

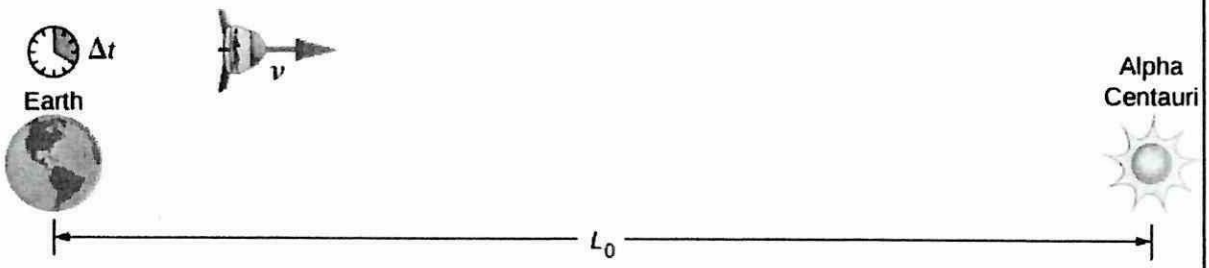

FIGURE Q1(a)

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LIST OF FORMULA

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$	$M = \frac{h_i}{h_o} = -\left\|\frac{d_i}{d_o}\right\|$
$E = \frac{hc}{\lambda} = hf$	$KE = (\gamma - 1)m_o c^2$
$n = \frac{c_0}{v}$	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$	$E^2 = m_o^2 c^4 + p^2 c^2$
$\frac{pc}{E} = \frac{v}{c}$	$E = \gamma m_o c^2$
$\lambda = \frac{h}{e}\sqrt{\frac{4\pi\varepsilon_o r}{m}}$	$v = \frac{e}{\sqrt{4\pi\varepsilon_o r}}$
$n\lambda = 2\pi r_n$	$2\pi r_n = \frac{nh}{e}\sqrt{\frac{4\pi\varepsilon_o r_n}{m}}$
$r_n = \frac{n^2 h^2 \varepsilon_o}{\pi m e^2}$	$r_n = n^2 a_o$
$E_n = -\frac{e^2}{8\pi\varepsilon_o r_n}$	$E_n = -\frac{me^4}{8\varepsilon_o^2 h^2}\left(\frac{1}{n^2}\right) = \frac{E_1}{n^2}$
$\frac{1}{\lambda} = -\frac{E_1}{hc}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$	$\Delta m = Z(m_H) + (A - Z)(m_n) - m_x$
$E_{rest\ mass} = mc^2$	$E_i - E_f = hf$

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LIST OF CONSTANT

Avogadro's Number, $N_A = 6.023 \times 10^{23}$ atoms

Electron charge, $e = 1.6 \times 10^{19}C$

Electron mass, $m_e = 9.109 \times 10^{-31}kg$

Neutron mass, $m_n = 1.675 \times 10^{-27}kg$

Proton mass, $m_p = 1.673 \times 10^{-27}kg$

Atomic mass number, $u = 1.6605 \times 10^{-27}kg$

$= 931.5MeV$

Plank's Constant, $h = 6.626 \times 10^{-34}J$

Speed of light, $c = 3 \times 10^{8}ms^{-1}$

Electric constant permitivitty of free space, $\varepsilon = 1.6 \times 10^{-12}C^2/Nm^2$

Radius of the orbit contain wavelength, $r_n = 5.3 \times 10^{-11}m$

Mass of electron $m_e = 9.1 \times 10^{-31}kg$

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