Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	MODERN PHYSICS
COURSE CODE	:	BWC 20403
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) In Millikan's experiment, an oil droplet of mass 1.92×10^{-14} kg is stationary in the space between the two horizontal plates which are 20 mm apart, the upper plate being earthed and the lower one at a potential of -6 kV.

(i) State the sign of the electric charge on the droplet and give relevant reason.

(2 marks)

(ii) Calculate the magnitude of the charge (neglect the buoyancy of air).

(7 marks)

(b) Based on observation, Rutherford came to certain conclusions about the structure of atom. Explain **THREE (3)** Rutherford's main conclusions about the structure of atom.

(6 marks)

(c) Describe the key difference between Thomson's and Rutherford's models of atom.

(4 marks)

(d) Explain why only a very small percentage of the alpha particles bounced back or deflected at very large angles.

(6 marks)

Q2 (a) If an electron has a velocity of 5.0×10^5 m/s, determine the wavelength in meter (m).

(3 marks)

(b) Rutherford found deviations from his equation at backward angles when he scattered 7.7 MeV α particle ($Z_1 = 2$) on aluminum ($Z_2 = 13$). He suspected the α particle might be affected by approaching the nucleus so closely. Estimate the size of the nucleus based on information given.

(4 marks)

(c) Protons can be accelerated near to the speed of light in particle accelerators. Calculate the de Broglie wavelength (in nm) of such a proton moving at 2.90×10^8 m/s. (Mass of a proton = 1.673×10^{-27} kg).

(3 marks)

(d) A photon with a wavelength of 1.5×10^{-8} m is emitted from an ultraviolet source into a vacuum. Calculate;

(i) the energy of the photon.

(3 marks)

(ii) the de Broglie wavelength of an electron with kinetic energy equal to the energy of the photon.

(6 marks)

(e) An electromagnetic wave has a wavelength of 625 nm. Determine the energy of the wave.

(6 marks)

Q3 (a) By using an appropriate diagram, describe the dispersion phenomenon discovered by Newton.

(4 marks)

(b) Based on the interaction of light source with diffraction grating, explain;

(i) continuous spectra.
(ii) band spectra.
(iii) line spectra.

(6 marks)

(c) If $R = 1.1 \times 10^{7}$ m^{-1}, determine the wavelength and frequency of the series limit for the Lyman, Balmer, and Paschen spectral series of hydrogen. Note that the Lyman series ends on $m = 1$, the Balmer series on $m = 2$, and the Paschen series on $m = 3$.

(9 marks)

(d) An astronomer finds a new absorption line with $\lambda = 164.1$ nm in the ultraviolet region of the Sun's continuous spectrum. He attributes the line to hydrogen's Lyman series. Is he right? Justify your answer.

(6 marks)

Q4 (a) Outline the difference between photon and phonon.

(2 marks)

(b) Standing in the middle of a 20-m-long pier, you notice that at any given instant there are 15 wave crests between the two ends of the pier. Estimate the minimum uncertainty in the wavelength that could be computed from this information.

(6 marks)

(c) Consider a small but macroscopic particle of mass, $m = 10^{6}$ g confined to a one-dimensional box with $L - 10^{6}$ m, for example, a tiny bead on a very short wire. Compute the bead's minimum kinetic energy and the corresponding speed.

(8 marks)

(d) Compute the de Broglie wavelengths of the following and consider each case possessed 4.5 keV kinetic energy.

(i) An electron.
(ii) A proton.
(iii) An alpha particle.

(9 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION : SEM I 2020/2021 PROGRAMME CODE: BWC
COURSE NAME : PHYSICS MODERN COURSE CODE: BWC 20403

List of Formulae

$p = \frac{E}{c} = \frac{hf}{c} = \frac{h}{\lambda}$	$\Delta\lambda = \lambda' \quad \lambda = \frac{h}{mc}(1 \quad cos\theta)$	$p = mv$
$K = \frac{1}{2}mv^2 = qV$	$E - qV$	$K_e = E - E'$
$E = hf \quad \phi$	$K = \frac{p^2}{2m} = eV$	$\lambda_c = \frac{h}{m_e c} = 2.43 \times 10^{-9} nm$
$v - \frac{E}{B}$	$E - \frac{V}{d}$	$\frac{e}{m_e} = \frac{E}{rB^2}$
$W = eV$	$\frac{e}{m_e} = \frac{E^2}{2VB^2}$	$\frac{e}{m_e} = \frac{yE}{x_1 B^2(\frac{1}{2}x_1 + x_2)}$
$F - 6\pi r\eta v$	$\rho = \frac{M}{V}$	$V = \frac{4}{3}\pi r^3$
$r = 3\left[\frac{\eta v_g}{2g(\rho_o - \rho_a)}\right]^{\frac{1}{2}}$	$q - \frac{18\pi\eta d}{V}\left[\frac{\eta v_g}{2g(\rho_o - \rho_a)}\right]^{\frac{1}{2}}(v_g - v_E)$	$N = \frac{q}{e}$
$k = \frac{1}{4\pi\epsilon_o}$	$r_e = \frac{ke^2}{2m_e c^2}$	$b - \frac{Z_1 Z_2 e^2}{8\pi\epsilon_o K} cot\frac{\theta}{2}$
$n = \frac{\rho N_A}{M_g}$	$\frac{N(\theta)}{N_i} = \frac{nt}{16}\left(\frac{e^2}{4\pi\varepsilon_o}\right)^2 \frac{Z_1^2 Z_2^2}{r^2 K^2 sin^4(\theta/2)}$	$K = \frac{Z_1 Z_2 e^2}{4\pi\epsilon_o r}$