UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	MODERN PHYSICS
COURSE CODE	:	BWC 20403
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Describe **FOUR (4)** methods of electron emission.

(4 marks)

(b) The work function for cesium is 1.35 eV. Calculate,

(i) the longest wavelength that can cause photo-emission from a cesium surface;

(4 marks)

(ii) the maximum velocity, which photoelectrons will be emitted from the cesium surface illuminated with light of wavelength 4×10^{-7} m. (Mass of electron is 9.1×10^{-31} kg).

(5 marks)

(c) X-rays of wavelength 10.0 pm are scattered from a target. Determine,

(i) the wavelength of the X-rays scattered through 45°;

(4 marks)

(ii) the maximum wavelength present in the scattered X-rays;

(4 marks)

(iii) the maximum kinetic energy (in eV) of the recoil electrons.

(4 marks)

Q2 (a) (i) Outline the de Broglie hypothesis.

(4 marks)

(ii) A photon has energy 6×10^{-20} J has linear momentum 2.0×10^{-30} kg m/s. Verify this statement.

(4 marks)

(iii) Protons can be accelerated to speeds near that of light in particle accelerators. Estimate 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).

(4 marks)

(b) Heinrich Hertz did the best thing in a series of brilliant and exhaustive experiments. He showed that Maxwell's theory was correct and that an oscillating electric current does indeed radiate electromagnetic waves that possess every characteristic of light except the same wavelength as light. Briefly describe the Hertz's experiment.

(4 marks)

(c) Rutherford found deviations from his equation at backward angles when he scattered 7.7 MeV a particle (Z_1 = 2) on aluminum (Z_2 = 13). He suspected this was because the α particle might be affected by approaching the nucleus so closely. Estimate the size of the nucleus based on these data.

(4 marks)

(d) Calculate the fraction per mm^2 area of 7.7 MeV a particles scattered at 45° from a gold foil of thickness 2.1×10^{-7} m at a distance of 1.0 cm from the target. Given, $n = 5.9 \times 10^{28}$ atom/m^3.

(5 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 $R = 1.097 \times 10^{-7}$ 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 λ = 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? Explain your answer.

(6 marks)

Q4 (a) Discuss 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 -

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List of Formulae

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