TERJEMAHAN

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2002/2003 Academic Session

February - March 2003

ZCT 104E/3 - Fizik IV (Modern Physics)

Time : 3 hours

Please check that the examination paper consists of **SIX** printed pages before you commence this examination.

Answer all FIVE questions. Students are allowed to answer all questions in English OR Bahasa Malasyia OR combination of both.

Given:

Speed of light $c = 3 \times 10^8$ ms^{-1}
Planck's constant $h = 6.626 \times 10^{-34}$ Js
Charge of electron = 1.602×10^{-19} C
Rest mass of electron = 9.11×10^{-31} kg
Rest mass of proton = 1.67×10^{-27} kg
Rest energy electron = 0.511 MeV
Rest energy of proton = 938.26 MeV
Rydberg constant $R = 1.0974 \times 10^7$ m^{-1}

1. (a) According to an observer S_1 , an explosion occurred $x_1 = 0$ and $t_1 = 0$ and a second explosion also occurred at $x_1 = 1$ km and $t_1 = 1 \times 10^{-6}$ s. However according to S_2, both the explosions occurred at the same time. What is the speed of S_2 with respect to S_1?

(35/100)

...5/-

(b) According to an observer that approaches a spherical object, the diameter of the object has been compressed to $\frac{1}{5}$ its original diameter in the direction of motion of the observer. At what speed is the observer travelling?

(20/100)

(c) A is an observer on earth and B an observer in a spaceship. The speed of the spaceship according to A is 2×10^8 ms^{-1}. Both A and B had synchronised their clocks when they were at rest relative to each other. According to A what is the time that would have gone by before their clocks differ by 1 second.

(45/100)

2. (a) The mass of a particle is 3 times its rest mass. What is the particle's speed?

(15/100)

(b) 'Find the momentum of a proton whose kinetic energy is 1 GeV.

(40/100)

(c) Protons are accelerated to an energy of 500 GeV by an accelerator. What then is the speed of these protons? If the intensity of the proton beam is 10^{14} s^{-1}, what is the minimum power required to accelerate the above protons.

(45/100)

3. (a) The threshold wavelength of the electromagnetic radiation required for the release of photoelectrons from a given surface is 3840 Å. Determine the work function (in eV) of the surface.

What will be the maximum kinetic energy (in eV) of the photoelectrons if the radiation impinging on the surface is 2000 Å?

(30/100)

(b) A photon of frequency 3×10^{19} Hz collides with an electron and is scattered by an angle θ. Find θ if the frequency of the scattered photon is 2.8×10^{19} Hz.

(35/100)

...6/-

(c) A positron collides head on with an electron and in the process both are annihilated. Before the collision the kinetic energy of each particle is 1.5 MeV. Determine the wavelength of the photons that are most likely to be created.

(35/100)

4. (a) Determine the voltage required to accelerate a proton so that its de Broglie wavelength is 500 nm.

(35/100)

(b) The position and momentum of a 5 MeV electron are determined simultaneously. If the uncertainty of its position is 0.1 nm, what is the percentage uncertainty of its momentum.

(40/100)

(c) Calculate the ground state energy of a macroscopic object of 9.1 mg by assuming that the object is confined to an infinitely deep one dimensional potential well of length 4 cm and comment on the answer found.

(25/100)

5. (a) Using the classical Planetary Model of the hydrogen atom, derive the expression for the energy of the atom and show that the size of the atom is about 1 Å. Assume that the binding energy of the electron in the atom is 13.6 eV and the constant $k = 8.99 \times 10^9$ Nm^2C^{-2}.

(45/100)

(b) Calculate the wavelength of the H_γ line in the Balmer series for the emission spectrum of the hydrogen atom.

(35/100)

(c) List the shortcomings of the Bohr model of the hydrogen atom.

(20/100)

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