RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
First Year – Semester II Examination – April / May 2015

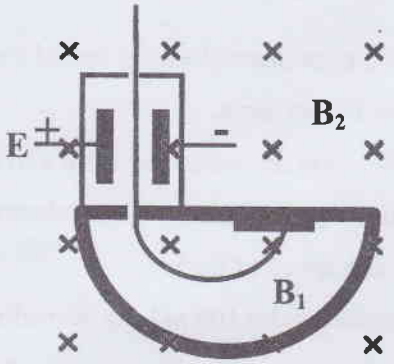
PHY 1104 – Modern Physics

Answer **Two** Questions **only**. Time allowed: **One hour**

Electron Charge (e) – 1.6×10^{-19}C, Velocity of Light (c) – 3.0×10^{8} m/s.

Electron Mass (m_e) – 9.1×10^{-31} kg,

1. Following figure shows a schematic diagram of a Bainbridge's mass spectrograph.



a) Briefly explain the mechanism of the Bainbridge's mass spectrograph.

(15 Marks)

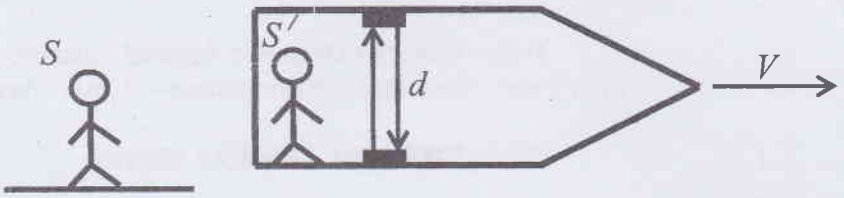
b) If the electric field is ***E*** and the magnetic fields inside and outside the chamber are B_1 and B_2 respectively, show that the **q/m** ratio of a particle is given by following equation.

$$\frac{q}{m} = \frac{E}{B_1 B_2 R}$$, where R is the radius of the path of the particle.

(20 Marks)

c) Particle A with charge q and mass m_A and particle B with charge $2q$ and mass m_B enter to a Bainbridge's mass spectrometer. If the radii of the trajectories of A and B are R and $2R$ respectively, calculate their mass ratio. (15 Marks)

2. Consider a spaceship moving to the right with a speed of V as shown in the following figure. A mirror is fixed to the ceiling of the space ship, and observer S', at rest in the system, holds a laser distance ***d*** from the mirror. At some instant the laser light emits a pulse of light directed at the mirror.



If the laser pulse reflects back from the mirror and reaches the laser,

a) Calculate the time interval for the round trip of the laser pulse, with respect to the observer inside the spaceship. (05 Marks)

b) Draw the path of the laser pulse with respect to an observer at rest on the Earth (S). (10 Marks)

c) Get an equation for the time interval for the round trip of the laser pulse, with respect to the observer (S) on earth. (15 Marks)

d) The period of a pendulum is measured to be 3.0 s in the spaceship. What is the period of the pendulum when measured by the observer on Earth when the spaceship is moving at a speed of $0.95c$? (10 Marks)

e) The spaceship is measured to be 100 m long according to the observer inside. What is the length of the spaceship with respect to the observer on the Earth? (10 Marks)

3. An electron, which has mass of $9.11 \times 10^{-31}\ kg$, moves with a speed of $0.800c$. Find

a) the momentum of the electron according to the classical expression. (05 Marks)

b) its relativistic momentum (10 Marks)

c) the total energy of the electron (10 Marks)

d) the kinetic energy of the electron. (10 Marks)

e) Starting from the relativistic momentum term, deduce an equation for the relativistic form of the Newton's second law. (F = ma) (15 Marks)

Useful Equations, $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ $E^2 = (pc)^2 + {E_0}^2$