THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF PHYSICS

PHYS2050   ELECTROMAGNETISM

MID SESSION EXAMINATION – SEPTEMBER, 2005

Time allowed = 50 minutes

Total number of questions = 4

Total number of marks = 50

Answer **ALL** questions

The questions are **not** of equal value

Portable battery powered electronic calculators (without alphabetic keyboards) may be used.

The paper may be retained by the candidate

Question 1 [12 marks]

The electric potential in a certain region of space depends only on the x and y coordinates and is given by $V(x,y) = -Cxy$, where C is a constant.

(a) Derive an expression for the electric field $\mathbf{E}$.

(b) Calculate the line integral of $\mathbf{E}$ along the (xyz) path

$(000) \rightarrow (100) \rightarrow (110)$

(c) Comment on your answer to (b) with reference to the electric potential. Is it what you expected ? Why or why not ?

Question 2 [10 marks]

Charge is distributed non-uniformly throughout a solid sphere of radius R. The volume charge density is $\rho(r) = Cr$, where r is the distance from the centre of the sphere and C is a constant.

(a) Derive an expression for the total charge on the sphere [Hint: use spherical coordinates]

(b) Derive an expression for the electric field $\mathbf{E}(r)$ inside the sphere.

Question 3 [20 marks]

A thin circular ring of radius R is uniformly charged with a total charge Q. A small particle of mass m and the same charge Q is placed at the centre of the ring. If the particle is slightly (i.e. infinitesimally) displaced from the centre of the ring out of the plane of the ring, it will be repelled by the ring. Derive an expression for the speed of the particle when it is very far from the ring (Hint: take "very far" to mean infinity).

Question 4 [8 marks]

The electric field strength of the Earth is 110 V/m at an altitude of 100 m and 25 V/m at 1000 m. Calculate the average atmospheric charge density (C/m^3) between these altitudes.