TEST I

Physics 23102 **Date prior to 1998**

Instructor: Declan Keane *Student* _____

Be sure to specify the units for any numerical quantities you calculate.
A table of physical constants is given elsewhere.

1. Two electrons are separated by a distance d. Show that the ratio of the force of gravitational attraction to the force of electrical repulsion is independent of d, and calculate the value of this ratio. You may take $e/m_{\text{electron}} = 1.76 \times 10^{11}$ C/kg, and $4\pi\epsilon_0 G = 7.42 \times 10^{-21}$ $(\text{C/kg})^2$.

2(a) What force does an electron experience in an electric field of 2 V/m ?

2(b) If an electron moves from the negative to the positive terminal of a 12V battery, what is the change in its potential energy (in joules)?

2(c) A 1 μF capacitor is initially uncharged, and then 10^9 electrons are transferred from one plate to the other. What voltage now appears across the plates?

3(a) Write down the mathematical expression for Gauss' law, and carefully explain the meaning of each symbol. Be sure to specify how an element of area can be treated as a vector, and describe the connection between the Gaussian surface and the charge that appears on the right-hand side of the equation.

3(b) A spherical object of radius R carries a net charge Q. We don't know whether the object is a conductor or not, or whether it is hollow or not; however, we know that the distribution of charge is spherically symmetric. Use Gauss' law to find the electric field at a distance d from the center of the object, where $d > R$.

4. A long straight wire of diameter 2 mm carries a charge of 1 μC per meter. (a) What is the electric field at a distance of 10 cm from the wire? (b) What is the electric potential difference between the surface of the wire and a point 10 cm from the wire? Derive any formula you use, starting from either Coulomb's law or Gauss' law.

Other exams have contained fewer problems of the above type, but have included a selection of true/false questions as in the quizzes.