

## 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  $4\pi\epsilon_0 G = 7.42 \times 10^{-21}$  (C/kg)<sup>2</sup>.
  
- 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  $\mu\text{F}$  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  $\mu\text{C}$  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.*