

Practice for MT1

GSI's – you are not obliged to provide students with specific answers to these specific problems at this time. Likewise, no answer key will be provided at this time. Encourage students to discuss, debate, argue, think, amongst themselves, in the first instance.

Multiple choice/fill-in/T or F

Charge can be created: T/F

Electrons have a permanent magnetic field: T/F

There are exceptions to Gauss' law: T/F

Every problem in electrostatics can be solved with Coulomb's law and the superposition principle: T/F.

In electrostatics, charge resides precisely on the circumference of a 2 dimensional disk? T/F.

In electrodynamics, charge resides precisely on the surface of every conductor: T/F.

Electric fields travel through empty space: T/F.

Problem 1. Three identical charges, each with charge Q and mass m , are arranged on the corners of an equilateral triangle of side length L . The spheres are released simultaneously. What is the speed of each charge when they are very far apart?

Problem 2. A non-conducting sphere has radius R and volume charge density ρ is centered at the origin.

a) What is the E -field outside the sphere? Show your work.

b) A particle with charge Q and mass m is released from a point d meters away from the surface of the sphere. Find the particle's speed when it reaches a position $2d$ from the surface of the sphere.

Problem 3. Very hard. Two large parallel plates are a distance L apart and have a uniform electric field between them. An electron is released from the negative plate and a proton is released from the positive plate. Neglect interactions between the two particles. At which distance from the positive plate do the two particles pass one-another? Use symbols of your own choice to denote any constants that you need.

Problem 4. How much work is needed to arrange three charges Q into an equilateral triangle? The particles are initially infinitely far apart. Take a to be the length of each side of the triangle.

Problem 5. Very hard. A non-conducting spherical shell of inner radius a and outer radius b has a negative volume charge density $\rho = A/r$ where A is a constant and r is the distance from the center of the shell. In addition, there is a charge Q at the center. What value should A have if the electric field in the shell ($a < r < b$) is to be uniform?

Hint: $dV = 4\pi r^2 dr$

Problem 6. A Charged Ring. A ring of radius R carries a uniform linear charge density λ . The ring rotates around its axis with an angular velocity ω . Find the electrical and magnetic field at the center of the ring.