PHYS1022 Electricity and Magnetism

Problem Sheet 4 – for workshop

1. Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is 6.0 kN.m^2/C.

(a) What is the net charge inside the box?

(b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box? Explain.

2. Space vehicles travelling through Earth's radiation belts can build up negative charge which can upset attempts to measure the ambient fields. Suppose a spherical metal satellite 1.3 m in diameter accumulates 2.4 μC of charge in one orbital revolution.

(a) Find the resulting surface charge density.

(b) Calculate the magnitude of the electric field just outside the surface of the satellite, due to the surface charge. Show how this can be calculated by using Gauss' law.

3. A nonconducting sphere of radius R = 0.1 m carries a uniform volume charge density ρ = 2.0 nC/m^3. Find the magnitude of the electric field at r = 0.5 R.

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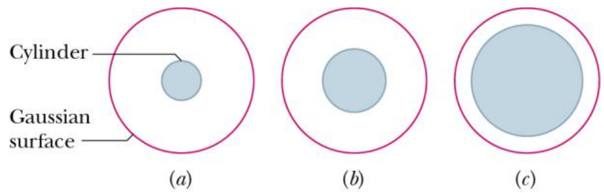
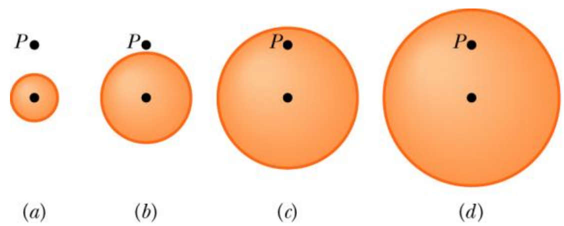
Problem Sheet 3 – for tutorials

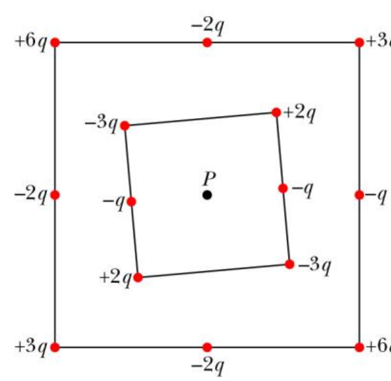
1. The figure shows in cross-section, three cylinders, each of uniform charge Q. Concentric with each cylinder is a cylindrical Gaussian surface, all three with the same radius. Rank the Gaussian surfaces according to the electric field at any point on the surface, greatest first.



2. The figure below shows four spheres, each with charge Q uniformly distributed through its volume.
(a) Rank the spheres according to their volume charge density, greatest first. The figure also shows a point P for each sphere, all at the same distance from the centre of the sphere.
(b) Rank the spheres according to the magnitude of the electric field they produce at point P, greatest first.



3. The figure shows two square arrays of charged particles. The squares, which are centred on point P, are misaligned. The particles are separated by either *d* or *d*/2 along the perimeters of the squares. What are the magnitude and direction of the net electric field at P?



4. The square surface shown measures 3.2 mm on each side. It is immersed in a uniform electric field with magnitude E = 1800 N/C. The field lines make an angle of 35˚ with a normal to the surface, as shown. Take that normal to be directed 'outward', as if the surface were one face of a box. Calculate the electric flux through the surface.