PH2420 Electromagnetism Problem Sheet 1

Note: Your work must be clearly presented; marks will be deducted for assignments that are scrappy and difficult to follow.

- 1. State *Coulomb's Law* for the electrostatic force between two point charges. (*A formula with definition and explanation of the terms is the best way to answer this part.*) Calculate the ratio of the electrostatic repulsion to the gravitational attraction between two electrons. Comment on your answer.
- 2. Two light pith balls, each of mass *m* are suspended from a point by threads of length *l*. Each ball carries a charge Q and the resultant repulsion forces them a distance *r* apart. By balancing the gravitational force, Coulomb force and the tension in the threads show that the Coulomb force is related to the separation *r* by

$$F_{\rm C} = \frac{mgr}{\sqrt{4l^2 - r^2}}$$

In the limit that the separation r is very much less than the length l show that r is related to the charge Q by

$$r^3 = \frac{2lQ^2}{4\pi\varepsilon_0 mg}.$$

Calculate the separation of the balls in the case where the threads are 10 cm long, the balls each weigh 1 mg and they both carry one electron of excess charge. (Use the $r \ll l$ limit.)

Discuss the feasibility of such a measurement.

- 3. In the modern system of units the fundamental electrical quantity is the ampère, specified in terms of the force between two current-carrying wires. In the past, however, *charge* was used as the fundamental electrical unit. The coulomb was specified in terms of the mass of silver (a monovalent metal) deposited by electroplating. What mass of silver would correspond to a charge transport of one coulomb?
- 4 The figure shows three charges of equal *magnitude* placed at the vertices of an equilateral triangle. Charges 1 and 3 are positive and charge 2 is negative.

Draw this figure and indicate on it arrows representing the magnitude and direction of the forces acting on charge 3 due to charge 1 and charge 2. Now draw a third arrow representing the magnitude and direction of the resultant force on charge 3.



