

Physics 1A — PHYS1131 2007-S1 Answers

1. 14 Marks Total

(a) Coulomb's law is given by  $F_e = k_e \frac{q_1 q_2}{r^2} \hat{r}$  where  $F_e$  is the electric force between two charges,  $q_1$  and  $q_2$ , a distance  $r$  apart.  $k_e$  is Coulomb's constant.  $\hat{r}$  is the unit vector directed between  $q_1$  and  $q_2$ .

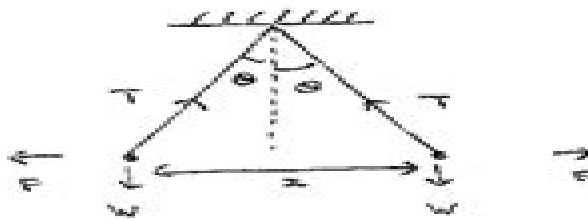
Coulomb's law states that the electric force between two charges depends on the product of the charges and inversely on the square of their separation.

The constant of proportionality is known as Coulomb's constant.

The direction of the force is along the line joining the charges, such that for two charges of the same sign it is repulsive (directed directly away from each other), whereas if the charges are of opposite sign, then it is directed towards each other.

Note OK to have used  $k_e = \frac{1}{4\pi\epsilon_0}$  instead [permittivity of free space].

(b)



(i) There are three forces acting on each charge, the electrostatic repulsion between the two charges,  $F$ , its weight due to gravity,  $W$ , and the tension in the silk thread,  $T$ .

These must be balanced for the charges to be in equilibrium.

We have  $W = mg$ , acting vertically, for the action of gravity,

and  $F = k_e q^2/x^2$ , acting horizontally, for the electric force.

Thus, resolving the forces:

$$\text{Horizontally: } T \sin(\theta) = F = \frac{k_e q^2}{x^2} \quad (1)$$

$$\text{Vertically: } T \cos(\theta) = W = mg \quad (2)$$

$$\text{Eliminating } T \text{ by dividing (1) by (2): } \tan(\theta) = \frac{k_e q^2}{mgx^2}$$

# Higher Physics Past Paper Answers

**JR Anderson**



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