Week 6, Session 2 Problems

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1 Coulomb's Law

1.1 Charges in a Bowl

Two identical charges, each with mass m, are at rest on the surface of a hemispherical bowl of radius R, separated by an angle θ.

(a) Find the charge Q on each of the charges.

(b) Is this equilibrium stable? If so, calculate the frequency of small oscillations about it.

(*Source: modified from physics-prep.com*)

1.2 Oh Charge, Where Art Thou?

Two point charges are located on the x axis. They are both positive, bu the one located at $x = 0$ has a charge of q while the one located at $x = L$ has a charge of $4q$. If a third charge is placed on the x axis in between the two charges so that the net force on ANY of the charges is zero, determine the magnitude of the third charge and its location.

(*Source: physics-prep.com*)

1.3 Return of the Spring

A spring with spring constant k_s and rest length L has positive charges Q attached to either end.

(a) Find an equation that will determine the length D of the spring, once the charges have come to rest.

(b) Repeat part (a), this time assuming that the charges on either end are both *negative*.

(c) Repeat again, this time assuming that the charges on either end have *opposite* signs.

(*Source: workbook*)

1.4 A Balancing Act

A charge q hangs on the end of a string while another charge $-Q$ of mass m is brought beneath it.

(a) At what distance d below the hanging mass is the charge $-Q$ in equilibrium?

(b) Is this equilibrium stable? If so, find the frequency of small oscillations about it.

1.5 Dipoles

(Challenge) Find the electric field due to a dipole located at the origin both along its axis and in the plane perpendicular to its axis. (Hint: find the field from two point charges with charge q located at $y = d/2$ and charge $-q$ located at $y = -d/2$ and then take the limit as d goes to zero.)