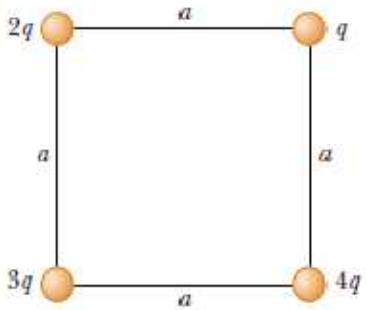
Applied Physics BS 101

The Electric Field

Problem 1: An object having a net charge of 24μC is placed in a uniform electric field of 610 N/C directed vertically. What is the mass of this object if it "floats'' in the field?
Ans.: 1.49g

Problem 2: Two point charges are located on the *x* axis. The first is a charge +*Q* at *x*=-*a*. The second is an unknown charge located at *x*=3*a*. The net electric field these charges produce at the origin has a magnitude of $2kQ/a^2$. What are the two possible values of the unknown charge?
Ans.: **(**a) q=-9Q if field is towards right and q=+27Q if if field is towards left.

Problem 3: Four point charges are at the corners of a square of side *a* as shown in Figure.
(a) Determine the magnitude and direction of the electric field at the location of charge *q*.
(b) What is the resultant force on *q*?



Ans.: $E = 3.06\frac{kq}{a^2}i + 5.06\frac{kq}{a^2}j,\ F = 3.06\frac{kq^2}{a^2}i + 5.06\frac{kq^2}{a^2}j$

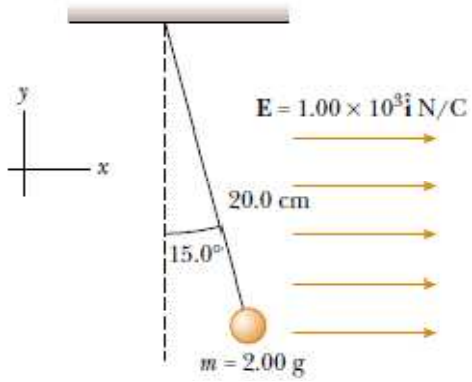
Problem 4: An electron and a proton are each placed at rest in an electric field of 520 N/C. Calculate the speed of each particle 48.0 ns after being released.
Ans.: Electron; $4.39 \times 10^6\ m/s$, **Proton;** $2.39 \times 10^3\ m/s$

Problem 5: A proton accelerates from rest in a uniform electric field of 640 N/C. At some later time, its speed is $1.2 \times 10^6\ m/s$ (nonrelativistic, because *v* is much less than the speed of light). (a) Find the acceleration of the proton. (b) How long does it take the proton to reach this speed? (c) How far has it moved in this time? (d) What is its kinetic energy at this time?
Ans.: $(a)6.14 \times \frac{10^{10}m}{s^2}, (b)1.95 \times 10^{-5}s, (c)11.7m, (d)1.2 \times 10^{-15}J$

Problem 6: A dipole with charge 6.0μC and separation 4.0 mm is immersed in an *E*-field of strength 3.0×10^6N/C. Calculate the maximum torque.
Ans.: $\tau = 72 \times 10^{-3}Nm$

Problem 7: A dipole with charge 6.0μC and separation 4.0 mm is immersed in an *E*-field of strength 3.0×10^6N/C.. Take the original position $\theta_0 = 70$, and the final position $\theta_1 = 20°$ and calculate the work performed on the dipole and the energy stored in the system.
Ans.: $W = -0.046J$

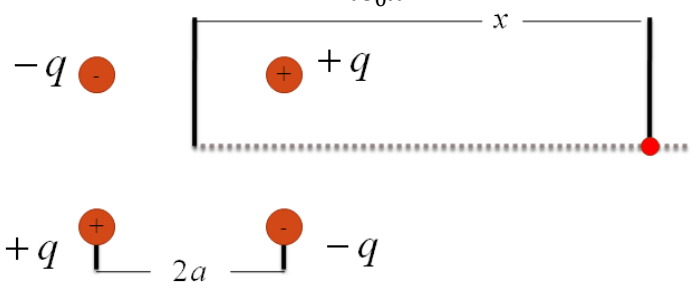
Problem 8: A small, 2g plastic ball is suspended by a 20.cm-long string in a uniform electric field as shown in Figure. If the ball is in equilibrium when the string makes a 15.0° angle with the vertical, what is the net charge on the ball?



Ans.: $q = 5.25\mu C$

Problem 9: If x >> a for electrical quadrupole shown below, show that electric field at point P is given by

$$E = \frac{3(2qa^2)}{2\pi\varepsilon_0 x^4}$$



Problem 10: If z >> d for electrical quadrupole shown below, show that electric field at point P is given by

$$E = \frac{3(2qd^2)}{4\pi\varepsilon_0 z^4}$$