

305.

Problem 28.44 (RHK)

A uniform vertical field \vec{E} is established in the space between two large parallel plates. A small conducting sphere of mass m is suspended in the field from a string of length L . We have to find the period of this pendulum when the sphere is given a charge $+q$ if the lower plate (a) is charged positively and (b) if it is charged negatively.



Solution:

If the lower plate is charged positively, the direction of the electric field \vec{E} will be vertically up and the net force acting downward on the conducting ball of mass m with charge $+q$ on it will be

$$mg - qE.$$

As the ball is suspended from a string of length L , it will be driven by the tension in the string and for small angular displacements from the vertical the equation of motion will be

$$mL \frac{d^2\theta}{dt^2} + (mg - qE)\theta = 0.$$

It is a simple harmonic motion equation. Its period will be

$$T_+ = 2\pi \sqrt{\frac{L}{(g - qE/m)}}.$$

(b)

If the lower plate is charged negatively, the direction of the electric field \vec{E} will be vertically down and the net force acting downward on the conducting ball of mass m with charge $+q$ on it will be $mg + qE$.

The period of simple harmonic motion of the oscillations in this case will be

$$T_- = 2\pi \sqrt{\frac{L}{(g + qE/m)}}.$$