1 Theory

Complete the following table:

Name	Expression	Differential Form
volume charge density	$\rho \equiv \frac{Q}{V}$	$dq = \rho dV$
surface charge density	$\sigma \equiv \frac{Q}{A}$	$dq = \sigma dA$
linear charge density	$\lambda \equiv \frac{Q}{l}$	$dq = \lambda dl$

2 Practice

The field above a positively charged infinite horizontal plane is given by

$$\mathbf{E} = \frac{\sigma}{2\epsilon_0}\hat{\mathbf{j}},$$

where σ is the uniform surface charge density, and ϵ_0 is the permittivity of free space. The strength of the field is such that a positively charged particle of mass m and charge q placed at a height h above the plane remains suspended.

(a) What is σ in terms of ϵ_0, q, m, and the local acceleration of gravity g?

$\sigma = \frac{2mg\epsilon_0}{q}$

(b) Why is h not involved in this expression?

The field strength does not depend on distance from the plane.

(c) What is the acceleration of the charge if it is placed *below* the plane?

$-2g$