# Gravitational and Electrostatic

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## 1 Formula

The strength of gravity from the Earth surface is approximately the same, therefore in most problems we approximate $g = 9.8\frac{m}{s^2}$. However, when as the distance from center of Earth increases, $g$ no longer holds to be a constant, but rather a function of the distance from center of Earth, $r$.

$$F = G\frac{m_1 m_2}{r^2}$$

At the same time, electro static forces generated by a point charge also have a similar formula.

$$F = k\frac{q_1 q_2}{r^2} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$$

In both formulas, constant $k$ and $g$ are scalars that can be interpreted as strength of the field. In Coulomb's law, the constant $k$ can change based on medium of the material the charged objects are immersed in, therefore it is written in an alternative $\frac{1}{4\pi\epsilon_0}$, where $\epsilon_0$ is the permittivity of free space.

## 2 Symmetry Argument

When the gravitational/electric force is generated by a point, objects that are $r$ units away will all experience force with the same magnitude and different directions – This is the symmetry argument, they are the same.

When dealing with g/e force generated by an infinitely long rod, a concentric cylinder enclosing the rod is a set (group) of points that experience force with same magnitude and different directions.

If it is an infinitely large plane that is producing the e/g force, two parallel planes will experience forces with same magnitude but different directions.

## 3 Green's Theorem and Gaussian Surface

$$\oint_c F \cdot dl = \iint_R curl(F)\, dA$$

## 4 Why $\frac{1}{r^2}$