Gravitational Field

A gravitational field is a region of space where any mass put inside will experience a gravitational force.

- Gravitational force: $F_G = \frac{\mathrm{GMm}}{r^2}$ (unit: N; vector)
- Gravitational field strength: gravitational force per unit mass, $g = \frac{F_G}{\mathrm{m}}$ (unit: $\mathrm{Nm^{-1}}$; vector)

- Gravitational potential energy: work done by external agents in bringing a mass from infinity to a point, $U = -\frac{\mathrm{GMm}}{\mathrm{r}}$ (unit: J; scalar)
  - In this case, external agents can only do negative work as the gravitational force is always attractive, hence U is always negative.
- Gravitational potential: work done per unit mass, $\varphi = -\frac{\mathrm{GM}}{\mathrm{r}}$ (unit: $\mathrm{J\,kg^{-1}}$; scalar)

Electric Field

An electric field is a region of space where an electric force acts on a stationary charge placed at any point in the region.

- Electric force: $F_E = \frac{1}{4\pi\varepsilon_0}\frac{\mathrm{Qq}}{r^2}$ (unit: N; vector).
- Electric field strength: electric force per unit positive charge, $E = \frac{F_E}{\mathrm{q}}$ (unit: $\mathrm{NC^{-1}}$; vector).

- Electric potential energy: work done by external agents in bringing a charge from infinity to a point, $U = \frac{1}{4\pi\varepsilon_0}\frac{\mathrm{Qq}}{\mathrm{r}}$ (unit: J; scalar).
  - External agents do positive work (i.e. the electric force is repulsive) → positive
- Electric potential: work done per unit positive charge, $V = \frac{\mathrm{U}}{\mathrm{q}}$ (unit: V; scalar)
  - Electric potential for positive charge is always positive as the force is repulsive.