B.Sc. Physics Part-I
Paper-I, Group-C

Gravitational fields and potentials.

Newton's law of Gravitation:

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

F → Gravitational force acting between two masses m_1 & m_2.
G → Universal gravitational Constant
m_1, m_2 → masses of particles 1 and 2 respectively
r → distance between the masses.

Vectorial form: $\vec{F} = -G \frac{m_1 m_2}{|\vec{r}|^2} \hat{r}$, $\vec{r} = \vec{r_2} - \vec{r_1}$
$\hat{r}$ → unit vector

Gravitational field/Intensity of the field:

Intensity (E) of the gravitational field (or the strength of gravitational field) of a particle of mass m at a point distance r from it is given by the force experienced by a unit mass placed at that point in the field.

$$\vec{E} = \frac{\vec{F}}{m} = -\frac{1}{m}\left[\frac{GMm}{r^2}\right]\hat{r}$$

, $\hat{r}$ unit vector along the direction of $\vec{r}$

$$\vec{E} = -\frac{GM}{r^2}\hat{r}$$

Gravitational potential:

Gravitational potential V at a point distance r from a object of mass m is defined by the amount of work done in moving a unit mass from infinity to that point

$$V = -\int_{\infty}^{r} \vec{E} \cdot d\vec{r} = -\int_{\infty}^{r} \frac{GM}{r^2} dr = -\frac{GM}{r}$$ or $$\boxed{V = -\frac{GM}{r}}$$