Newton's Law of Gravitation [mln3]

Gravitational potential of a mass distribution: $\Phi(\mathbf{r}) = -G\int d^3r' \frac{\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}$;
$\rho(\mathbf{r})$: mass density;
$G \simeq 6.67 \times 10^{-11}\mathrm{Nm^2kg^{-2}}$: universal gravitational constant.

Gravitational field (acceleration due to gravity):

$$\mathbf{g}(\mathbf{r}) = -\nabla\Phi(\mathbf{r}) = -G\int d^3r' \,\frac{\rho(\mathbf{r}')(\mathbf{r}-\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|^3} \;\Rightarrow\; \Phi(\mathbf{r}) = -\int_{\mathbf{r}_0}^{\mathbf{r}} d\mathbf{r}'\cdot\mathbf{g}(\mathbf{r}')$$

Gravitational force on point mass m: $\mathbf{F}(\mathbf{r}) = m\mathbf{g}(\mathbf{r})$.

Gravitational potential energy of point mass m: $V(\mathbf{r}) = m\Phi(\mathbf{r})$.

Field equation: $-\nabla\cdot\mathbf{g}(\mathbf{r}) = \nabla^2\Phi(\mathbf{r}) = G\int d^3r'\rho(\mathbf{r}')\nabla\cdot\frac{\mathbf{r}-\mathbf{r}'}{|\mathbf{r}-\mathbf{r}'|^3} = 4\pi G\rho(\mathbf{r})$,
where we have used $\nabla\cdot\frac{\mathbf{r}-\mathbf{r}'}{|\mathbf{r}-\mathbf{r}'|^3} = 4\pi\delta(\mathbf{r}-\mathbf{r}')$.

Gauss' theorem: $\oint d\mathbf{A}\cdot\mathbf{g}(\mathbf{r}) = \int_V d^3r\;\nabla\cdot\mathbf{g}(\mathbf{r})$.

Gauss' law: $\oint d\mathbf{A}\cdot\mathbf{g}(\mathbf{r}) = -4\pi G m_{in}$.

Gravitational self energy: $V_S = -\frac{1}{2}G\int d^3r\int d^3r'\,\frac{\rho(\mathbf{r})\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}$.

Massive spheres:

$$\mathbf{F}_{12} = -\mathbf{F}_{21} = -G\frac{m_1m_2}{R^2}\,\hat{\mathbf{r}},$$

$$\mathbf{g}(R) = \frac{\mathbf{F}_{12}}{m_2} = -G\frac{m_1}{R^2}\,\hat{\mathbf{r}},$$

$$\Phi(R) = -\int_\infty^R dr\,g(r) = -G\frac{m_1}{R}$$

$$V_2(R) = m_2\Phi(R) = -G\frac{m_1m_2}{R}$$