315.

Problem 29.11 (RHK)

"*Gauss' law for gravitation*" *is*

$$\frac{1}{4\pi G}\Phi_g = \frac{1}{4\pi G}\oint \vec{g}.d\vec{A} = -m,$$

where m is the enclosed mass and G is the universal gravitational constant. We will derive Newton's law of gravitation from this and explain the significance of the minus sign.

Solution:

Consider a Gaussian sphere, a sphere of radius *r* centred at the mass point of mass, *m*. We assume that the gravitational field $\vec{g}$ due to the mass point is radial and its magnitude is equal for all points at a distance *r* from it but the direction of the gravitational field varies and is toward the mass point.

We calculate the gravitational flux under the above assumptions. It will be

$$\Phi_g = -4\pi r^2 g \ .$$

The Gauss' law for gravitation is

$$\frac{1}{4\pi G}\Phi_g = \frac{1}{4\pi G}\oint \vec{g}.d\vec{A} = -m.$$

We therefore have

$$-\frac{r^2 g}{G} = -m,$$

And

$$g = \frac{Gm}{r^2},$$

which is the Newton's law of gravitation. The significance of minus sign in the Gauss' law for gravitation is that the gravitational field due to a mass point is radial and is attractive.